Alaska LNG

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DRAFT RESOURCE REPORT NO. 10
ALTERNATIVES
PUBLIC VERSION

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RESOURCE REPORT NO. 10

SUMMARY OF FILING INFORMATION

Filing Requirement	Found in Section
Address the "no action" alternative. (§ 380.12(l) (1)). • Discuss the costs and benefits associated with the alternative.	10.2
For large projects, address the effect of energy conservation or energy alternatives to the project. (§ 380.12(l) (1)).	10.2.1
Identify system alternatives considered during the identification of the project and provide the rationale for rejecting each alternative. (§ 380.12(l) (1)). • Discuss the costs and benefits associated with each alternative.	10.3.1, 10.4.1
Identify major and minor route alternatives considered to avoid impact on sensitive environmental areas (i.e., wetlands, parks, or residences) and provide sufficient comparative data to justify the selection of the proposed route. (§ 380.12(l) (2) (ii)). • For onshore projects near to offshore areas, be sure to address alternatives using offshore routings.	10.4.2
Identify alternative sites considered for the location of major new aboveground facilities and provide sufficient comparative data to justify the selection of the proposed site. (§ 380.12(l) (2) (ii)).	10.3.2, 10.5.2

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ACRONYMS AND ABBREVIATIONS

ABBREVIATION	DEFINITION
Abbreviations for Units of Measurement	
°C	degrees Celsius
°F	degrees Fahrenheit
BSCF/D	billion standard cubic feet per day
cfs	cubic feet per second
cm	centimeters
dB	decibels
dBA	A-weighted decibels
ft	feet
g	grams
gpm	gallons per minute
ha	hectare
hp	horsepower
Hz	hertz
in	inches
kg	kilogram
kHz	kilohertz
kW	kilowatts
L_{dn}	day-night sound level
L_{eq}	equivalent sound level
L_{max}	maximum sound level
m^3	cubic meters
Ma	mega-annum (millions of years)
mg	milligrams
mg/L	milligrams per liter
mg/m^3	milligrams per cubic meter
MGD	million gallons per day
mm	millimeters
MMBtu/hr	million British thermal units per hour
MMSCF/D	million standard cubic feet per day
MPH	miles per hour
MMTA	million metric tons per annum
ng	nanograms
ppb	parts per billion
ppbv	parts per billion by volume
ppm	parts per million
ppmv	parts per million by volume
Psig	pounds per square inch gauge
rms	root mean square
SPL	sound pressure level
tpy	tons per year

ABBREVIATION	DEFINITION
µg	microgram
µg/kg	micrograms per kilogram
µPa	micropascals
Other Abbreviations	
§	section or paragraph
AAAQS	Alaska Ambient Air Quality Standards
AAC	Alaska Administrative Code
ACC	Alaska Conservation Corps
ACEC	Areas of Critical Environmental Concern
ACP	Arctic Coastal Plain
ACRC	Alaska Climate Research Center
ACS	U.S. Census, American Community Survey
AD	aggregate dock
ADCCED	Alaska Department of Commerce, Community, and Economic Development
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADGGS	Alaska Division of Geological and Geophysical Surveys
ADM	average daily membership
ADNR	Alaska Department of Natural Resources
ADOLWD	Alaska Department of Labor and Workforce Development
ADOT&PF	Alaska Department of Transportation and Public Facilities
AEIC	Alaska Earthquake Information Center
AES	Arctic Slope Regional Corporation Energy Service
AGDC	Alaska Gasline Development Corporation
AGPPT	Alaska Gas Producers Pipeline Team
AHPA	Alaska Historic Preservation Act
AHRS	Alaska Heritage Resources Survey
AIDEA	Alaska Industrial Development and Export Authority
AKNHP	Alaska Natural Heritage Program
AMP	approximate mile post
ANCSA	Alaska Native Claims Settlement Act
ANGPA	Alaska Natural Gas Pipeline Act
ANGTS	Alaska Natural Gas Transportation System
ANILCA	Alaska National Interest Lands Conservation Act
ANIMIDA	Arctic Nearshore Impact Monitoring in the Development Area
ANS Task Force	Aquatic Nuisance Species Task Force
ANVSA	Alaska Native Village Statistical Area
AOGCC	Alaska Oil and Gas Conservation Commission
AOI	Area of Interest
APCI	Air Products and Chemicals Inc.
APDES	Alaska Pollutant Discharge Elimination System
APE	Area of Potential Effect
API	American Petroleum Institute
APP	Alaska Pipeline Project

ABBREVIATION	DEFINITION
Applicants	ExxonMobil Alaska LNG LLC, ConocoPhillips Alaska LNG Company, BP Alaska LNG LLC, TransCanada Alaska Midstream LP, and Alaska Gasline Development Corporation
APSC	Alyeska Pipeline Service Company
AQRV	Air Quality Related Value
Arctic NWR	Arctic National Wildlife Refuge
ARD	acid rock drainage
ARDF	Alaska Resource Data File
ARPA	Archaeological Resources Protection Act of 1979
ARRC	Alaska Railroad Corporation
AS	Alaska Statute
ASAP	Alaska Stand Alone Pipeline
ASME	American Society of Mechanical Engineers
ASOS	Automated Surface Observation System
ASRC	Arctic Slope Regional Corporation
ATC	Allakaket Tribal Council
ATWS	additional temporary workspace
AWOS	Automated Weather Observing System
B.C.	British Columbia
BACT	Best Available Control Technology
BGEPA	Bald and Golden Eagle Protection Act
BIA	U.S. Department of the Interior, Bureau of Indian Affairs
BLM	U.S. Department of the Interior, Bureau of Land Management
BMP	best management practices
BOD_5	biochemical oxygen demand
BOEM	U.S. Department of the Interior, Bureau of Ocean Energy Management
BOG	boil-off gas
BP	Before Present
C.F.R.	Code of Federal Regulations
CAA	Clean Air Act
CAMA	Central Arctic Management Area
CCP	Comprehensive Conservation Plans
CDP	Census Designated Place
CEA	Chugach Electric Association
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CGF	Central Gas Facility
CGP	Construction General Permit
CH_4	methane
CHA	Critical Habitat Area
CIRCAC	Cook Inlet Regional Citizens Advisory Council
CIRI	Cook Inlet Region Inc.
CLG	Certified Local Government
CO	carbon monoxide

ABBREVIATION	DEFINITION
CO_2	carbon dioxide
CO_2e	total greenhouse gas emissions, in CO_2-equivalent global warming potential
COC	Certificate of Compliance
CONUS	Continental U.S.
COOP	National Weather Service, Cooperative Observer Program
CPCN	Certificate of Public Convenience and Necessity
CRA	Certificate of Reasonable Assurance
CSD	Contaminated Sites Database
CSP	Contaminated Sites Program
CSU	conservation system units
CV	coefficient of variation
CWA	Clean Water Act
DB	Denali Borough
DEM	Digital Elevation Model
DGGS	ADNR Division of Geological and Geophysical Surveys
DH	dock head
DHSS	Alaska Department of Health and Social Services
DMLW	Alaska Department of Natural Resources, Division of Mining, Land, and Water
DPS	Distinct Population Segment
DWPP	Drinking Water Protection Program
EDA	U.S. Department of Commerce, Economic Development Administration
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPRP	Emergency Preparedness and Response Plan
ERL	Environmental, Regulatory and Lands
ERMA	Extended Recreation Management Areas
ESA	Endangered Species Act
ESD	Emergency Shut Down
ESU	Evolutionary Significant Unit
FAA	U.S. Department of Transportation, Federal Aviation Administration
FCC	Federal Communications Commission
FE	U.S. Department of Energy, Office of Fossil Energy
FEED	front-end engineering design
FEIS	Final Environmental Impact Statement
FEMA	U.S. Department of Homeland Security, Federal Emergency Management Agency
FERC	U.S. Department of Energy, Federal Energy Regulatory Commission
FERC Plan	FERC Erosion Control, Revegetation, and Maintenance Plan
FERC Procedures	FERC Wetland and Waterbody Construction and Mitigation Procedures
FLPMA	Federal Land Policy and Management Act (of 1976) BLM
FMP	Fisheries Management Plan

ABBREVIATION	DEFINITION
FNSB	Fairbanks North Star Borough
FR	Federal Regulation
GDP	Gross Domestic Product
GHG	greenhouse gases
GIS	geographic information system
GMU	Game Management Units
GP	General Permit
GRI	Gas Research Institute
GTP	gas treatment plant
GWP	Global Warming Potential
H_2S	hydrogen sulfide
HABS	Historic American Building Survey
HAER	Historic American Engineering Record
HAP	Hazardous Air Pollutant
HAPC	Habitat Areas of Particular Concern
HCA	High Consequence Area
HDD	horizontal directional drill
HDMS	Hazard Detection and Mitigation System
HGM	hydrogeomorphic
HLV	heavy lift vessel
HMR	Hazardous Materials Regulations
HRS	Hazard Ranking System
IBA	Important Bird Areas
ICS	Incident Command System
IHA	Incidental Harassment Authorization
IHLC	Inupiat History, Language, and Culture
ILI	In-line Inspection
IMP	Integrity Management Plan
IP	Individual Permit
ISO	International Organization for Standardization
JPO	State and Federal Joint Pipeline Office
kbpd	thousand barrels per day
KCC	Kuparuk Construction Camp
KOP	key observation points
KPB	Kenai Peninsula Borough
KTC	Kuparuk Transportation Company
LiDAR	light detection and ranging
Liquefaction Facility	natural gas liquefaction
LLC	Limited Liability Company
LNG	liquefied natural gas
LNGC	liquefied natural gas carrier
LOA	Letter of Authorization
LOD	Limits of Distribution

ABBREVIATION	DEFINITION
LP	Limited Partnership
LPG	liquefied petroleum gas
LUP	Land Use Permit
LUST	Leaking Underground Storage Tanks
MACT	maximum achievable control technology
Mainline	An approximately 800-mile-long, large-diameter gas pipeline
MAOP	maximum allowable operating pressure
MARPOL	Marine Pollution Protocol
MBTA	Migratory Bird Treaty Act
MCD	marine construction dock
MHHW	mean higher high water
MHW	mean high water
ML&P	Anchorage Municipal Light and Power
MLA	Mineral Leasing Act
MLBV	Mainline block valve
MLLW	mean lower low water
MLW	mean low water
MMPA	Marine Mammal Protection Act
MMS	Mainline Meter Station
MOE	margin of error
MOF	material offloading facility
MP	Mainline milepost
MPRSA	Marine Protection Research and Sanctuaries Act of 1972
MSB	Matanuska-Susitna Borough
MSCFD	Thousand standard cubic feet per day
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NAS	nonindigenous aquatic species
NCC	national certification corporation
NCDC	National Climatic Data Center
NDE	non-destructive examination
NEP	non-essential experimental population
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NFIP	National Flood Insurance Program
NGA	Natural Gas Act
NHPA	National Historic Preservation Act of 1996, as amended
NID	Negligible Impact Determination
NLURA	Northern Land Use Research Alaska, LLC
NMFS	National Oceanic and Atmospheric Administration, National Marine Fisheries Service
NO_2	nitrogen dioxide
NO_X	nitrogen oxides
NOAA	National Oceanographic and Atmospheric Administration

ABBREVIATION	DEFINITION
NOI	Notice of Intent
North Slope	Alaska North Slope
NPDES	National Pollutant Discharge Elimination Systems
NPL	National Priority List
NPP	National Park and Preserve
NPR-A	National Petroleum Reserve – Alaska
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NSA	Noise-Sensitive Areas
NSB	North Slope Borough
NSPS	New Source Performance Standards
NTC	national training center
NTP	Notice to Proceed
NVIC	Navigation and Vessel Inspection Circular
NWA	Northwest Alaska Pipeline
NWI	National Wetland Inventory
NWR	National Wildlife Refuge
O_3	Ozone
OC	open-cut
OCS	Outer Continental Shelf
OD	outside diameter
OEP	FERC, Office of Energy Projects
OHA	ADNR Division of Parks and Outdoor Recreation, Office of History and Archaeology
ONA	Outstanding Natural Area
OPMP	ADNR, Office of Project Management and Permitting
OU	Operating unit
PAC	potentially affected community
Pb	the element lead
PBTL	Prudhoe Bay Gas Transmission Line
PBU	Prudhoe Bay Unit
PCB	polychlorinated biphenyl
PHMSA	Pipeline and Hazardous Materials Safety Administration
$PM_{2.5}$	particulate matter having an aerodynamic diameter of 2.5 microns or less
PM_{10}	particulate matter having an aerodynamic diameter of 10 microns or less
PMP	Point Thomson Gas Transmission Line milepost
POC	Plan of Cooperation
POD	Plan of Development
Project	Alaska LNG Project
PRPA	Paleontological Resources Preservation Act
PSD	Prevention of Significant Deterioration
PTTL	Point Thomson Gas Transmission Line
PTU	Point Thomson Unit

ABBREVIATION	DEFINITION
PWS	public water supply
Q&A	question and answer
RCA	Regulatory Commission of Alaska
RCRA	Resource Conservation and Recovery Act
RNA	Research Natural Area
ROD	Record of Decision
ROE	right-of-entry
ROW	right-of-way
RR	Resource Report
SCC	Deadhorse Airport
SDWA	Safe Drinking Water Act
SEIS	Supplemental Environmental Impact Statement
SGR	State Game Refuge
SHPO	State Historic Preservation Office(r)
SIP	State Implementation Plan
SMA	Special Management Areas
SRMA	Special Recreation Management Areas
SO_2	sulfur dioxide
SPCC	Spill Prevention, Control, and Countermeasure Plan
SPCO	State Pipeline Coordinator's Office
SPLASH	Structure of Populations, Levels of Abundance, and Status of Humpbacks
SPMT	self-propelled module transporters
SRA	State Recreation Area
SRR	State Recreation River
STATSGO	State Soil Geographic
STATSGO2	State Soil Geographic2 – General Soils Map of Alaska & Soils Data (2011)
SWAPA	Southwest Alaska Pilots Association
SWPPP	Stormwater Pollution Prevention Plan
TAHC	total aliphatic hydrocarbons
TAPS	Trans-Alaska Pipeline System
TBD	To be determined
TCC	Tanana Chiefs Conference
The Applicants' Plan	Applicants' Upland Erosion Control, Revegetation, and Maintenance Plan
The Applicants' Procedures	Applicants' Wetland and Waterbody Construction, and Mitigation Procedures
TPAH	total polycyclic aromatic hydrocarbons
TSA	Transportation Security Administration
TSCA	Toxic Substances Control Act
TSD	tug support dock
TSS	total suspended solids
UCIDA	United Cook Inlet Drift Association
UIC	Underground Injection Control
U.S.	United States
U.S.C.	U.S. Code

ABBREVIATION	DEFINITION
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USDHHS	U.S. Department of Health and Human Services
USDOE	U.S. Department of Energy
USDOI	U.S. Department of the Interior
USDOT	U.S. Department of Transportation
USDW	underground sources of drinking water
USFS	U.S. Department of Agriculture, Forest Service
USFWS	U.S. Department of the Interior, Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	volatile organic compound
VPSO	Village Public Safety Officer
VRM	Visual Resource Management Methodology
VSM	Vertical Support Members
WELTS	Well Log Tracking System
WRCC	Western Regional Climate Center
WSA	Waterway Suitability Assessment
WSR	Wild and Scenic Rivers

Information in this draft Resource Report, including maps, is preliminary and may change during Project pre-filing. Updated information will be provided in the subsequent draft and final versions of the Resource Reports.

10.0 RESOURCE REPORT NO. 10 – ALTERNATIVES

10.1 PROJECT DESCRIPTION

The Alaska Gasline Development Corporation, BP Alaska LNG LLC, ConocoPhillips Alaska LNG Company, ExxonMobil Alaska LNG LLC, and TransCanada Alaska Midstream LP (Applicants) plan to construct one integrated LNG Project (Project) with interdependent facilities for the purpose of liquefying supplies of natural gas from Alaska, in particular the Point Thomson Unit (PTU) and Prudhoe Bay Unit (PBU) production fields on the Alaska North Slope (North Slope), for export in foreign commerce and opportunity for in-state deliveries of natural gas.

The Natural Gas Act (NGA), 15 U.S.C. § 717a(11) (2006), and FERC regulations, 18 C.F.R. § 153.2(d) (2014), define “LNG terminal” to include “all natural gas facilities located onshore or in State waters that are used to receive, unload, load, store, transport, gasify, liquefy, or process natural gas that is ... exported to a foreign country from the United States.” With respect to this Project, the “LNG terminal” includes the following: a liquefaction facility (Liquefaction Facility) in Southcentral Alaska; an approximately 800-mile, large diameter gas pipeline (Mainline); a gas treatment plant (GTP) on the North Slope; a gas transmission line connecting the GTP to the PTU gas production facility (PTU Gas Transmission Line or PTTL); and a gas transmission line connecting the GTP to the PBU gas production facility (PBU Gas Transmission Line or PBTL). All of these facilities are essential to export natural gas in foreign commerce.

These components are shown in Resource Report No. 1, Figure 1.1-1, and their current basis for design is described below.

The new Liquefaction Facility will be constructed on the eastern shore of Cook Inlet in the Nikiski area of the Kenai Peninsula. The Liquefaction Facility will include the structures, equipment, underlying access rights and all other associated systems for pre-processing (other than that performed by the GTP) and liquefaction of natural gas, as well as storage and loading of LNG, including terminal facilities (dock) and auxiliary marine vessels used to support marine terminal operations (excluding LNG carriers). The Liquefaction Facility will include three liquefaction trains combining to process up to approximately 20 million metric tons per annum (MMTPA) of LNG. Three 160,000 cubic meter (m^3) tanks will be constructed to store the LNG. The Liquefaction Facility will be capable of accommodating two LNG carriers. The size range of LNG carriers that the Liquefaction Facility will accommodate will be determined through further engineering study and consultation with the United States Coast Guard (USCG) as part of the Waterway Suitability Assessment (WSA) process.

In addition to the Liquefaction Facility, the LNG Terminal will include the following interdependent facilities:

- Mainline: A new large-diameter natural gas pipeline approximately 800 miles in length will extend from the Liquefaction Facility to the GTP on the North Slope, including the structures, equipment, and all other associated systems. The diameter of the pipeline has not been finalized but for the purpose of these Resource Reports a 42-inch diameter pipeline is assumed. The Mainline will include compressor stations, heater stations, meter stations, and various mainline block valves; pig launcher and receiver facilities; and associated ancillary and auxiliary facilities. Ancillary and auxiliary facilities will include additional temporary work spaces, access roads, helipads, construction camps, pipe storage areas, contractor yards, material extraction sites, and material disposal sites. Along the Mainline route, there will be at least five off-take interconnection points to allow for the opportunity for future in-state deliveries of natural gas. The size and location of such interconnection points are unknown at this time. None of the potential third-party facilities used to condition, if required, or move natural gas away from these off-take points will be part of the Project.

- GTP: A new GTP and associated facilities in the Prudhoe Bay area will receive natural gas from the PBU Gas Transmission Line and the PTU Gas Transmission Line. The GTP will treat/process the natural gas for delivery into the Mainline. The Project also includes a new pipeline that will deliver natural gas processing byproducts from the GTP to the PBU.

- PBU Gas Transmission Line: A new natural gas transmission line will extend approximately one mile from the inlet flange of the GTP to the outlet flange of the PBU gas production facility.

- PTU Gas Transmission Line: A new natural gas transmission line will extend approximately 60 miles from the inlet flange of the GTP to the outlet flange of the PTU gas production facility.

- Ancillary Facilities: Existing State of Alaska transportation infrastructure will be used during the construction of these new facilities including ports, airports, roads, and airstrips (potentially including previously abandoned airstrips). The potential need for new infrastructure and modifications or additions to these existing in-state facilities is under evaluation. The Liquefaction Facility, Mainline, and GTP will require the construction of material offloading facilities.

Draft Resource Report No. 1, Appendices A and B contain general maps of the Project footprint. Detailed plot plans will be developed during the pre-front-end engineering and design (Pre-FEED) process and will be provided to the Commission in a subsequent draft of Resource Report No. 1. An update to the current list of affected landowners is being filed under separate cover as privileged and confidential information.

Outside the scope of the Project, but in support of, or related to, the Project, additional facilities or expansion/modification of existing facilities will be needed or may be constructed. These other projects may include:

- Modifications/new facilities at the PTU;

- Modifications/new facilities at the PBU;

- Relocation of the Kenai Spur Highway; and
- Third-party pipelines and associated infrastructure to transport natural gas from the off-take interconnection points to markets in Alaska.

10.1.1 Purpose of Resource Report

As required by 18 C.F.R. § 380.12, Alaska LNG Applicants have prepared this draft Resource Report in support of a future application under Section 3 of the NGA to construct and operate the Project facilities. The purpose of this draft Resource Report is to describe the alternatives considered for Project facilities. The alternatives considered include the following:

- Energy alternatives;
- System alternatives;
- Site/route alternatives; and
- Construction/design alternatives.

The data for this Resource Report were compiled based on a review of the following:

- Engineering design and proposed construction plans;
- U.S. Geological Service (USGS) topographic maps;
- Recent aerial photography;
- Field survey data; and
- Geographic Information System (GIS) data from federal and state agencies.

10.1.2 Project Siting Requirements

Siting requirements of the proposed Project include the following:

- Liquefaction Facility site that is close to ice-free deep water and shipping channels to support shipment of facility modules during construction and to ensure easy access by LNG carriers (LNGCs) during operations. The proposed site should also include stable geology, require minimal grading or earthwork, and have access to road infrastructure;
- Liquefaction Facility site with sufficient space and favorable terrain to accommodate liquefaction processing facilities, LNG storage, and a Marine Terminal that can move up to 20 MMTPA of LNG;
- Marine Terminal with berths to allow for LNGCs to dock and load that minimizes the need for construction and maintenance dredging; and

- Interdependent Facilities:
  - The Mainline and associated facilities (e.g., compressor stations, heater stations, meter stations, mainline block valves, launchers/receivers) necessary to support transportation of natural gas from Alaska's North Slope to Nikiski.
  - GTP to treat natural gas on the North Slope, which is close to supporting resources and facilities: the Beaufort Sea for the delivery of modules during construction; existing industrial infrastructure (e.g., roadways) to support construction; water and gravel for construction and operations; and the proximity to existing North Slope developments.
  - PBU and PTU Transmission Lines and associated facilities necessary to connect the GTP to the PBU and PTU gas production facilities.

10.1.3 Types of Alternatives Considered

This draft Resource Report evaluates alternative concepts at the overall system level and at the individual project component level. A subsequent draft of this Resource Report will include refinement of the major and minor route alternatives of the proposed pipelines (Mainline, PTTL, and PBTL) and site selection alternatives for the aboveground facilities.

10.2 NO-ACTION ALTERNATIVE

Under the No-Action Alternative, the Project would not go forward and not be constructed. The No-Action Alternative would fail to accomplish the Project Purpose to commercialize North Slope natural gas and does nothing to further the need to address rapidly increasing global energy demand (see Section 1.2 of Resource Report No. 1). Alaska North Slope resources would remain stranded for the foreseeable future. Other means to have natural gas processed, transported, and delivered to the residents of the state in order to provide new or supplement current supply would need to be determined.

The No-Action Alternative does not further national security and other global objectives and benefits associated with the export of LNG. Without LNG exports from new supply sources such as the Project, foreign markets would likely increasingly rely on other sources of energy, including some less environmentally and economically attractive alternatives, or originating from less politically stable locations. Use of traditional energy sources, such as coal, fuel oil, or nuclear, would have greater environmental effects than LNG. On the other hand, renewable energy sources, such as solar, wind, and geothermal are not currently as economically competitive or reliable as LNG.

The No-Action Alternative does not further other national interests associated with development of North Slope natural gas. Since the discovery of oil at Prudhoe Bay in the late 1960s, there has been the recognition that the extraction and transportation of the natural gas associated with that oil is also in the national interest (e.g., Alaska Natural Gas Transportation Act [ANGTA], 15 U.S.C § 719 (1976); Alaska Natural Gas Pipeline Act [ANGPA], PL 108-324 (2004), Presidential Finding Concerning Alaska Natural Gas, 53 Fed. Reg. 999 (Jan. 15, 1988)). Furthermore, under the No-Action Alternative, the regional and national economies would not benefit from increased employment opportunities, economic activity, and government revenues.

The No-Action Alternative also does not further State of Alaska and local interests in development of North Slope natural gas. The State of Alaska would lose the benefit of a long-term source of revenue.

Furthermore, the opportunity for a more reliable and abundant in-state natural gas supply would not be realized. A stable supply of natural gas into the foreseeable future not only would benefit Alaskans and local industries, but it would support potential future economic development. The No-Action Alternative renders these benefits unachievable.

In summary, the No-Action Alternative would fail to capture the major objectives and benefits the Project would provide at the national and State of Alaska level, including the following:

- Bringing Alaska LNG to global markets, which supports the economic and national security interests of the United States;
- Providing the opportunity for in-state gas deliveries;
- Stimulating state, regional, and national economies through job creation, an enhanced tax base, and increased economic activity;
- Providing a long-term source of revenue to Alaska state and local governments, supporting public services;
- Creating thousands of jobs for construction and operation of the Project, including numerous opportunities for Alaska businesses and contractors; and
- Producing regional and global environmental benefits by providing, through natural gas and LNG, a cleaner source of energy than many existing alternatives.

10.2.1 Alternative Energy Resources

The No-Action Alternative could force potential natural gas customers to seek other forms of energy.

While execution of the Project would result in the benefits noted above, it is uncertain as to whether the No-Action Alternative would result in international energy conservation rather than the substitution of less environmentally friendly fuels. As such the alternative energy sources evaluated relative to natural gas as proposed for the Project include (see Table 10.2.1) the following:

- Biomass;
- Coal;
- Geothermal;
- Hydrokinetic (wave and tidal);
- Hydropower;
- Nuclear;
- Oil;

- Solar; and
- Wind energy.

Many industrialized countries, including the U.S., are emphasizing the use of renewable energy resources, such as wind or solar power, as a means to reduce greenhouse gas (GHG) emissions and other pollutants. However, contributions from renewable energy represent a very small share of the energy mix, and many renewable sources are intermittent in nature. For example, although renewable energy (excluding hydropower) is projected to account for 28 percent of the overall projected growth in electricity generation in the U.S. from 2012 to 2040 (EIA, 2013),[a] the share of U.S. electricity generation coming from renewable fuels (including conventional hydropower) is projected to remain less than 20 percent, with projected growth from 12 percent in 2012 to 16 percent in 2040 (EIA, 2013).[b]

Consequently, other energy sources, such as natural gas, are essential. Natural gas has many attributes that make its use attractive, contributing to its growing role in the global energy mix, including that it is readily available, dependable, and economically viable. As can be seen in Table 10.2-1, natural gas use also has clear environmental advantages when compared to other fossil fuel alternatives.

The purpose of the Project is to export LNG to foreign markets while creating an opportunity for in-state deliveries of natural gas. Therefore, the Project will not displace alternative energy sources from being utilized in the lower 48 states of the U.S. and Hawaii. LNG exported to foreign markets can serve as a complement to intermittent renewable energy sources and provide consuming nations with an alternative to higher CO_2 emitting fossil fuels, such as coal.[c] Similarly, any Alaska in-state gas deliveries could displace consumption of higher emitting fossil fuels such as fuel oil, coal, or wood (e.g., Fairbanks), and complement any local use of renewables.

TABLE 10.2.1

Alternative Energy Resources to Natural Gas

Alternative Energy Resource	Preferred Alternative Over LNG	Description and Limitations
Biomass	No	Biomass energy can be used to generate electricity and heat by burning wood wastes, combusting pulping liquor at pulp mills and tapping methane gas at landfills and wastewater treatment facilities. However, biomass combustion has availability, environmental, and reliability issues that have limited its role to a small percentage of the overall energy supply in foreign markets.[a]

[a] 2014 Annual Energy Outlook's Reference Case

[b] 2014 Annual Energy Outlook's Reference Case with Federal subsidies for renewable generation assumed to expire as enacted. Extensions of such subsidies could have a large impact on renewable generation. The long-run projections for renewable capacity are also sensitive to natural gas prices and the relative costs of alternative generation sources (EIA, 2014).

[c] Life Cycle Greenhouse Gas Perspective on Exporting Liquefied Gas from the United States (DOE/NETL, 2014)

TABLE 10.2.1

Alternative Energy Resources to Natural Gas

Alternative Energy Resource	**Preferred Alternative Over LNG**	**Description and Limitations**
Coal	No	Although a readily available energy alternative in many countries, coal does not burn as cleanly as natural gas, which emits half as much CO_2 as coal, less than a third as much nitrogen oxides, and, in the U.S., one (1) percent as much sulfur dioxide.[b] .The burning of coal results in adverse effects to air and water quality, including acid rain, unless expensive air pollution controls are installed at coal-burning power plants. Increased reliance on coal would lead to adverse environmental effects related to additional coal mining and the transportation of coal to power plants. Attempts to develop commercial-scale 'clean-coal' power plants that utilize carbon sequestration technologies are still largely in the early stages of development.
Geothermal	No	To date, geothermal resources do not provide a measurable portion of global energy supply. Theoretically, geothermal electric generation could provide significant renewable base load quantities in the long term.[c]. However, it is not currently used or planned for use on a commercial scale except in relatively few countries like Iceland.
Hydrokinetic (wave and tidal)	No	Hydrokinetic energy is the energy held by a body of water through the water's motion. Hydrokinetic power involves harnessing energy from waves, tides, or currents. Specific devices have been designed to capture energy from water in motion. One of the main benefits of hydrokinetic energy is that it can be harnessed continuously, without direct dependence on sunlight or wind. However, the technology is geographically specific and not yet sufficiently developed to be considered a viable alternative for the foreign markets targeted by the Project.[d]
Hydropower	No	The development of new hydropower energy sources is geographically restricted. Potential adverse environmental effects associated with hydropower energy are now also recognized, such as impairment to fish migration and flooding of inhabited land.[e]
Nuclear	No	Nuclear energy is a viable alternative in terms of limiting the air emissions of GHGs and other criteria air pollutants. However, nuclear energy generation can result in long-term environmental effects associated with disposal of radioactive waste products. In addition, nuclear energy has traditionally faced negative public perception concerning the inherent safety risks. Worldwide public scrutiny of nuclear facilities following the 2011 Fukushima Daiichi nuclear disaster in Japan has resulted in a significant re-evaluation and shutdown of select nuclear power plants. Current obstacles to new nuclear facilities include: 1. Challenging regulatory hurdles, such as regulatory authorizations; 2. Lack of financing; and 3. Shortage of necessary infrastructure
Oil	No	The burning of natural gas results in fewer air quality emissions than any other liquid hydrocarbon.[a]
Solar	No	Solar energy comprises a very small percentage of the global energy supply.[a] Therefore, solar energy is not viewed in the near-term as providing the quantity of energy comparable to LNG exports from the Project. Continued technological advances and decreases in the installation costs of solar electrical systems are required before this source is a viable energy alternative.[g]
Wind	No	Although growing as a renewable energy source, wind energy comprises a very small percentage of the overall energy supply in foreign markets.[a]. Thus, wind energy is not capable of providing a quantity of energy comparable to LNG exports from the Project. With continued technological advances, wind energy may become a viable energy alternative for suitable geographic regions.
Energy Conservation	No	Energy conservation could alleviate some of the growing demand for energy. However, energy conservation requires widespread political will, industry research and industry development before it will become a viable alternative for significantly lowering the demand for a reliable energy source.[h]

TABLE 10.2.1

Alternative Energy Resources to Natural Gas

Alternative Energy Resource	Preferred Alternative Over LNG	Description and Limitations

Source:

a EIA. 2011. International Energy Outlook 2011. http://www.eia.gov/forecasts/ieo/pdf/0484(2011).pdf. U.S. Department of Energy.

b U.S. Environmental Protection Agency (EPA). 2013. Electricity from Natural Gas. http://www.epa.gov/cleanrgy/natgas.htm. http://www.epa.gov/cleanenergy/energy-and-you/affect/natural-gas.html.

c Massachusetts Institute of Technology (MIT). 2006. The Future of Geothermal Energy: Impact of enhanced geothermal systems on the United States in the 21st Century, an assessment by an MIT led interdisciplinary panel, Idaho Falls: Idaho National Laboratory. http://geothermal.inel.gov/publications/future_of_geothermal_energy.pdf.

d Ocean Energy System (OES). 2008. The Development of Wave Energy Utilization. http://www.ocean-energy-systems.org/ocean_energy/waves/.

e EPA. 2013. Hydroelectricity-Environmental Impacts. http://www.epa.gov/cleanenergy/energy-and-you/affect/hydro.html.

f Nuclear Energy Institute. 2007. Nuclear Industry Leaders Identify Challenges on Road to U.S. Nuclear Energy Renaissance. http://www.nei.org/newsandevents/newsreleases/industryleadersindentifychallenges/; Schneider, M. and A. Froggatt. 2013. World Nuclear Industry Status Report 2013. http://www.worldnuclearreport.org/IMG/pdf/20130716msc-worldnuclearreport2013-lr-v4.pdf .

g Wells Fargo. 2005. Identifying the Opportunities in Alternative Energy. https://www08.wellsfargomedia.com/downloads/pdf/about/csr/alt_energy.pdf; DOE. 2005. Basic Research Need for Solar Energy Utilization. http://science.energy.gov/~/media/bes/pdf/reports/files/seu_rpt.pdf.

h EPA and DOE. 2010. Coordination of Energy Efficiency and Demand Response. http://www.epa.gov/cleanenergy/documents/suca/ee_and_dr.pdf.

10.3 LIQUEFACTION FACILITY ALTERNATIVES

10.3.1 Liquefaction Facility System Alternatives

System alternatives are alternatives to the Project that would make use of other existing, modified, or proposed LNG and/or natural gas facilities to meet the objectives and siting requirements of the Project. System alternatives make it unnecessary to construct all or part of the Project, although modifications or additions to the system alternative may be required to increase capacity or provide receipt and delivery capability consistent with that of the Project. Such modifications or additions may result in environmental impacts less than, comparable to, or greater than those associated with Project construction and operation. System alternatives are analyzed to determine whether potential environmental effects associated with Project construction and operation could be avoided or minimized while still allowing the stated purpose and need of the Project to be met. In order to be a viable system alternative to the proposed Project, any potential alternative should meet at least the following requirements:

- Satisfy the Project objectives;
- Be technically viable;
- Be economically feasible;
- Provide a substantial environmental advantage over the proposed Project; and

- Be able to secure all applicable authorizations to meet the Project schedule.

System alternatives were evaluated for a new facility constructed on the eastern shore of Cook Inlet in the Nikiski area of the Kenai Peninsula (preferred alternative). To evaluate these system alternatives, the Project summaries provided by FERC (FERC, 2014) and Natural Resources Canada (NRC, 2014) were reviewed for the following:

- Site Alternatives (See Section 10.3.2);
- Existing LNG export terminals;
- Authorized, but not yet constructed, LNG export terminals; and
- Proposed or planned LNG export terminals.

The potential export of natural gas via pipeline was also evaluated.

10.3.1.1 Existing LNG Export Terminals

ConocoPhillips Alaska's Kenai LNG Plant located in Nikiski began operating in 1969, and for more than 40 years was the only LNG export plant of domestic production in the U.S. (ConocoPhillips Alaska, 2013). In 2013, the plant's export license expired. However, due to a change in market conditions, including additional gas supplies in the Cook Inlet Basin, ConocoPhillips Alaska pursued a new license which was granted in 2014 and allows export of the equivalent of 40 billion cubic feet (bcf) of LNG over a two-year period (ConocoPhillips Alaska 2014).

The existing Kenai LNG Plant does not accommodate the Project need and purpose. The capacity of the existing Kenai LNG Plant (approximately 1.3 MMTPA) is substantially less than the capacity of the proposed Project (up to 20 MMTPA). Expansion of the existing Kenai LNG Plant is not deemed feasible, partly due to adjacent industrial facilities. However, even if deemed technically viable and economically feasible, the expansion of the existing Kenai LNG Plant from approximately 1.3 MMTPA to 20 MMTPA would not present materially different environmental effects, as compared to construction of a new 20 MMTPA facility. Further, to commercialize North Slope gas, new gas treatment and pipeline infrastructure from the North Slope to Southcentral Alaska would be required, similar or equivalent to that required for the proposed Project. Because of these factors, expansion of the existing Kenai LNG Plant does not present a viable alternative to the proposed Project, and will not be analyzed in further detail.

10.3.1.2 Proposed or Planned LNG Export Terminals

A potential system alternative to the proposed Project is use of another proposed or planned North American export terminal, including existing LNG import terminals which are proposing or planning to add liquefaction capability. There are currently several proposed or planned export facilities in the U.S. and Canada including the following (FERC, 2014; NRC, 2014; volumes are listed if provided by FERC, 2014):

- Woodside Petroleum Ltd. and Chevron Canada Ltd. – 1.28 billion standard cubic feet per day (BSCF/D) (Kitimat, British Columbia [B.C.]);

- Aurora LNG – 3.12 BSCF/D (Prince Rupert, B.C.);
- BC LNG Export Cooperative – 0.23 BSCF/D (Douglas Island, B.C.);
- Cameron LNG – 1.7 BSCF/D (FERC Docket No. CP13-25-000; Cameron Parish, Louisiana);
- Canaport LNG – capacity not listed (Saint John, New Brunswick);
- CE FLNG – 1.07 BSCF/D (FERC Docket No. PF13-11-000; Plaquemines Parish, Louisiana);
- Cedar LNG – capacity not listed (Kitimat, B.C.);
- Cheniere – Corpus Christi LNG – 2.1 BSCF/D (FERC Docket No. CP12-507-000; Corpus Christi, Texas);
- Discovery LNG – capacity not listed (Campbell River, B.C.);
- Dominion Cove Point LNG Terminal – 0.82 BSCF/D (FERC Docket No. CP13-113-000; Chesapeake Bay in Lusby, Maryland);
- Excelerate Liquefaction – 1.38 BSCF/D (FERC Docket No. CP14-71-000 & 72-000; Lavaca Bay, Texas);
- Freeport LNG Development, LP (Freeport LNG) – 1.8 BSCF/D (FERC Docket No. CP12-509-000; Brazoria County, Texas);
- Goldboro LNG – 1.4 BSCF/D (Guysborough County, Nova Scotia);
- Golden Pass Products LLC (Golden Pass LNG) – 2.1 BSCF/D (FERC Docket No. CP14-517; Sabine Pass, Texas);
- Grassy Point LNG (Prince Rupert, B.C.) – capacity not listed;
- Gulf LNG Energy, LLC (Gulf LNG) – 1.5 BSCF/D (FERC Docket No. PF13-4-000; Jackson County, Mississippi);
- Jordan Cove Energy Project, L.P. Terminal – 0.9 BSCF/D (FERC Docket No. CP13-483; Coos Bay, Oregon);
- Kestrel Energy – Downeast LNG – 0.45 BSCF/D (FERC Docket No. PF14-19-000; Robbinston, Maine);
- Kitsault Energy Project – 2.7 BSCF/D (Kitsault, B.C.);
- LNG Canada – 3.23 BSCF/D (Kitimat, B.C.);
- Louisiana LNG – 0.30 BSCF/D (FERC Docket No. PF14-17-000; Plaquemines Parish, Louisiana);

- Magnolia LNG – 1.07 BSCF/D (FERC Docket No. CP14-347-000; Lake Charles, Louisiana);
- Orca LNG – 3.2 BSCF/D (Prince Rupert, B.C.);
- Oregon LNG Terminal – 1.25 BSCF/D (FERC Docket No. CP09-6-000; Astoria, Oregon);
- Pacific NorthWest LNG – 2.74 BSCF/D (Prince Rupert, B.C.);
- Prince Rupert LNG – 2.91 BSCF/D (Prince Rupert, B.C.);
- Sabine Pass LNG, LP (Sabine Pass LNG) – 2.76 BSCF/D (FERC Docket Nos. CP11-72-000 and CP13-2-000; Cameron Parish, Louisiana);
- Sabine Pass LNG, LP (Sabine Pass LNG) – 1.40 BSCF/D (FERC Docket Nos. CP13-552-000, and CP13-553-000; Cameron Parish, Louisiana);
- Southern LNG Company (Elba Island) Terminal – 0.35 BSCF/D (FERC Docket No. CP14-103-000; Savannah, Georgia);
- Steelhead LNG – 0.11 BSCF/D (Port Alberni, B.C.);
- Triton LNG – 0.32 BSCF/D (Kitimat or Prince Rupert, B.C.);
- Trunkline LNG Company, LLC (Lake Charles LNG) – 2.2 BSCF/D (FERC Docket No. CP14-120; Calcasieu Parish, Louisiana); Venture Global – 1.40 BSCF/D (FERC Docket No. PF15-2-000; Cameron Parish, Louisiana ;);
- WesPac Marine Terminal – 0.4 BSCF/D (Delta, B.C.);
- Woodfibre LNG – 0.29 BSCF/D (Squamish, B.C.); and
- WCC LNG – 4.0 BSCF/D (Kitimat or Prince Rupert, B.C.).

Construction of new pipeline infrastructure to connect the Alaska North Slope supplies with the identified facilities would result in environmental effects greater than those of the proposed Project, including thousands of miles of additional pipeline. In addition, the transportation costs for some of these facilities to ship to some foreign markets, depending on their geography (e.g., North American East Coast) would likely not be economically feasible. Therefore, use of a different proposed or planned export terminal was determined to not be a viable alternative and was not further evaluated.

10.3.1.3 Export of Natural Gas via Pipeline

The purpose of the Project is to supply foreign global markets by LNG. International transport of LNG by vessel has the advantage of greater flexibility over natural gas transport via pipeline, as it is not bound to a rigid piping system with fixed starting and end points. As a consequence, LNG allows for dispersed and flexible delivery points. Economically, LNG is more competitive for long distance transport of natural gas, because overall costs (construction, maintenance, and operation) are less affected by distance (Cornot-Gandolphe et al., 2003; Messner and Babies, 2012). Direct export of North Slope natural gas to foreign markets by pipeline would not likely be technically or economically feasible. The direct transport of Alaska North Slope natural gas to countries in North America though technically feasible, would not be economically feasible as these countries are forecast to have sufficient if not abundant natural gas supplies for the foreseeable future. Accordingly, the direct transport to foreign markets by pipeline rather than as LNG by vessel is not viewed as a reasonable alternative and in any case would not meet the purpose of the Project with respect to its necessary alignment to global LNG markets.

10.3.2 Liquefaction Facility Site Alternatives

As the annual ice free window on the North Slope is only about two months, year-around LNG shipping would require specialized vessels and loading facilities suitable for the ice conditions. Also, as the Beaufort Sea is shallow near shore, the loading facility would need to be situated offshore. Cost for construction of natural gas liquefaction and LNG terminal and loading facilities on the Alaska North Slope would also be expected to be significantly more than in Southcentral Alaska. Altogether, these factors indicate liquefaction at, and shipping from, the northern region of Alaska would be prohibitive for cost reasons. In addition, the associated pipeline route from the North Slope to Southcentral Alaska provides an opportunity to access natural gas from the North Slope for a significant area of the State that might make it available for industrial use and in the most populous areas of the State. Thus, site selection for the Liquefaction Facility focused on Southcentral Alaska.

10.3.2.1 Methodology, Constraints, and Rationale for Liquefaction Facility Alternative Evaluation

Sites in Southcentral Alaska were evaluated using initial site screening criteria. Criteria were developed for the following:

- Siting an “LNG Terminal” (as defined in Resource Report No. 1) facility – These criteria include aspects such as water depth offshore of the potential site (i.e., presence of shallow water [less than 50 feet] for a distance greater or less than 1,000 feet), distance to the open sea, required footprint size (e.g., topography constraints), potential site contamination, and constraints for pipeline access to the facility.

- Land uses presenting potential conflicts or need for mitigation for siting an LNG facility and associated pipeline – These criteria include aspects such as marine use conflicts, federal lands (e.g., National Wildlife Refuges, U.S. Forest Service), or Native owned land. This includes conflicts along the pathway(s) of pipeline or waterway access to the site.

- Permitting an LNG facility – These criteria include aspects such as the presence of Endangered Species Act (ESA) critical habitat, emission conflicts (air, noise, water, light — direct and indirect), dredge disposal options, and permitting constraints.

- Environmental and social impacts of an LNG facility – These criteria include aspects such as potential conflicts or need for mitigation with respect to subsistence use, current infrastructure, local recreational facilities/opportunities, and local land use planning.

Data used for the screening analysis included federal, state, and borough agency compiled databases which include landownership, resource location/information, geology, hydrology, fisheries, ESA listed species habitat, environmental constraints, and public uses.

10.3.2.2 Liquefaction Facility Siting Alternatives

More than 20 sites in Southcentral Alaska were evaluated using the screening analysis described in Section 10.3.2.1 (see Figure 10.3.2-1). Based on the screening analysis results, which included consideration of geotechnical/geological, sea ice, engineering, marine transportation, shallow water (dredging), ESA issues, regulatory constraints, and pipeline siting/permitting aspects, two potential liquefaction facility siting alternatives were identified for further evaluation.

Anderson Bay – Valdez

Anderson Bay lies within the city limits of Valdez, an incorporated city connected via road to Interior Alaska. The oil and gas sector is the largest private employer in Valdez. Anderson Bay has been the proposed location for an LNG liquefaction facility in previous, but now inactive filings with the FERC and other agencies. The Anderson Bay location is situated on undeveloped lands owned by the State of Alaska and managed by the Alaska Department of Natural Resources. The principle disadvantages with the Anderson Bay site are its undeveloped location which presents significant space and terrain constraints. Extensive earthworks would be required to level the steep terrain at the site. Extensive fill placement in the water would be required to build up the shoreline for dock works. These physical alterations would present serious practicability and significant environmental impacts both on the land and in the water, including site blasting and leveling and likely need for construction of a sea wall for the terminal. There are concerns about air permitting major sources at this site due to proximity to the Valdez Marine Terminal and dispersion characteristics.

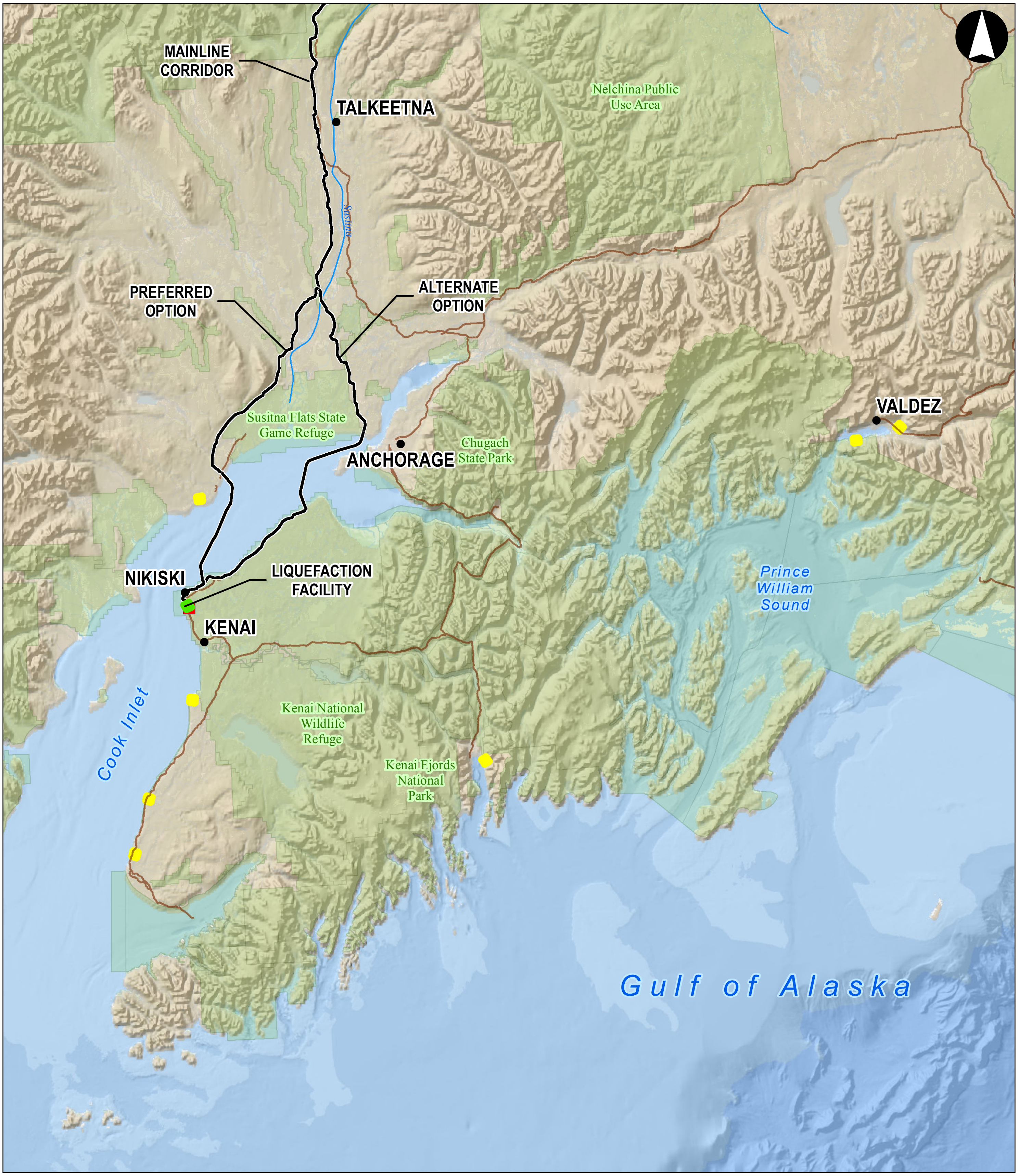
There would also be potential for marine conflicts in the Valdez harbor and docking area, Valdez Narrows, and shipping channels in Prince William Sound with existing traffic (e.g., oil tankers, fishing vessels, ferries, cruise ships, and tourist/recreational users). In addition, the pipeline pathway would impact federal lands without following an existing utility corridor.

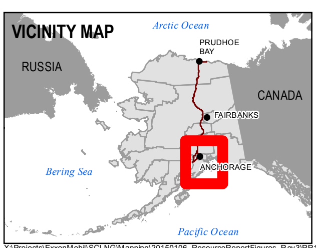
For these reasons, the location is not considered to be the preferred alternative.

Nikiski – Cook Inlet (Proposed Site)

The Nikiski location is on Alaska's Kenai Peninsula, approximately nine miles northwest of the city of Kenai, which has a population of 4,493 residents. The Nikiski location contains a portion of the Nikiski Industrial Area, which includes four major petrochemical processing facilities, and is one of the largest existing industrial complexes in Alaska. Currently, there are three marine facilities at Port Nikiski and infrastructure in place to support industrial facilities. While there is active shipping activity in this vicinity, the potential conflicts would be less than at the Anderson Bay site. The presence of all of these facilities provides historical information and records that help in the planning and development of a new export terminal. This includes the track record of the existing LNG export terminal that confirms that such a facility can operate safely in Cook Inlet.

There is considerable oil and gas activity in northern Cook Inlet, numerous pipeline and marine cable crossings and considerable experience in constructing the infrastructure necessary to support a new Liquefaction Facility. On and offshore, the oil and gas industry has studied the environment for decades





LEGEND

- Alaska LNG Facility
- Alaska Place Names
- Project Corridor
- Major Highways
- Major Rivers
- Alternatve LNG Facility Location
- Preferred LNG Facility Location
- State and Federal Conservation Lands

0 12.5 25 50 Miles

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DATE:	2015-01-14	SHEET:	1 of 1

GEOGRAPHIC AREAS EVALUATED FOR SITING OF THE LIQUEFACTION FACILITY

FIGURE 10.3.2-1

Alaska LNG

X:\Projects\ExxonMobil\SCLNG\Mapping\20150106_ResourceReportFigures_Rev3\RR10\Figure 10_3_2-1 - Geographic Areas Evaluated for Siting of the Liquefaction Facility.mxd and has safely built and operated facilities there to support the Southcentral Alaska gas needs as well as liquids for the petrochemical facilities.

The Eastern Cook Inlet/ Nikiski location presents decisive advantages over alternative sites in terms of key factors including adequate space, favorable terrain, and access to road infrastructure, existing industrial facilities, and minimal need for environmentally intrusive earthworks, grading, and fill. In particular, the Eastern Cook Inlet/ Nikiski area affords relatively level and accessible terrain where the multi-functional Liquefaction Facility—the liquefaction trains, LNG storage, and Marine Terminal—can be collocated on the several hundred acres required with an efficient design, access and operational functionality. (Please see the description of the Liquefaction Facility in Resource Report No. 1 for details of these features.) The Kenai coast provides room for docking facilities and direct access to Cook Inlet shipping channels. The terrain features at this site are superior to the Anderson Bay site in terms of space, constructability, and access for location of the complex Project facilities. The relative air permitting challenges are fewer at this site; there are existing sources but more advantageous dispersion in the area. Locating the plant in Nikiski better positions the Project for long-term natural gas supplies to the large population centers of Southcentral Alaska via one or more of the five off-take interconnection points.

10.3.3 Liquefaction Facility Layout Alternatives

This information will be provided in a subsequent draft of this Resource Report.

10.3.4 Marine Terminal Layout Alternatives

This information will be provided in a subsequent draft of this Resource Report.

10.3.5 Modular Offloading Facility Alternatives

This information will be provided in a subsequent draft of this Resource Report.

10.3.6 Liquefaction Alternatives

This information will be provided in a subsequent draft of this Resource Report.

10.3.7 LNG Tank Alternatives

This information will be provided in a subsequent draft of this Resource Report.

10.3.8 Flare Design Alternatives

This information will be provided in a subsequent draft of this Resource Report.

10.4 PIPELINE ALTERNATIVES

10.4.1 Pipeline System Alternatives

System alternatives evaluated for the Mainline (preferred alternative), an approximate 800-mile pipeline constructed from the Liquefaction Facility to the GTP on the North Slope, include the following:

- Planned or Proposed Pipeline Systems; and
- Existing Pipeline Systems.

It has long been recognized that the extraction and transportation of natural gas from Prudhoe Bay and Point Thomson is in the national interest (e.g., Presidential Finding Concerning Alaska Natural Gas, 53 Fed. Reg. 999 (Jan. 15, 1988)) and is consistent with the purpose of the Project. Therefore, only pipeline alternatives that would meet the Project purpose were considered.

10.4.1.1 Use of Alternative New Pipeline Systems

Three alternative new planned pipeline systems were identified as described below.

Alaska Stand Alone Pipeline Project

The Alaska Stand Alone Pipeline Project (ASAP Project) is designed to deliver utility grade natural gas from Alaska's North Slope to Fairbanks, Anchorage, and as many other communities within the state as practical. The ASAP Project consists of a gas conditioning facility at Prudhoe Bay; a 727-mile, 36-inch diameter, mostly buried pipeline from Prudhoe Bay to ENSTAR's existing gas distribution system near Anchorage at Big Lake; and a 29-mile, 12-inch diameter lateral to Fairbanks (ASAP Public Scoping Report, November 25, 2014). The Project's breakdown for natural gas from the projected 500 million standard cubic feet per day (MMSCF/D) is as follows (AGDC, 2014):

- 200 MMscf/d – Cook Inlet area current demand;
- 50 MMscf/d – Cook Inlet area future demand (2030);
- 60 MMscf/d – Fairbanks area future demand (2030); and
- 190 MMscf/d – Future commercial and industrial use.

The Alaska District, U.S. Army Corps of Engineers (USACE) has been designated the lead federal agency and the Notice of Intent (NOI) to prepare a Supplemental Environmental Impact Statement (SEIS) was published August 1, 2014, which initiated a scoping comment period that ended on October 14, 2014. The current published timeline has construction of the ASAP Project spanning from 2018 to 2021 (AGDC, 2014).

The ASAP Project would not meet the purpose and need of the Project as its pipeline design capacity is not sufficient to meet the throughput requirements of the Project. The environmental effects associated with expansion of the ASAP Project to meet the throughput needs of the Project, specifically the throughput needs of the liquefaction facility together with potential off-take points, would likely be similar to those of constructing the preferred alternative (Mainline). Therefore, use of the ASAP Project was not considered a viable alternative to the Project.

Alaska Pipeline Project

On May 1, 2009, FERC granted a pre-filing request for the Alaska Pipeline Project (APP) (FERC Docket No. PF09-11-000) which would have consisted of the following components in Alaska:

- Approximately 58 miles of 32-inch-diameter pipeline from the PTU to a natural gas treatment plant near Prudhoe Bay; and

- Approximately 745 miles of 48-inch diameter pipeline, extending from a natural gas treatment plant to the Alaska-Yukon border east of Tok, Alaska, including provisions for intermediate natural gas delivery points within Alaska.

The APP system would have been capable of transporting 4.5 BSCF/D of sales quality natural gas and extended to pipeline facilities in Alberta, Canada for markets in the contiguous U.S. and North America.

On May 3, 2012, open season for the APP was terminated by its sponsors and the APP is no longer a viable alternative. As part of the APP termination, its sponsors stated that alternatives would be evaluated which include a pipeline to an LNG facility located at tidewater in Southcentral Alaska as an alternative to a natural gas pipeline through Alberta.

Denali – The Alaska Gas Pipeline (Denali Project)

On June 25, 2008, FERC granted a pre-filing request for the Denali – The Alaska Gas Pipeline Project (Denali Project) (FERC Docket No. PF08-26-000):

- Denali Project planned to construct an Alaska natural gas transportation system, as defined by Section 103 of the Alaska Natural Gas Pipeline Act, which would consist of a 48- to 52-inch-diameter pipeline system between the Alaska North Slope and Alberta, Canada, capable of transporting about 4.0 billion cubic feet per day of natural gas. Denali Project also planned to construct a new gas treatment plant on the Alaska North Slope.

- Denali Project held an Open Season from July 6, 2010 through October 4, 2010. Subsequent to the Open Season, the project was terminated.

10.4.1.2 Use of Existing Pipeline Systems, With or Without System Upgrading

One existing pipeline system, a crude oil pipeline, was identified from the North Slope to Southcentral Alaska.

Trans-Alaska Pipeline System Alternative

The Trans-Alaska Pipeline System (TAPS) is an 800-mile-long, 48-inch-diameter crude oil pipeline that currently transports crude oil from the North Slope to a tanker terminal in Valdez, Alaska, for shipment to United States markets.

TAPS presently has capacity to accommodate additional crude oil throughput, including crude oil produced from future development in Beaufort and Chukchi seas leases. The potential for future Offshore Continental Shelf and other onshore production likely complicates changing TAPS configuration in the near future. Regardless, considering TAPS as an alternative to the Project raises the following issues:

- TAPS could not simultaneously transport oil and natural gas, so an alternative means of transporting oil from the North Slope would need to be developed.

- TAPS would need to be converted from a crude oil pipeline to a natural gas pipeline. This would require a detailed technical analysis to determine the feasibility of converting and certificating TAPS for natural gas transmission service in compliance with pipeline safety regulations. This would also likely require a reduction in the current Maximum Allowable Operating Pressure (MAOP) for natural gas service.

- Hydraulic simulations indicate a maximum natural gas flow capability through TAPS of approximately 1.5 BSCF/D due to the lower MAOP after conversion to natural gas transmission service. The conversion of TAPS to natural gas service would not allow sufficient gas volumes to be shipped to support the LNG design required.

For these reasons, the option of converting TAPS for natural gas use as a portion of the Mainline (preferred alternative) was not analyzed in detail and is not considered a viable alternative.

10.4.2 Pipeline Route Alternatives

Pipeline route alternatives can be divided into three categories:

- Major route alternatives;

- Minor route alternatives; and

- Route variations.

Major and minor route alternatives refer to deviations from the proposed pipelines (Mainline, PTTL, and PBTL) alignment. Major route alternatives are designed to avoid sensitive features or major terrain obstacles. The receipt and delivery points of major route alternatives are generally the same as the corresponding segments of the proposed pipeline; however, they could have substantially different alignments. Minor route alternatives are smaller in scale and designed to address similar issues. On a smaller scale, route variations are designed to avoid or reduce impacts on specific, localized resources including wetlands, residences, archaeological sites, and terrain constraints.

10.4.2.1 Methodology, Constraints, and Rationale for Route Selection

Installation of new pipelines along existing rights-of-way (such as other pipelines and roads) is often environmentally preferable to constructing in a new greenfield right-of-way, as impacts can normally be reduced by siting within and/or adjacent to previously disturbed utility rights-of-way and roads. Additionally, existing rights-of-way typically coincide with existing infrastructure, rather than creating a new right-of-way through previously undisturbed areas. However, collocating facilities within a shared right-of-way can be operationally challenging and may not be preferred from an operations and maintenance standpoint.

Mainline

To route the proposed Mainline, a two-mile-wide study corridor was established that generally follows the existing TAPS and Dalton highway corridor from the Prudhoe Bay area to Livengood. The proposed route is also aligned with existing transportation corridors south of Livengood (Parks Highway, as practical). After establishing a corridor that generally followed existing rights-of-way, a 2,000-foot wide corridor was identified using preliminary data from existing literature and field reconnaissance. A variety of factors were considered in refining the route, including pipeline length, land requirements, affected landowners, accessibility, constructability, and environmental impacts. The proposed Mainline alignment represents the currently preferred route, whereas the alternatives presented represent segments of the original route that were rejected in favor of the currently preferred route.

Key constraints and siting objectives that were identified and assessed included the following considerations where practicable:

- Avoiding Native allotments, national parks, national wildlife refuges, wilderness preserves, and populated areas;
- Avoiding steep terrain, side slopes, unstable slopes, and other geophysical/geotechnical hazards;
- Avoiding sensitive environmental and cultural resources based on existing available agency-supplied information;
- Enhancing constructability and reducing cost for both onshore and offshore corridor alternatives;
- Reducing impact from construction logistics;
- Attempting to parallel existing linear corridors;
- Avoiding populated areas while still facilitating access to the natural gas for in-state users;
- Avoiding large, wide river crossing locations; and
- Avoiding unstable geologic conditions for pipeline construction and operation, and unsuitable soils for construction and operations.

Point Thomson Gas Transmission Line (PTTL)

To route the proposed PTTL, initially a "straight line approach" was taken from the proposed GTP to the PTU, while maintaining separation between the pipeline alignment and the Beaufort Sea shoreline. The route was then aligned to generally follow the existing Badami liquids pipeline. This adjustment provides greater avoidance of waterbody crossings. Subsequent routing revisions were made primarily to cross and remain to the south of the Point Thomson Export Pipeline (liquids), improve major river crossing locations, avoid pingos (mounds of earth-covered ice found in Arctic and subarctic regions), and provide greater separation from established drill pads and production facilities. No major or minor route alternatives have been evaluated for the PTTL.

PBU Gas Transmission Line (PBTL)

Due to its length (approximately one mile), the route of the proposed elevated PBTL is a "straight line approach" from the GTP to the existing CGF. No major or minor route alternatives have been evaluated for the PBTL.

10.4.2.2 Major Route Alternatives

There are no major route alternatives for the proposed PTTL or PBTL. Major route alternatives for the proposed Mainline are discussed below. Additional information concerning alternative routes will be provided in a subsequent draft of this Resource Report.

Straight Line (Shortest Distance) Route Alternative

Engineering teams evaluated an alternative to the Mainline that would route the pipeline in a straight line directly from the GTP to the proposed Liquefaction Facility in Cook Inlet. The Straight Line Route Alternative is shorter than the proposed Mainline, and it consequently would require less pipeline to construct and less permanent pipeline right-of-way to maintain. However, following preliminary investigation, the Straight Line Route Alternative poses multiple, noteworthy construction, environmental, and commercial challenges that make it an impractical and infeasible alternative despite its shorter length. For example, the Straight Line Route Alternative would cross through the middle of the Denali National Park, which is avoided by the proposed Mainline route. Therefore, this alternative was eliminated from further consideration.

Valdez Route Configuration

The APP evaluated an alternative approximately 811-mile-long pipeline system that would transport natural gas from the GTP to a new LNG facility in Valdez. The Valdez LNG alternative would follow the proposed Project route (and TAPS) to Livengood. At Livengood, the alternative would branch off the proposed Project route and continue to follow TAPS south to the Port of Valdez. This alternative route would only be viable if the Liquefaction Facility and Marine Terminal were located in Anderson Bay, and was not further evaluated due to the selection of the Nikiski site as described previously in Section 10.3.2.2.

Cook Inlet Configurations

Engineering teams evaluated alternative routes for the Mainline as it approached the Cook Inlet, crossed the Cook Inlet, and then connected with the Liquefaction Facilities at Nikiski, along roughly the most southerly 100 miles of the pipeline. Key constraints and siting objectives that were identified and assessed included the constraints identified in the Mainline description above.

Three major corridor alternatives were identified (see Figure 10.4.2-1):

- East Corridor: The East Corridor lies west of the Susitna River to near the Deshka River where it would cross the Big Susitna and Little Susitna Rivers reaching a landfall on the north shore of the Cook Inlet in the Point MacKenzie area;

- West Corridor: The West Corridor stays west of the Susitna River and proceeds south-southwesterly, reaching a landfall on the north shore of the Cook Inlet in the Beluga area; and

- West-East Corridor: The West-East Corridor parallels the West Corridor until it crosses Cook Inlet. This alternative crosses the Cook Inlet, makes landfall on the south shore of the Cook Inlet in the Miller Creek area, and then parallels the East Corridor.

All of these major corridors cross the Cook Inlet. Based on the analyses conducted to date, the East and West Corridors are potentially viable alternatives to be evaluated further, with the West Corridor considered to be the base case. The West Corridor was selected as the base case as it has a preferred Cook Inlet crossing. The marine considerations of the East Corridor alternative are:

- The long shallow shore crossing near Point MacKenzie;
- Crossing several buried submarine power cables in shallow waters; and
- The transition from the shallow shoal to the Cook Inlet Navigation Channel, deviating to the west to avoid the shipping channel.

Additionally, the East Corridor alternative crossing length of Cook Inlet is longer than the West alternative. Onshore, the East Corridor alternative would cross from Miller Creek (the landing point for the East Corridor alternative) through the Captain Cook State Park. The West Corridor alternative avoids crossing Captain Cook State Park. On the Kenia Peninsula, the East Corridor alternative would also cross wetlands adjacent to the Kenai National Moose Range. These wetlands would be avoided by the West Corridor alternative.

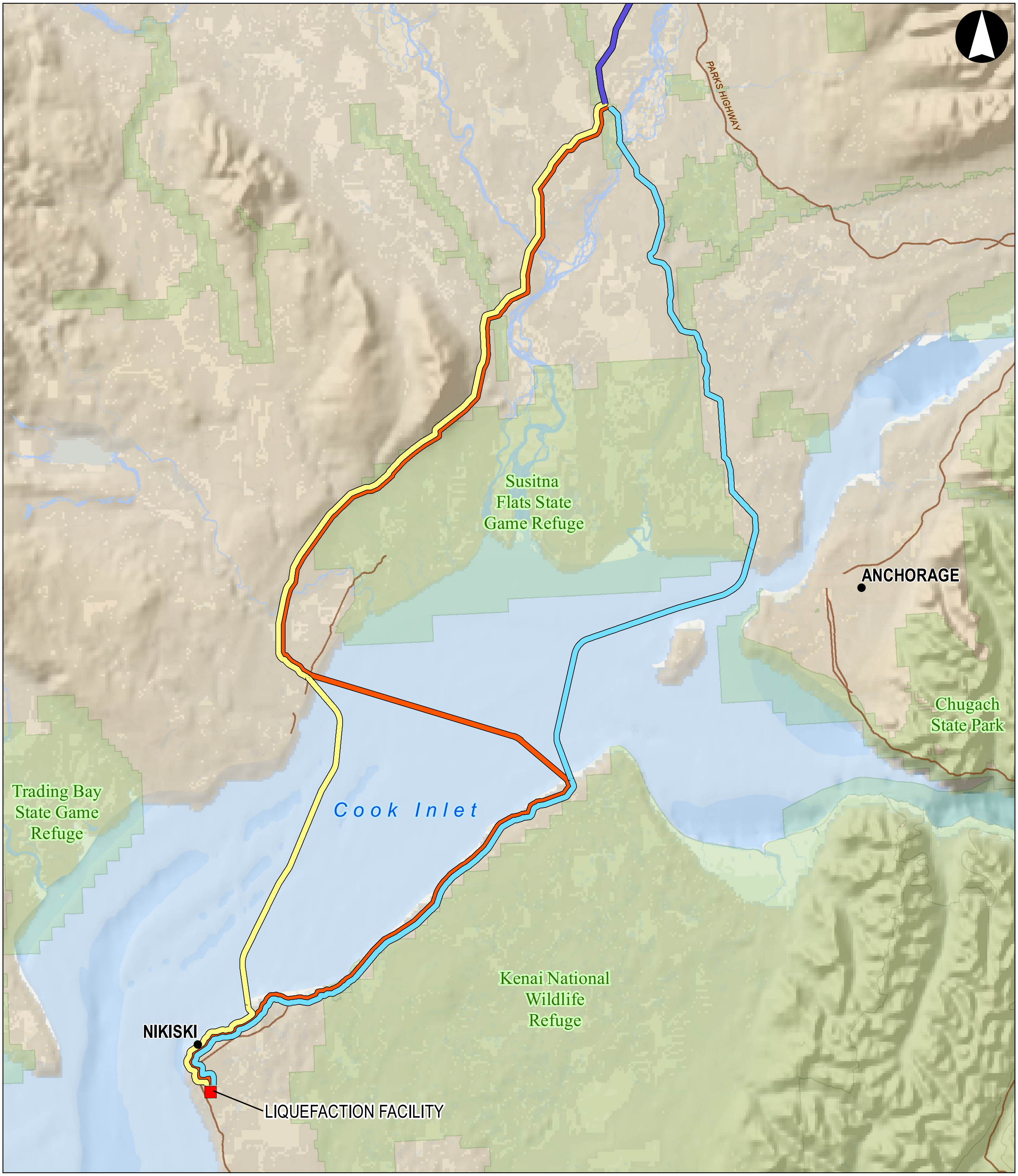
The West Corridor alternative may require construction of a dock facility in the Beluga area to transport pipe, equipment, supplies, and manpower for that option while the East Corridor alternative would most likely use existing infrastructure. The Applicants will continue to evaluate both the East and West Corridor alternatives during the Pre-FEED. However, the West-East Corridor alternative has no clear advantage compared to the other two alternatives. It is longer (12 to 26.1 miles) than the other two alternatives, and, therefore, was not further considered. Additional details of the East and West Corridors will be provided in a subsequent draft of this Resource Report.

Preferred Alternative

The corridor for the Mainline begins at the GTP in the Prudhoe Bay area on the Alaska North Slope and will generally follow the Dalton Highway and TAPS southward from the Prudhoe Bay area to Livengood. From there, the corridor generally follows Parks Highway (Alaska Highway 3) southward to a point just past the town of Trapper Creek. From this point, the pipeline corridor will continue cross-country to the south and southwest following along the west side of the Susitna River to the Deshka River. From the Deshka River, the mainline corridor runs southwest to the north shore of Cook Inlet to the northeast of Viapan Lake which is between the towns of Beluga and Tyonek. The offshore portion of the Mainline corridor crosses Cook Inlet to the Kenai Peninsula at Boulder point. From the south shore of Cook Inlet at Boulder Point, the Mainline corridor continues south and west to the termination point at the proposed Liquefaction Facility. The corridor will cross the Beluga, Theodor, Lewis, Ivan, Yentna, Deshka, Tanana, Nenana (four crossings) and Yukon Rivers.

Summary of Comparative Impacts

This information will be provided in a subsequent draft of this Resource Report.



VICINITY MAP

LEGEND

● Alaska Place Names	West Route
Project Facility	East Route
Major Highways	West-East Route
Mainline Corridor	State and Federal Conservation Lands

0 4 8 16 Miles

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COOK INLET CONFIGURATION ALTERNATIVES

FIGURE 10.4.2-1

Alaska LNG

X:\Projects\ExxonMobil\SCLNG\Mapping\20150106_ResourceReportFigures_Rev3\RR10\Figure 10_4_2-1 Cook Inlet Configuration Alternatives.mxd

10.4.2.3 Minor Route Variations

This information will be provided in a subsequent draft of this Resource Report, including routing variations in the vicinity of Denali National Park.

10.4.2.4 Design Alternatives

Typically, natural gas transmission pipelines are installed belowground. Burying the pipeline can enhance operational security of the system, and usually has the lowest installed life-cycle cost. The elevated sections on the warm oil TAPS are to reduce the potential for pipeline movement due to thaw settlement. This Project design will address thaw settlement considerations by cooling the natural gas in permafrost areas. The Project currently proposes the option to install the PTTL and Mainline as a belowground pipeline system but is also examining the installation aboveground of the most northerly 60 miles of the Mainline and the PTTL. Given its short length and existing infrastructure, the PBTL will be installed aboveground on vertical support members (VSMs).

The Project is considering an aboveground configuration of the PTTL and Mainline in continuous permafrost. The technical considerations of installing sections of the PTTL and Mainline aboveground include the following:

- Construction: The additional materials and labor required to construct the VSMs, including insulation and thermo siphons, adds to the complexity of installation and to the cost of aboveground installation.

- Materials: Pipe materials that are qualified for the low ambient temperatures which the pipeline would experience during outage conditions (-49°F versus 5°F for the proposed design) may be a challenge to procure. While pipe that would meet the low temperature mechanical property requirements for the PTTL may likely be achievable with technical developments, the large diameter, thick walled pipe that would be required for the Mainline would be more challenging.

- Operations: Designing an aboveground pipeline system to be able to operate at ambient temperatures during shut-in situations would require the addition of facilities to manage cold restarts during the winter and might require additional facilities to modify the natural gas composition.

10.5 GTP ALTERNATIVES

In determining the potential site locations for the GTP, engineering staff first conducted a regional analysis, and subsequently performed an evaluation of site alternatives within the chosen region.

10.5.1 Methodology, Constraints, and Rationale for GTP Alternative Evaluation

A regional analysis was conducted based on identifying alternative GTP site locations that met the following criteria:

- Minimizes distance to expected point of GTP byproduct stream receipt facilities

- Avoids existing contaminated sites;

- Safely distant from existing operating facilities;
- Reduces environmental impacts; and
- Utilizes existing infrastructure to the extent possible.

In particular, four geographical areas were evaluated (refer to Figure 10.5.1-1):

- PBU: In the vicinity of the developed area of the PBU, including Deadhorse;
- West of PBU: Beginning outside the developed area of the PBU and extending westward, the western boundary of this area is not specifically defined;
- South of PBU: Beginning south of Deadhorse and extending southward, the southern boundary of this area is the Brooks Range; and
- East of PBU: Beginning outside the developed area of the PBU and extending eastward, the eastern boundary is defined by the Arctic National Wildlife Refuge (Arctic NWR).

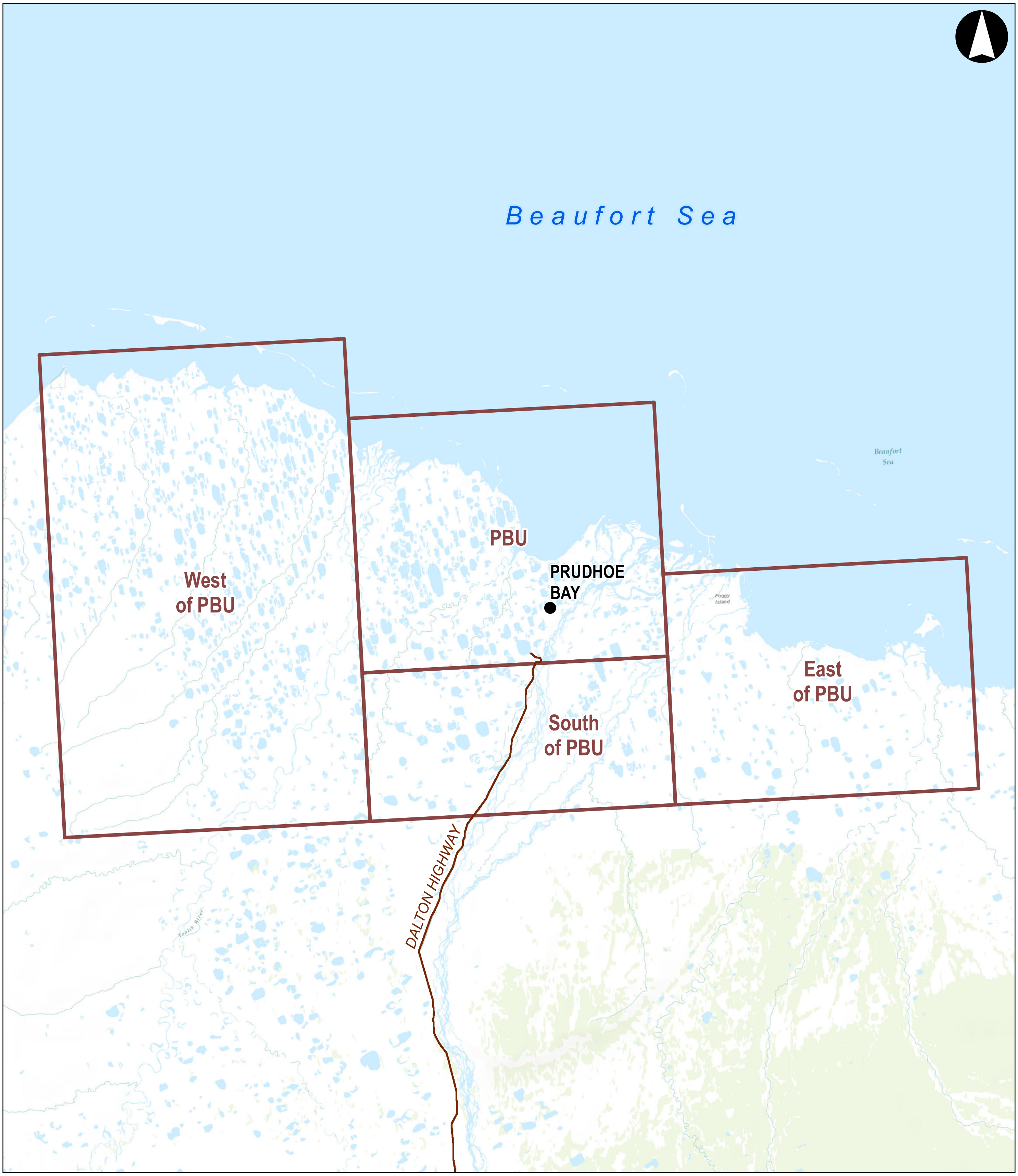
Siting criteria consisted of several specific technical, economic, and operational criteria required to accommodate a GTP and its related facilities. Table 10.5.1-1 summarizes these criteria and identifies whether the geographical areas fulfilled the initial criteria.

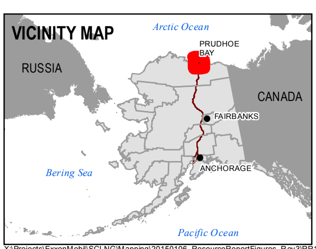
TABLE 10.5.1-1

Geographic areas evaluated for GTP Siting

Preferred Criteria for a Gas Treatment Plant Site	PBU (Preferred GTP location)	East of PBU	South of PBU	West of PBU
Minimize distance to feed natural gas source (CGF and/or PTU)	Yes	Yes	No	No
Minimize distance to byproduct stream receipt facilities	Yes	No	No	No
Proper safety distance from existing operating facilities and public/private infrastructure	Yes	Yes	Yes	Yes
Reduce total footprint (i.e., near existing infrastructure that could be used by Project)	Yes	No	No	No
Reduce total impact (i.e., near existing resources/services for both construction and operation use)	Yes	No	No	No

As illustrated in Table 10.5.1-1, none of the three alternative areas were able to fulfill all of the siting criteria. Therefore, these alternative areas were not evaluated further.





LEGEND

- Alaska Place Names
- Major Highways
- Major Rivers
- Geographic Areas for GTP Siting

0 3.75 7.5 15 Miles

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SCALE:	1:600,000		
DATE:	2015-01-14	SHEET:	1 of 1

GEOGRAPHIC AREAS EVALUATED FOR GTP SITING

FIGURE 10.5.1-1

Alaska LNG

X:\Projects\ExxonMobil\SCLNG\Mapping\20150106_ResourceReportFigures_Rev3\RR10\Figure 10_5_1-1 - Geographic Areas Evaluated for Siting of the GTP.mxd

Once the Prudhoe Bay area was identified as the preferred regional area to construct the GTP (Table 10.5.1-1), the engineering staff identified the proposed GTP site and three alternative sites within the preferred regional area. As shown on Figure 10.5.1-2, these included the following:

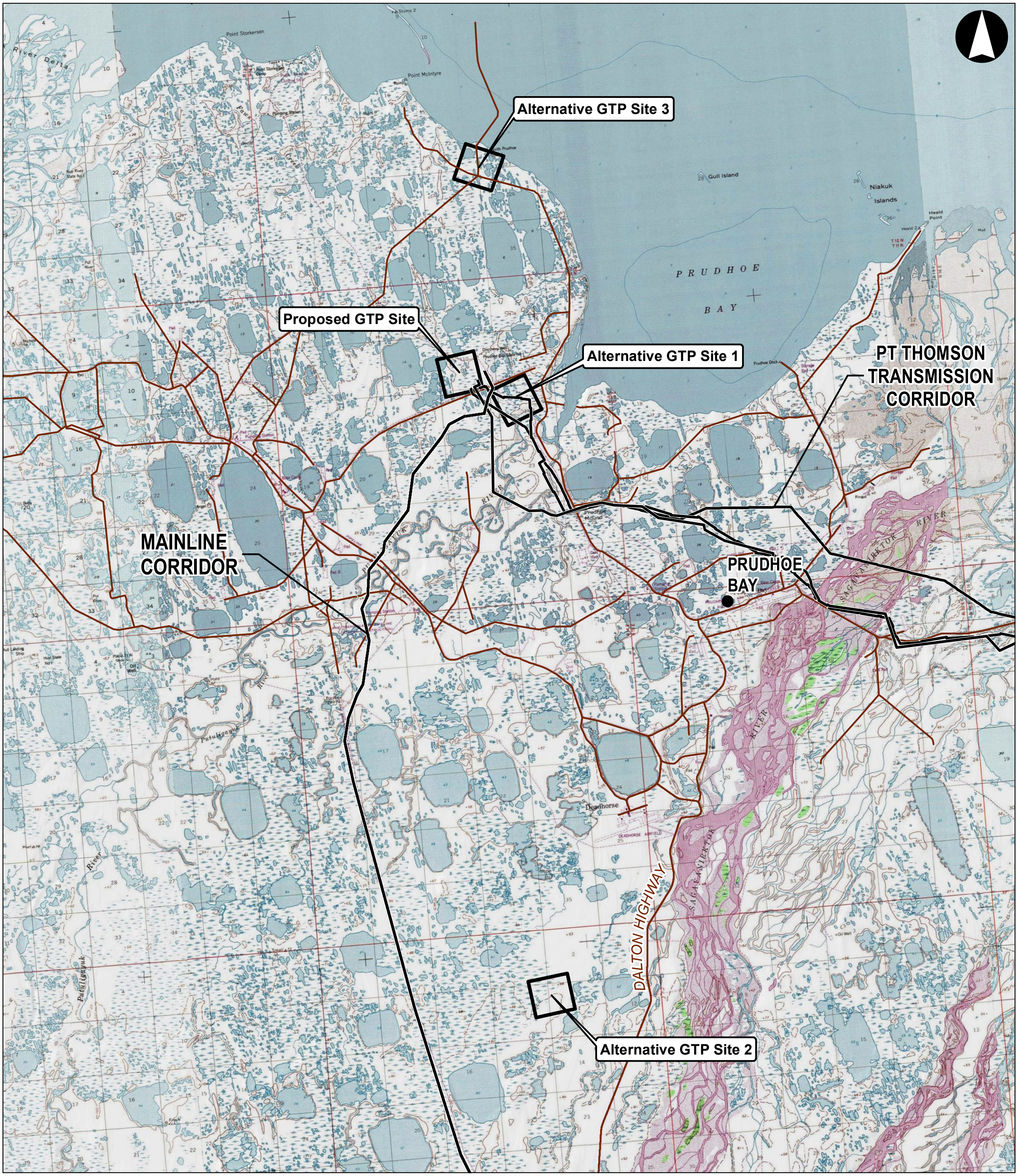
- Proposed GTP site: Located approximately 3,000 feet west of the existing CGF;
- GTP Site Alternative 1: Located north of the Putuligayuk-23 mine (Put-23), between Put-23 and the CGF;
- GTP Site Alternative 2: Located approximately 3 miles southwest of the Deadhorse Airport and 1 mile west of the Dalton Highway; and
- GTP Site Alternative 3: Located north of the CGF/Central Compression Plant area on the Prudhoe Bay shoreline approximately 2,500 feet southeast of the West Dock staging pad.

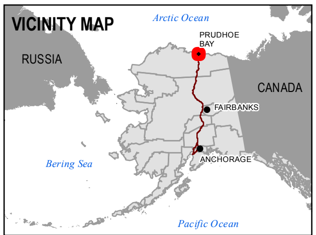
GTP Site Alternative 1 was assumed to have an identical pad footprint to the proposed site and a similar logistical execution plan consisting of using Dock Head (DH) 2 to offload the modules and transport them to the site, primarily using existing roads. Infrastructure differences between these alternatives were primarily the length of road upgrades, pipeline crossings, and new transfer line lengths. GTP Site Alternative 2 has a similar pad footprint and logistical execution plan except that the alternative pad size would likely be greater than the proposed pad size in order to accommodate additional compression needed for this alternative. GTP Site Alternative 3 had a unique pad footprint that included a newly built dock extending out into Prudhoe Bay. As a result, GTP Site Alternative 3 modules would not need to be transported over existing roadways.

10.5.2 GTP Siting Alternatives

Engineering staff developed specific site requirements to assist in evaluating site differences for the GTP. These included several important environmental, land, development, and operational factors that were considered relevant to successful siting, construction, and operation of the facility. Each individual factor was considered relative to the merits of the proposed site. Potential impacts associated with a given factor were quantified, where possible, or otherwise defined in comparative terms to evaluate the merits of each site.

The following subsections summarize the Project's analysis for each alternative site and Table 10.5.2-1 summarizes the specific results for all sites compared together.





LEGEND

- Alaska Place Names
- Project Corridor
- Major Roads
- Major Rivers
- Potential GTP Facility

0 1 2 4 Miles

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SCALE:	1:150,000
DATE: 2015-02-05	SHEET: 1 of 1

ALTERNATIVE SITES EVALUATED FOR SITING OF THE GTP

FIGURE 10.5.1-2

Alaska LNG

X:\Projects\ExxonMobil\SCLNG\Mapping\20150106_ResourceReportFigures_Rev3\RR10\Figure 10_5_1-2 - Alternative Sites Evaluated for Siting of the GTP.mxd

TABLE 10.5.2-1

Comparison of the GTP Site Alternatives

Factors Considered	Proposed Site	Site Alternative 1 (North of Put-23 Mine)	Site Alternative 2 (South of Deadhorse)	Site Alternative 3 (Onshore)
GTP SITE CHARACTERISTICS				
Pad Footprint Inclusive of Flare Area (acres)	235	235	>235 (For additional compression.)	>235 (For additional compression.)
Site Design Complexity (Relative Complexity)	Low.	Low.	Moderate. Additional compression needed. Location near Deadhorse Airport may impact design of the facility (building/stack height.)	Moderately High. (Structural support of large modules (i.e., piles, footings, etc.) more complex due to increased potential for gravel subsidence in nearshore area.)
Operational and Safety Considerations	Acceptable.	Acceptable.	Less Acceptable (Some concern with proximity to nearby Deadhorse Airport.)	Least Acceptable. (Maintenance impacted by salt spray. Operations impacted by higher wind speeds, additional wind-driven snow, and safety concerns relative to polar bears. Plant egress is constrained on shore side.)
Land Use/Zoning	Locations with evidence of previous disturbance are present in close proximity to the site (e.g., pads, pilings). This location and surrounding area are located in the Prudhoe Bay vicinity. Land within the PBU is designated for industrial development.	Pipelines and elevated electrical utilities cross site area. This location and surrounding area are located in the Prudhoe Bay vicinity near Put 23 Mine. Land within the PBU is designated for industrial development.	Site is located within 5 miles of the Deadhorse Airport. Outside of the PBU. (North Slope Borough development permit would be required.)	Site is located on previously undeveloped coastal land, but is located within close proximity to West Dock, roads, and other industrial development. This location and surrounding area are located in the Prudhoe Bay vicinity. Land within the PBU is designated for industrial development.
MODULE DELIVERY ISSUES				
Route Length (Miles)	6.7	6.7	20	0
Foreign Utility Line Crossings (Relative Complexity)	Minor. (Both existing and new crossings would require minor improvements to cross-over.)	Moderately Significant. (One large [~60-inch-diameter] elevated pipeline and one high-voltage power line would need to be crossed.)	Significant. (Numerous crossings would require significant upgrades.)	None.
Route Transit Conflicts	Low. (Haul route issues on the spine road from Dock Head [DH] 2.)	Low. (Haul route issues on the spine road from DH2. Good access to site during operations.)	Significant. (Modules must pass through highly developed and highly traveled areas to reach site from DH2.)	None.

TABLE 10.5.2-1

Comparison of the GTP Site Alternatives

Factors Considered	Proposed Site	Site Alternative 1 (North of Put-23 Mine)	Site Alternative 2 (South of Deadhorse)	Site Alternative 3 (Onshore)
Channel Dredging Volume (Million Cubic Yards)	2.5	2.5	2.5	3.5 (Greater than others because of the need to bring modules all the way to shoreline through shallower waters.)
CENTRAL GAS FACILITY FEED GAS AND GTP BYPRODUCT PIPELINE TO EXPECTED PBU RECEIPT POINT CONSIDERATIONS				
Length (Miles)	0.9	1.3	12.5	4.5
Foreign Pipeline Crossings (Number)	None.	2	2	3
Road Crossings (Number)	None.	1	4	1
GENERAL ENVIRONMENTAL CONSIDERATIONS				
Air Quality and Noise	Site is located in an industrial area. GTP is expected to meet applicable ambient air and noise quality standards. Noise emissions resulting from pile driving and other in-water construction activities would have the potential to affect fish and marine mammals.	Site is located in an industrial area and would be expected to meet applicable ambient air and noise quality standards. Noise emissions resulting from pile driving and other in-water construction activities would have the potential to affect fish and marine mammals.	Site would be expected to meet applicable ambient air and noise quality standards. Noise emissions resulting from pile driving and other in-water construction activities would have the potential to affect fish and marine mammals.	Site is located in an industrial area and would be expected to meet applicable ambient air and noise quality standards. Because pile driving and other in-water construction activities would be of longer duration, of greater magnitude, and cover a larger area, the potential risk that noise emissions resulting from these activities would impact fish and marine mammals is also increased.
Visual Impact	Site is located in the Prudhoe Bay area. The potential for visual impacts would be minor due to existing developments.	Site is located in the Prudhoe Bay area. The potential for visual impacts would be minor due to existing developments.	Site area would be just outside of developed area and extend the developed footprint. The potential for visual impacts would be greater than Proposed Site and Alternate 1.	Site is located along the coast and just outside of developed area. The potential for visual impacts would be greater than other sites.
Cultural Resources	Site is located to avoid historical landmark (original PBU discovery well).	No known cultural resource issues.	No known cultural resource issues.	No known cultural resource issues.
Soil Contamination	No known sites identified.	No known sites identified but located adjacent to North Slope Borough Oxbow landfill.	Site is located in undeveloped area and probability of encountering contamination is low.	Site is located in undeveloped area and probability of encountering contamination is low.
Affected Habitat Type	Palustrine emergent wetlands, tundra lakes/ponds, and estuarine intertidal and tidal wetlands	Palustrine emergent wetlands, tundra lakes/ponds and estuarine intertidal and tidal wetlands	Palustrine emergent wetlands, tundra lakes/ponds, and estuarine intertidal and tidal wetlands	Estuarine fringe, intertidal and tidal wetlands

TABLE 10.5.2-1

Comparison of the GTP Site Alternatives

Factors Considered	Proposed Site	Site Alternative 1 (North of Put-23 Mine)	Site Alternative 2 (South of Deadhorse)	Site Alternative 3 (Onshore)
PRESENCE OF CRITICAL HABITAT OR FEDERALLY ENDANGERED SPECIES OR PROXIMITY TO SPECIAL WILDLIFE AREAS				
Polar Bear	Located within potential feeding and denning areas.	Located within potential feeding and denning areas.	Located within potential feeding and denning areas.	Located within potential feeding and denning areas.
Spectacled and Steller's Eiders	Located within potential nesting areas.	Located within potential nesting areas.	Located within potential nesting areas.	Located within potential nesting areas.
Bowhead Whale	Studies indicate that bowhead whales are generally not present in the Project area during July-September if the dredging for module delivery occurs during the summer months.	Studies indicate that bowhead whales are generally not present in the Project area during July-September if the dredging for module delivery occurs during the summer months.	Studies indicate that bowhead whales are generally not present in the Project area during July-September if the dredging for module delivery occurs during the summer months.	Studies indicate that bowhead whales are generally not present in the Project area during July-September if the dredging for module delivery occurs during the summer months.

10.5.2.1 GTP Site Alternative 1 Analysis

GTP Site Alternative 1 is located north of the Put-23 mine, between Put-23 and the CGF. Access to the site would be via a 6.7-mile-long module haul route from the West Dock. GTP Site Alternative 1 would require more road and pipeline crossings than the proposed site, and additional work would be needed to avoid an electric transmission line near the site.

Specifically, the Site Alternative 1 module haul route would cross both existing and new pipeline crossings, one of which is an existing large-diameter elevated pipeline crossing that would be moderately difficult to cross. The proposed site module haul access road would also cross existing and new pipeline crossings, but only minor issues are anticipated with completing those crossings. Both haul routes are the same length.

The required infrastructure at GTP Site Alternative 1 would not be noticeably different from that needed for the proposed site, and the engineering complexity would be similar for the two sites. Both sites would require the same quantity of dredging.

The PBTL from the CGF and the GTP byproducts transport pipeline to an expected PBU receipt point would be approximately 0.4 mile longer for Site Alternative 1 compared to the proposed site, and would require crossing two existing pipelines and one road, whereas the PBTL and the byproducts transport pipeline for the proposed site would not require crossings of existing pipelines or roads.

Table 10.5.2-1 provides a comparison of environmental considerations of the proposed site and GTP Site Alternative 1. For the most part, the two sites would have similar impacts. For instance, both sites are presently designated as industrial sites and would require construction of a new facility. Wetland permitting would be required at both sites and the impacts would be similar. No known cultural or paleontological resources would be impacted by either alternative. However, the GTP Site Alternative 1 is located in an area identified by U.S. Fish and Wildlife Service (USFWS) as having more appropriate topographic and macrohabitat features for polar bear terrestrial denning habitat (USFWS, 2010). While impacts to polar bears could be mitigated, the potentially higher presence of denning sites might impact construction timing or routing or operations. Alternative 1 would also require more power and pipeline crossings than the proposed site. As a result, this alternative was eliminated from further consideration.

10.5.2.2 GTP Site Alternative 2 Analysis

GTP Site Alternative 2 is located approximately five miles southwest of the Deadhorse Airport and one mile west of the Dalton Highway. Access to the site would be via a 20-mile-long module haul route from the West Dock, which is about 14 miles longer than the haul route for the proposed site. Modules on the haul route would pass through highly developed and highly traveled areas to reach the site from West Dock. The PBTL from the CGF and the GTP byproducts transport pipeline to an expected PBU receipt point would be substantially longer for Site Alternative 2 compared to the proposed site.

Due to the length and route of the haul road, and its proximity to the airport, PBU operators and other Deadhorse activities would likely encounter potential conflicts during transport of GTP modules from DH2. All pipeline crossings between DH2 and the location south of the airport are existing crossings, and would likely need to be significantly upgraded to handle module loads.

Additional compression would be needed with GTP Site Alternative 2, which would require a larger pad footprint than the proposed site, and proximity to the Deadhorse Airport may be of concern for building and stack heights. Both sites would require the same quantity of dredging, however, and the GTP itself would be located outside of polar bear habitat.

Table 10.5.2-1 provides a comparison of environmental considerations for the proposed site and GTP Site Alternative 2. The GTP Site Alternative 2 would require a larger footprint in an undeveloped non-industrial area and, due to the need for increased compression, would also produce increased air emissions. GTP Site Alternative 2 is not preferable for the economic and environmental reasons stated above. As a result, this site was eliminated from further consideration.

10.5.2.3 GTP Alternative 3 Analysis

GTP Site Alternative 3 is located north of the CGF area on the Prudhoe Bay shoreline approximately 2,500 feet southeast of the West Dock staging pad. GTP Site Alternative 3 presents the greatest ease of site access during construction and operations. The site would require development of dockface for offloading of modules directly onto the pad. In addition, because flares cannot be installed onshore due to conflicts with existing roads and infrastructure, flares would need to be installed in the ocean, potentially increasing costs for installation and flare line routing. This would result in a greater pad footprint, but would eliminate the need for expanding DH2. Installation of piles would be deeper and more complicated because Adfreeze piles (standard North Slope piling method of surrounding piles with a water/sand slurry that subsequently freezes to secure the piles) could not be assumed at nearshore locations. In addition, more gravel would be needed for filling in low-lying areas.

Due to its location away from PBU processing facilities, construction and operation of GTP Site Alternative 3 would have minimal impacts on existing PBU operations. The complexity of integrating module movement with other West Dock users is also eliminated. In addition, developing this site avoids issues associated with crossing pipelines and developing access roads for module transport that would need to be addressed for the proposed site.

The disadvantages of GTP Site Alternative 3 compared to the proposed site are that it would require dredging substantially more material in Prudhoe Bay and is the most complex to design due to the additional module structural support and possible gravel subsidence. Due to its location and increased dredging and dockface footprint, this alternative would also have a greater potential to affect nearshore intertidal and sub-tidal habitats, polar bear habitats, and marine mammals relative to the proposed site. Maintenance at GTP Site Alternative 3 would also be affected by salt spray, higher wind speeds, and wind-driven snow associated with the coastal area. Additional compression would also be required, as well as additional space required for the compression.

Table 10.5.2-1 provides a comparison of environmental considerations of the proposed site and GTP Site Alternative 3. GTP Site Alternative 3 is not preferable due to the disadvantages described above. As a result, this site was eliminated from further consideration.

10.5.3 GTP Layout Alternatives

This information will be provided in a subsequent draft of this Resource Report.

10.5.4 Module Delivery Alternatives

The current design basis includes that modules will be required to construct the GTP and Associated Infrastructure[d] based on a four-year open-water season sealift delivery schedule. These modules would be approximately 90-feet wide, 150-feet high, and 350-feet long, with the largest modules weighing up to 9,000 short tons. The large module sizes provide for reduced North Slope transportation, interconnection work, and labor, which all correspond to reduced cost, risk, and impact. Alternative transportation options for GTP module delivery to the North Slope are summarized in the following subsections, including transport via truck, railroad, and onsite fabrication.

Engineering staff determined that the largest modules would need to be shipped by sealift because the size and weight of the modules exceed the capacity of either truck or rail transportation. A secondary study was conducted to determine the feasibility of breaking up the larger modules into smaller pieces for transport by either truck and/or rail transportation, however, the labor cost and time associated with reassembling these pieces made these options not viable.

Consequently, modules will be transported to the GTP construction area primarily utilizing sealifts.

10.5.4.1 Onsite Fabrication

Onsite fabrication of the GTP would require substantial equipment, material, and workforce increases in the Prudhoe Bay area. Fabricating onsite would substantially increase the cost of the GTP (by approximately double). To date, no significant oil and natural gas facilities have been fabricated on the North Slope due to Arctic conditions and cost. This option was determined to be the most cost-intensive option of fabrication, and onsite fabrication was eliminated from further consideration.

[d] Associated Infrastructure and additional temporary workspace (ATWS), access roads, helipads, airstrips, construction camps, pipe storage areas, contractor yards, borrow sites, and dock modifications, as discussed in Section 1.3.2.5 of Resource Report No. 1.

10.5.4.2 Truck Transportation

Truck transportation is the most common method to transport freight to the North Slope, with travel times from four to ten days depending on site-of-origin, size, and weight of the module, weather, and other demands for road uses that may be present during transport. Special permits from the ADOT&PF are required to transport modules larger than 22-feet wide, by 15 feet, 6 inches high, by 80-feet-long, and exceeding 100 tons gross weight. The heaviest load that has ever been carried on Alaska roads from Anchorage to Prudhoe Bay to-date was 20-feet wide by 14 feet, 6 inches high, by 76 feet long, with 110-tons gross weight.

Several of the road route segments to Prudhoe Bay have limitations or restrictions, including:

- Nikiski to Anchorage: Weight limitation at the Canyon Creek Bridge;
- Anchorage to Fairbanks: Height restriction of 15 feet, 6 inches at Denali Park's Nenana River Bridge in Rex and Tanana River Bridge in Nenana; and
- Fairbanks to North Slope: Safety standard considerations, in particular, at Atigun Pass, with slopes up to 18 percent. In addition, there is a 110-ton weight restriction for multiple bridges along this segment.

All paved and unpaved roads maintained by the ADOT&PF allow 100 percent legal axle load with overloads allowed upon application and receipt of written authorization from the Division of Measurement and Standards and Commercial Vehicle Enforcement. Between April 1 and June 1, however, load restrictions may apply due to weather conditions, varying between 50 and 100 percent of legal axle load.

The transportation of over 58,000 tons of equipment and approximately 250,000 tons of material by road is not practical due to the limitations associated with the Dalton Highway, the only road connection to Prudhoe Bay (i.e., two-lane, 360-mile-long, and unpaved highway). Bridge weight restrictions of about 100 tons, road closures due to ice, snow, and break-up all increase safety, schedule, cost, and execution risks. Therefore, this alternative was eliminated from further consideration, other than for transportation of some materials and some small skids and modules.

10.5.4.3 Rail Transportation

The Alaska Railroad is capable of handling modules or vessels in the 250-ton range and load height generally must be less than width. Smaller modules fabricated in Alaska could be shipped via rail to Fairbanks utilizing the Alaska Railroad Corporation infrastructure, which has undergone improvements over the last 10 years. The Alaska Railroad system does not extend to Prudhoe Bay, and all rail shipments would then have to be transported via highway after reaching Fairbanks, therefore this alternative was eliminated from further consideration.

10.5.5 North Slope Dock Alternatives

Engineering staff conducted an evaluation that considered several dock configurations and the number of barge berths that would be needed in Prudhoe Bay to accommodate the large number of barges that would be offloaded within the open-water (ice-free) work window and in consideration of concurrent dock usage by non-Project entities and potential weather delays. Based on this evaluation, new berths would be required to offload barges within the estimated 45-day open-water work window. These berths would assist in mitigating potential schedule impacts caused by external constraints such as adverse weather conditions, and/or concurrent activities at West Dock.

While there are numerous dock structures in and around Prudhoe Bay, the West Dock facility is the primary dock facility that could support GTP module transfer. The West Dock structure has two active dock heads, including DH2, which serves heavy loads, and DH3, which is restricted by a relatively low-weight-bearing causeway (cannot handle the module size contemplated for this Project without major modifications). West Dock is the closest port facility to the proposed GTP site, with no reasonable alternative available elsewhere. Therefore, DH2 has been selected as the preferred dock option for this Project subject to validation during Pre-FEED.

The following dock modifications specific to DH2, which could accommodate a variable number of barges and barge sizes, were considered in this study:

- Improvements to existing dock only;
- Widening the existing dock face to the east;
- Building new flat-face dock to the east of the existing dock and extended out into deeper water;
- Widening existing dock to the east and adding finger piers; and
- Building a sawtooth dock to the east of existing dock.

These configurations were evaluated based on the following criteria:

- Environmental;
- Safety;
- Schedule;
- Impact on/from Prudhoe Bay operations;
- Cost;
- Land impact;
- Constructability of infrastructure;
- Efficiency of offload operation – water;
- Efficiency of offload operation – land; and
- Benefits to future operations.

The results of this evaluation are summarized in Table 10.5.5-1.

TABLE 10.5.5-1

Comparison of Dock Location and Modification Alternatives

Option	Advantages	Disadvantages
Configuration 1. Improve existing dock with no increase in footprint	• Minimal land impact • Lowest cost • No increase in footprint • Less permitting complexity	• Does not support offload operation schedule • Impacts PBU operations during improvement and during offloading
Configuration 2. (Preferred Alternative) Expand existing dock to the east with new berths	• Flat face provides good efficiency and operational flexibility for marine operations • Lowest land impact of expanded dock options • Lowest cost per berth • Separates Project from non-Project activities • Minimal increase in footprint • Minimal impact to seafloor receptors • Future use potential	• Requires dredging, however, smallest volume of dredged spoils of expanded dock configurations (roughly equal to Configuration 3)
Configuration 3. New dock extending to the north and east of existing dock with new berths	• Flat face provides good efficiency and operational flexibility for marine operations • Future use potential • Separates Project from non-Project activities	• May cause sedimentation at existing dock • Smallest volume of dredged spoils of expanded dock configurations (roughly equal to Configuration 2)
Configuration 4. Widen existing dock to east and add finger pier dock with new berths	• Finger piers allow greater barge and offload access from the sides • Separates Project from non-Project activities • Future use potential	• Sedimentation likely between piers • Increases dredge volume from Configuration 2 and 3 • May complicate docking operation when barges are in place • Highest cost-to-berth ratio
Configuration 5. Build a sawtooth dock to east of existing dock with new berths	• Reasonable cost-to-berth ratio • Future use potential • Separates Project from non-Project activities	• Complicates in-water docking operation • Complicates onshore offload operation • Impacts existing dock usage during offload time • Largest volumes of dredged spoils • Highest land impact

Based on this analysis, Configuration 2 – the flat-faced dock option– would offer superior operational flexibility, future uses, and good separation from non-Project activities to mitigate potential schedule impacts. These same modifications could be made at DH3, which would reduce dredging requirements; however, this would require the temporary closing of the causeway breach during the four sealift years. As the purpose of the breach was to facilitate the migration of fish from one side of the causeway to the other, this option was eliminated from further consideration to avoid any potential fish migration issues.

10.5.5.1 Navigational Channel Alternatives

As depicted in Figure 10.5.5-1, the shape of Prudhoe Bay and the seafloor limit the number of practical navigational channel alternatives to a fan-shaped area extending north to northeast from DH2. While many channel configurations within this fan shape are feasible, the proposed navigational channel was chosen to facilitate tug and barge navigation given the prevailing wind and current, as well as reduce the amount of dredge material generated. Engineering staff evaluated placing the channel extending nearly due north from DH2, but eliminated this as it provided less desirable tug and barge movement and may interfere with DH3 activities. Soil testing will be conducted on the currently preferred navigation channel, and if soil contamination is found in the proposed channel, the route will be re-evaluated.

10.6 CONSTRUCTION ALTERNATIVES

This information will be provided in a subsequent draft of this Resource Report.

10.6.1 Dredge Method and Dredge Material Placement Alternatives

This information will be provided in a subsequent draft of this Resource Report.

10.6.1.1 Alternative Dredge and Transportation Methods

Several methods of dredging are currently used worldwide, and in a variety of climates. The following dredging methods may be used independently or in combination:

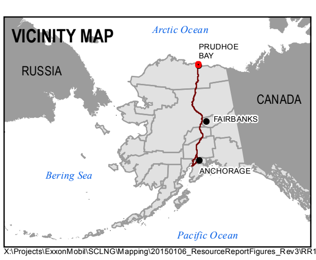
- Hydraulic Cutterhead Dredging – Cutterhead dredges would use rotating cutters and hydraulic means (pumps) to move dredge material from the seafloor into a discharge pipe. The discharge pipe would terminate at the disposal location or within a hopper barge. Booster pumps could be added to increase the discharge pipe length. Cutterhead dredges can achieve very high rates of dredge production and are capable of removing a wide range of soil types, including permafrost. Cutterhead dredges are especially suitable for silty soils.

- Mechanical Clamshell Dredging – A mechanical clamshell dredge would consist of a barge-mounted machine with a clamshell bucket that would cut sediment from the seafloor and raise it through the water column. The sediment would then be transferred to a hopper barge. The hopper barge would be towed to a disposal location where the spoils would then be dumped onto the ocean floor. Clamshell dredging is a widely used dredging method and works with many soil types, however, it is less suitable to silty soils.

- Barge-Mounted Excavator – This method of dredging would be conducted during the open-water season. Excavators would be mounted on barges and dredge to the required depth. Dredged material would be transferred to the disposal site via barge and dumped onto the ocean floor. This method is widely used and works with many soil types, however, it is less suitable to silty soils.

- Elevated Excavator – This method of dredging would be conducted during the open-water season. The Project would utilize excavators that can elevate the cab and can motor above the waterline, while the tracks remain underwater. This method would be suitable for the shallower maneuvering basin area in combination with a barge-mounted excavator to dredge the channel in deeper water. The dredged material would be transferred to the disposal site via barge and dumped onto the ocean floor.

- Hydraulic Dredging with Integrated Hopper – Hopper dredges would use hydraulic means (pumps) to move dredge material from the seafloor to a hopper. The dredge (dredge and hopper) would transit from the dredge location to the dredge material disposal location. This method could achieve high rates of dredge production and would require fewer support vessels, as it would be a self-contained dredger and hopper. At shallow water depths, this option would be the least feasible.



LEGEND

- ● Alaska Place Names
- Major Rivers
- Project Corridor
- GTP Facility Infrastructure

0 0.5 1 2 Miles

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BATHYMETRY OF PRUDHOE BAY

FIGURE 10.5.5-1

Alaska LNG

X:\Projects\ExxonMobil\SCLNG\Mapping\20150106_ResourceReportFigures_Rev3\RR10\Figure 10_5_5-1 - Bathymetry of Prudhoe Bay.mxd

- Winter Through Ice Dredging – This method of dredging would be conducted in the winter on the sea ice. Equipment would be used to remove the sea ice and excavators would then remove the sediment in the seafloor. The sediment would be loaded onto dump trucks and transported to the disposal site. Ice roads would be constructed to provide access. In locations where ice is not grounded to the seafloor, the ice road and working areas would be thickened as necessary to support the heavy machinery.

None of these methods have been eliminated from consideration.

10.6.1.2 Alternative Material Placement

Marine Terminal

This information will be provided in a subsequent draft of this Resource Report.

West Dock Modifications

The existing channel from DH2 will need to be widened and deepened (out to the 16-foot depth contour) to accommodate the larger vessels for module offloading. The following methods may be used for dredged material disposal:

- Open-Water Placement in Stefansson Sound – Dredged material may be disposed of in Stefansson Sound.

- Open-Water Placement North (Seaward) of the Barrier Islands – Dredged material may be disposed of beyond the barrier islands in deeper water than the proposed site. Depending on the distance to the disposal site this would reduce the effectiveness of transporting dredge material hydraulically via pipeline from a cutterhead suction dredger. Hopper barges would be the most effective means to transport dredged material beyond five miles. Additional hopper barges and tugs would be required to maintain production rates, which would increase dredge costs. Based on these factors, disposal beyond the barrier islands was eliminated from further consideration.

- Disposal beyond the continental shelf was also considered, but was dismissed due to concerns over floating ice density in summer, which can pose a navigational hazard, and due to the impractical logistics required to move the large volume of material the necessary distance (approximately 50 miles offshore).

- Beach Replenishment and Island Building – Dredge spoils worldwide are frequently used for beach replenishment and barrier island building. This disposal method would require that the spoils would consist of a high percentage of sand/clay/gravel and a low percentage of silt. Beaches and islands could be built by hydraulically placing the dredged material in the desired location in the summer. Use of hopper barges would be less feasible for this method of disposal. Soil type is an important consideration for beach replenishment and island building. If the dredged material has a very high content of silt, it may not be appropriate for this disposal method.

- Upland Beneficial Reuse – Upland placement of dredging spoils is often used worldwide to dispose of dredge material. This alternative was eliminated due to the potential damage caused by saline-rich soils being deposited on top of permafrost tundra, which may have adverse effects on the wetlands.

- Structural Beneficial Reuse along the Causeway and Offshore West Dock - The use of dredged material as structural fill for the expansion of DH2 and the causeway was evaluated but eliminated due to the additional cost and schedule impacts. An additional year of construction would be added to the construction schedule to de-water and densify the material sufficiently for structural purposes. Dredging would also have to occur two years prior to the first sealift, which would increase the maintenance dredging quantities, and an alternate disposal site would have to be permitted for the disposal of dredged material from maintenance dredging.

Alternative dredge material placement options are still being evaluated and additional information will be provided in a subsequent draft of this Resource Report.

10.7 ABOVEGROUND PIPELINE FACILITY ALTERNATIVES

10.7.1 Compressor Station Alternatives

This information will be provided in a subsequent draft of this Resource Report.

10.7.2 Heater Station Alternatives

This information will be provided in a subsequent draft of this Resource Report.

10.8 ANCILLARY FACILITY ALTERNATIVES

10.8.1 Access Road Alternatives

This information will be provided in a subsequent draft of this Resource Report.

10.8.2 Helipad Alternatives

This information will be provided in a subsequent draft of this Resource Report.

10.8.3 Airstrip Alternatives

This information will be provided in a subsequent draft of this Resource Report.

10.8.4 Construction Camps, Pipe Storage Areas, and Contractor Yards

This information will be provided in a subsequent draft of this Resource Report.

10.8.5 Material Sites

This information will be provided in a subsequent draft of this Resource Report.

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