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

Willow Master Development Plan

Environmental Impact Statement

DRAFT

Volume 4: Appendices E.13 through I
August 2019

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

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

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

Mission

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

Cover Photo Illustration: Caribou in the Alpine Development on Alaska's North Slope.
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Willow Master Development Plan

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Marine Mammals Technical Appendix

August 2019

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List of Acronyms

CRD	Colville River Delta
dB	decibels
dBA	A-weighted decibels
dB re 1 µPa	decibels referenced to 1 micro Pascal
EIS	Draft Environmental Impact Statement
ESA	Endangered Species Act
Hz	Hertz
kHz	kilohertz
m	meter
MMPA	Marine Mammal Protection Act
Project	Willow Master Development Plan Project
rms	root-mean-square
SPL	sound pressure level
TL	transmission loss
USDOT	U.S. Department of Transportation
USFWS	U.S. Fish and Wildlife Service

1.0 MARINE MAMMALS

This appendix contains additional information on species and applicable underwater noise concepts and methodologies used in the development of the Willow MDP Environmental Impact Statement (EIS), Section 3.13, *Marine Mammals*.

1.1 Marine Mammal Special Status Species and Habitats

1.1.1 Polar Bear

Polar bears are protected by both the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA). Denning habitat is an important factor for success of the species, and it is a parameter often used to describe effects to the species. Polar bears may den on land or on ice. Only pregnant females den during the winter, typically entering the den in October or November and leaving in late March or April (Lentfer and Hensel 1980). Males and nonbreeding females remain active through the winter. Terrestrial dens are excavated in compacted snowdrifts adjacent to coastal banks of barrier islands and mainland bluffs, river or stream banks, and other areas with steep topographic relief to catch drifting snow (Durner, Amstrup, and Fischbach 2003). Dens are often located at the edge of stable sea ice on the shoreward side of barrier islands. Between Utqiaġvik and the Kavik River (east of Prudhoe Bay), 95% of dens occupied by radio-collared bears were located within 5 miles of the coast (Durner et al. 2009); historical reports of dens found by other methods demonstrate that some females den farther inland (Durner et al. 2010; Seaman 1981).

Polar bear critical habitat was designated by the U.S. Fish and Wildlife Service (USFWS) in 2011 (75 FR 76086). There are three units of critical habitat in the analysis area (Figure 3.13.1 in the Willow MDP EIS, Section 3.13, *Marine Mammals*):

- **Sea-Ice Critical Habitat**: Used for feeding, breeding, denning, and movements; comprises U.S. territorial waters extending from the mean high-tide line seaward over the continental shelf to the 984-foot (300-meter [m]) depth contour.
- **Terrestrial Denning Critical Habitat**: Occurs along the northern coast of Alaska where there are coastal bluffs or riverbanks suitable for capturing and retaining snowdrifts of sufficient depth to sustain maternal dens through the winter, as described by Durner et al. (2001). Between the Kavik River and Utqiaġvik, terrestrial denning critical habitat occurs within 5 miles of the mainland coast.
- **Barrier Island Critical Habitat**: Used for denning, refuge from human disturbance, and movements along the coast; comprises barrier islands and associated mainland spits, includes a "no disturbance zone" extending 1 mile around all designated barrier-island habitat. (The no disturbance zone does not automatically preclude Willow Master Development Plan Project (Project) activities from occurring within it.)

Existing human-made structures and the land on which they were located on the effective date of the final critical habitat designation (75 FR 76086) are excluded from critical habitat. In addition, seven specific areas were excluded: the communities of Utqiaġvik and Kaktovik and five U.S. Air Force radar sites—Point Barrow, Point Lonely, Oliktok Point, Bullen Point, and Barter Island.

Because of topography and the distribution of suitable habitat characteristics across the landscape, not all portions of terrestrial denning critical habitat are suitable for denning. Thus, the U.S. Geological Survey mapped common denning habitat characteristics to describe suitable potential terrestrial denning habitat (Durner, Amstrup, and Ambrosius 2001; Blank 2012) along the Beaufort Sea coast, as shown in Figures 3.13.1 and 3.13.2.

1.1.2 Bearded Seal

Bearded seals are benthic feeders, preferring relatively shallow waters with drifting pack ice, where they feed on clams, shrimp, crabs, squid, and fish (Kovacs 2009). Hence, bearded seals typically prefer water depths of 80 to 250 feet in the Beaufort Sea (Stirling, Kingsley, and Calvert 1982). Bearded seals are closely associated with sea ice, and they prefer ice that is constantly in motion, which naturally creates

open areas of water. They prefer broken, drifting pack ice but also use bottom-fast ice (Burns 1983; Kelly 1988).

During winter, bearded seals sometimes concentrate around consistently open leads in the ice and near the edge of pack ice (Kovacs 2009). Sea ice is important for reproduction, molting, and breeding (Cameron et al. 2010). Bearded seals pup on ice in late April or early May, mate after pups are weaned 2 to 3 weeks later, and molt in May and June (Kelly 1988). The primary predator of bearded seals is the polar bear.

As seasonal sea-ice cover retreats in the spring, bearded seals travel northward from the Bering Sea to the Chukchi and Beaufort seas and then back to the Bering Sea in fall and winter when the ice begins to form again (Cameron et al. 2010). Bearded seals are less common in the Beaufort Sea, where only a few overwinter (Burns 1983; MacIntyre et al. 2013). Most of the population disperses widely throughout northern Alaska waters in the open-water season, when some move into the Beaufort Sea (Burns 1983). Suitable habitat in the Beaufort Sea appears to be more limited than in the Chukchi Sea, which supports a higher rate of productivity than the Beaufort Sea (Bengston et al. 2005).

During the open-water season, bearded seals have been documented in Harrison Bay offshore from the Project, albeit in much lower numbers than ringed seals (Tetra Tech EC Inc. 2005, 2006, 2007; LGL 2008, 2011), and a few bearded seals have been documented in the waters near Oliktok Point (LGL 2008, 2011). Bearded seals are uncommon in the shallow waters near the Colville River Delta (CRD) because they tend to prefer drifting ice offshore (Seaman 1981).

1.1.3 Ringed Seal

Ringed seals typically inhabit waters greater than 16 feet deep. Thus, they are not abundant in the nearshore waters immediately off the CRD and barrier islands but are more common farther offshore in Harrison Bay (Seaman 1981). Ringed seals can winter on bottom-fast ice (Kelly, Bengtson, et al. 2010), a habitat not used by other seal species. Ringed seals are strongly associated with sea ice; thus, changes in ice conditions influence their movements, foraging, reproductive behavior, and vulnerability to predation (Kelly, Bengtson, et al. 2010). Arctic ringed seals use sea ice for resting, pupping, and molting; they only rarely come ashore (Kelly, Badajos, et al. 2010; Kelly, Bengtson, et al. 2010).

Ringed seals move northward as ice cover recedes, spending summer far offshore (over 100 miles in some years), and return southward as ice advances in fall (Seaman 1981). Ringed seals forage in the open sea on fish, crustaceans, zooplankton, and invertebrates (Harwood, Smith, and Auld 2012; Kovacs 2007). The ringed seal is the primary prey species for polar bears and also is preyed on by Arctic foxes.

1.2 Noise and Marine Mammals

This section summarizes the properties of underwater noise, which are relevant to understanding the effects of noise produced by construction and operations activities on the underwater marine environment in the analysis area. This document does not provide a detailed calculation to acoustical thresholds of specific Project components proposed under the action alternatives. This detailed information would be analyzed further in a MMPA authorization request and associated ESA Section 7 consultation.

1.2.1 Overview of Acoustics

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air or water. The disturbed particles of the medium move against undisturbed particles causing an increase in pressure. This increase in pressure causes adjacent undisturbed particles to move away, spreading the disturbance away from its origin. This combination of pressure and particle motion makes up an acoustic wave.

The intensity of sound is characterized by decibels (dB). The mathematical definition of a decibel is the base 10 logarithmic function of the ratio of the pressure fluctuation to a reference pressure. Decibels are measured using a logarithmic scale, so sound levels cannot be added or subtracted directly. For example, if a sound's intensity is doubled, the sound level increases by 3 dB, regardless of the initial sound level. Thus: 60 dB + 60 dB = 63 dB, and 80 dB + 80 dB = 83 dB. The decibel measures the difference in orders

of magnitude (× 10), so 10 dB means 10 times the power, 20 dB means 100 times the power, 30 dB means 1,000 times the power, and so on.

Because the decibel is a relative measure, any absolute value expressed in dB is meaningless without the appropriate reference. The metric that describes the change in pressure (amplitude) is the pascal (Pa), approximately equivalent to 0.0001465 pounds per square inch. In this document, all underwater sound levels are expressed in decibels referenced to 1 micro Pascal (dB re 1 µPa) and all airborne sound levels are expressed in dB re 20 µPa. It is possible to convert between the reference pressures, in this instance 26 dB. However, the efficiencies of sound generation and reception in air and water differ greatly, so simply adding a constant to the underwater sound pressure level (SPL) will not allow a reasonable assessment of how the sound is perceived by the receiver. Table E.13.1 summarizes terms commonly used to describe sounds.

The method commonly used to quantify airborne sounds consists of evaluating all frequencies of a sound according to a weighting system that reflects that human hearing is less sensitive at low frequencies and extremely high frequencies than at mid-range frequencies. This is called A-weighting, and the measured level is called the A-weighted sound level (dBA). Sound levels to assess potential noise impacts on terrestrial wildlife, airborne or underwater, are not weighted and measure the entire frequency range of interest, unless specified by an agency.

Hertz (Hz) is a measure of how many times each second the crest of a sound pressure wave passes a fixed point. For example, when a drummer beats a drum, the skin of the drum vibrates a number of times per second. When the drum skin vibrates 100 times per second, it generates a sound pressure wave that is oscillating at 100 Hz, and this pressure oscillation is perceived by the ear/brain as a tonal pitch of 100 Hz. Sound frequencies between 20 and 20,000 Hz (or 20 kilohertz [kHz]) are within the range of sensitivity of the best human ear. The hearing sensitivities of the animals of interest in this document will be discussed for each species below.

As sound propagates out from the source, there are many factors that change the amplitude. These include the spreading of sound over a wide area (spreading loss), loss to friction between particles that vibrate (absorption), and scattering and reflections from objects in the path (including surface or seafloor). The total propagation including these factors is called the transmission loss (TL). In air, TL parameters vary with frequency and type of source, temperature, wind, source and receiver height, and ground type. Underwater, TL parameters vary with frequency and type of source, temperature, wind, sea conditions, source and receiver depth, water chemistry, and bottom composition and topography. For ease in estimating distances to agency thresholds, simple TL can be calculated using logarithmic spreading loss with the formula:

$$TL = B * log10(R)$$

TL is transmission loss, B is logarithmic loss, and R is radius to the threshold

In air, the standard value of B is 20 (or reported as 20 log(R)), resulting in a reduction of 6 dB for every doubling of distance. For underwater TL, there are three common spreading models used by the agencies: 1) cylindrical spreading for shallow water, or 10 log(R), resulting in a reduction of 3 dB for every doubling of distance; 2) spherical spreading for deeper water, or 20 log(R), resulting in a reduction of 3 dB for every doubling of distance; and 3) practical spreading used when agencies have not defined the depth for the other models, or 15 log(R), resulting in a reduction of 4.5 dB for every doubling of distance.

Table E.13.1. Definition of Acoustical Terms

Term	Definition
Decibel, dB	A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. The reference pressure for water is 1 micro Pascal (µPa) and for air is 20 µPa (approximate threshold of human audibility).
Sound exposure level, SEL	Sound exposure level is the total noise energy produced from a single noise event and is the integration of all the acoustic energy contained within the event. SEL incorporates both intensity and duration of a noise event. SEL is expressed in dB re 1 μPa^2-sec.
Sound pressure level, SPL	Sound pressure is the force per unit area, usually expressed in µPa (or 20 micro Newtons per square meter), where 1 Pascal is the pressure resulting from a force of 1 Newton exerted over an area of 1 m^2. The sound pressure level is expressed in decibels as 20 times the logarithm to the base 10 of the ratio between the pressure exerted by the sound to a reference sound pressure. Sound pressure level is the quantity that is directly measured by a sound level meter.
Frequency, Hz or kHz	Frequency is expressed in terms of oscillations, or cycles, per second. Cycles per second are commonly referred to as Hertz (Hz). Typical human hearing ranges from 20 Hz to 20,000 Hz (or 20 kHz).
Peak sound pressure (unweighted)	Peak sound pressure level is based on the largest absolute value of the instantaneous sound pressure over the measured frequency range, reported as dB re 1 µPa for underwater or dB re 20 µPa for airborne.
Root-mean-square, rms	The rms level is the square root of the energy divided by a defined time period. For pulses, the rms has been defined as the average of the squared pressures over the time that comprises that portion of waveform containing 90% of the sound energy for one impulse.
Ambient noise level	The background sound level, which is a composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.

1.2.2 Applicable Noise Criteria

Under the MMPA, the National Marine Fisheries Service and USFWS have defined levels of harassment for marine mammals. Level A harassment is defined as the potential to injure and Level B harassment is defined as the potential to disturb. Table E.13.2 summarizes the thresholds for assessing potential impacts on marine mammals from underwater and airborne sound.

Table E.13.2. Marine Mammal Injury and Disturbance Thresholds for Underwater and Airborne Sound

Marine Mammals	Underwater Injury Threshold (Level A) Impulsive	Underwater Injury Threshold (Level A) Non-Impulsive	Underwater Disturbance Threshold (Level B) Impulsive	Underwater Disturbance Threshold (Level B) Non-Impulsive	Airborne Threshold (Level B)
Low-frequency cetaceans	219 dB L_{pk} 183 dB SEL	199 dB SEL	160 dB rms	120 dB rms	N/A
Mid-frequency Cetaceans	*230 dB L_{pk}* 185 dB SEL	198 dB SEL	160 dB rms	120 dB rms	N/A
High-frequency cetaceans	202 dB L_{pk} 155 dB SEL	173 dB SEL	160 dB rms	120 dB rms	N/A
Phocid pinnipeds	218 dB L_{pk} 185 dB SEL	201 dB SEL	160 dB rms	120 dB rms	90 dB rms
Otariid pinnipeds	232 dB L_{pk} 203 dB SEL	219 dB SEL	160 dB rms	120 dB rms	100 dB rms
Polar bears, walrus, sea otters	190 dB rms	180 dB rms	160 dB rms	160 dB rms	N/A

Note: All underwater sound levels are reported as decibels referenced to 1 microPascal (dB re 1 µPa) and all airborne sound levels are reported as dB re 20 µPa. Peak (L_{pk}) is instantaneous maximum sound level; sound exposure level (SEL) is the accumulative sound energy over a 24-hour period; root-mean-square (rms) is the arithmetic mean of the squares of the measured pressure of the sound. N/A (not applicable).

1.2.3 Airborne Acoustic Environment of Beaufort Sea

The airborne acoustic environment is characterized in the Willow MDP EIS, Section 3.6, *Noise*.

1.2.4 Underwater Acoustic Environment of Beaufort Sea

The underwater acoustic environment consists of sounds from natural, biologic, and anthropogenic sources. Underwater sound levels in the ocean vary over time, as these sources fluctuate on daily, seasonal, and annual scales. Natural sources include geologic processes, earthquakes, wind, thunder, rain, waves, ice, etc. Biologic sources include marine mammals and fish. Anthropogenic sounds are those generated by human including vessels, scientific research equipment, aircraft, and offshore industrial activities.

The Beaufort Sea has a narrow continental shelf that drops off to the north into the Beaufort Sea Plateau, a deep basin with depths of 6,500 to 10,000 feet, allowing for long-range propagation of high amplitude, low frequency sounds. The module delivery options are all in very shallow waters of Harrison Bay. Generally, underwater sound levels in shallow waters increase with increasing wind speed (Wenz 1962). Marine mammal vocalizations and anthropogenic sounds have been measured using seafloor-mounted passive acoustic monitoring devices since the late 1970s. The typical reported ambient levels range from 77 to 135 dB re 1 µPa (LGL Alaska Research Associates Inc., Greeneridge Sciences, and Jasco Applied Sciences 2013; Greene Jr., Blackwell, and McLennan 2008) with general ambient conditions approximately 120 dB re 1 µPa. For consideration of underwater noise effects from Project-related noise sources, the analysis assessed the distance needed for a noise source to attenuate to the underwater background sound level of 120 dB re 1 µPa.

1.2.5 Description of Underwater Sound Sources

The acoustic characteristics of each of the Project activities are described in the following section and summarized in Table E.13.3. Aspects of module transfer island construction that have the potential to incidentally harass marine mammals are the airborne noise generated by vibratory and impact pile driving during winter (through bottom-fast ice), some construction activities through ice, and vessels. Pile removal (through vibration or cutting) when the island is decommissioned would have the potential to incidentally harass marine mammals by airborne and underwater noise. Barges and support vessels would also generate underwater and airborne noise, but with a lesser intensity.

Table E.13.3. Summary of Noise Sources

Activity	Airborne Sound Level (dBA re 20 µPa)	Underwater Sound Level (dB re 1 µPa)	Frequency	Reference
Impact driving of pipe piles	101 dBA at 50 feet	185 dB rms at 32.8 feet 195 dB peak at 32.8 feet	Range: 100–4,000 Hz Concentration: 125 Hz	Airborne: USDOT 2006 Underwater: Illingworth and Rodkin 2007
Vibratory driving of pipe piles	101 dBA at 50 feet	150 dB rms at 32.8 feet 165 dB peak at 32.8 feet	Range: 100–4,000 Hz Concentration: 125 Hz	Airborne: USDOT 2006 Underwater: Illingworth and Rodkin 2007
Vibratory pile removal	101 dBA at 50 feet	129 dB at 328 feet	Range: 10–10,000 Hz	Airborne: USDOT 2006 Underwater: Pangerc et al 2017
Vibratory driving of sheet piles	81 dBA at 328 feet	143 dB rms at 328 feet	Range: 10–10,000 Hz Concentration: 24-25 Hz	Greene et al. 2008
Screeding (tug & barge)	NA	164-179 dB rms at 3.28 feet	Range: 10–10,000 Hz Concentration: 10–2,000 Hz	Blackwell and Greene 2003
Ice trenchers (bulldozer)	64.7 dBA at 328 feet	114 dB rms at 328 feet	Range: 10–8,000 Hz Concentration: 31–400 Hz	Greene et al. 2008
Grading excavators (backhoe)	78 dBA at 50 feet	125 dB rms at 328 feet	Range: 10–8,000 Hz Concentration: 31-400 Hz	Airborne: USDOT 2006 Underwater: Greene et al. 2008
Ditchwitch	76.3 dBA at 328 feet	122 dB rms at 328 feet	Range: 10-8,000 Hz Concentration: 20–400 Hz	Greene et al. 2008
General vessel operations	NA	145-175 dB rms at 3.28 feet	10–1,500 Hz	Richardson et al. 1995; Blackwell and Greene 2003

Note: dB (decibels); dB re 1 µPa (decibels referenced to 1 micro Pascal); dBA (A-weighted decibels); Hz (Hertz); NA (not applicable); rms (root-mean-square); USDOT (U.S. Department of Transportation)

1.2.5.1 Impact Pile Driving

The U.S. Department of Transportation (USDOT's) Construction Noise Model Handbook provides a summary of equipment with measured maximum airborne sound levels at 50 feet (15 m). The handbook reports an airborne level of 101 dBA at 50 feet (15 m) for impact pile driving.

1.2.5.2 Vibratory Pile Driving and Removal

Illingworth and Rodkin (2007) reported SPLs of 12-inch H-piles are 150 dB rms and 165 dB peak re 1 µPa at 32.8 feet. Greene et al. (2008) measured underwater sound, airborne sound, and iceborne vibrations associated with construction of Northstar Island (~39 feet depth). For vibratory pile driving of sheet piles, they reported underwater levels of 142.9 dB re 1 µPa at 328 feet (100 m) with energy between 10 and 10,000 Hz and concentrated at 25 Hz. They reported airborne levels of 81 dB at 328 feet (100 m) with the energy between 10 and 10,000 Hz and concentrated at 50 Hz. Airborne sound levels associated with pile removal is the same as installation. Underwater sound is slightly lower for removal than installation (Table E.13.3).

1.2.5.3 Underwater Construction

Seabed preparation may use a barge with a screeding device. Blackwell and Greene (2003) reported a source level of 164 dB re 1 µPa rms at 3.28 (1 m) feet for the tug *Leo* pushing a full barge near the Port of Anchorage. The source level increased to 179 dB re 1 µPa rms at 3.28 feet (1 m) when the tug was using its thrusters to maneuver the barge during docking. Most of the sound energy is in the band of 100 to

2,000 Hz with a large peak at 50 Hz. There are no measurements available in Alaska of screeding, so these levels are used as a proxy for characterization of these activities.

In their analysis of Northstar Island, Greene et al. (2008) measured an underwater sound level of a bulldozer at 114.2 dB re 1 µPa rms at 328 feet (100 m), a backhoe at 124.8 dB re 1 µPa rms at 328 feet (100 m), and a ditchwitch at 122 dB re 1 µPa rms at 328 feet (100 m) with the center frequency between 10 and 63 Hz. They reported that broadband sounds from these activities diminished to the median background level of 77 to 116 dB re 1 µPa rms (10 to 10,000 Hz range) at distances between 0.62 and 3.1 miles (1 and 5 kilometers).

The measured airborne level of the bulldozer and ditchwitch were 64.7 dB and 76.3 re 20 µPa rms at 328 feet (100 m), respectively; and airborne sound associated with the backhoe was not measured Greene et al. (2008). The USDOT's Construction Noise Model Handbook provides a summary of equipment with measured maximum levels at 50 feet. The handbook reports an airborne level of 78 dBA at 50 feet.

1.2.5.4 Vessels

Some vessels such as tugs and cargo ships can under some circumstances generate underwater sound exceeding the non-impulsive threshold of 120 dB due largely to the continuous cavitation sound produced from the propeller arrangement of both drive propellers and thrusters. Large ships produce broadband SPLs of about 180 dB re 1 µPa rms at 3.28 feet (1 m) (Richardson et al. 1995; Blackwell and Greene 2003). Thrusters have generally smaller blade arrangements operating at higher rotations per minute (rpm) and, therefore, largely produce more cavitation sound than drive propellers.

1.2.6 Calculation of Distances to Thresholds

A detailed analysis of impacts to marine mammals would be included in the MMPA authorization request. For purposes of this EIS, distances from construction activities were estimated to the 120 dB underwater and 90 dB airborne thresholds. Assuming a TL of 20 log(R) for both media, the estimated distances to the underwater and airborne thresholds are summarized in Table E.13.4. Airborne noise from construction activities would be below the 90-dB airborne threshold within 175 feet for all activities, and less than 75 feet for the non-pile-driving activities. Underwater noise from construction activities such as use of a backhoe, dozer, or ditchwitch would be below the 120-dB threshold between 164 and 583 feet from the source. The estimated distance for impact pile driving is approximately 11 miles assuming only simple spreading loss, but actual levels would be expected to be below background within 2.5 miles because of the depth of activity.

Table E.13.4. Estimates of Noise Levels to Thresholds by Activity

Activity	Distance to 90 dB airborne threshold (feet)	Distance to 120 dB underwater threshold (feet)
Impact pipe pile driving[a]	175	NA
Vibratory pipe pile driving	175	1,037
Vibratory sheet pile driving	116	4,633
Bulldozer	18	164
Backhoe	12	583
Ditchwitch	68	413
Vessel	NA	1,844

Note: NA (not applicable)

[a] Typically impact pile driving is evaluated for distances to a 160-dB threshold, in which case the distance for impact pile driving to reach that threshold is estimated to be 583 feet.

1.3 Comparison of Alternatives: Marine Mammals

Tables E.13.5 and E.13.6 summarize impacts to marine mammals from action alternatives and module delivery options.

Table E.13.5. Comparison of Project Impacts That May Affect Marine Mammals by Action Alternative and Module Delivery Option

Impact	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Road	Alternative D: Disconnected Access	Option 1: Proponent's Module Transfer Island	Option 2: Point Lonely Module Transfer Island
Pipe piles below OHW (number)	56	36	52	9	9
Bridges (number)	7	6	6	NA	NA
Sheet pile (number)	0	0	0	685	685
Acres of ice infrastructure[a]	2,872.3	3,400.3	4,451.2	1,446.1	2,775.8
Acres of multi-season ice pad	30.0	30.0	25.8[b]	30.0	30.0
Acres of gravel fill	442.7	487.8	410.7	12.8	13.0
Acres of fill in polar bear potential terrestrial denning habitat	0.6	0.5	0.6	NA	NA
Acres of fill in polar bear critical habitat	0	0	0	12.8	13.0
Acres of ice infrastructure in polar bear critical habitat	1.5	2.0	1.5	378.3	189.9
Acres of disturbance (within 0.5-mile of in-water work, USFWS buffer)	NA	NA	NA	669.4	631.2
Acres of disturbance (potential terrestrial denning habitat within 1-mile of winter activity, USFWS buffer)	853.5	857.5	851.5	1,032.8	1,397.0
Nearest known polar bear den to gravel infrastructure (miles)	3.0	3.0	3.0	3.5	8.7
Nearest known polar bear den to ice infrastructure (miles)	6.2	6.2	6.2	<0.1	<0.1

Note: NA (not applicable); OHW (ordinary high water); USFWS (U.S. Fish and Wildlife Service). A comparison ground, air, and marine traffic is provided in Table E.11.8 in Appendix E.11, *Birds Technical Appendix*.

[a] Total acres ice infrastructure includes freshwater and seawater ice infrastructure; includes multi-season ice pads in total.

[b] Alternative D would construct 30.0 total acres of multi-season ice pads but 4.2 acres would be filled with gravel.

Table E.13.6. Comparison Marine Mammals from Module Delivery Options

Project Component	Effect to Marine Mammals	Option 1: Proponent's Module Transfer Island	Option 2: Point Lonely Module Transfer Island
Gravel fill in marine area	Habitat loss Temporary habitat alteration from sedimentation or turbidity Disturbance or displacement from noise during gravel recontouring in summer	12.8 acres lost 11 to 15 acres altered 125 dB rms at 328 feet (100 m) from the source	13.0 acres lost 11 to 15 acres altered 125 dB rms at 328 feet (100 m) from the source
Pile & sheet pile installation[a]	Disturbance or displacement from airborne noise in winter	Noise detailed in Table E.13.3	Same as Option 1
Pile & sheet pile removal	Disturbance or displacement from airborne and underwater noise in summer	Noise detailed in Table E.13.3 9 pipe piles 200 feet of sheet piles (685 total sheet pile)	Same as Option 1
Screeding	Temporary habitat alteration Disturbance or displacement from noise or human activity Displacement of benthic prey	4.9 acres altered, 2 occurrences 164–179 dB rms at 3.28 feet (1 m) Fish entrained in screeded material would no longer be available as forage	Same as Option 1
Acres of ice infrastructure	Habitat alteration due to compressed ice and snow	Total acres: 1,445.5 Onshore: 109.9 miles of ice road (1,247.3 acres) and 108.0 acres of ice pads Offshore: 7.2 miles of ice roads (90.2 acres) 378.3 acres of ice in terrestrial denning critical habitat	Total acres: 2,775.7 Onshore: 227.9 miles of ice road (2,570.1 acres) and 183.1 acres of ice pads Offshore: 1.8 miles of ice roads (22.5 acres) 189.9 acres of ice in terrestrial denning critical habitat
Barge traffic	Disturbance or displacement from noise and human activity	Temporary disturbance along nearshore barge route ~600 more miles of sealift barge traffic[b] 145–175 dB rms at 3.28 feet (1 m) from the source	Temporary disturbance along nearshore barge route ~22,400 more miles of support vessel traffic[b] 145–175 dB rms at 3.28 feet (1 m) from the source

Note: dB (decibels); rms (root-mean-square); m (meter)
[a] No underwater noise anticipated from pile and sheet-pile installation since gravel would be placed and piles would be driven through bottom-fast ice.
[b] Both options would have the same number of trips, but distance traveled would vary by module delivery option. Atigaru Point is approximately 50 miles from Point Lonely. Six roundtrip barge trips over that distance is 600 miles. Barges would travel from southern Alaska. Support vessels would originate at Oliktok Point; 224 roundtrip support vessel trips over 50 miles is 22,400 miles.

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Willow Master Development Plan

Appendix E.14
Land Ownership and Use Technical Appendix

There is no technical appendix for this resource

August 2019

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Willow Master Development Plan

Appendix E.15
Economics Technical Appendix

August 2019

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Memorandum

Date: May 22, 2019

To: Kristen Hansen, DOWL

From: Patrick Burden and Leah Cuyno

Re: Economic Analysis of Proposed Alternatives for the Willow Master Development Plan EIS

DOWL requested Northern Economics to quantify the potential economic impacts of the proposed alternatives being considered for the Willow Master Development Plan (MDP) EIS. The results of this economic impact analysis will be used to inform the environmental consequences section of the EIS.

This memorandum transmits the results of the economic impact analysis and describes the approach, assumptions, and data used in the analysis.

Scope of Analysis

Project Alternatives

For the purpose of this quantitative analysis, only the action alternatives are analyzed-- Alternatives B, C, and D. Note that Alternative A, is the No Project alternative; no development will occur under this alternative and the existing or baseline economic conditions will continue.

Alternative B is the *Proponent's Project* alternative.

Alternative C is described as the *'disconnected infield roads'* alternative.

Alternative D is described as the *'disconnected access'* alternative.

Alternative C is being considered to reduce effects to caribou movement and decrease the number of stream crossings required; this is also intended to further reduce impacts to subsistence users.

Alternative D is being considered to minimize the length of linear infrastructure on the landscape and provide another strategy to decrease effects to caribou movement and subsistence.

The project components and features of these 3 action alternatives are shown in Figure 1. The proposed development scenarios for all three action alternatives include 5 drill sites, a central processing facility, airstrip/s and operations center, gravel roads, and pipelines. However, certain features, particularly with respect to location and access vary depending on the alternative. For example, Alternative C removes a portion of the infield road (versus Alternative B) that crosses Iqalliqpik (Judy) Creek which could impede caribou movement across linear features (i.e., this alternative would avoid the junction of two roads, which could be a pinch point that deflects caribou movement).

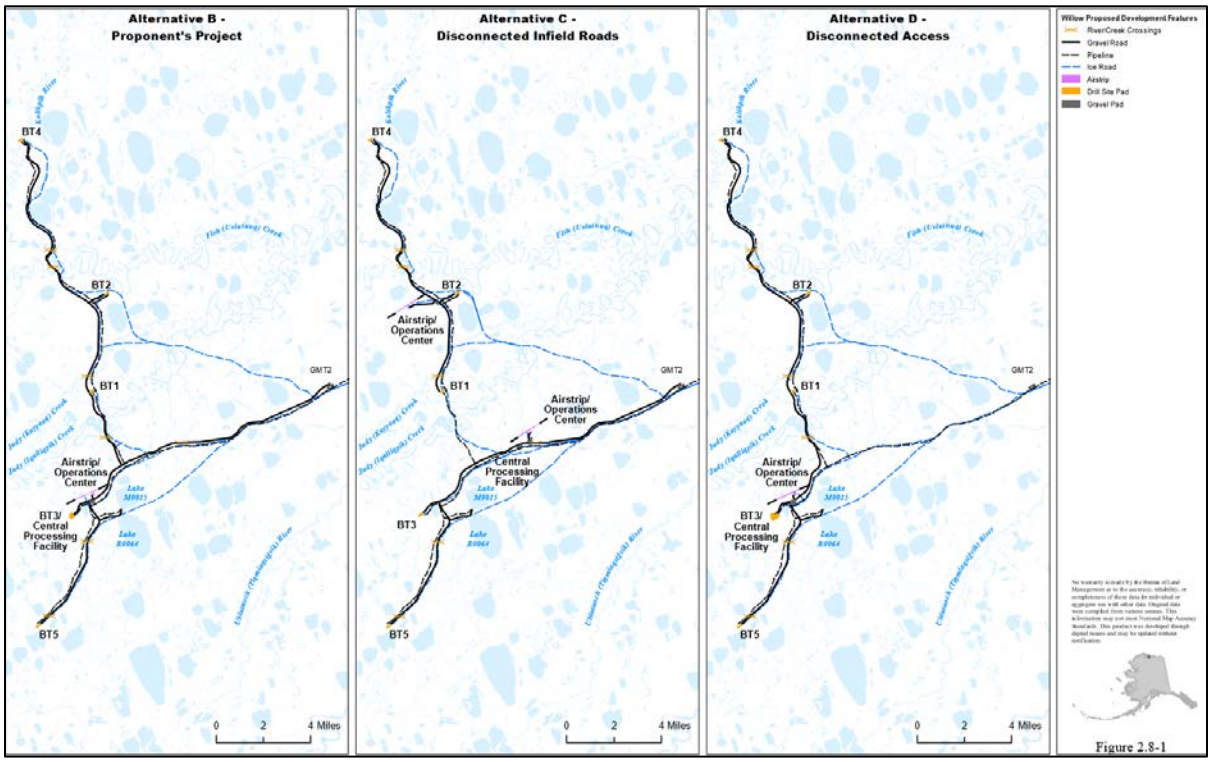
Under Alternative C, the Willow Processing Facility (WCF), South operations center, and primary airstrip would be located approximately 5 miles east of their location in Alternative B, near the Greater Mooses Tooth Unit (GMTU) and Bear Tooth Unit (BTU) boundary. A second airstrip and operations center would be located near BT2 to accommodate personnel and materials transported between the South operations center and BT1, BT2, and BT4 (see Figure 1).

Alternative D, on the other hand, would not be connected by an all-season gravel access road to GMTU; however, it would employ the same gravel infield roads as proposed under Alternative B.

In addition to the facilities described above, a total of 6 sealift barges are anticipated for the Project to deliver large, prefabricated modules to the North Slope. Two module delivery options have been identified—at Atigaru Point and at Point Lonely, both options would involve construction of a temporary gravel island with a 5- to 10-year design life.

These alternatives are described in more detail in Chapter 2 of the EIS document.

Figure 1. Willow Proposed Development Features of the Three Action Alternatives: B, C, and D



Source: Project Description, Draft Willow MDP EIS, 2019.

Economic Indicators

This analysis quantifies the potential economic effects or consequences of the Project alternatives with respect to the following economic indicators:

1. **Potential Revenues.** This analysis provides estimates of the following potential government revenue streams--
    - State of Alaska: Royalty Revenue, Property Tax, Production Tax, Oil Surcharge, Corporate Income Tax.
    - Federal Government: Royalty Revenue, Corporate Income Tax, Gravel sales
    - North Slope Borough: Property Tax
2. **Potential Employment.** This analysis provides estimates of the direct, indirect, and induced employment effects associated with the construction phase and operations phase of the proposed Project alternatives. Employment effects reflect the total number of average part-time and full-time jobs resulting from the proposed construction and production (operations) activities.

3. **Potential Labor Income.** This analysis provides estimates of the potential labor income effects associated with the construction phase and operations phase of the proposed Project alternatives.

Approach, Assumptions, and Data

Estimating Potential Revenues

To quantify the potential streams of government revenues, the cash-flow model originally developed by the Alaska Department of Natural Resources (DNR) for evaluation of oil and gas projects in the Alaska North Slope was adapted and modified to reflect the Willow MDP EIS project alternatives. The DNR model is based on the current fiscal regime and contains input cells that are fixed due to statutes or regulations; the major fiscal model parameters are shown in the table below.

Table 1. Alaska Fiscal Model Parameters

Category	Definition (Alaska Statute)	Value
Conservation Surcharges ($/barrel)	*43.55.201, 43.55.300*	$0.05
North Slope Oil Tax		
Production Tax Rate on PTV	*43.55.011 (e)*	35%
$/BOE QCE exclusion ($/barrel)	*43.55.165 (e)(18)*	$0.30
Overhead allowance for lease expenditures	*43.55.165 (a)(2), 15 AAC 55.271*	4.5%
Minimum tax		
Minimum Gross Tax (applied on GVPP)	*43.55.011 (f)*	4.0%
Oil and Gas Property Tax		
Property Tax Rate	*43.56.010*	2.0%
Gross Value Reduction on "New Oil"		
GVR %	43.55.160 (f)	20.0%
Additional GVR % (New field, ROY>12.5%)	43.55.160 (f &g)	30.0%
GVR Year Limit	*43.55.160 (f)*	7
GVR Oil Price limit: 3 years with ANS price above	*43.55.160 (f)*	$70.00
State and Federal Income Tax		
State Income Tax		9.40%
Federal Income Tax		21.00%

The major inputs and assumptions used in the model to reflect the proposed project include:

1. Capital Expenditures (CAPEX)

Over the last 10 years Northern Economics, Inc. (NEI) has been working on projects for the U.S. Bureau of Ocean Energy Management, the U.S. Bureau of Land Management, the Alaska Gasline Development Corporation, as well as companies operating on the North Slope of Alaska, to estimate the effects of oil and gas development on local communities, the regional entities, and the State of Alaska. As part of these projects, NEI has often conducted surveys of operating companies and those providing support to the operating companies on shore and offshore, plus being provided with proprietary data from company specific projects.

The facility CAPEX estimates presented in this memo are based on data from five proprietary project CAPEX estimates that had central processing facilities. The CAPEX estimates were adjusted to fit the

specification required by the DNR cash-flow model, and a linear regression equation for CAPEX was developed based on total volume of oil and natural gas liquids (NGLs) produced over the life of the field, and whether the project had seasonal access. The regression equation has the form of seasonal access (1 if seasonal access, 0 if year-round access) * 810.215935 + million barrels of oil and NGLs produced (MMBO) * 0.630787 + 4137.326. The equation has a coefficient of determination (r^2) of 0.60.

Drilling CAPEX was estimated using the same variables as the facility CAPEX. The drilling regression equation has the form of seasonal access * 27.9 + MMBO * 1.230835 + 2781.832. The equation has a coefficient of determination (r^2) of 0.72.

The estimated drilling and facilities capital expenditures are shown in the table below.

Table 2. Estimated Capital Expenditures by Alternative, in millions of 2019 $

Capital Expenditure Item:	Alternatives B and C	Alternative D
Drilling	$3,536	$3,513
Facilities	$5,320	$5,308
Total:	**$8,856**	**$8,821**

Source: Northern Economics estimates.

2. Operating Expenditures (OPEX)

OPEX was also estimated using the same variables as noted above for CAPEX. The OPEX regression equation has the form of seasonal access * -5587.9272 + MMBO * 0.194248 + 10040.11. The regression equation has a coefficient of determination (r^2) of 0.99.

The total cumulative operating expenditures for Alternatives B and C are estimated to amount to $4.9 billion, and $4.4 billion for Alternative D.

3. Crude Oil Price Forecasts

Two oil price projections were used in this analysis to provide a range of estimates for the potential revenue effects— 1) the latest U.S. Energy Information Administration (EIA) oil price projections published in the *Annual Energy Outlook 2019* on January 24, 2019, and 2) the latest Alaska Department of Revenue (ADOR) oil price projections published in the *Fall Revenue Sources Book 2018* in December 14, 2018.

The ADOR oil price forecast reflects a more conservative price forecast (at $62.03 per barrel in real 2018$, average over 2019 to 2029 period) while the EIA price forecast reflects a higher oil price scenario (at $95.56 per barrel in real 2018$, average over 2019 to 2050). The ADOR forecast is a 10-year forecast through 2029 and the EIA forecast is through year 2050. Prices beyond the timeframe published were extrapolated using the cumulative annual growth rate provided in the 10-year forecast.

4. Netback Costs: Tariffs/Transportation Costs

For royalty calculations, oil is valued at the wellhead, hence, netback costs which include marine transportation cost, quality adjustment, TAPS tariff, and pipeline and feeder line tariffs, are deducted from the projected market price. Estimates of netback costs used in this analysis are from the Alaska Department of Revenue's Fall Revenue Sources Book 2018; except for the feeder line tariff data which was obtained from the Alaska Department of Natural Resources, Division of Oil and Gas.

5. Projected Annual Production Volumes

The table below shows the projected oil production in millions of barrels of oil per year (MMBO) by alternative. Note that Alternatives B and C have the same production profile while Alternative D has a different production profile partly due to the longer construction period because of the absence of year-round transportation access. All Alternatives have a 26-year production life with Alternative D having slightly less total production volumes than Alternatives B and C.

Table 3. Annual Production Volumes in millions of barrels of oil (MMBO)

Year	Alternative B	Alternative C	Alternative D
2024	1.46	1.46	
2025	17.01	17.01	
2026	31.13	31.13	16.43
2027	41.18	41.18	31.13
2028	46.88	46.88	41.18
2029	47.68	47.68	46.88
2030	45.25	45.25	47.68
2031	40.39	40.39	45.25
2032	35.74	35.74	40.39
2033	33.96	33.96	35.74
2034	32.65	32.65	33.96
2035	30.63	30.63	32.65
2036	28.71	28.71	30.63
2037	26.95	26.95	28.71
2038	24.00	24.00	26.95
2039	19.64	19.64	24.00
2040	15.94	15.94	19.64
2041	13.32	13.32	15.94
2042	11.20	11.20	13.32
2043	9.83	9.83	11.20
2044	8.56	8.56	9.83
2045	7.00	7.00	8.56
2046	5.69	5.69	7.00
2047	4.79	4.79	5.69
2048	4.18	4.18	4.79
2049	3.74	3.74	4.18
2050	3.41	3.41	3.74
2051			3.25
2052			2.92

Source: CPAI, 2019.

Estimating Employment and Income Effects

Direct manpower requirements for the Willow MDP were estimated by CPAI and presented in this memorandum. The potential indirect and induced employment and income effects for this analysis were estimated using the IMPLAN model of the Alaska economy. The IMPLAN model is an input-output model that is commonly used in economic impact studies to measure the multiplier effects/stimulus effects of an economic development project.

The estimates of industry spending on capital expenditures (CAPEX; construction costs) and on operating expenditures (OPEX) for each of the project alternatives, as described above, were used as inputs for the model. The IMPLAN model provides estimates of the number of part-time and full-time indirect and induced jobs required to meet the increase in demand for goods, materials, and services during the construction and the operations phases of the proposed project. These indirect and induced jobs (and associated income) are considered the multiplier effects or stimulus effects that result from the increase in demand in various industries/sectors in the Alaska economy, particularly those that support the construction sector, and the oil and gas extraction/production sector (indirect effects), as well as all the other sectors that provide goods and services to the industry workers (induced effects).

The IMPLAN model provides estimates of indirect and induced labor income based on information on average Alaska wages and salaries in the various sectors of the economy.

Results

Projected Government Revenues

The Willow MDP is projected to generate revenues to the federal government, the State of Alaska, and the North Slope Borough from royalties, taxes, and other fees. The projected revenues by revenue stream and by Alternative are presented in the table below. The values shown in the table reflect the estimated total cumulative revenues through the end of the production life of the field.

Table 4. Estimated Potential Revenues of the Willow MDP EIS Alternatives

Revenue Category	Alternative B		Alternative C		Alternative D	
	DOR Price	EIA Price	DOR Price	EIA Price	DOR Price	EIA Price
State of Alaska						
Royalty Revenue	$2,529.3	$4,212.2	$2,529.3	$4,212.2	$2,479.7	$4,056.6
Property Tax	$156.4	$156.4	$156.4	$156.4	$156.6	$156.6
Production Tax	$671.7	$6,115.3	$671.7	$6,115.3	$774.8	$5,946.8
Oil Surcharge	$24.6	$24.6	$24.6	$24.6	$24.1	$24.1
Corporate Income Tax	$869.2	$1,939.1	$869.2	$1,939.1	$866.1	$1,861.9
Total:	**$4,251.2**	**$12,447.6**	**$4,251.2**	**$12,447.6**	**$4,301.1**	**$12,046.0**
Federal Government						
Royalty Revenue	$2,529.3	$4,212.2	$2,529.3	$4,212.2	$2,479.7	$4,056.6
Corporate Income Tax	$1,889.5	$4,054.9	$1,889.5	$4,054.9	$1,872.0	$3,887.6
Gravel sales	$9.9	$9.9	$11.2	$11.2	$10.7	$10.7
Total:	**$4,428.7**	**$8,277.0**	**$4,430.0**	**$8,278.3**	**$4,362.4**	**$7,955.0**
North Slope Borough						
Property Tax	$1,929.4	$1,929.4	$1,929.4	$1,929.4	$1,931.0	$1,931.0

Source: Northern Economics estimates.

At the State level, there are several potential sources of revenues that would be generated from the proposed development. Production from the Willow development would result in royalties paid to the federal government, and State of Alaska would receive 50 percent of those royalties. The federal royalty

rate is 16.67 percent of the wellhead value. Total estimated cumulative state royalties range from $2.5 billion to $4.2 billion under Alternatives B and C; Alternative D is estimated to result in lower royalties.

The state would receive property tax payments on onsite facilities and these revenues would start accruing during the construction phase. Total State property tax revenues are projected to amount to a little over $156 million under all Alternatives.

Oil produced and sold from lands within Alaska are subject to a severance tax as the resources leave the land. This severance tax is commonly referred to as the "production tax." The production tax applies to oil produced from any area within the boundaries of the state, including lands that are owned by the state, the federal government (like NPR-A), or private parties, such as Native corporations. Severance tax or production tax payments are based on the current tax rate of 35 percent of the production value, which is the value at the point of production, less all qualified lease expenditures (net value). Qualified lease expenditures include certain qualified capital and operating expenditures. Total production taxes are estimated to range from $672 million to over $6 billion, depending on the oil price, under Alternatives B and C. Estimated production taxes under Alternative D are slightly higher under the DOR price case relative to Alternatives B and C because of the State's fiscal provisions particularly with respect to the loss carry-forwards and tax credits.

An oil and gas corporation's Alaska income tax liability depends on the relative size of its Alaska and worldwide activities and the corporation's total worldwide net earnings. State corporate income tax is calculated as 9.4 percent of the Alaska share of worldwide income for each corporation. The ADNR model, however, does not take into consideration corporate worldwide income (which is unknown at this time) but simply evaluates all the costs and revenues and the resulting state income tax given the 9.4 percent income tax rate. Total estimated state corporate income tax payments could range between $869 million and $1.9 billion under Alternatives B and C. In addition, the state would also receive oil surcharge revenues estimated to amount to about $24 million. Conservation surcharges apply to all oil production in Alaska and are in addition to oil and gas production taxes. Revenues derived from these surcharges are intended to be used for oil and hazardous substance release prevention and response

At the Federal level, projected federal royalty revenue, corporate income taxes, and gravel royalties could amount to between $4.4 billion and $8.3 billion through 2050 under Alternatives B and C. Total federal revenues are estimated to be lower under Alternative D.

At the regional level, the NSB government is anticipated to benefit from property tax revenues. The property tax would be based on the assessed valuation of the facilities developed onsite. The annual levy is based on the full and true value of property taxable under AS 43.56. For production property, the full and true value is based on the replacement cost of a new facility, less depreciation. The depreciation rate is based on the economic life of proven reserves. Pipeline property is treated differently; it is valued on the economic value of the property over the life of the proven reserves. The State property tax rate is 20 mills. A local tax is levied on the state's assessed valued for oil and gas property within a city or borough and is subject to local property tax limitations. The current tax rate for the NSB is 18.5 mills (hence, the state portion of the property tax is 1.5 mills). Property tax payments would start to accrue during the construction phase. Total cumulative NSB property tax revenues are estimated to amount to $1.9 billion under Alternatives B and C, and slightly higher under Alternative D due to the longer construction schedule for this alternative.

The City of Nuiqsut could also potentially benefit from higher bed tax revenues from higher hotel occupancy during the initial construction years while mobilization of construction equipment is occurring and even during operations. The City of Nuiqsut currently has a 12 percent bed tax. The change in the level of hotel occupancy however is difficult to quantify at this point because the timing and level of activities are uncertain and may vary. The City also has a tobacco tax that could generate additional revenues for the City. Furthermore, the City of Nuiqsut would be eligible to receive funds

through the NPR-A Impact Mitigation Grant Program, which is funded by royalty and other revenues from leases in the NPR-A. As noted above, production from the Willow development is anticipated to generate royalties that would significantly increase funds for the NPR-A Impact Mitigation Grant Program.

Projected Employment and Income Effects

Table 5 presents the direct manpower requirements during the construction phase of the proposed development. These estimates are specific to the Proponent's Project alternative and were estimated by CPAI. Peak construction employment is anticipated to occur in 2022 with about 1,600 jobs (seasonal peak) or 800 jobs (annual average). The jobs created during the construction phase would be temporary, with some activities only occurring over several months (i.e. ice road construction). In addition to these construction jobs, drilling activities that are anticipated to occur from 2023 to 2035, are estimated to generate 140 jobs annually (including the completions spread).

Direct construction and drilling activities would also support on average about 2,300 indirect and induced part-time and full-time jobs per year in other sectors of the state's economy over the construction phase (under Alternatives B and C). Alternative D would result in slightly lower indirect and induced jobs (about 2,100), mainly due to slightly lower estimated construction spending under this alternative.

Table 5. Estimated Number of Direct Construction Jobs: Proponent's Project Alternative

Year	Seasonal Peak	Annual Average
2020	40	25
2021	375	225
2022	1,600	800
2023	1,200	775
2024	925	625
2025	550	250
2026	800	410
2027	500	235
2028	60	35

Source: CPAI, 2019.

During the operations phase, annual operations and maintenance activities are estimated to generate 350 direct jobs; these will include direct North Slope positions as well as direct CPAI positions based in Anchorage (CPAI, 2019). These operations and maintenance jobs would mostly be year-round but there will be some jobs associated with production activities that will also be seasonal in nature.

In addition to the direct jobs, annual operations and maintenance activities are projected to create an additional 360 indirect and induced jobs per year.

These estimated jobs are available for workers residing in the North Slope, other areas of Alaska, and outside Alaska. It is unknown at this time how many workers from North Slope communities and other Alaska communities would participate in the direct oil and gas activities. According to the Alaska Department of Labor and Workforce Development, over the past decade, the share of oil industry workers who are not Alaska residents has grown, ranging from 28 percent nonresident in 2009 to 37 percent in 2016. This percentage of non-resident workers could change in the future, depending on availability of training programs and labor supply.

Oil field development projects in the North Slope typically require specialty tradesmen and construction workers with the skills and experience in ice roads, pipeline construction, facilities construction, and drilling; and these jobs are typically held by non-local workers. However, opportunities do exist for

North Slope residents that live near existing oil developments. Local residents have participated in oil and gas jobs such as ice road monitors, camp security and facilities operators, and subsistence representatives. The Alaska Department of Labor and Workforce Development and the oil and gas industry have training programs geared towards developing special skills required in oilfield services. This is expected to create more employment opportunities for local residents.

Table 6 shows the prevailing average yearly earnings of workers in various industries in Alaska that are associated with the direct construction and operations jobs described above. The table shows that direct oil and gas industry jobs currently pay about $150,000 per year; and the oil and gas extraction sector paying even more at approximately $225,000 per year.

Note that a direct oil and gas industry worker either works for an oil producer or an oilfield service company. Thousands of other jobs that directly serve the oil and gas industry but are not categorized under this sector are generally included in the Support Activities for Mining sector; some of these jobs are in security, catering, accommodations, transportation, and logistics services.

Indirect and induced jobs, on the other hand, would be jobs in a variety of other sectors of the Alaska economy that provide goods and services to the oil and gas industry and its direct workers. The projected annual average earnings associated with these indirect and induced jobs are estimated to be about $57,000.

Table 6. Prevailing Statewide Average Annual Earnings by Selected Industries associated with the Direct Construction and Operations Jobs

Industry	Average Annual Earnings
Oil and Gas Industry	$147,584
Oil and Gas Extraction	$224,827
Support Activities for Mining	$101,136
Construction (industry-wide average)	$78,872
Construction of Buildings	$72,560
Heavy Construction	$103,616
Specialty Trade Contractors	$68,897

Source: ADOLWD, 2019.

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Willow Master Development Plan

Appendix E.16
Subsistence and Sociocultural Systems Technical Appendix

August 2019

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List of Acronyms

ATV	all-terrain vehicle
CRD	Colville River Delta
NSB	North Slope Borough
Project	Willow Master Development Plan Project
SRB&A	Stephen R. Braund and Associates

Glossary Terms

Direct effects analysis area – All subsistence use areas within 2.5 miles of Willow Master Development Plan Project infrastructure.

Household – One or more individuals living in one housing unit, whether or not they are related.

Subsistence use areas – The geographic extent of a resident's or community's use of the environment to conduct traditional subsistence activities.

Subsistence – A traditional way of life in which wild renewable resources are obtained, processed, and distributed for household and community consumption according to prescribed social and cultural systems and values.

1.0 SUBSISTENCE USES OF NUIQSUT AND UTQIAĠVIK

This appendix provides detailed data tables, figures, and discussion related to Nuiqsut and Utqiaġvik (Barrow) **subsistence** uses. The following sections provide a brief introduction to Iñupiat subsistence harvesting patterns, followed by a description of each community's **subsistence use areas**, harvest and use data, timing of subsistence activities, travel methods, and resource importance.

1.1 Introduction

The Iñupiat are an Alaska Native people whose territory extends throughout Northwest and Northern Alaska. Archaeological research indicates that humans have occupied northern Alaska for roughly 14,000 years (Kunz and Reanier 1996). At the time of European contact, the North Slope was inhabited by two indigenous Iñupiat populations, the Tagiugmiut and the Nunamiut. The Tagiugmiut ("people of the sea") inhabited coastal areas of the Arctic Coastal Plain and relied primarily on harvests of marine mammals, terrestrial mammals (primarily caribou), and fish. The Nunamiut ("people of the land") inhabited the interior, including the Brooks Range and Arctic Foothills areas, and relied mostly on terrestrial mammals and fish, with caribou comprising the majority of their subsistence harvests. Being located on or near the coast, the study communities of Nuiqsut and Utqiaġvik were traditionally inhabited by the Tagiugmiut. The Iñupiat continue to be the primary occupants of the North Slope today and continue the traditions of their ancestors, including the hunting, harvesting, and sharing of wild resources. Subsistence activities tend to occur near communities, along rivers and coastlines, or at particularly productive sites where resources are known to occur seasonally. Residents often conduct subsistence activities from camps located in areas that provide access to multiple resources throughout the year. Harvesters apply traditional knowledge, which is passed down through generations and learned through experience on the land, to determine the locations, timing, and methods for their subsistence activities. Relevant traditional knowledge includes knowledge about the distribution, migration, and seasonal variation of animal populations, and other environmental factors such as tides, currents, ice, and snow conditions.

Prior to the 1950s, when mandatory school attendance and economic factors such as a decline in fur prices compelled families to permanently settle into centralized communities, the Iñupiat were seminomadic and ranged over large geographic areas for trapping, fishing, gathering, and hunting activities. Contemporary subsistence use areas include many of these traditional use areas. Certain harvest locations are used infrequently or by a small number of harvesters; however, these places may still be important to a community if they are particularly productive areas or if they have cultural, historical, or familial significance to the user. As an example, while the Prudhoe Bay development area is no longer part of the contemporary use area of the Nuiqsut people, residents continue to identify with the area as part of their traditional territory due to its historical use by their ancestors. Like other communities on the North Slope, Nuiqsut and Utqiaġvik have a "mixed, subsistence-market" economy (Walker and Wolfe 1987), where families invest money into small-scale, efficient technologies to harvest wild foods. In recent years, the advent of snow machines and all-terrain vehicles (ATVs), including four-wheelers, has reduced the time required to travel to traditional hunting and harvesting areas, but has also increased the need for cash employment to purchase, maintain, and procure supplies for the new equipment, a hallmark of the mixed cash economy (Ahtuangaruak 1997; Impact Assessment Inc. 1990a, 1990b; SRB&A and ISER 1993; Worl and Smythe 1986).

While the use of camps and cabins continues, residents of the North Slope today more commonly use their communities as a base from which they conduct same-day subsistence activities (Impact Assessment Inc. 1990a; SRB&A 2010b, 2017).

1.2 Subsistence Overview

1.2.1 Nuiqsut

Nuiqsut is located on the Nigliq Channel of the Colville River, in an area that provides abundant opportunities for subsistence harvesting of terrestrial mammals, marine mammals, fish, and waterfowl. Although the location is less advantageous for marine mammal harvests than some other North Slope

communities which are located directly on the coast, the Beaufort Sea is easily accessible via the Nigliq Channel. The Colville River is the largest river system on the North Slope and supports the largest overwintering areas for whitefish, which local residents harvest in substantial quantities (Craig 1987; Seigle, Gutierrez et al. 2016).

The Nuiqsut area was traditionally a gathering place where Iñupiat and Athabascan people gathered to trade and fish, maintaining connections between the Nunamiut and the Tagiugmiut (Brown 1979). After the 1971 passage of the Alaska Native Claims Settlement Act, 27 Iñupiat families from Barrow resettled at Nuiqsut to live a more traditional lifestyle and to reclaim their ancestral ties to the area (Impact Assessment Inc. 1990b). The site was selected primarily for its easy access to the main channel of the Colville River for fishing and hunting and for the ease of movement between upriver hunting sites and downriver whaling and sealing sites (Brown 1979).

Today, according to the North Slope Borough's (NSB's) most recent census, Nuiqsut has a population of 449 residents living in 138 **households** (NSB 2016). Primary sources of employment in the community include the village corporation (Kuukpik Corporation), the NSB, and the NSB school district (NSB 2018). Nuiqsut is one of 11 Alaska Eskimo bowhead whaling communities. It is the closest community to the major oil producing fields of the North Slope, which have resulted in impacts to subsistence and sociocultural systems (SRB&A 2009, 2017, 2018) but also provided jobs, corporate dividends, and local revenue.

1.2.1.1 Subsistence Use Areas

Figure E.16.1 depicts Nuiqsut subsistence use areas for all resources over multiple historic and contemporary time periods (BLM 2004; Brown, Braem et al. 2016; Pedersen 1979, 1986; SRB&A 2010b). Use areas from all these studies overlap with portions of the Willow Master Development Plan Project (Project) area. Lifetime (pre-1979) use areas show Nuiqsut residents using a large area centered on the community to harvest subsistence resources; reported use areas extended offshore approximately 15 miles, as far east as Camden Bay, south along the Itkillik River, and west as far as Teshekpuk Lake. Subsequent use area data shows Nuiqsut residents traveling across a progressively larger area to harvest subsistence resources. Use areas for the 1995–2006 time period document Nuiqsut residents traveling beyond Atqasuk in the west, offshore more than 50 miles northeast of Cross Island, overland to Cape Halkett and Utqiaġvik in the north, to Camden Bay in the east, and beyond the Colville River in the south. The majority of these use areas are concentrated around the Colville River, in areas to the southwest of the community, offshore areas north of the Colville River Delta (CRD), and northeast of Cross Island. Use areas for other time periods (1973–1986; 2014) are generally within the extent of the Pedersen (1979) and Stephen R. Braund and Associates (SRB&A) (2010b) use areas described above. SRB&A (2010b) notes that for the 1995–2006 time period, wolf and wolverine use areas continued farther south toward Anaktuvuk Pass but were not documented due to the extent of the map used during interviews.

Nuiqsut subsistence use areas for individual resources are shown on Figures E.16.2 through E.16.9 for the time periods listed above, in addition to the 2008–2016 time period (SRB&A 2018) for caribou only. Nuiqsut subsistence use areas for large land mammals are shown on Figures E.16.2 through E.16.4. Nuiqsut caribou use areas are shown on Figure E.16.2. As indicated on the figure, areas consistently used by Nuiqsut residents for caribou hunting are in an overland area between the Ikpikpuk and Kuparuk rivers, north to the coast, and south along the Colville River. The maximum extent of the use areas documented among all the studies extends from Atqasuk in the west toward Point Thomson in the east and south along the Colville and Anaktuvuk rivers to Anaktuvuk Pass. SRB&A's (2010b) overlapping use areas show the greatest number of caribou use areas are concentrated along the Colville River and CRD, along the Itkillik River, and overland to the west and south of the community; these areas generally correspond to the caribou hunting areas reported during the 2008–2016 study years (SRB&A 2018).

Nuiqsut moose use areas (Figure E.16.3) show residents' consistent use of areas adjacent to the Colville River for moose harvests. While lifetime (pre-1979) use areas were completely confined to the Colville River, more recent moose use areas have expanded to include other tributaries including the Chandler and

Anaktuvuk rivers and Fish (Uvlutuuq) Creek. Moose use areas for the 1995–2006 time period show the highest amount of overlapping use along the Colville River south of Nuiqsut as far as Umiat. Figure E.16.4 depicts Nuiqsut grizzly bear use areas for the lifetime and 1973–1986 time periods, including areas along the Colville River watershed from Fish Creek to Umiat.

Nuiqsut small land mammal use areas are shown on Figure E.16.5. Lifetime (pre-1979) use areas show residents using overland areas near the community, as well as the more southern Colville, Chandler, Anaktuvuk, Itkillik, and Kuparuk rivers to harvest small land mammals. Subsequent studies, including those for the 1973–1986 and 1995–2006 time periods, depict an expansion from previously recorded use areas. SRB&A's (2010b) wolf and wolverine use areas for the 1995–2006 time period extend to the Meade River in the west and beyond the Dalton Highway in the east, including a single use area which extends east to just south of Kaktovik. Small land mammal use areas for the most recent available use area study show less use to the east and west of the community and more use south into the Brooks Range.

Nuiqsut fishing areas from multiple time periods are shown on Figure E.16.6 and indicate consistent use of the Colville River and smaller tributaries including the Itkillik, Chandler, and Anaktuvuk rivers as well as Fish and Judy (Kayyaaq) creeks. Contemporary use areas extend somewhat father along the Colville and Itkillik rivers as well as along Fish Creek.

Nuiqsut use areas for birds (Figure E.16.7) are mostly concentrated along the Colville River and nearby overland areas for various time periods, though they also include offshore eider hunting areas extending from Cape Halkett to Camden Bay. Lifetime (pre-1979) wildfowl use areas are generally located near the Colville River and in nearshore locations extending east to Prudhoe Bay. More recent goose and eider use areas (1994–2003 and 1995–2006 time periods) occur in a somewhat larger area and include areas offshore and east of Prudhoe Bay to Camden Bay. The most recent documentation of bird use areas for the 2014 time period shows them being north of the community and offshore into Harrison Bay.

Figure E.16.8 displays Nuiqsut use areas for vegetation for several time periods and shows use of the Colville River as far south as Umiat and areas near Fish (Uvlutuuq) Creek for harvests of vegetation and berries. In addition, berry gathering areas were documented along the Itkillik, Chandler, and Anaktuvuk rivers during a study for the 1994–2003 time period.

Nuiqsut marine mammal use areas (Figure E.16.9) show use of the Beaufort Sea and CRD at varying extents depending on the time period. Lifetime Nuiqsut use areas for marine mammals included offshore areas from Atigaru Point to Kaktovik at distances of less than 20 miles; subsequent studies documented use areas extending to Cape Halkett in the west and varying distances to the east. SRB&A's (2010b) use areas showed Nuiqsut residents harvesting marine mammals up to 40 miles offshore to the north of the community and even farther offshore (approximately 60 miles) in an area near Cross Island, a sandy barrier island used traditionally and currently as a base of operations for Nuiqsut whaling crews. Nuiqsut 2001–2016 bowhead whale hunting global positioning system tracks extend as far east as Flaxman Island and over 30 miles offshore from Cross Island.

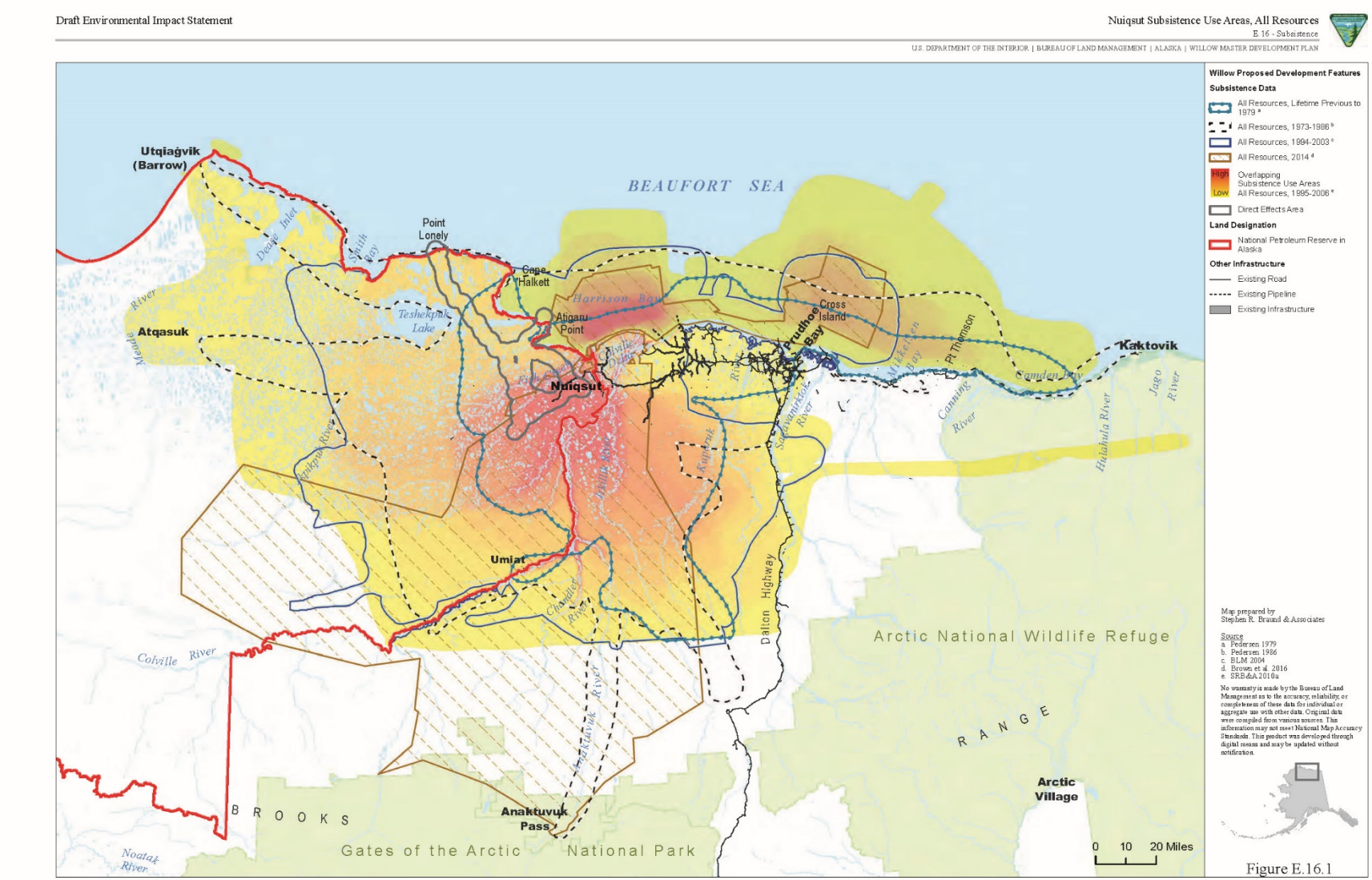


Figure E.16.1. Nuiqsut Subsistence Use Areas, All Resources

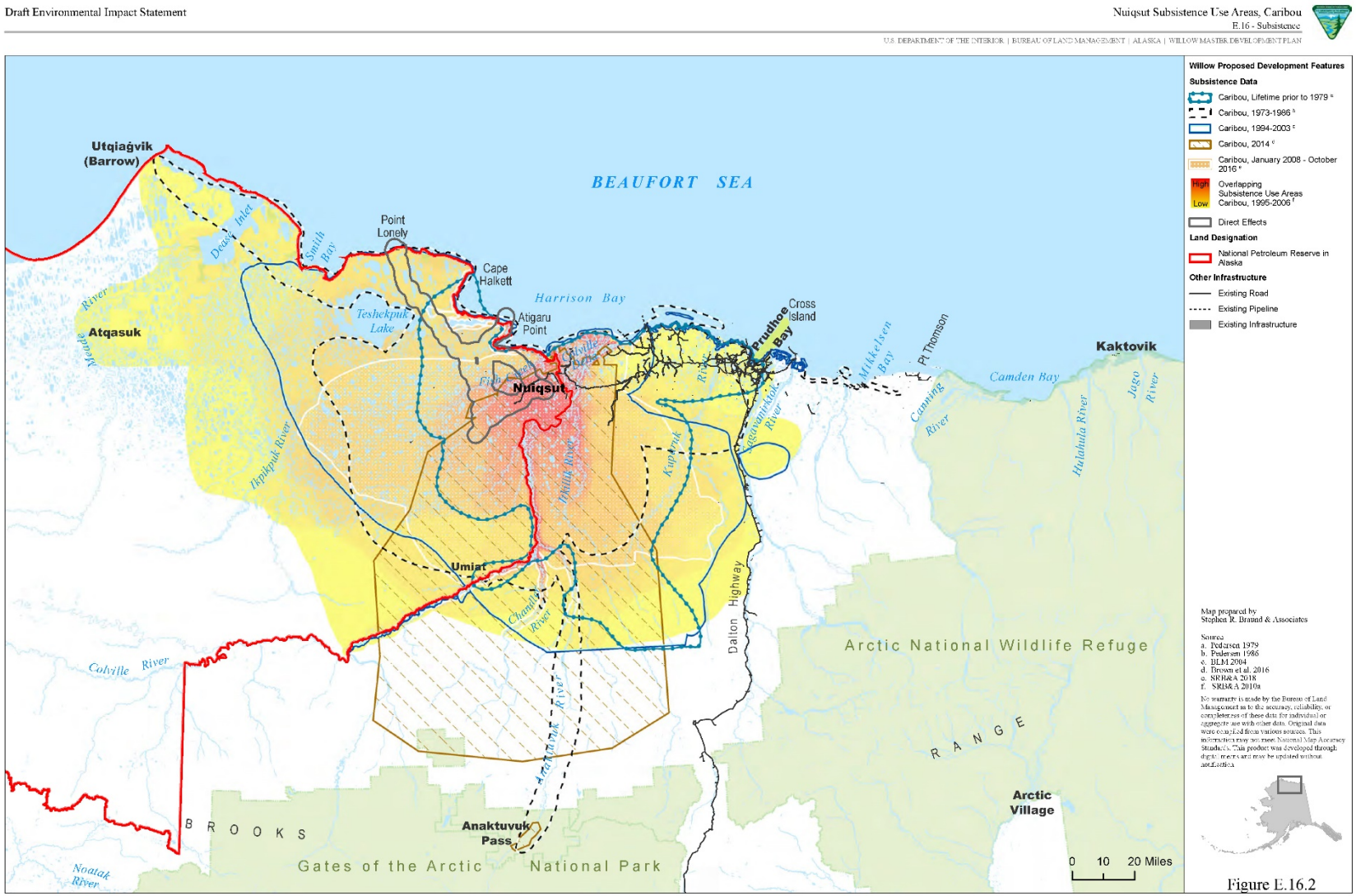


Figure E.16.2. Nuiqsut Subsistence Use Areas, Caribou

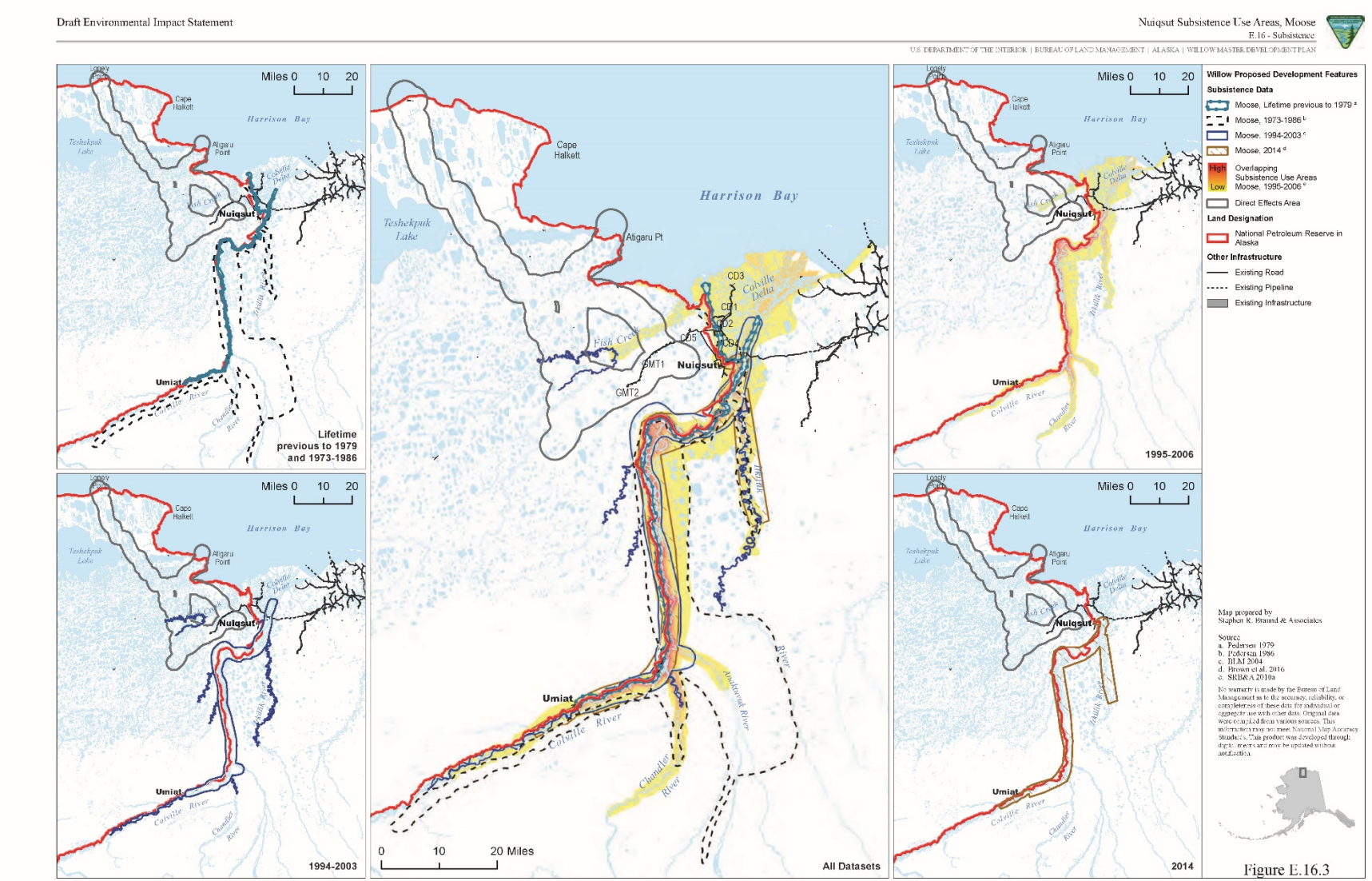


Figure E.16.3. Nuiqsut Subsistence Use Areas, Moose

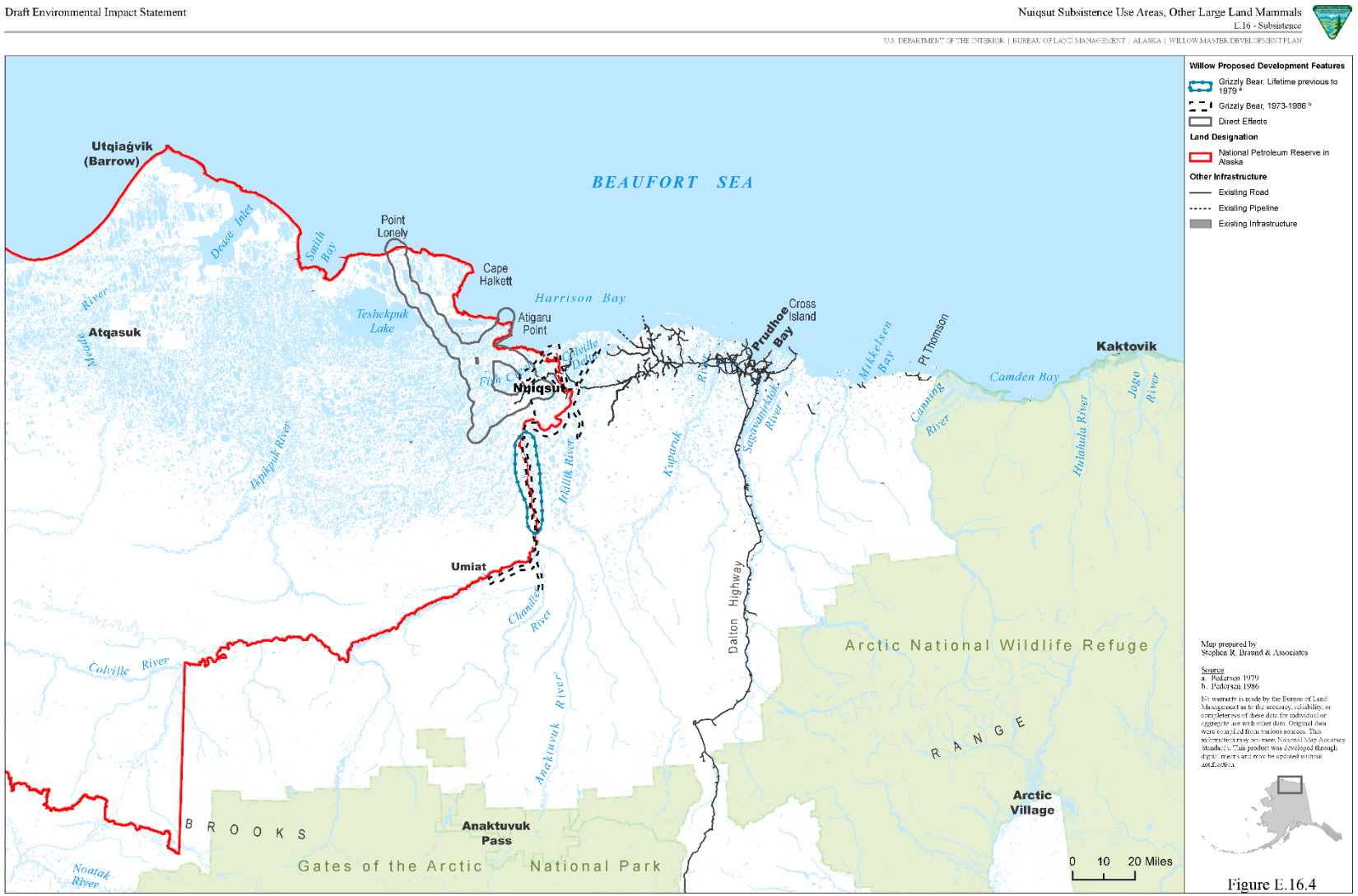


Figure E.16.4. Nuiqsut Subsistence Use Areas, Other Large Land Mammals

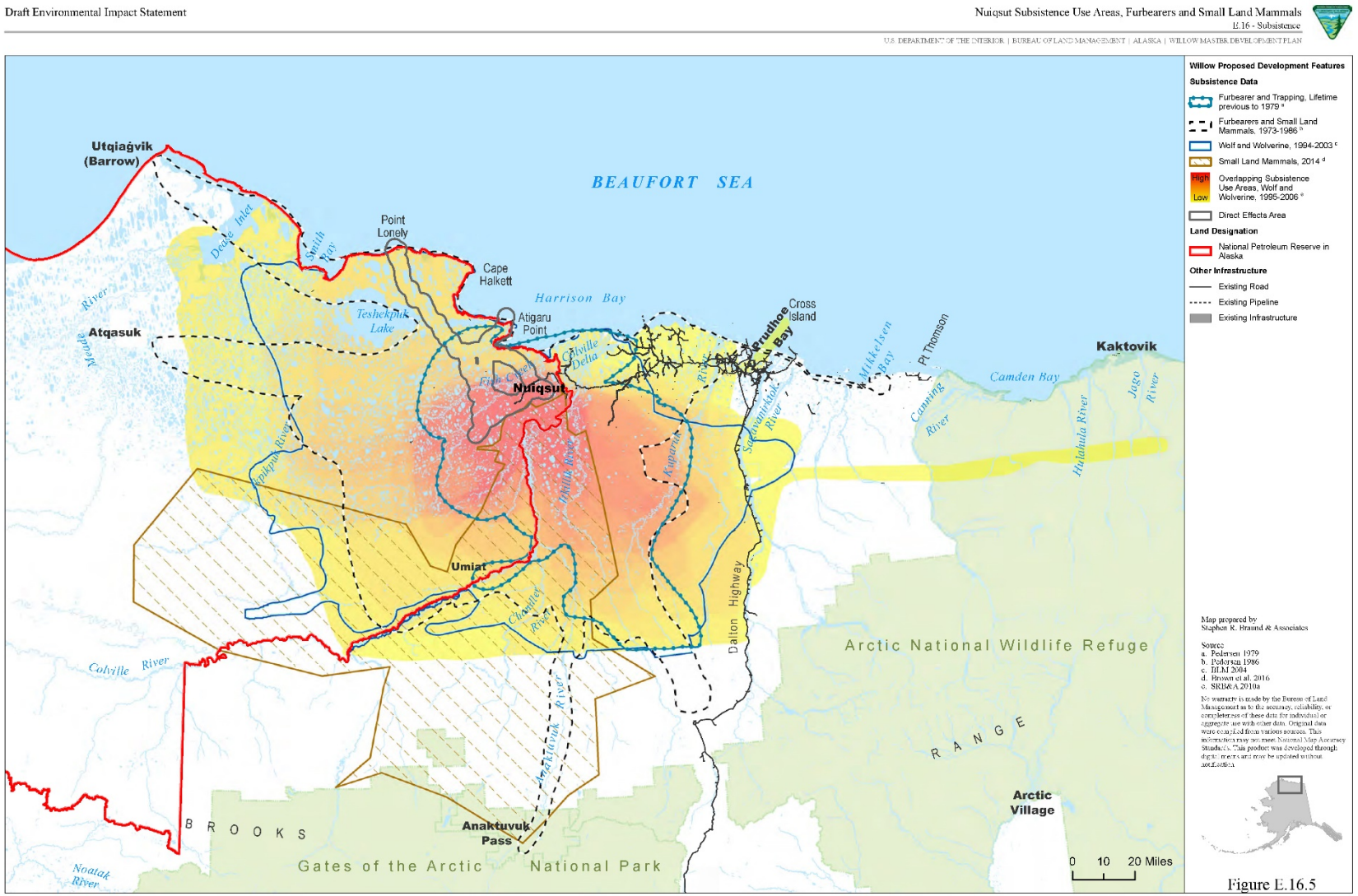


Figure E.16.5. Nuiqsut Subsistence Use Areas, Furbearers and Small Land Mammals

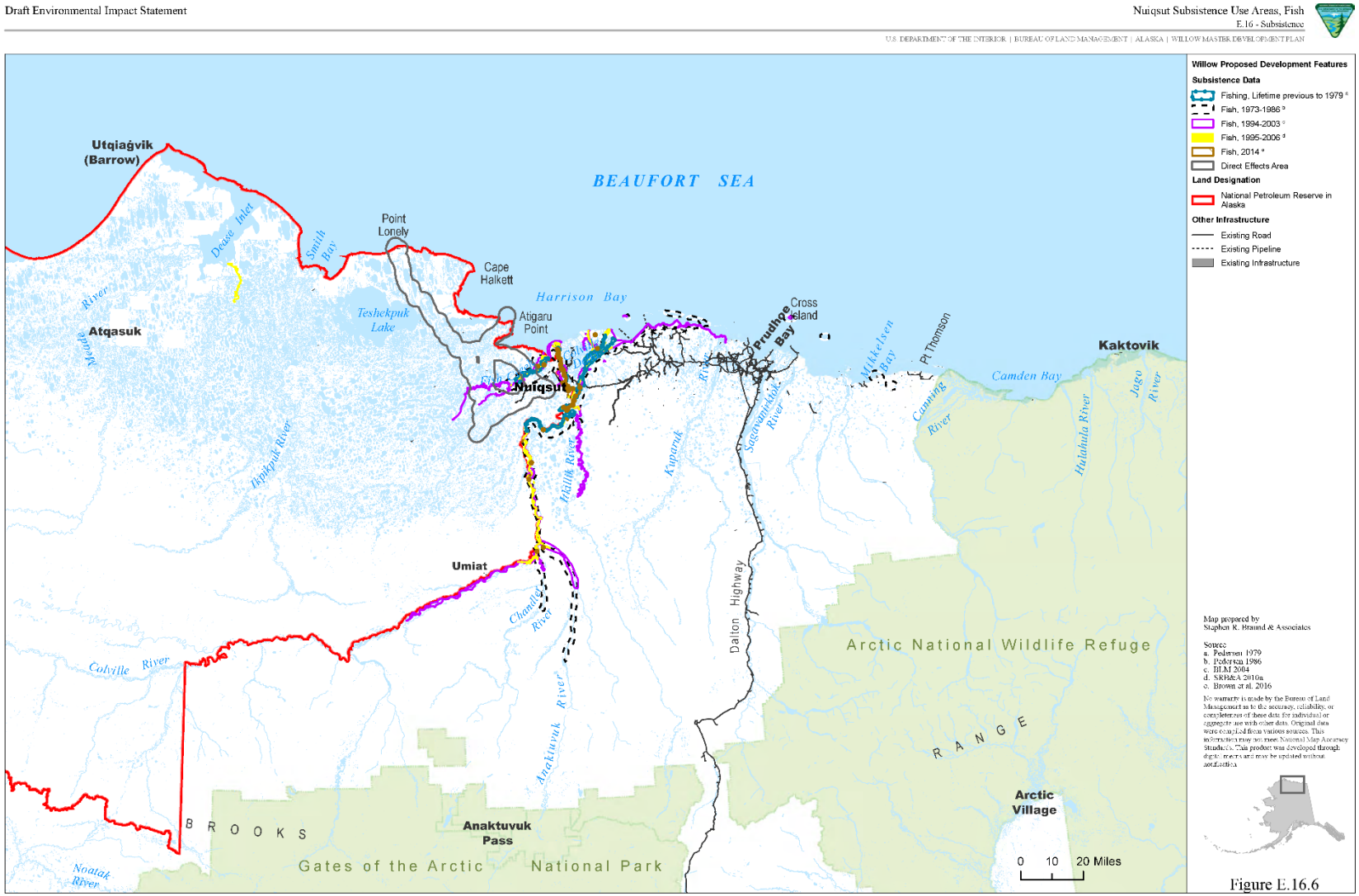


Figure E.16.6. Nuiqsut Subsistence Use Areas, Fish

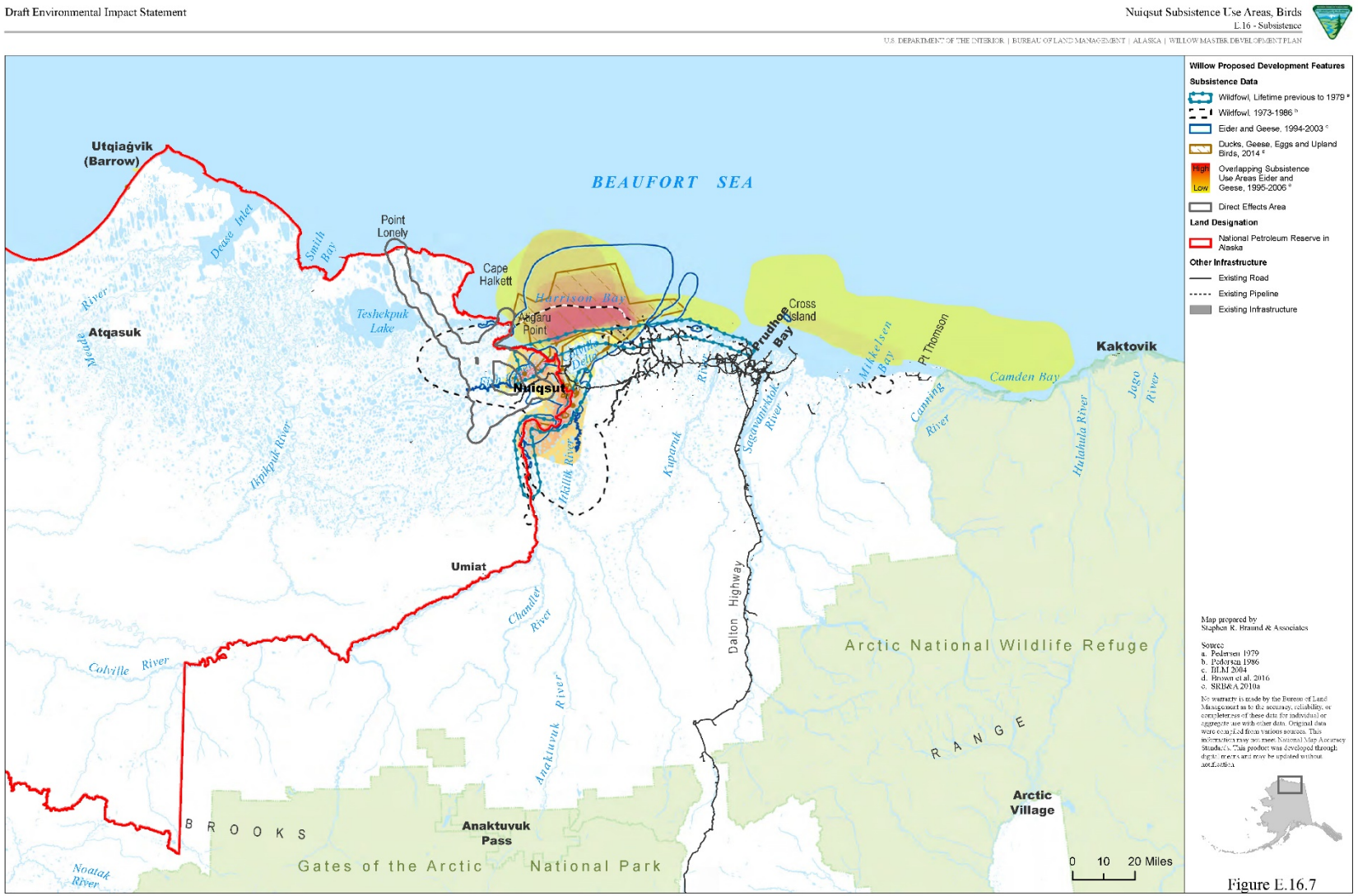


Figure E.16.7. Nuiqsut Subsistence Use Areas, Birds

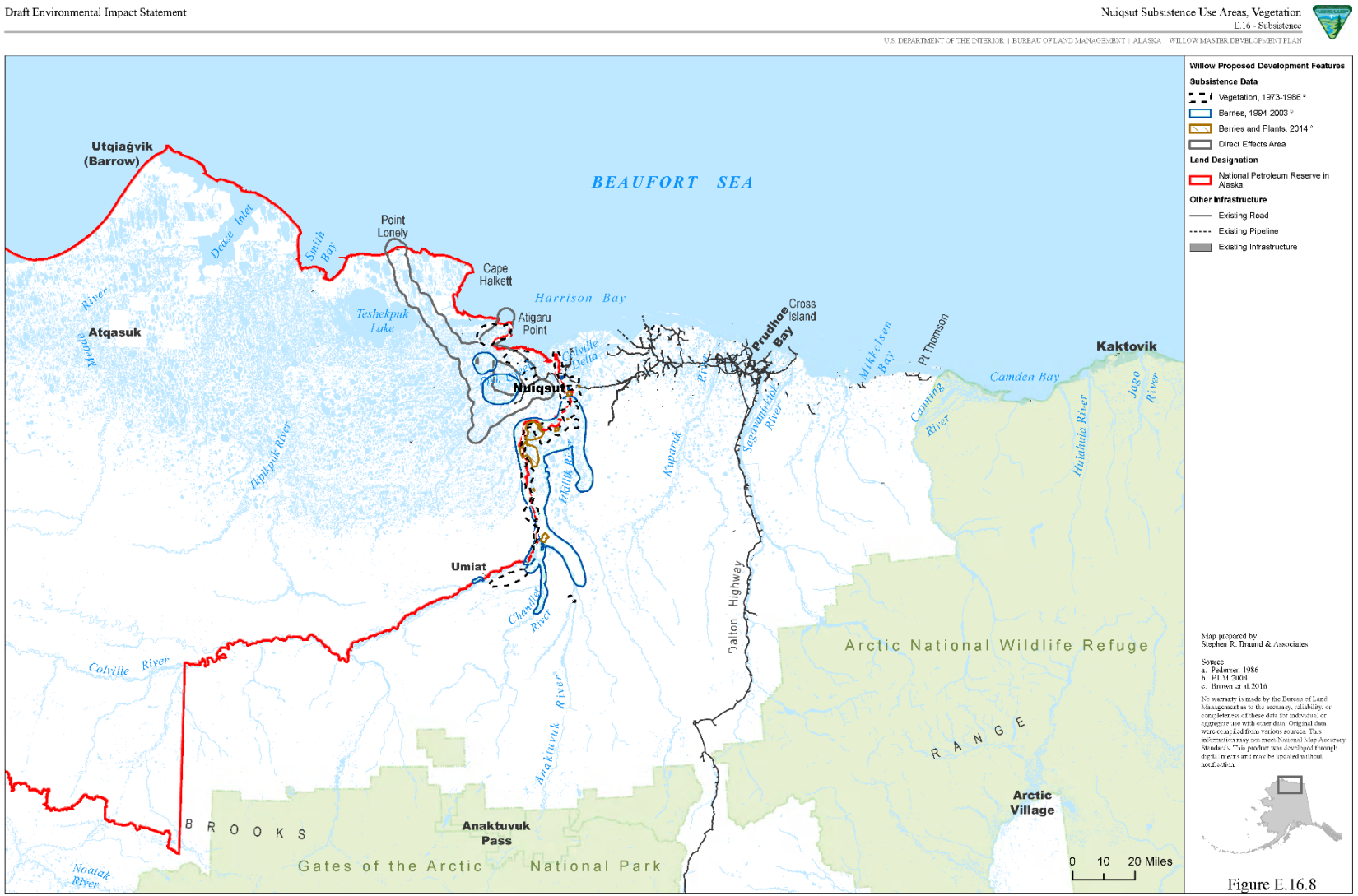


Figure E.16.8. Nuiqsut Subsistence Use Areas, Vegetation

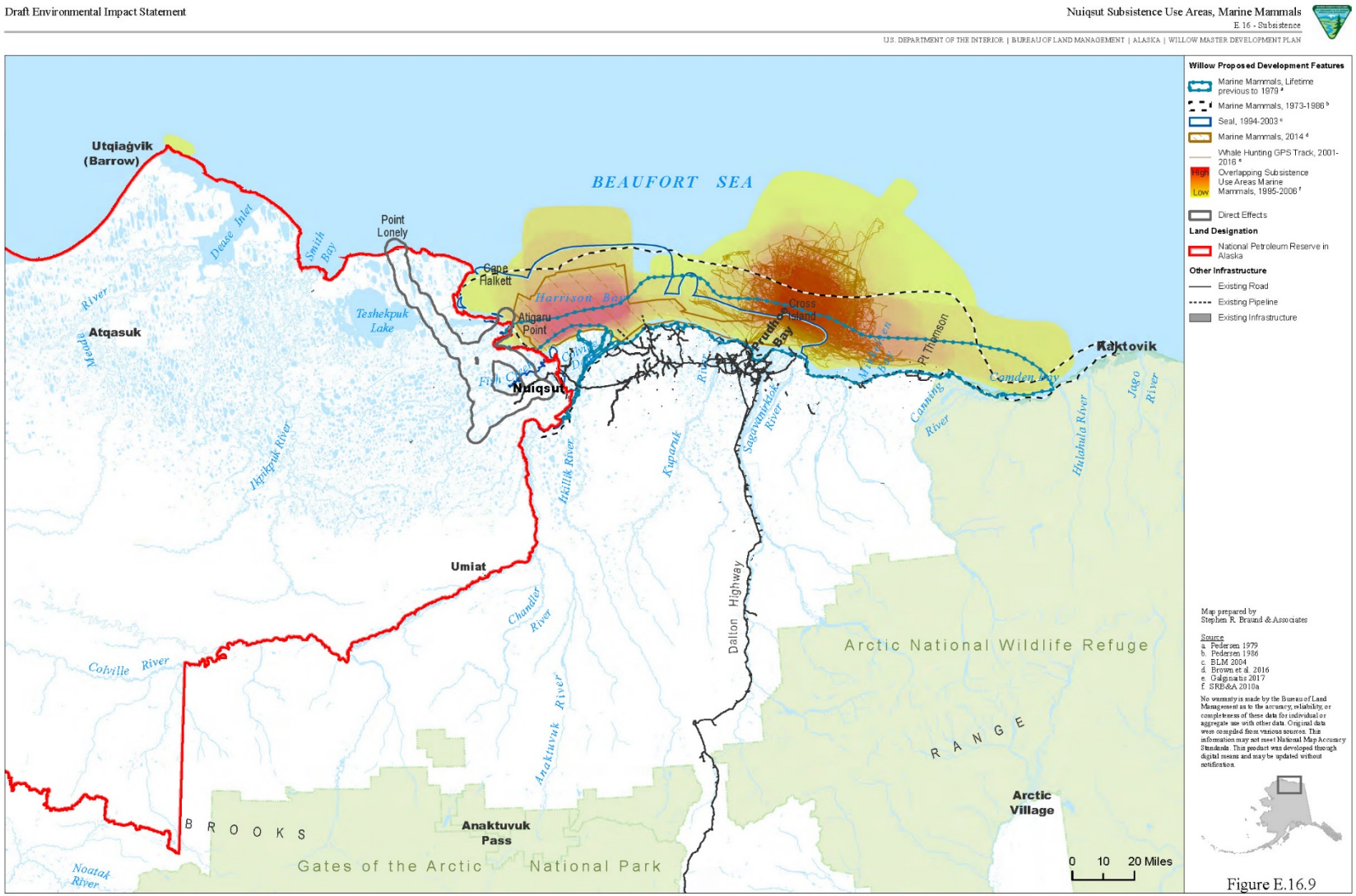


Figure E.16.9. Nuiqsut Subsistence Use Areas, Marine Mammals

1.2.1.1.1 Direct Effects Analysis Area

Subsistence use of the **direct effects analysis area**, defined as the area within 2.5 miles of Project infrastructure, is relatively high. For the 1995–2006 time period, use areas overlapping the direct effects analysis area accounted for nearly one-quarter (24%) of all use areas documented for Nuiqsut harvesters (Table E.16.1). Across 9 years of the Nuiqsut Caribou Subsistence Monitoring Project (2008–2016), 20% of caribou use areas overlapped the direct effects analysis area.

Table E.16.1. Nuiqsut Use Areas within the Direct Effects Analysis Area

Source	Resource Type	Time Period	Total Number of Use Areas	Number (%) of Use Areas in Direct Effects Area
SRB&A 2010b	All Resources	1995–2006	758	183 (24%)
SRB&A 2010a, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018	Caribou	2008–2016	1,692	332 (20%)

As shown in Figures E.16.1 through E.16.9, Nuiqsut harvesters have reported using the direct effects analysis area to harvest the following resources during one or more study years: caribou, moose, other large land mammals, furbearers and small land mammals, fish, birds, vegetation, and marine mammals. Resources which overlap during most study years include caribou, furbearers and small land mammals, fish, and marine mammals. While some resources overlap with a large proportion of the direct effects analysis area (e.g., caribou, furbearers and small land mammals), others overlap with smaller portions, such as where the direct effects analysis area intersects with fishing or hunting areas along Fish Creek (e.g., fish, birds) or in offshore waters near Atigaru Point (e.g., marine mammals).

1.2.1.2 Harvest and Use Data

Tables E.16.2 and E.16.3 provide Nuiqsut harvest data for various years between 1985 and 2015. Eleven study years include data solely for caribou harvests (Braem, Kaleak et al. 2011; SRB&A 2012, 2013, 2014, 2015, 2016, 2017, 2018) (Table E.16.3). During available study years, Nuiqsut households have harvested between 399 (in 1985, a year when the community did not successfully harvest a bowhead whale) and 896 (in 2014) pounds of subsistence resources per capita (Table E.16.2). Land mammals, marine mammals, and fish are all major subsistence resources in Nuiqsut. During four study years, marine mammals contributed more total edible pounds than any other resource. Non-salmon fish were the top harvested resource during the remaining three study years and accounted for between 173 (in 1985) and 248 (in 1993) pounds per capita during years with per capita harvest data. Large land mammals were generally the second- or third-most harvested resource during all study years and provided between 169 (in 1985) and 261 (in 2014) pounds per capita. Nuiqsut residents harvest other resources such as migratory birds, upland game birds, salmon, bird eggs, and vegetation in much smaller quantities. Small land mammals are also harvested, but because they are harvested primarily for their fur and contribute little in the way of edible pounds.

In terms of species, bowhead whales, whitefish (Arctic cisco, or *qaaktaq*, and broad whitefish), and caribou are the primary subsistence species harvested in Nuiqsut. Bowhead whale harvests have accounted for between 28.7% and 60.3% of the total harvest during all study years (except for 1985 and 1994–1995, when Nuiqsut did not successfully harvest a whale) (Table E.16.3). Arctic cisco harvests have accounted for between 1.9% and 14.9% of the total harvest, broad whitefish have accounted for between 5.3% and 45% of the total harvest, and caribou have accounted for between 21.7% and 37.5% of the total harvest. Other subsistence species with substantial contributions to Nuiqsut subsistence harvests include moose, seals, goose, Arctic grayling, least cisco, and burbot.

Data on subsistence participation and use by Nuiqsut households are available for various study years (Tables E.16.2 and E.16.3). As shown in Table E.16.2, 100% of households report using subsistence resources during study years, and over 90% of households participate in subsistence activities (i.e., attempting to harvest). Across all study years, participation in subsistence activities was highest for non-salmon fish, large land mammals, and migratory birds. Specifically, in 2014, over half of Nuiqsut households participated in harvests of caribou, broad whitefish, white-fronted goose, cloudberries, and

Arctic cisco. In 2016, 76% of households participated in caribou hunting activities. Sharing of subsistence resources, a core Iñupiaq value, is also high among Nuiqsut households; between 95% and 100% of households report receiving subsistence foods during available study years. Sharing is particularly common with marine mammals (between 95% and 100% of households receiving); large land mammals (between 70% and 92% receiving); and non-salmon fish (between 71% and 90% receiving).

Table E.16.2. Nuiqsut Subsistence Harvest Estimates by Resource Category, All Resources Study Years

Study Year	Resource	Percent of Households Use	Percent of Households Try to	Percent of Households Harvest	Percent of Households Give	Percent of Households Receive	Estimated Harvest Number[a]	Estimated Harvest Total Pounds[b]	Estimated Harvest Average Household Pounds	Estimated Harvest Per Capita Pounds	Percent of Total Harvest
1985	All resources	100	98	98	95	100	–	160,035	2,106	399	100.0
1985	Salmon	60	43	40	23	23	441	1,366	18	3	0.9
1985	Non-salmon fish	100	93	93	83	75	67,712	69,243	911	173	43.3
1985	Large land mammals	98	90	90	80	70	536	67,621	890	169	42.3
1985	Small land mammals	65	63	58	23	13	688	245	3	1	0.2
1985	Marine mammals	100	48	23	30	100	59	13,355	176	33	8.3
1985	Migratory birds	90	90	85	60	55	1,733	6,626	87	17	4.1
1985	Upland game birds	88	88	88	58	13	1,957	1,370	18	3	0.9
1985	Bird eggs	25	25	23	8	10	262	40	1	<1	<0.1
1985	Vegetation	38	50	18	10	20	–	169	2	<1	0.1
1992[c]	All resources	–	–	–	–	–	–	150,195	–	–	100.0
1992[c]	Salmon	–	–	–	–	–	6	65	–	–	0.0
1992[c]	Non-salmon fish	–	74	–	–	–	36,701	51,890	–	–	34.5
1992[c]	Large land mammals	–	–	–	–	–	299	41,386	–	–	27.6
1992[c]	Small land mammals	–	–	–	–	–	46	1	–	–	0.0
1992[c]	Marine mammals	–	–	–	–	–	49	52,865	–	–	35.2
1992[c]	Migratory birds	–	–	–	–	–	1,105	3,655	–	–	2.4
1992[c]	Upland game birds	–	–	–	–	–	378	265	–	–	0.2
1992[c]	Eggs	–	–	–	–	–	25	4	–	–	<0.1
1992[c]	Vegetation	–	32	–	–	–	–	66	–	–	<0.1
1993	All resources	100	94	90	92	98	–	267,818	2,943	742	100.0
1993	Salmon	71	45	36	39	47	272	1,009	11	3	0.4
1993	Non-salmon fish	97	79	79	87	90	71,626	89,481	983	248	33.4
1993	Large land mammals	98	76	74	82	92	691	87,306	959	242	32.6
1993	Small land mammals	53	45	42	27	18	599	84	1	<1	<0.1
1993	Marine mammals	97	58	37	79	97	113	85,216	936	236	31.8
1993	Migratory birds	87	74	73	63	65	2,238	3,540	39	10	1.3
1993	Upland game birds	60	45	45	42	26	973	681	7	2	0.3

Study Year	Resource	Percent of Households Use	Percent of Households Try to [illegible]	Percent of Households Harvest	Percent of Households Give	Percent of Households Receive	Estimated Harvest Number[a]	Estimated Harvest Total Pounds[b]	Estimated Harvest Average Household Pounds	Estimated Harvest Per Capita Pounds	Percent of Total Harvest
1993	Eggs	40	21	19	15	23	346	104	1	<1	<0.1
1993	Vegetation	79	71	71	27	40	–	396	4	1	0.1
1994–1995[d]	All resources	–	–	–	–	–	–	83,228	–	–	100.0
1994–1995[d]	Salmon	–	–	–	–	–	10	31	–	–	<0.1
1994–1995[d]	Non-salmon fish	–	–	–	–	–	15,190	46,569	–	–	56.0
1994–1995[d]	Large land mammals	–	–	–	–	–	263	32,686	–	–	39.3
1994–1995[d]	Small land mammals	–	–	–	–	–	42	0	–	–	0.0
1994–1995[d]	Marine mammals	–	–	–	–	–	25	1,504	–	–	1.8
1994–1995[d]	Migratory birds	–	–	–	–	–	569	2,289	–	–	2.8
1994–1995[d]	Upland game birds	–	–	–	–	–	58	58	–	–	0.1
1994–1995[d]	Vegetation	–	–	–	–	–	14	91	–	–	0.1
1995–1996	All resources	–	–	–	–	–	–	183,576	–	–	100.0
1995–1996	Salmon	–	–	–	–	–	42	131	–	–	0.1
1995–1996	Non-salmon fish	–	–	–	–	–	10,612	16,822	–	–	9.2
1995–1996	Large land mammals	–	–	–	–	–	364	43,554	–	–	23.7
1995–1996	Small land mammals	–	–	–	–	–	27	0	–	–	0.0
1995–1996	Marine mammals	–	–	–	–	–	178	120,811	–	–	65.8
1995–1996	Migratory birds	–	–	–	–	–	683	2,166	–	–	1.2
1995–1996	Upland birds	–	–	–	–	–	19	13	–	–	<0.1
1995–1996	Vegetation	–	–	–	–	–	12	78	–	–	<0.1
2000–2001	All resources	–	–	–	–	–	–	183,246	–	–	100.0
2000–2001	Salmon	–	–	–	–	–	10	75	–	–	<0.1
2000–2001	Non-salmon fish	–	–	–	–	–	26,545	27,933	–	–	15.2
2000–2001	Large land mammals	–	–	–	–	–	504	62,171	–	–	33.9
2000–2001	Small land mammals	–	–	–	–	–	108	2	–	–	<0.1
2000–2001	Marine mammals	–	–	–	–	–	31	87,929	–	–	48.0
2000–2001	Migratory birds	–	–	–	–	–	1,192	5,108	–	–	2.8
2000–2001	Upland birds	–	–	–	–	–	23	16	–	–	<0.1
2000–2001	Vegetation	–	–	–	–	–	2	13	–	–	<0.1
2014	All resources	100	95	90	91	97	–	371,992	3,444	896	100.0
2014	Salmon	64	41	40	31	35	–	3,889	36	9	1.0
2014	Non-salmon fish	93	78	71	72	71	–	85,106	788	205	22.9

Study Year	Resource	Percent of Households Use	Percent of Households Try to [illegible]	Percent of Households Harvest	Percent of Households Give	Percent of Households Receive	Estimated Harvest Number[a]	Estimated Harvest Total Pounds[b]	Estimated Harvest Average Household Pounds	Estimated Harvest Per Capita Pounds	Percent of Total Harvest
2014	Large land mammals	91	66	64	67	72	–	108,359	1,003	261	29.1
2014	Small land mammals	17	16	10	2	7	–	0	0	0	0.0
2014	Marine mammals	95	55	40	71	95	–	169,367	1,568	408	45.5
2014	Migratory birds	79	71	66	52	38	–	4,742	44	11	1.3
2014	Upland birds	16	12	12	9	5	–	78	1	<1	<0.1
2014	Vegetation	67	55	53	21	38	–	414	4	1	0.1

Source: 1985 (ADF&G 2018); 1992 (Fuller and George 1999); 1993 (Pedersen 1995a); 1994–1995 (Brower and Hepa 1998); 1995–1996, 2000–2001 (Bacon, Hepa et al. 2009); 2014 (Brown, Braem et al. 2016).
Note: The estimated harvest numbers for the 1994–1995, 1995–1996, and 2000–2001 data were derived by summing individual species in each resource category. Also for those study years, total pounds were derived from conversion rates found at ADF&G (2018), and total (usable) pounds for bowhead whales were calculated based on the method presented in SRB&A and ISER (1993). These estimates do not account for whale girth and should be considered approximate; more exact methods for estimating total whale weights are available in (George, Philo et al. n.d.).
[a] Estimated numbers represent individuals in all cases except vegetation, where they represent gallons.
[b] Estimated pounds include only edible pounds and therefore do not include estimates for resources that are not typically eaten by community residents (e.g., furbearers).
[c] The estimated pounds of moose harvested in 1992 is likely too high (Fuller and George 1999).
[d] The 1994–1995 study year underrepresents the harvest of Arctic cisco and humpback whitefish (Brower and Hepa 1998); Nuiqsut did not successfully harvest a bowhead whale in 1994–1995.

Table E.16.3. Nuiqsut Subsistence Harvest Estimates by Selected Species, All Study Years

Study Year	Resource[a]	Percent of Households Use	Percent of Households Try to Harvest	Percent of Households Harvest	Percent of Households Give	Percent of Households Receive	Estimated Harvest Number[b]	Estimated Harvest Total Pounds[c]	Estimated Harvest Average Household Pounds	Estimated Harvest Per Capita Pounds	Percent of Total Harvest
1985	Caribou	98	90	90	80	60	513	60,021	790	150	37.5
1985	Cisco	98	75	73	65	60	46,478	29,354	386	73	18.3
1985	Broad whitefish	95	80	78	70	40	7,900	26,861	353	67	16.8
1985	Bowhead whale	100	23	5	8	100	0	7,458	98	19	4.7
1985	Moose	40	40	18	20	25	13	6,650	88	17	4.2
1985	White-fronted goose	90	90	85	55	48	1,340	6,028	79	15	3.8
1985	Arctic grayling	78	65	63	48	35	4,055	3,650	48	9	2.3
1985	Humpback whitefish	48	45	38	33	13	4,345	3,476	46	9	2.2
1985	Arctic char	75	63	60	33	35	1,060	2,969	39	7	1.9
1985	Burbot	75	60	60	43	33	669	2,675	35	7	1.7
1985	Bearded seal	48	25	15	15	35	15	2,675	35	7	1.7
1985	Ringed seal	53	25	18	23	40	40	1,676	22	4	1.0
1992	Bowhead whale	–	–	–	–	–	2	48,715	–	–	32.4
1992	Caribou	–	81	–	–	–	278	32,551	–	–	21.7
1992	Arctic cisco	–	–	–	–	–	22,391	22,391	–	–	14.9

Study Year	Resource[a]	Percent of Households Use	Percent of Households Try to Harvest	Percent of Households Harvest	Percent of Households Give	Percent of Households Receive	Estimated Harvest Number[b]	Estimated Harvest Total Pounds[c]	Estimated Harvest Average Household Pounds	Estimated Harvest Per Capita Pounds	Percent of Total Harvest
1992	Broad whitefish	–	–	–	–	–	6,248	15,621	–	–	10.4
1992	Moose[d]	–	–	–	–	–	18	8,835	–	–	5.9
1992	Humpback whitefish	–	–	–	–	–	1,802	4,504	–	–	3.0
1992	Arctic char	–	–	–	–	–	1,544	4,324	–	–	2.9
1992	Bearded seal	–	–	–	–	–	16	2,760	–	–	1.8
1992	Arctic grayling	–	–	–	–	–	3,114	2,491	–	–	1.7
1992	Canada goose	–	–	–	–	–	319	1,437	–	–	1.0
1993	Caribou	98	74	74	79	79	672	82,169	903	228	30.7
1993	Bowhead whale	97	37	5	76	97	3	76,906	845	213	28.7
1993	Broad whitefish	90	66	66	65	66	12,193	41,455	456	115	15.5
1993	Arctic cisco	89	69	68	81	60	45,237	31,666	348	88	11.8
1993	Ringed seal	65	42	31	40	55	98	7,277	80	20	2.7
1993	Burbot	79	63	57	53	55	1,416	5,949	65	16	2.2
1993	Moose	69	47	10	29	63	9	4,403	48	12	1.6
1993	Arctic grayling	79	69	65	44	27	4,515	4,063	45	11	1.5
1993	Least cisco	63	52	47	36	27	6,553	3,277	36	9	1.2
1994–1995[e]	Broad whitefish	–	–	–	–	–	3,237	37,417	–	–	45.0
1994–1995[e]	Caribou	–	–	–	–	–	258	30,186	–	–	36.3
1994–1995[e]	Arctic cisco	–	–	–	–	–	9,842	6,889	–	–	8.3
1994–1995[e]	Moose	–	–	–	–	–	5	2,500	–	–	3.0
1994–1995[e]	Goose unidentified	–	–	–	–	–	474	2,133	–	–	2.6
1994–1995[e]	Ringed seal	–	–	–	–	–	24	1,008	–	–	1.2
1995–1996	Bowhead whale	–	–	–	–	–	4	110,715	–	–	60.3
1995–1996	Caribou	–	–	–	–	–	362	42,354	–	–	23.1
1995–1996	Broad whitefish	–	–	–	–	–	2,863	9,735	–	–	5.3
1995–1996	Ringed seal	–	–	–	–	–	155	6,527	–	–	3.6
1995–1996	Arctic cisco	–	–	–	–	–	5,030	3,521	–	–	1.9
1995–1996	Bearded seal	–	–	–	–	–	17	2,974	–	–	1.6
1995–1996	Least cisco	–	–	–	–	–	1,804	1,804	–	–	1.0
1999–2000	Caribou	–	–	–	–	–	413	–	–	112	–
2000–2001	Bowhead whale	–	–	–	–	–	4	86220	–	–	47.1
2000–2001	Caribou	–	–	–	–	–	496	57,985	–	–	31.6
2000–2001	Arctic cisco	–	–	–	–	–	18,222	12,755	–	–	7.0
2000–2001	Broad whitefish	–	–	–	–	–	2,968	10,092	–	–	5.5
2000–2001	White-fronted goose	–	–	–	–	–	787	3,543	–	–	1.9
2000–2001	Moose	–	–	–	–	–	6	3,000	–	–	1.6
2002–2003	Caribou	95	47	45	49	80	397	–	–	118	–
2003–2004	Caribou	97	74	70	81	81	564	–	–	157	–
2004–2005	Caribou	99	62	61	81	96	546	–	–	147	–
2005–2006	Caribou	100	60	59	97	96	363	–	–	102	–
2006–2007	Caribou	97	77	74	66	69	475	–	–	143	–
2010	Caribou	94	86	76	–	–	562	65,754	707	–	–
2011	Caribou	92	70	56	49	58	437	51,129	544	134	–

Study Year	Resource[a]	Percent of Households Use	Percent of Households Try to Harvest	Percent of Households Harvest	Percent of Households Give	Percent of Households Receive	Estimated Harvest Number[b]	Estimated Harvest Total Pounds[c]	Estimated Harvest Average Household Pounds	Estimated Harvest Per Capita Pounds	Percent of Total Harvest
2012	Caribou	99	68	62	65	79	501	58,617	598	147	–
2013	Caribou	95	79	63	62	75	586	68,534	692	166	–
2014	Bowhead	93	29	21	57	91	5	148,087	1,371	357	39.8
2014	Caribou	90	66	64	67	59	774	105,193	974	253	28.3
2014	Broad whitefish	72	60	59	52	40	11,439	36,605	339	88	9.8
2014	Arctic cisco	83	52	48	59	53	46,277	32,394	300	78	8.7
2014	Bearded seal	67	38	22	40	62	13,846	13,846	128	33	3.7
2014	Least cisco	33	28	28	19	7	13,332	9,333	86	22	2.5
2014	Ringed seal	52	40	35	38	33	108	6,156	57	15	1.7
2015	Caribou	96	84	78	74	72	621	72,631	719	178	–
2016	Caribou	96	76	67	73	73	489	56,277	592	132	–

Source: 1985 (ADF&G 2018); 1992 (Fuller and George 1999); 1993 (Pedersen 1995a); 1994–1995 (Brower and Hepa 1998); 1995–1996, 2000–2001 (Bacon, Hepa et al. 2009); 1999–2000, 2002–2007 (Braem, Kaleak et al. 2011); 2010, 2011, 2012, 2013 (SRB&A 2012, 2013, 2014, 2015); 2014 (Brown, Braem et al. 2016); 2015, 2016 (SRB&A 2017, 2018).
Note: For all resources study years (1985, 1992, 1993, 1994–1995, 1995–1996, 2000–2001), species are listed in descending order by percent of total harvest and are limited to species accounting for at least 1.0% of the total harvest; for single-resource study years, species are listed in descending order by total estimated pounds (or total number harvested, in the case of salmon study years) and limited to the five top species. Years lacking "% of total harvest" data were not comprehensive (i.e., all resources) study years. The estimated harvest numbers for the 1992, 1994–1995, 1995–1996 and 2000–2001 data were derived by summing individual species in each resource category. Also, for those study years, total pounds were derived from conversion rates found at ADF&G (2018) and total (usable) pounds for bowhead whales were calculated based on the method presented in SRB&A and ISER (1993). These estimates do not account for whale girth and should be considered approximate; more exact methods for estimating total whale weights are available in (George, Philo et al. n.d.). For the 2002–2003, 2003–2004, 2004–2005, 2005–2006, 2006–2007, 2010, and 2011 study years, total pounds were derived from conversion rates from (Braem, Kaleak et al. 2011).
[a] This table shows individual species unless they are not available for a given study year.
[b] Estimated numbers represent individuals in all cases except vegetation, where they represent gallons.
[c] Estimated pounds include only edible pounds and therefore do not include estimates for resources that are not typically eaten by community residents (e.g., furbearers).
[d] The estimated pounds of moose harvested in 1992 is likely too high (Fuller and George 1999).
[e] The 1994–1995 study year underrepresents the harvest of Arctic cisco and humpback whitefish (Brower and Hepa 1998); Nuiqsut did not successfully harvest a bowhead whale in 1994–1995.

1.2.1.2.1 Direct Effects Analysis Area

Nuiqsut residents harvest various resources within the direct effects analysis area, including caribou, furbearers (wolf and wolverine), seal, goose, eiders, and fish (broad whitefish and burbot). As shown in Tables E.16.2 and E.16.3, caribou are among the top species harvested, in terms of edible weight, by the community of Nuiqsut, as are broad whitefish. During most years, over half of Nuiqsut households participate in the harvests of these resources. Seals, particularly bearded seals, are another important resource that are harvested within the direct effects analysis area. Although not harvested in the same quantities as resources such as caribou and broad whitefish, a substantial proportion of households participate in seal hunting (Table E.16.2). Similarly, while migratory birds generally account for less than 5% of the total annual harvest, a high percentage of households participate in harvests of these resources (between 70% and 90% across available study years; Table E.16.2). Wolf and wolverine hunting is an important, specialized activity that is practiced by a more limited subset of the community but which provides income and supports traditional crafts.

Harvest amounts specific to the direct effects analysis area are available only for caribou. These data show the percentage of the reported caribou harvest that came from the direct effects analysis area between 2008 and 2016. These data represent only the harvests reported by a sample of active harvesters

interviewed during each study year and are not based on the total estimated community harvest; thus, other harvests may have occurred within the direct effects analysis area during the study.

As shown in Table E.16.4, across nine years of the Nuiqsut Caribou Subsistence Monitoring Project, between 6% and 19% of annual caribou harvests have occurred within the direct effects analysis area. As noted above, residents often travel to the west of their community to hunt caribou by four-wheeler or snow machine in an area east and south of the direct effects analysis area. Caribou often travel through the analysis area before arriving in hunting areas closer to the community.

Table E.16.4. Nuiqsut Caribou Harvests Within the Direct Effects Analysis Area, 2008–2016

Study Year	Percent of Caribou Harvests Within Direct Effects Analysis Area
Year 1	8
Year 2	8
Year 3	8
Year 4	19
Year 5	15
Year 6	8
Year 7	14
Year 8	6
Year 9	10

Source: SRB&A 2018

Based on data from SRB&A (2010b), which collected subsistence use areas for key resources for the 1995–2006 time period, the direct effects analysis area is commonly used by caribou hunters (88% of harvesters for that resource), wolf and wolverine hunters (88% and 87%, respectively), goose hunters (33%), and bearded seal hunters (30%) (Table E.16.5). For resources as a whole, the vast majority (94%) of Nuiqsut harvesters reported using the direct effects analysis area during the study period. Based on more recent caribou harvesting data for the 2008–2016 time period, the data show that on an annual basis, between 35% and 78% of respondents use the direct effects analysis area (Table E.16.6); thus, the area remains a key caribou hunting ground for the community.

Table E.16.5. Percent of Nuiqsut Harvesters Using the Direct Effects Analysis Area, 1995–2006

Resource	Percent of Nuiqsut Resource Respondents	Total Number of Last 10 Respondents for Resource	Number of Respondents in Direct Effects Area
Caribou	88%	32	28
Wolverine	88%	24	21
Wolf	87%	23	20
Goose	33%	33	11
Bearded seal	30%	27	8
Ringed seal	22%	23	5
Eiders	14%	28	4
Broad whitefish	12%	26	3
Moose	10%	31	3
Burbot	3%	30	1
Percent of total harvesters	94%	33	31

Source: SRB&A 2010b

Table E.16.6. Percent of Nuiqsut Caribou Harvesters Using the Direct Effects Analysis Area, 2008–2016

Study Year	Number Using Direct Effects Area	Percent Using Direct Effects Area	Total Respondents
Year 1	28	78%	36
Year 2	26	49%	53
Year 3	32	56%	57
Year 4	30	52%	58
Year 5	29	51%	57
Year 6	21	37%	57
Year 7	33	55%	60
Year 8	23	40%	58
Year 9	22	35%	63

Source: SRB&A 2018

1.2.1.3 Timing of Subsistence Activities

Table E.16.7 provides data on the timing of Nuiqsut subsistence activities, based on studies from the 1970s through the 2010s. Overall, Nuiqsut harvesters target the highest numbers of resources, including non-salmon fish, caribou, moose and other large land mammals, seals and bowhead whales, and plants and berries, during the summer and fall months of August and September.

Table E.16.7. Nuiqsut Annual Cycle of Subsistence Activities

Resource	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Freshwater non-salmon	M	L	M	M	L	L	M	H	H	H	H	L
Marine non-salmon	–	–	–	–	–	–	–	–	H	H	–	–
Salmon	–	–	–	–	–	–	H	M	–	–	–	–
Caribou	L	L	L	L	L	M	H	H	M	M	L	L
Moose	L	–	–	–	–	–	L	H	H	M	L	L
Bear	M	M	M	L	L	L	L	L	H	M	M	M
Muskox	–	–	–	–	–	–	–	H	H	H	–	–
Furbearers	H	H	H	H	M	L	L	L	L	L	M	H
Small land mammals	–	–	–	–	L	L	H	H	L	–	–	–
Marine mammals	–	–	M	H	L	L	M	H	H	L	L	L
Upland birds	M	M	H	H	M	L	–	L	L	M	M	M
Waterfowl	–	–	–	L	H	H	M	M	M	M	L	L
Eggs	–	–	–	–	–	H	–	–	–	–	–	–
Plants and berries	–	–	–	–	L	L	H	H	–	–	–	–
Total # of resource categories by month	6	5	6	7	9	10	10	12	11	10	8	8

Source: 1995–1996, 2000–2001 (Bacon, Hepa et al. 2009); 2002–2007 (Braem, Kaleak et al. 2011); 1994–1995 (Brower and Hepa 1998); Pre-1979 (Brown 1979); 2014 (Brown, Braem et al. 2016); 2004 (EDAW Inc., Adams/Russel Consulting et al. 2008); 1992 (Fuller and George 1999); 2001–2012 (Galginaitis 2014); 1988 (Hoffman, Libbey et al. 1988); 1979 (Libbey, Spearman et al. 1979); 1995–2006 (SRB&A 2010b); 2008–2016 (SRB&A 2018).

Note: "–" (no documented activity and/or harvests); L (limited activity and/or harvests); M (moderate activity and/or harvests); H (high activity and/or harvests)

The month of April marks the beginning of the spring waterfowl hunting season which peaks in May and June. Some residents also harvest goose eggs after the birds begin nesting in June. Beginning as early as May (depending on the timing of breakup), residents travel by boat along the local river system and into the Beaufort Sea to harvest various resources including caribou, waterfowl, seals, and fish. Caribou hunting occurs throughout the year, but with the most intensity during the summer months of July and August. During this time, residents also set nets for broad whitefish in local river systems or harvest fish such as Arctic grayling and Dolly Varden with rod and reel, often while hunting caribou along the Colville River. Throughout the summer months, residents also travel to the ocean to hunt for ringed seals, bearded seals, and king and common eiders with some coastal caribou hunting occurring as well (SRB&A 2010b). Most berry and plant gathering occurs in July and August.

Beginning in August and continuing throughout September, some residents shift their focus upriver in search of moose, with caribou often a secondary pursuit during these trips. Summer rod-and-reel harvests of non-salmon fish, particularly Arctic grayling, continue into the fall as well. Preparation for the bowhead whale hunt begins in August, with whaling crews generally traveling to Cross Island in September. While at Cross Island, Nuiqsut hunters may harvest polar bears and other marine resources; these harvesting events generally occur when whaling is not active due to weather or travel conditions. The fall Arctic cisco fishery, a major community event, may begin in September but is most productive between October and mid-November when the fish are running upriver and residents harvest them in the CRD with gillnets. Other fish, including humpback whitefish, broad whitefish, and least cisco are caught incidentally during this time. Caribou are also harvested during October and November as available to the west of the community.

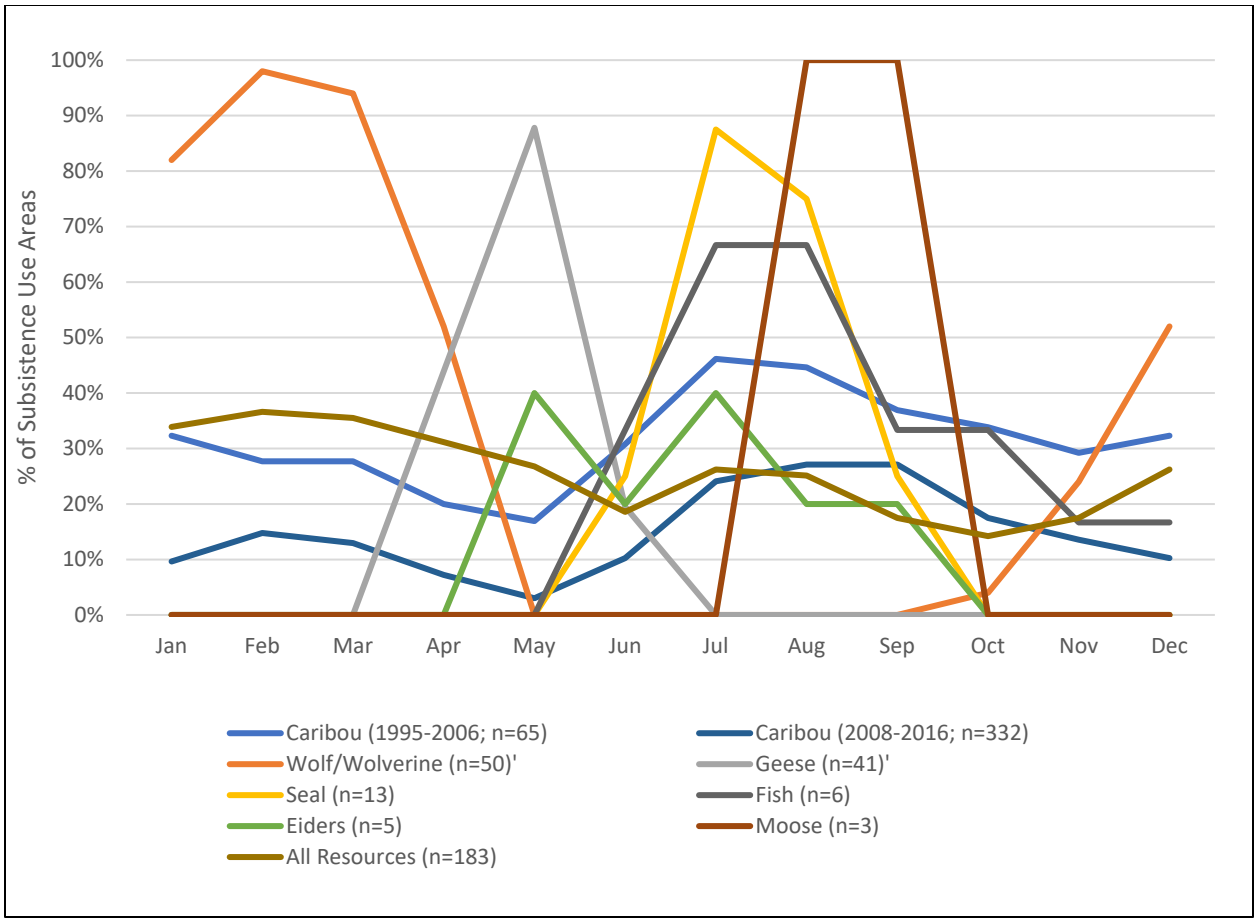
Starting in November and December and continuing through April, hunters pursue wolves and wolverines and target caribou and ptarmigan as needed and available. Residents may also fish for burbot through the ice during the winter.

1.2.1.3.1 Direct Effects Analysis Area

Nuiqsut harvesters use the direct effects analysis area at varying levels throughout the year (Figure E.16.10). For resources as a whole for the 1995–2006 time period, uses of the direct effects analysis area are somewhat consistent throughout the year but with a peak in the winter (January through March) and again in the summer (July and August). During both the 1995–2006 and 2008–2016 time periods, caribou hunting in the direct effects area peak from July through September but continue through the winter. Data from the more recent time period (2008–2016) show decreasing use of the direct effects analysis area in the winter months, consistent with the increasing use of ATVs over snow machines to access areas west of Nuiqsut (SRB&A 2018). Wolf and wolverine hunters use the direct effects analysis area solely during the winter months of November through April, with goose hunting peaking in the spring months of April and May. Seal and eider hunting occur offshore primarily during the open water months of June through September, although some eider hunting occurs as early as May.

1.2.1.4 Travel Method

As shown in Table E.16.8, boat is the primary travel method used for subsistence pursuits of most resources, including various non-salmon fish, caribou, moose, bowhead whale, seals, and eider. Snow machine is the primary method of travel used for late fall, winter, and early spring pursuits of Arctic cisco, burbot, wolf and wolverine, and goose, and shows that while boat remains the primary method of travel to caribou-use areas, in recent years ATVs and trucks have become much more common while snow machine travel has become less common.



Source: SRB&A 2010b, 2018

Figure E.16.10. Nuiqsut Subsistence Use Areas by Month in Direct Effects Analysis Area, by Resource

Table E.16.8. Nuiqsut Travel Method to Subsistence Use Areas

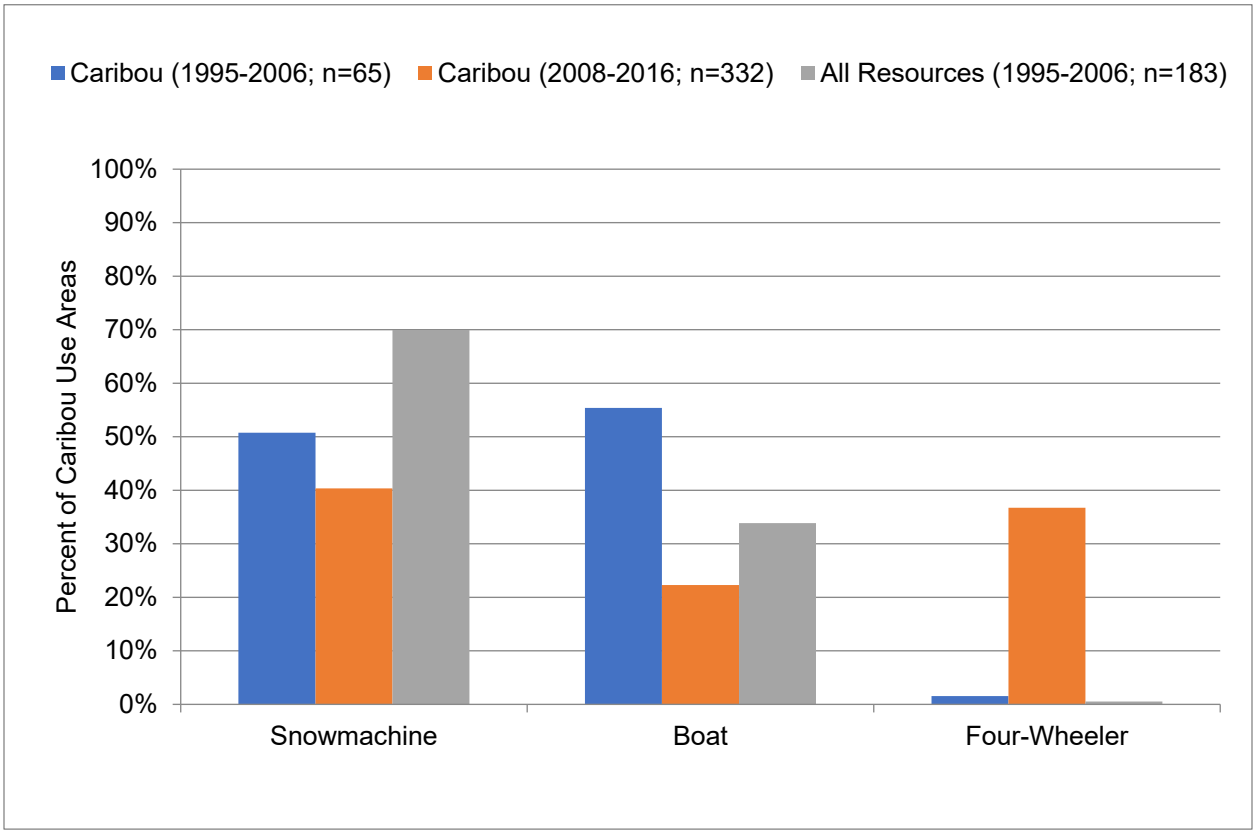
Resource	Boat	Snow Machine	Foot	Car/Truck	ATV	Plane
Arctic cisco and burbot	L	H	L	M	–	–
Arctic char/Dolly Varden and broad whitefish	H	M	M	–	–	–
Caribou	H	M	–	L	M	–
Moose	H	–	M	–	–	–
Wolf and wolverine	M	H	–	–	–	M
Bowhead whale	H	–	–	–	–	–
Seals	H	M	–	–	–	–
Goose	M	H	M	L	L	–
Eider	H	M	–	–	–	–
Total number of resources targeted	9	7	4	3	2	1

Source: 1995–2006 (SRB&A 2010b); 2008–2016 (SRB&A 2018).
Note: ATV (all-terrain vehicle); "–" (no documented use of travel method); L (limited use of travel method); M (moderate use of travel method); H (high use of travel method). Caribou based on SRB&A (2017). All others based on SRB&A (2010b).

1.2.1.4.1 Direct Effects Analysis Area

Because the direct effects analysis area includes terrestrial, riverine, and marine areas, travel methods used by Nuiqsut harvesters vary by location. As shown in Figure E.16.11, for the 1995–2006 time period,

snow machine was the primary method used to access the direct effects analysis area, followed by boat. No other travel methods were used (except minimally) within the direct effects area. Specifically, for caribou, Nuiqsut residents primarily accessed the area by boat, followed by snow machine. During the 2008–2016 time period, Nuiqsut caribou hunters accessed the direct effects analysis area to a lesser extent by boat (22% of use areas). The majority of use areas were accessed during that time period by snow machine or ATV (four-wheeler). Figure E.16.11 shows a substantial increase in the use of ATVs in the direct effects analysis area during the 2008–2016 time period. Recent data from the Caribou Subsistence Monitoring Project also show increased use of trucks to access caribou hunting areas west of the community due to the construction of easily accessible gravel roads (SRB&A 2018).



Source: SRB&A 2010b, 2018

Figure E.16.11. Nuiqsut Travel Methods in Direct Effects Analysis Area

1.2.1.5 Resource Importance

An analysis of resource importance based on harvest (percent of total harvest), harvest effort (percent of households attempting harvests) and sharing (percent of households receiving) variables is provided in Table E.16.9. Based on this analysis, resources of major importance in Nuiqsut are Arctic cisco, Arctic grayling, bearded seal, bowhead whale, broad whitefish, burbot, caribou, cloudberry, white-fronted goose, and driftwood.

Table E.16.9. Relative Importance of Subsistence Resources Based on Selected Variables, Nuiqsut[a]

Resource Category	Resource	Percent of Households Trying to Harvest	Percent of Households Receiving	Percent of Total Harvest
Major resources[b]	Arctic cisco	61	57	8.8
Major resources[b]	Arctic grayling	50	24	1.0
Major resources[b]	Bearded seal	32	50	1.6
Major resources[b]	Bowhead whale[c]	30	96	30.4
Major resources[b]	Broad whitefish	69	49	15.5
Major resources[b]	Burbot	51	35	1.0
Major resources[b]	Caribou	73	75	29.9
Major resources[b]	Cloudberry	55	29	0.0
Major resources[b]	White fronted goose	62	36	1.4
Major resources[b]	Wood[d]	50	3.2	0.0
Moderate resources[e]	Arctic char	38	22	0.9
Moderate resources[e]	Arctic fox	14	1	0.0
Moderate resources[e]	Beluga	2	24	0.0
Moderate resources[e]	Bird eggs	16	12	0.0
Moderate resources[e]	Blueberries	29	16	0.0
Moderate resources[e]	Brant	17	9	0.1
Moderate resources[e]	Brown bear	14	18	0.2
Moderate resources[e]	Canada goose	42	24	0.4
Moderate resources[e]	Chum salmon	23	11	0.6
Moderate resources[e]	Ground squirrel	45	8	0.1
Moderate resources[e]	Humpback whitefish	26	9	1.0
Moderate resources[e]	King eider	24	19	0.0
Moderate resources[e]	Least cisco	40	17	1.1
Moderate resources[e]	Long-tailed duck	8	13	0.0
Moderate resources[e]	Moose	40	41	2.5
Moderate resources[e]	Pink salmon	28	17	0.4
Moderate resources[e]	Polar bear	7	29	0.2
Moderate resources[e]	Ptarmigan	48	15	0.2
Moderate resources[e]	Rainbow smelt	13	22	0.1
Moderate resources[e]	Red fox	22	2	0.0
Moderate resources[e]	Ringed seal	36	43	1.6
Moderate resources[e]	Snow goose	19	7	0.0
Moderate resources[e]	Spotted seal	13	5	0.1
Moderate resources[e]	Walrus	7	43	0.2
Moderate resources[e]	Wolf	18	6	0.0
Moderate resources[e]	Wolverine	22	5	0.0
Minor resources[f]	Arctic cod	7	7	0.0
Minor resources[f]	Chinook salmon	2	9	0.0
Minor resources[f]	Coho salmon	3	5	0.0
Minor resources[f]	Common eider duck	7	3	0.1
Minor resources[f]	Cranberries	9	5	0.0
Minor resources[f]	Crowberries	7	2	0.0
Minor resources[f]	Dall sheep	–	9	0.0
Minor resources[f]	Dolly Varden	10	3	0.4
Minor resources[f]	Lake trout	3	8	0.0
Minor resources[f]	Muskox	–	8	0.3
Minor resources[f]	Northern pike	7	7	0.0
Minor resources[f]	Northern pintail	5	1.6	0.0
Minor resources[f]	Round whitefish	5	1	0.1
Minor resources[f]	Saffron cod	7	–	0.0
Minor resources[f]	Sheefish	–	6	0.0

Resource Category	Resource	Percent of Households Trying to Harvest	Percent of Households Receiving	Percent of Total Harvest
Minor resources[f]	Sockeye salmon	3	6	0.0
Minor resources[f]	Sourdock	5	7	0.0
Minor resources[f]	Weasel	5	–	0.0

Source: 1985 (ADF&G 2018); 1992 (Fuller and George 1999); 1993 (Pedersen 1995b); 1994–1995 (Brower and Hepa 1998); 1995–1996, 2000–2001 (Bacon, Hepa et al. 2009); 1999–2000, 2002–2007 (Braem, Kaleak et al. 2011); 2010, 2011, 2012, 2013 (SRB&A 2012, 2013, 2014, 2015); 2014 (Brown, Braem et al. 2016); 2016 (SRB&A 2018).

[a] For space considerations, resources contributed an average of less than 1% of harvest, less than 5% attempting harvests, and less than 5% receiving harvests are categorized as minor and are not be shown.

[b] Major resources contribute > 9% total harvest, have ≥ 50% of households attempting harvest, or have ≥ 50% of households receiving resource.

[c] Averages include unsuccessful bowhead whale harvest years.

[d] The inclusion of wood is based on a single study year (1993); data on wood were not collected during any other study year.

[e] Moderate resources contribute 2% to 9% of total harvest, have 11% to 49% of households attempting harvest, or have 11% to 49% of households receiving resource.

[f] Minor resources contribute < 2% of total harvest, have ≤ 10% of households attempting harvest, or have ≤ 10% of households receiving resource.

1.2.2 Utqiaġvik

Utqiaġvik (Barrow) is the North Slope's most populous community and is located on the northern coast of the Chukchi Sea. The town site is approximately 7.5 miles south of Point Barrow, the demarcation point between the Chukchi and Beaufort seas. In 2016, residents of Barrow voted to formally rename the town to its original Iñupiaq name of Utqiaġvik. The community is also traditionally known as Ukpeagvik, which means "place where snowy owls are hunted" (NSB 2018). Continuous occupation of the Utqiaġvik area began approximately 1,300 years ago. Following European contact in the early 1800s, the growth of the commercial whaling and trapping industries brought Iñupiat from across the North Slope to Utqiaġvik in pursuit of employment and trade opportunities. The Naval Petroleum Reserve 4 was established in 1923, and during World War II, the U.S. Navy established a base camp in Utqiaġvik in the late 1940s as a place to launch oil exploration in the reserve (Jensen 2009). The established mission of the naval base camp shifted away from oil exploration in the 1950s, and the base became the Naval Arctic Research Laboratory. Throughout the late 1900s, Utqiaġvik continued to grow as new economic opportunities, including oil and gas exploration, arose on the North Slope. Today, Utqiaġvik is the headquarters for various regional organizations and corporations including the NSB and the Arctic Slope Regional Corporation (NSB 2016). In 2014, the population of Utqiaġvik was estimated at 4,825 residents living in 1,588 households; 65.9% were Alaska Native (NSB 2016). The community remains primarily Iñupiat, and subsistence remains an important part of the community's identity and social fabric.

1.2.2.1 Subsistence Use Areas

Figure E.16.12 depicts Utqiaġvik subsistence use areas for all resources for various historic and contemporary time periods (BLM 2004; Brown, Braem et al. 2016; Pedersen 1979; SRB&A 2010b, Unpublished; SRB&A and ISER 1993). Time periods range from lifetime use areas documented in 1979 (Pedersen 1979) to single-year use areas documented in 2014 (Brown, Braem et al. 2016). Lifetime (pre–1979) use areas include locations as far south as the Colville River near Umiat, beyond Nuiqsut in the east, offshore from the community to the southeast and southwest, and inland beyond Wainwright toward Point Lay. Harvest sites and use areas for the 1987–1989 time period are similar to those recorded for the pre–1979 time period but extend farther offshore from the community. The harvest sites for this time period are concentrated in offshore areas between Peard Bay and Smith Bay and onshore areas extending south from the community beyond the Colville River and into the foothills of the Brooks Range. More recent use areas studies for the 1994–2003 and 1997–2006 time periods show somewhat larger use area extents, with use areas extending well offshore to the north of the community, east toward the Kuparuk River area, south to the Colville River, and as far west as Point Lay. Overlapping subsistence use areas for the 1997–2006 time period show the greatest concentration of use areas occurring offshore from the community up to 20 miles and in an overland area south of the community and along the Chipp and

Ikpikpuk rivers. Use areas for the 2014 time period are consistent with these areas of highest overlapping use. In addition, some isolated use areas were reported for the 2014 time period offshore from Icy Cape and near Point Lay.

Resource-specific use area maps for Utqiaġvik are shown in Figures E.16.13 through E.16.20 for the time periods mentioned above. Utqiaġvik subsistence use areas for large land mammals are shown in Figures E.16.13 through E.16.15. Caribou use areas (Figure E.16.13) cover an extensive area from Icy Cape to Prudhoe Bay and as far south as the Colville River. Caribou hunting areas for the 1997–2006 time period extend farther south and east than previous time periods; the highest numbers of overlapping caribou use areas extend in an overland area approximately 30 miles south of the community and along local river systems. Caribou use areas for the most recent time period (2014) are generally within those documented for 1997–2006. Figure E.16.14 depicts Utqiaġvik moose use areas, and for most time periods, shows use concentrated along the Colville River where moose are more likely to be found. Use areas from the 1997–2006 and 2014 time periods indicate use of a considerably larger area extending between Utqiaġvik and the Colville River. Utqiaġvik use areas for other large land mammals (e.g., grizzly/brown bear, Dall sheep, and polar bear) are shown on Figure E.16.15. Polar bear use areas occur in the Chukchi Sea at distances of no more than 20 miles from shore, while grizzly bear use areas are concentrated in various inland areas bounded by Wainwright and the Kuk River in the west, and the Ikpikpuk River in the east.

Utqiaġvik small land mammal use areas (Figure E.16.16) cover an extensive area from Point Lay to the Kuparuk River and beyond the Colville River in the south. The extent of furbearer and small land mammal use areas has expanded over time. Lifetime furbearer and small land mammal use areas cover areas from Wainwright in the west to Nuiqsut in the east, and as far south as the Colville River, while 1997–2006 use areas for wolf and wolverine extend beyond Icy Cape to Point Lay in the west, past Nuiqsut to the Kuparuk River in the east, and well beyond the Colville River in the south. High numbers of overlapping use areas occur south and east of the community toward the Colville River. Small land mammal use areas for the most recent time period (2014) occurred primarily along the Ikpikpuk River toward the Colville River.

Utqiaġvik fishing areas for all available time periods are depicted in Figure E.16.17 and show residents fishing across a large river and lake system to the south of the community, west to the Kuk River near Wainwright, and as far east as Teshekupk Lake and the Colville River. Most time periods also show fish harvesting in coastal waters and lagoon systems in the Chukchi and Beaufort seas. More recent use areas from the 1994–2003, 1997–2006, and 2014 time periods occur along river and lake systems to the south and east of the community as far as the Teshkpuk Lake and upper Judy Creek areas.

Utqiaġvik use areas for birds (Figure E.16.18), including eiders and goose, are relatively consistent over time, though extending considerably farther offshore during the 1997–2006 time period (SRB&A 2010b). Use areas are located in the vicinity of Utqiaġvik, offshore at a distance greater than 40 miles, inland beyond Atqasuk in the west, and east as far as Nuiqsut. Bird use areas from more recent time periods (1994–2003, 1997–2006, and 2014) are concentrated along the Meade, Chipp, and Ikpikpuk rivers. Utqiaġvik harvests of vegetation (including berries and plants) and wood are depicted in Figure E.16.19 for various time periods. The vegetation and wood harvests generally occur to the south and southeast of the community, in addition to coastal areas (primarily for driftwood). More recent use areas for the 2014 time period occur over a large area extending southwest to Wainwright and southeast to the Ikpikpuk River. Several isolated berry and plant harvesting areas have also been reported as far as Point Lay and Colville River.

Utqiaġvik subsistence use areas for marine mammals are shown on Figure E.16.20 and occur at varying offshore distances in the Beaufort and Chukchi seas. The offshore extent of marine mammal use areas has grown over time. SRB&A's (2010b) 1997–2006 marine mammals use areas show Utqiaġvik residents traveling beyond Wainwright in the west and offshore more than 80 miles, with the highest numbers of overlapping use areas occurring between 10 and 25 miles from shore. During the 2014 time period, marine mammal use areas occurred between Icy Cape and Dease Inlet, and up to approximately 40 miles from shore.

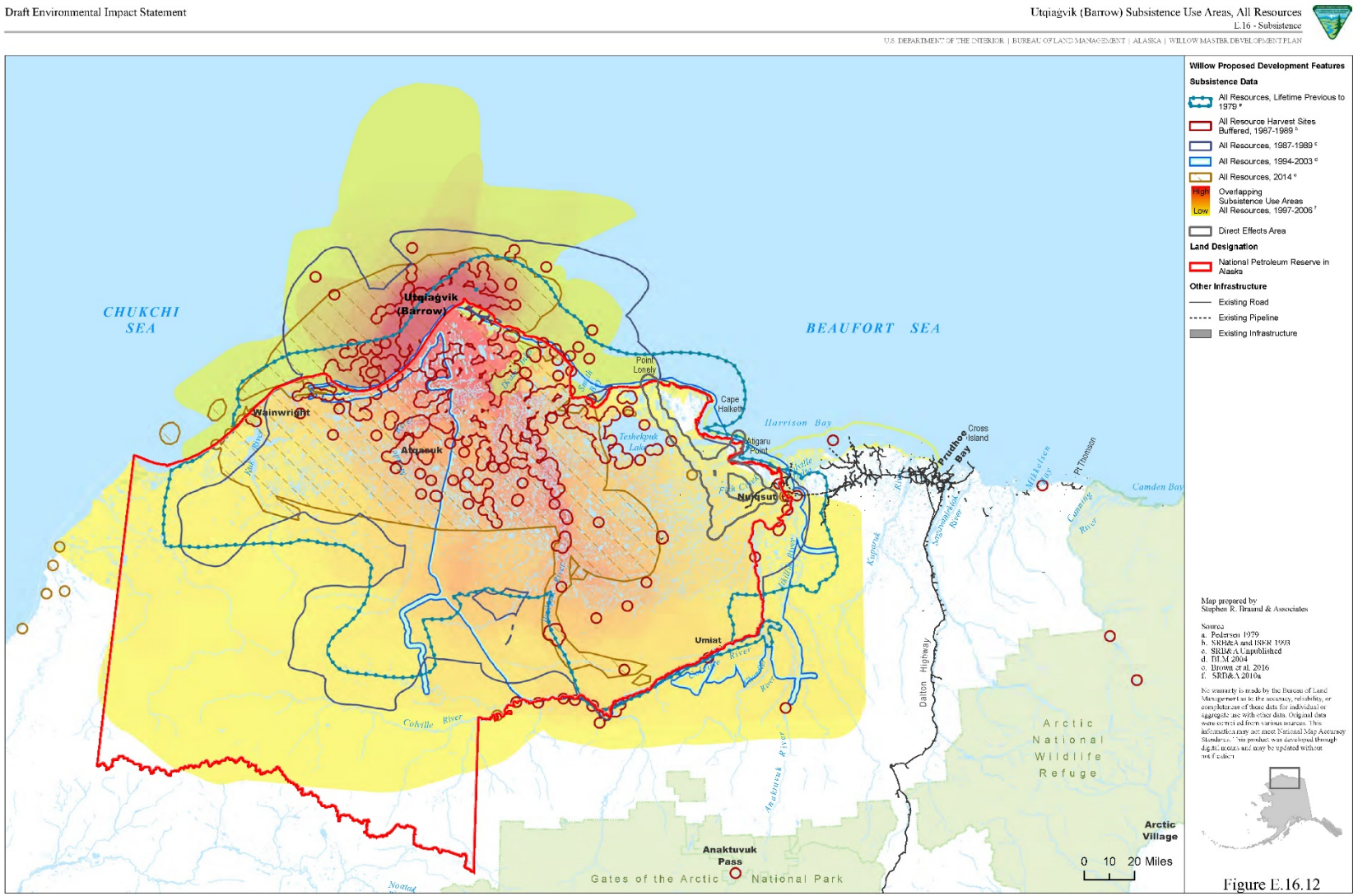


Figure E.16.12. Utqiaġvik Subsistence Use Areas, All Resources

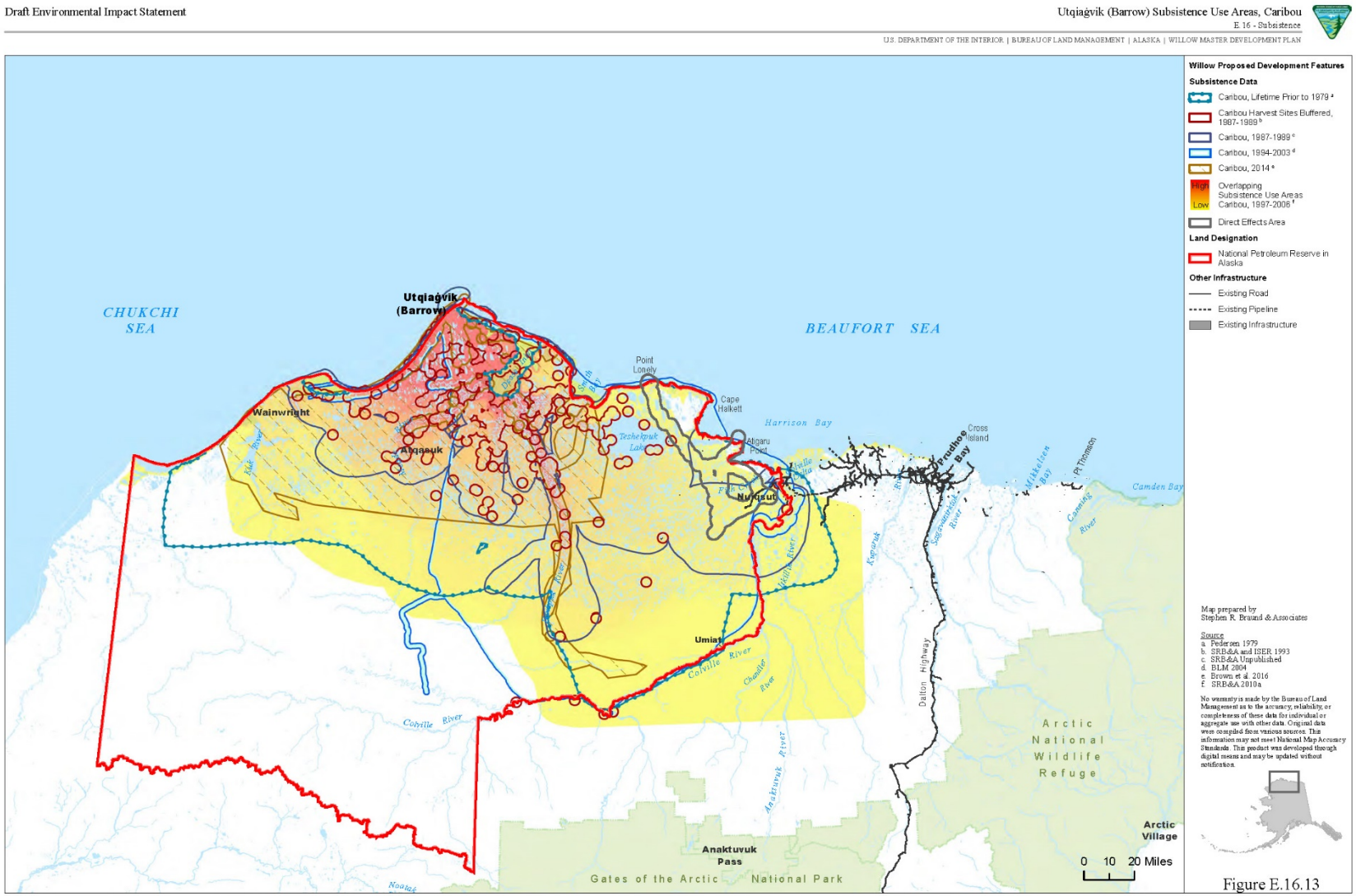


Figure E.16.13. Utqiaġvik Subsistence Use Areas, Caribou

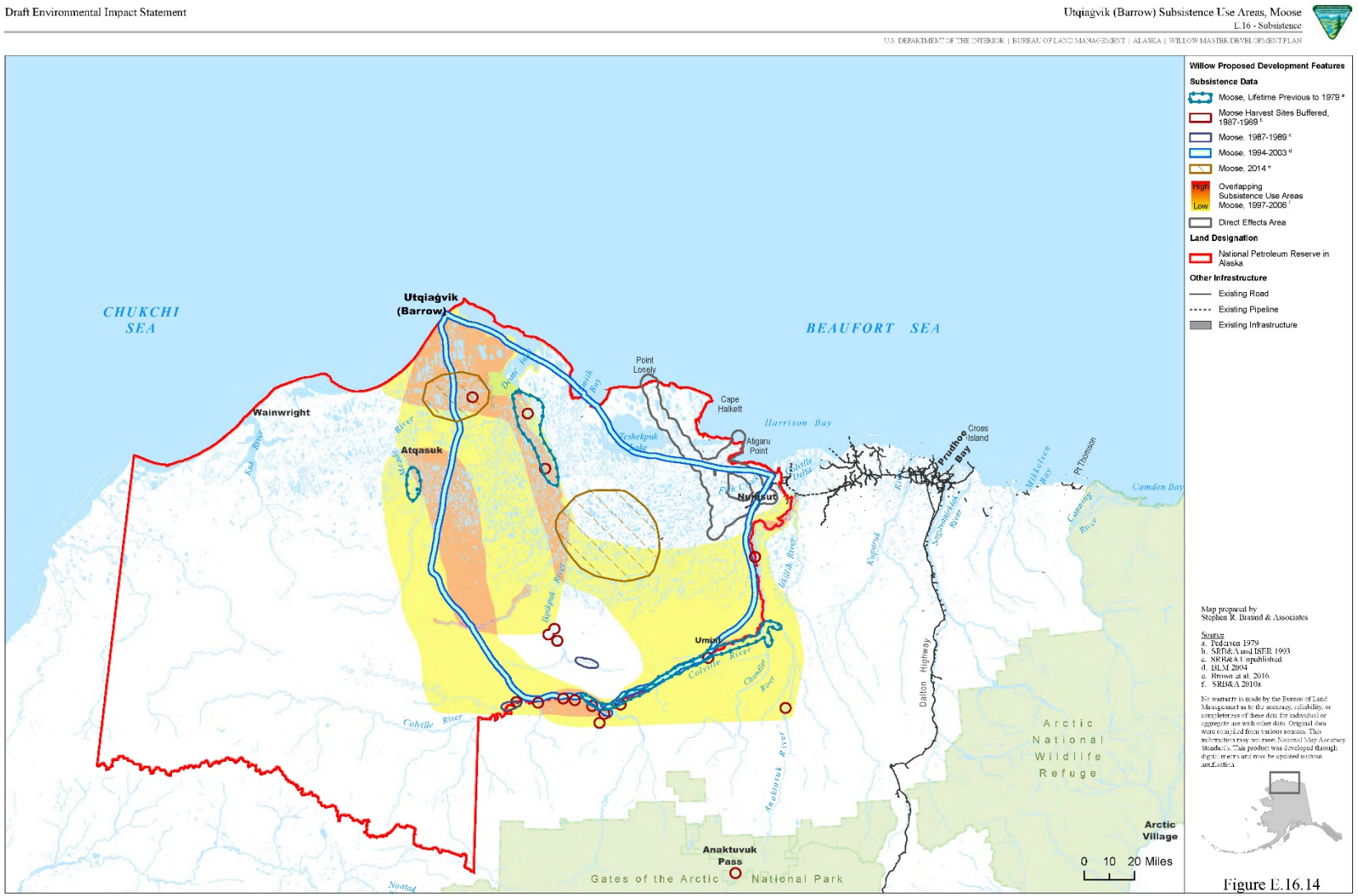


Figure E.16.14. Utqiaġvik Subsistence Use Areas, Moose

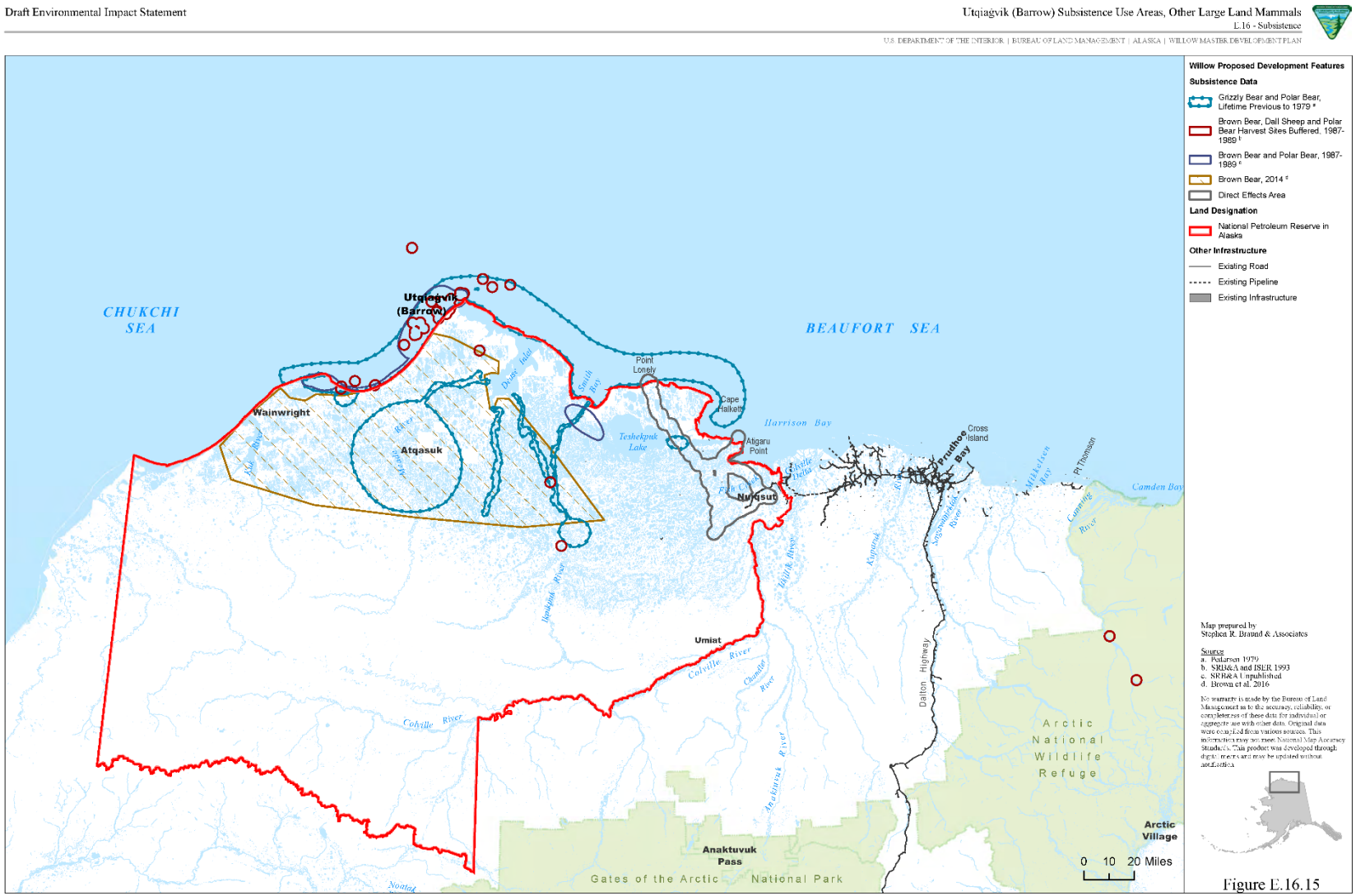


Figure E.16.15. Utqiaġvik Subsistence Use Areas, Other Large Land Mammals

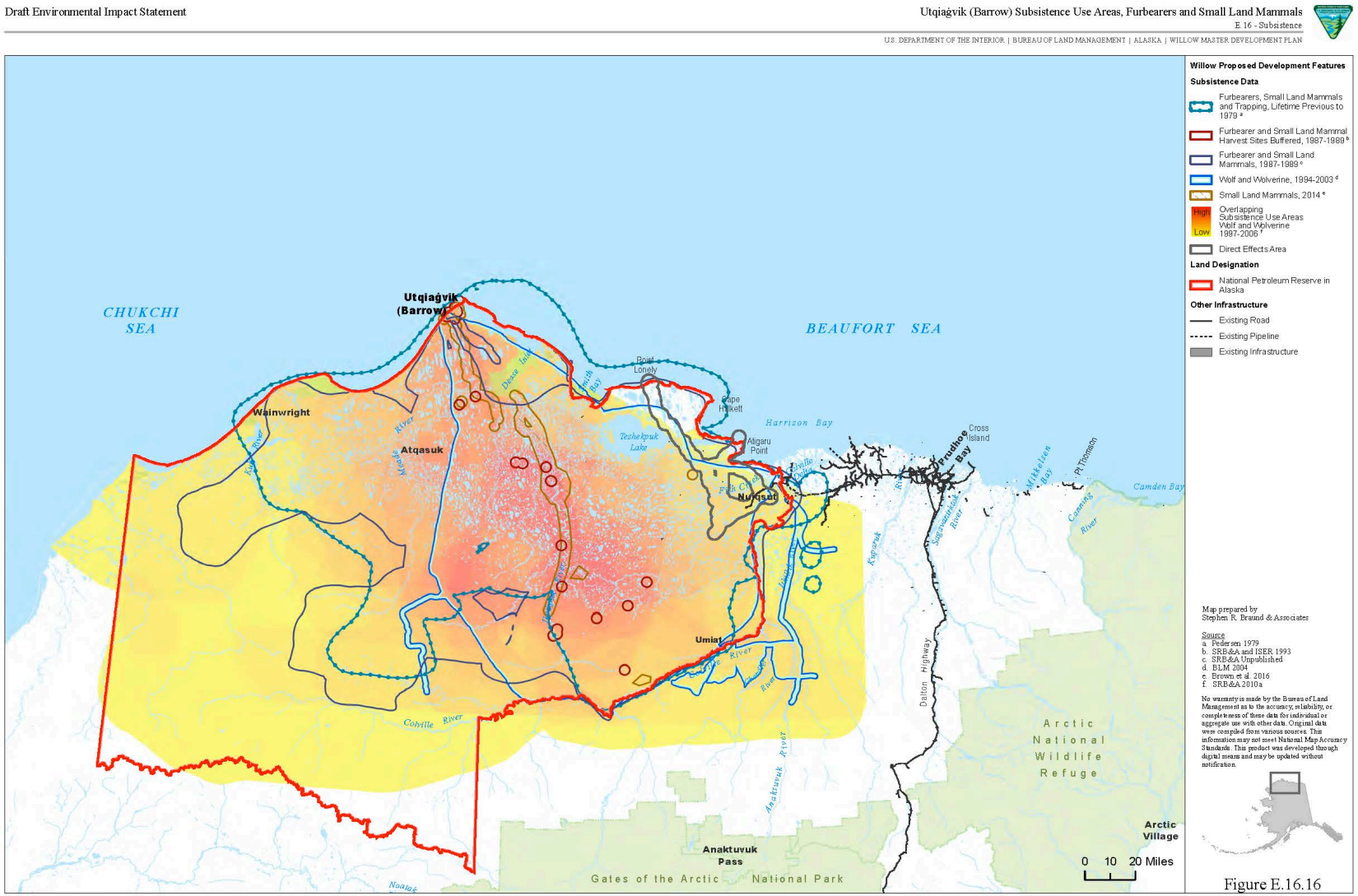


Figure E.16.16. Utqiaġvik Subsistence Use Areas, Furbearers and Small Land Mammals

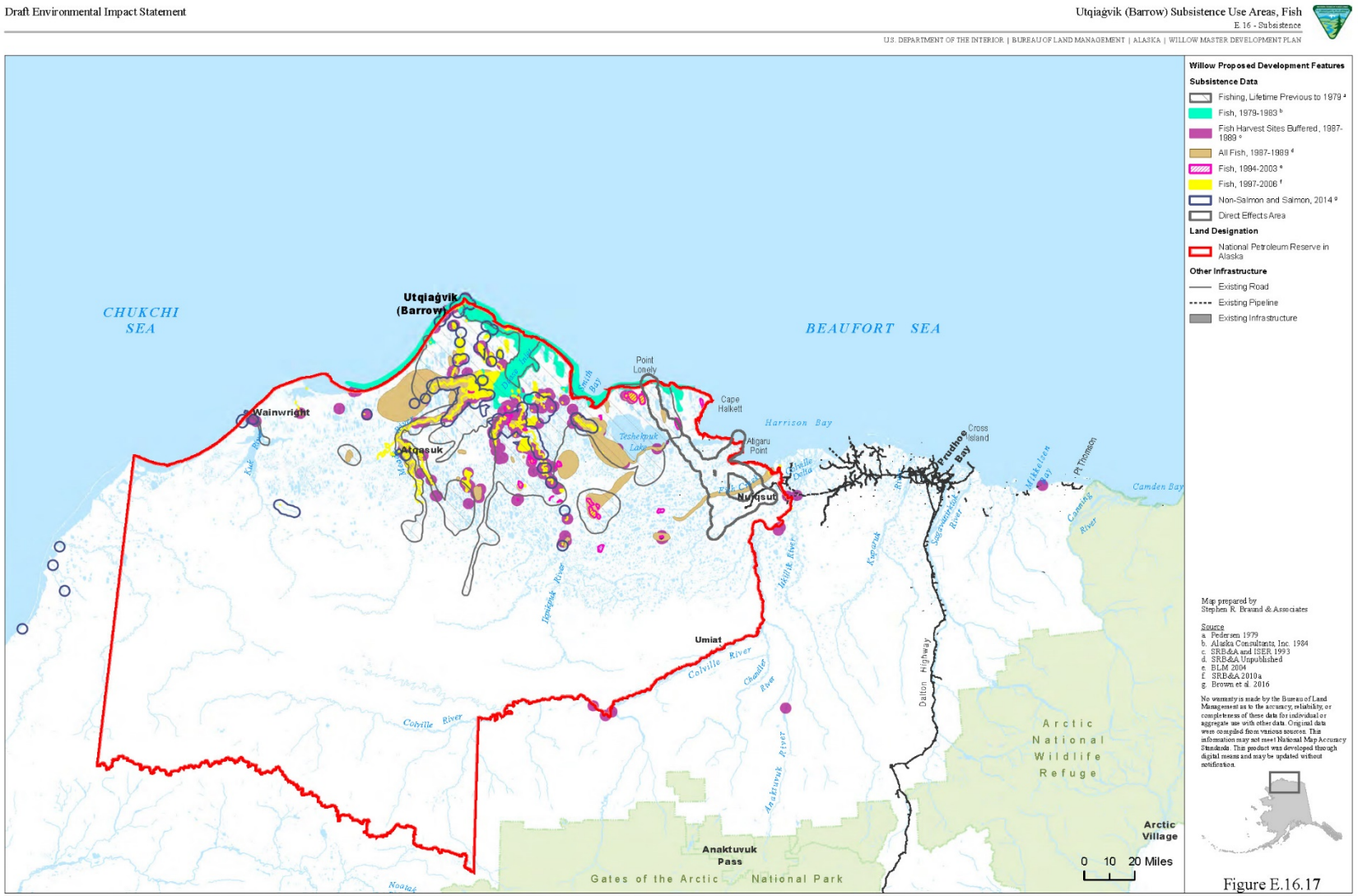


Figure E.16.17. Utqiaġvik Subsistence Use Areas, Fish

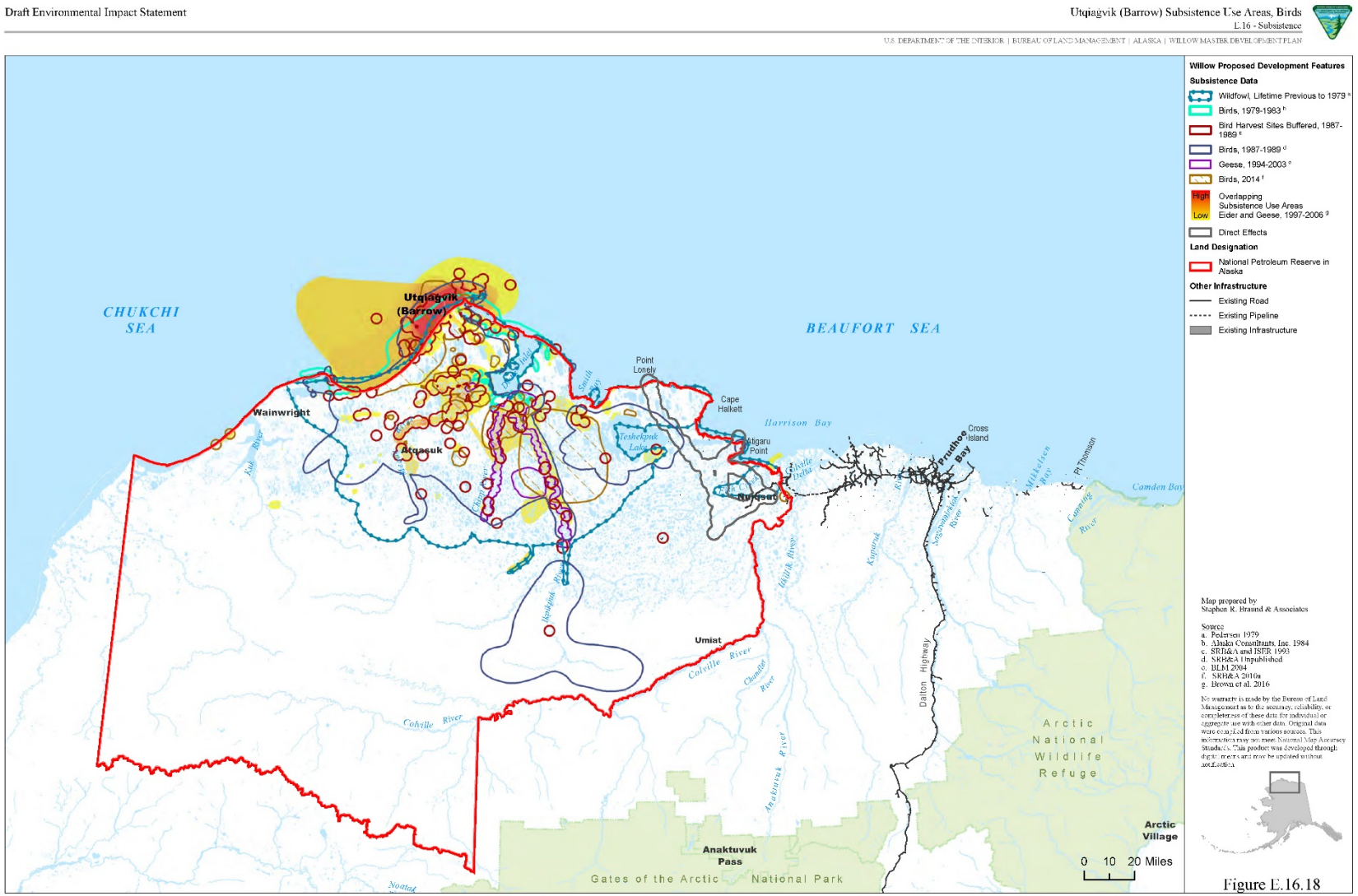


Figure E.16.18. Utqiaġvik Subsistence Use Areas, Birds

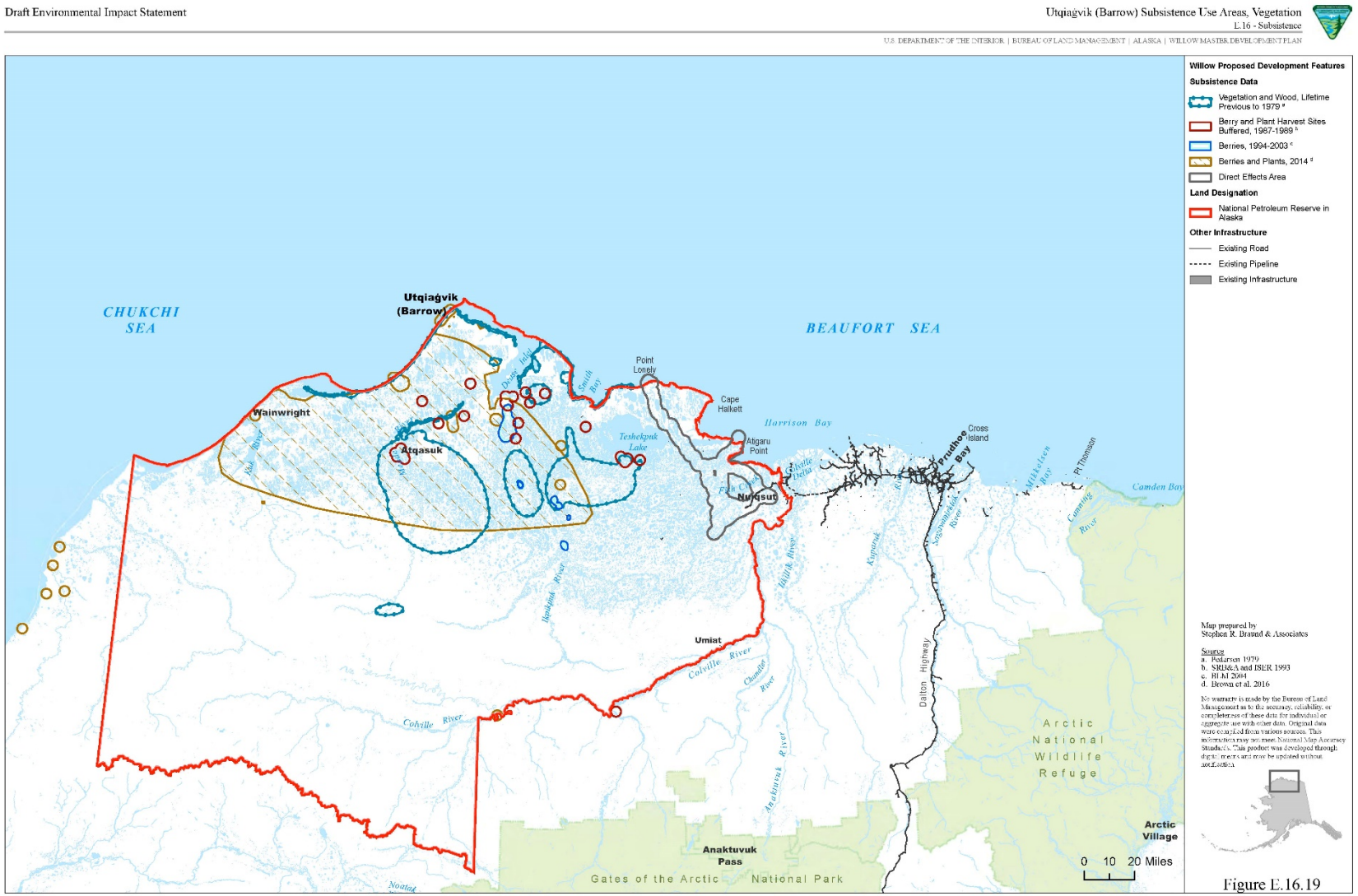


Figure E.16.19. Utqiaġvik Subsistence Use Areas, Vegetation

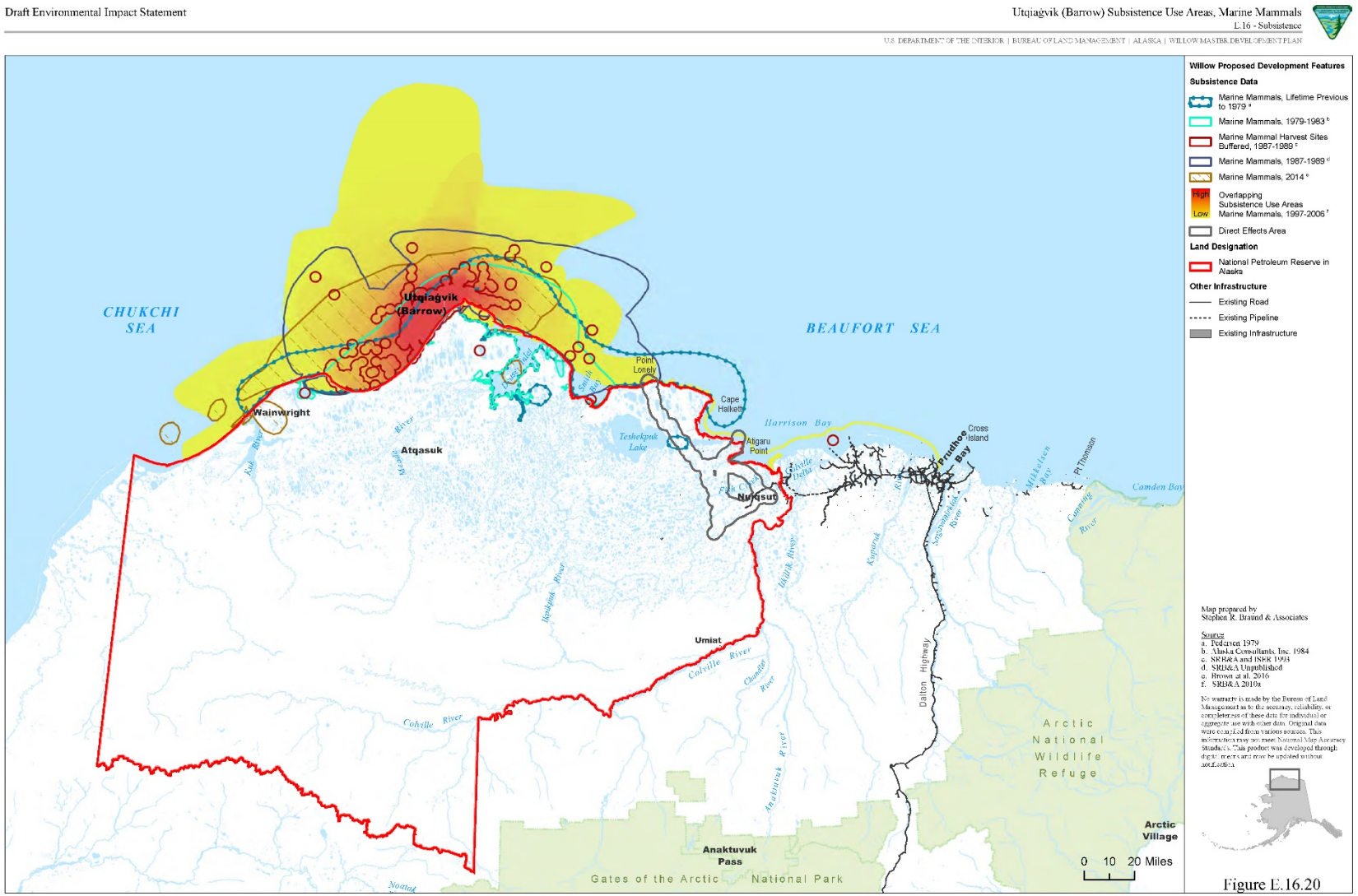


Figure E.16.20. Utqiaġvik Subsistence Use Areas, Marine Mammals

1.2.2.1.1 Direct Effects Analysis Area

Subsistence use of the direct effects analysis area, defined as the area within 2.5 miles of Project infrastructure, is limited among Utqiaġvik harvesters. For the 1995–2006 time period, use areas overlapping the direct effects analysis area accounted for only 2% of all use areas documented for Utqiaġvik harvesters (Table E.16.10).

Table E.16.10. Utqiaġvik Use Areas within the Direct Effects Analysis Area

Source	Resource Type	Time Period	Total Number of Use Areas	Number (%) of Use Areas in Direct Effects Area
SRB&A 2010b	All resources	1995–2006	2,029	40 (2%)

In general, the direct effects area is located in the northeastern periphery of Utqiaġvik's extensive subsistence use areas. Resource uses that overlap include caribou, moose, other large land mammals, furbearers and small land mammals, fish, birds, and marine mammals (Figures E.16.12 through E.16.20). Resources that overlap during a majority of study years include caribou and furbearers and small land mammals. While most resource uses overlap a smaller portion of the direct effects analysis area or overlap areas of low overlapping use, the direct effects area is directly to the east of Teshekpuk Lake, which is an area of high subsistence activity for caribou, furbearers and small land mammals, and fish.

1.2.2.2 Harvest and Use Data

Tables E.16.11 through E.16.13 provide subsistence harvest data for Utqiaġvik. Intermittent subsistence harvest studies exist for Utqiaġvik harvests from 1987 through 2014, including 10 comprehensive (i.e., all resources) studies (Tables E.16.11 and E.16.13) (Bacon, Hepa et al. 2009; Brown, Braem et al. 2016; Fuller and George 1999; SRB&A and ISER 1993) and three single-resource studies (Table E.16.12) (Naves 2010). Studies show Utqiaġvik households harvesting between 204 and 362 per capita pounds of subsistence resources during available study years. Marine mammals have contributed the highest amount toward the total subsistence harvests in Utqiaġvik (at least 50% of pounds usable weight), followed by large land mammals (between 20% and 40%). Non-salmon fish and migratory birds provided a smaller, but substantial, portion of the yearly harvest during most years. While bird harvests by Utqiaġvik households appear modest in terms of pounds, residents of Utqiaġvik harvest large numbers of both migratory and upland game birds. In 2014, Utqiaġvik residents harvested an estimated 19,049 migratory birds and 911 upland game birds. The single-resource bird harvest study from the mid-to-late 2000s shows varying levels of bird and egg harvests by Utqiaġvik residents from year to year (Table E.16.12).

In terms of species, bowhead whales have been the most harvested resource during all but two study years (1987 and 2014), providing between 29.7% and 68.1% of the subsistence harvest (Table E.16.13). Caribou was the second-most harvested resource during all but two study years, accounting for between 13.3% and 30.6% of Utqiaġvik harvests. Other subsistence species that have contributed highly to Utqiaġvik subsistence harvests over the study years include seal (bearded and ringed), walrus, whitefish (especially broad whitefish), goose, ducks (primarily eiders), polar bear, Arctic grayling, and moose. The most recent comprehensive study year (2014) also showed beluga and salmon (chum and sockeye) among the top species harvested. Although only accounting for a small portion of Utqiaġvik's yearly harvest, vegetation (e.g., berries and plants), marine invertebrates (e.g., clams), and eggs are also harvested by Utqiaġvik residents annually.

Participation in subsistence activities by Utqiaġvik households is relatively high. Available data show at least half of Utqiaġvik households successfully harvesting subsistence resources during each of the study years (Table E.16.11). An even higher percentage of households use subsistence resources; in 2014, 89% of Utqiaġvik households used subsistence resources. Household participation rates are particularly high in harvests of marine mammals, migratory birds, large land mammals, and non-salmon fish (Table E.16.11). Sharing is an important tool for maintaining social networks and distributing food throughout the community. In 2014, 87% of Utqiaġvik households received subsistence resources, and 63% gave subsistence resources away. The most commonly received resources include marine mammals, non-salmon fish, and large land mammals.

Table E.16.11. Utqiaġvik Subsistence Harvest Estimates by Resource Category, All Resources Study Years

Study Year	Resource	Percent of Households Use	Percent of Households Try to	Percent of Households Harvest	Percent of Households Give	Percent of Households Receive	Estimated Harvest Number[a]	Estimated Harvest Total Pounds[b]	Estimated Harvest Average HH Pounds	Estimated Harvest Per Capita Pounds	Percent of Total Harvest
1987	All resources	–	–	58	–	–	–	621,067	663	206	100.0
1987	Salmon	–	–	3	–	–	196	1,190	1	<1	0.2
1987	Non-salmon fish	–	–	–	–	–	45,367	67,262	72	22	10.8
1987	Large land mammals	–	–	–	–	–	1,660	213,777	228	71	34.4
1987	Small land mammals	–	–	–	–	–	233	58	<1	<1	<0.1
1987	Marine mammals	–	–	41	–	–	–	316,229	337	105	50.9
1987	Migratory birds	–	–	–	–	–	8,125	20,618	22	7	3.3
1987	Upland game birds	–	–	16	–	–	2,454	1,717	2	1	0.3
1987	Vegetation	–	–	3	–	–	–	216	<1	<1	<0.1
1988	All resources	–	–	50	–	–	–	614,669	656	204	100.0
1988	Salmon	–	–	1	–	–	80	490	1	<1	0.1
1988	Non-salmon fish	–	–	14	–	–	38,005	50,571	54	17	8.2
1988	Large land mammals	–	–	27	–	–	1,599	207,005	221	69	33.7
1988	Small land mammals	–	–	–	–	–	152	0	0	0	0.0
1988	Marine mammals	–	–	39	–	–	654	334,069	357	111	54.3
1988	Migratory birds	–	–	34	–	–	7,832	21,419	23	7	3.5
1988	Upland game birds	–	–	9	–	–	1,350	945	1	<1	0.2
1988	Vegetation	–	–	2	–	–	–	169	<1	<1	<0.1
1989	All resources	–	–	61	–	–	–	872,092	931	289	100.0
1989	Salmon	–	–	10	–	–	2,088	12,244	13	4	1.4
1989	Non-salmon fish	–	–	13	–	–	66,199	106,226	113	35	12.2
1989	Large land mammals	–	–	39	–	–	1,705	214,676	229	71	24.6
1989	Small land mammals	–	–	2	–	–	68	7	<1	0	<0.1
1989	Marine mammals	–	–	45	–	–	591	508,181	542	169	58.3
1989	Migratory birds	–	–	37	–	–	12,539	29,215	31	10	3.3
1989	Upland game birds	–	–	5	–	–	329	231	<1	<1	<0.1
1989	Vegetation	–	–	–	–	–	–	1,312	1	<1	0.2
1992[c]	All resources	–	–	–	–	–	–	1,363,738	–	–	100.0
1992[c]	Salmon	–	–	–	–	–	1,161	8,236	–	–	0.6
1992[c]	Non-salmon fish	–	–	–	–	–	50,596	87,769	–	–	6.4
1992[c]	Large land mammals	–	–	–	–	–	2,033	250,447	–	–	18.4
1992[c]	Small land mammals	–	–	–	–	–	260	35	–	–	<0.1
1992[c]	Marine mammals	–	–	–	–	–	1,080	991,528	–	–	72.7

Study Year	Resource	Percent of Households Use	Percent of Households Try to	Percent of Households Harvest	Percent of Households Give	Percent of Households Receive	Estimated Harvest Number[a]	Estimated Harvest Total Pounds[b]	Estimated Harvest Average HH Pounds	Estimated Harvest Per Capita Pounds	Percent of Total Harvest
1992[c]	Migratory birds	–	37	–	–	–	10,223	22,922	–	–	1.7
1992[c]	Upland game birds	–	–	–	–	–	1,332	933	–	–	0.1
1992[c]	Eggs	–	–	–	–	–	89	13	–	–	<0.1
1992[c]	Marine invertebrates	–	–	–	–	–	1,774	694	–	–	0.1
1992[c]	Vegetation	–	16	–	–	–	291	1,164	–	–	0.1
1995–1996	All resources	–	–	–	–	–	–	1,194,484	–	–	100.0
1995–1996	Salmon	–	–	–	–	–	301	1,628	–	–	0.1
1995–1996	Non-salmon fish	–	–	–	–	–	29,334	42,778	–	–	3.6
1995–1996	Large land mammals	–	–	–	–	–	2,164	294,236	–	–	24.6
1995–1996	Small land mammals	–	–	–	–	–	220	54	–	–	<0.1
1995–1996	Marine mammals	–	–	–	–	–	883	789,821	–	–	66.1
1995–1996	Migratory birds	–	–	–	–	–	14,746	61,217	–	–	5.1
1995–1996	Upland game birds	–	–	–	–	–	–	152	–	–	<0.1
1995–1996	Eggs	–	–	–	–	–	21	3	–	–	<0.1
1995–1996	Marine invertebrates	–	–	–	–	–	2,208	4,416	–	–	0.4
1995–1996	Vegetation	–	–	–	–	–	27	178	–	–	<0.1
1996–1997	All resources	–	–	–	–	–	–	1,181,132	–	–	100.0
1996–1997	Salmon	–	–	–	–	–	345	2,063	–	–	0.2
1996–1997	Non-salmon fish	–	–	–	–	–	27,469	44,964	–	–	3.8
1996–1997	Large land mammals	–	–	–	–	–	1,158	157,420	–	–	13.3

Study Year	Resource	Percent of Households Use	Percent of Households Try to	Percent of Households Harvest	Percent of Households Give	Percent of Households Receive	Estimated Harvest Number[a]	Estimated Harvest Total Pounds[b]	Estimated Harvest Average HH Pounds	Estimated Harvest Per Capita Pounds	Percent of Total Harvest
1996–1997	Small land mammals	–	–	–	–	–	157	213	–	–	<0.1
1996–1997	Marine mammals	–	–	–	–	–	486	957,692	–	–	81.1
1996–1997	Migratory birds	–	–	–	–	–	4,472	18,533	–	–	1.6
1996–1997	Upland game birds	–	–	–	–	–	–	224	–	–	<0.1
1996–1997	Vegetation	–	–	–	–	–	4	23	–	–	<0.1
2000	All resources	–	–	–	–	–	–	1,285,565	–	–	100.0
2000	Salmon	–	–	–	–	–	2,100	10,247	–	–	0.7
2000	Non-salmon fish	–	–	–	–	–	78,065	114,455	–	–	7.3
2000	Large land mammals	–	–	–	–	–	3,390	460,642	–	–	29.5
2000	Small land mammals	–	–	–	–	–	421	423	–	–	<0.1
2000	Marine mammals	–	–	–	–	–	1,491	909,927	–	–	58.3
2000	Migratory birds	–	–	–	–	–	15,647	63,826	–	–	4.1
2000	Upland game birds	–	–	–	–	–	–	1,071	–	–	0.1
2000	Eggs	–	–	–	–	–	11	3	–	–	<0.1
2000	Marine invertebrates	–	–	–	–	–	36	109	–	–	<0.1
2000	Vegetation	–	–	–	–	–	71	382	–	–	<0.1
2001	All resources	–	–	–	–	–	–	1,082,241	–	–	100.0
2001	Salmon	–	–	–	–	–	332	1,720	–	–	0.2
2001	Non-salmon fish	–	–	–	–	–	4,453	10,003	–	–	0.9
2001	Large land mammals	–	–	–	–	–	1,840	249,943	–	–	23.1
2001	Small land mammals	–	–	–	–	–	118	0	–	–	0.0
2001	Marine mammals	–	–	–	–	–	777	793,162	–	–	73.3
2001	Migratory birds	–	–	–	–	–	6,390	26,326	–	–	2.4
2001	Upland game birds	–	–	–	–	–	–	1,029	–	–	0.1
2001	Marine invertebrates	–	–	–	–	–	13	36	–	–	<0.1
2001	Vegetation	–	–	–	–	–	3	22	–	–	<0.1
2003	All resources	–	–	–	–	–	–	1,245,943	–	–	100.0
2003	Salmon	–	–	–	–	–	4,793	22,617	–	–	1.8
2003	Non-salmon fish	–	–	–	–	–	20,109	36,922	–	–	3.0

Study Year	Resource	Percent of Households Use	Percent of Households Try to	Percent of Households Harvest	Percent of Households Give	Percent of Households Receive	Estimated Harvest Number[a]	Estimated Harvest Total Pounds[b]	Estimated Harvest Average HH Pounds	Estimated Harvest Per Capita Pounds	Percent of Total Harvest
2003	Large land mammals	–	–	–	–	–	2,098	285,297	–	–	22.9
2003	Small land mammals	–	–	–	–	–	84	7	–	–	<0.1
2003	Marine mammals	–	–	–	–	–	1,551	871,568	–	–	70.0
2003	Migratory birds	–	–	–	–	–	8,119	23,349	–	–	1.9
2003	Upland game birds	–	–	–	–	–	443	438	–	–	<0.1
2003	Eggs	–	–	–	–	–	44	185	–	–	<0.1
2003	Marine invertebrates	–	–	–	–	–	1,733	5,198	–	–	0.4
2003	Vegetation	–	–	–	–	–	61	362	–	–	<0.1
2014	All resources	89	57	52	63	87	–		1214	362	100.0
2014	Salmon	69	26	24	26	55	12,087	57,262	36	11	3.0
2014	Non-salmon fish	69	29	27	37	60	106,555	196,049	124	37	10.2
2014	Large land mammals	72	39	33	39	57	4,335	595,004	376	112	30.9
2014	Small land mammals	8	6	5	2	4	1,474	0	0	0	0.0
2014	Marine mammals	71	30	18	45	70	1,792	1,020,943	645	192	53.1
2014	Migratory birds	53	32	29	29	35	19,049	48,271	31	9	2.5
2014	Upland game birds	9	9	8	4	1	911	638	0	0	<0.1
2014	Eggs	13	7	7	3	7	3,688	1,113	1	0	0.1
2014	Marine invertebrates	7	2	2	2	5	561	1,096	1	0	0.1
2014	Vegetation	43	18	16	15	35	853	2,975	2	1	0.2

Source: 1995–1996, 1996–1997, 2000, 2001, 2003 (Bacon, Hepa et al. 2009); 2014 (Brown, Braem et al. 2016); 1992 (Fuller and George 1999); 1987–1989 (SRB&A and ISER 1993).

[a] Estimated numbers represent individuals in all cases except vegetation, where they represent gallons. The estimated harvest numbers for the 1995–1996, 1996–1997, 2000, 2001, and 2003 data were derived by summing individual species in each resource category.

[b] Estimated pounds include only edible pounds and therefore do not include estimates for resources that are not typically eaten by community residents (e.g., furbearers). The estimated harvest pounds for the 1995–1996, 1996–1997, 2000, 2001, and 2003 data total pounds were derived from conversion rates found at ADF&G (2011) and total (usable) pounds for bowhead whales were calculated based on the method presented in SRB&A and ISER (1993). These estimates do not account for whale girth and should be considered approximate; more exact methods for estimating total whale weights are available in George et al. (n.d.).

[c] Household participation for the 1992 study year based on Table A5 in Fuller and George (1999); participation in migratory bird harvests includes waterfowl and eggs. Participation in vegetation harvests includes only berries.

Table E.16.12. Utqiaġvik Subsistence Harvest Estimates by Resource Category, Non-Comprehensive Study Years

Study Year	Resource	Percent of Households Use	Percent of Households Try to Harvest	Percent of Households Harvest	Percent of Households Give	Percent of Households Receive	Estimated Harvest Number	Estimated Harvest Total Pounds	Estimated Harvest Average Household	Estimated Harvest Per Capita Pounds
2005	Birds	–	–	–	–	–	10,943	–	–	–
2007	Birds	–	–	–	–	–	38,152	–	–	–
2008	Birds	–	–	–	–	–	35,250	–	–	–
2005	Eggs	–	–	–	–	–	32	–	–	–
2007	Eggs	–	–	–	–	–	1,783	–	–	–
2008	Eggs	–	–	–	–	–	204	–	–	–

Source: 2005, 2007, 2008 (Naves 2010)
Note: Estimated harvest number for birds include upland game birds and migratory birds combined.

Table E.16.13. Utqiaġvik Subsistence Harvest Estimates by Selected Species, All Study Years

Study Year	Resource[a]	Percent of Households Use	Percent of Households Try to Harvest	Percent of Households Harvest	Percent of Households Give	Percent of Households Receive	Estimated Harvest Number[b]	Estimated Harvest Total Pounds[c]	Estimated Harvest Average HH	Estimated Harvest Per Capita Pounds	Percent of Total Harvest
1987	Caribou	–	–	26	–	–	1,595	186,669	199	62	30.1
1987	Bowhead whale	–	–	31	–	–	7	184,629	197	61	29.7
1987	Walrus	–	–	11	–	–	84	64,663	69	21	10.4
1987	Bearded seal	–	–	25	–	–	236	41,518	44	14	6.7
1987	Broad whitefish	–	–	11	–	–	10,579	27,519	29	9	4.4
1987	Moose	–	–	6	–	–	52	25,786	28	9	4.2
1987	Ringed seal	–	–	14	–	–	466	19,574	21	6	3.2
1987	Goose	–	–	20	–	–	2,873	12,740	14	4	2.1
1987	Unknown whitefish	–	–	3	–	–	5,108	10,215	11	3	1.6
1987	Arctic grayling	–	–	14	–	–	12,664	10,131	11	3	1.6
1987	Ducks	–	–	22	–	–	5,252	7,878	8	3	1.3
1987	Least cisco	–	–	–	–	–	–	7,024	8	2	1.1
1988	Bowhead whale	–	–	35	–	–	11	233,313	249	77	38.0
1988	Caribou	–	–	27	–	–	1,533	179,314	191	59	29.2
1988	Walrus	–	–	6	–	–	61	47,215	50	16	7.7
1988	Bearded seal	–	–	11	–	–	179	31,436	34	10	5.1
1988	Broad whitefish	–	–	11	–	–	11,432	29,423	31	10	4.8
1988	Moose	–	–	4	–	–	53	26,367	28	9	4.3
1988	Ringed seal	–	–	10	–	–	388	16,304	17	5	2.7
1988	Goose	–	–	19	–	–	3,334	14,672	16	5	2.4
1988	Least cisco	–	–	2	–	–	–	7,505	8	2	1.2
1988	Arctic grayling	–	–	11	–	–	8,684	6,947	7	2	1.1
1988	Ducks	–	–	20	–	–	4,498	6,747	7	2	1.1
1989	Bowhead whale	–	–	45	–	–	10	377,647	403	125	43.3
1989	Caribou	–	–	39	–	–	1,656	193,744	207	64	22.2
1989	Broad whitefish	–	–	–	–	–	30,047	78,921	84	26	9.0

Study Year	Resource[a]	Percent of Households Use	Percent of Households Trv to Harvest	Percent of Households Harvest	Percent of Households Give	Percent of Households Receive	Estimated Harvest Number[b]	Estimated Harvest Total Pounds[c]	Estimated Harvest Average HH	Estimated Harvest Per Capita Pounds	Percent of Total Harvest
1989	Walrus	–	–	13	–	–	101	77,987	83	26	8.9
1989	Seal	–	–	11	–	–	440	33,077	35	11	3.8
1989	Moose	–	–	6	–	–	40	20,014	21	7	2.3
1989	Polar bear	–	–	4	–	–	39	19,471	21	6	2.2
1989	Bearded seal	–	–	11	–	–	109	19,152	20	6	2.2
1989	Goose	–	–	13	–	–	3,944	16,289	17	5	1.9
1989	Ringed seal	–	–	11	–	–	328	13,774	15	5	1.6
1989	Ducks	–	–	37	–	–	8,589	12,883	14	4	1.5
1989	Humpback whitefish	–	–	10	–	–	3,648	9,119	10	3	1.0
1992[d]	Bowhead whale	–	–	–	–	–	22	729,952	–	–	53.5
1992[d]	Caribou	–	46	–	–	–	1,993	233,206	–	–	17.1
1992[d]	Walrus	–	26	–	–	–	206	159,236	–	–	11.7
1992[d]	Bearded seal	–	–	–	–	–	463	81,471	–	–	6.0
1992[d]	Broad whitefish	–	–	–	–	–	23,997	59,993	–	–	4.4
1992[d]	Moose	–	–	–	–	–	34	17,115	–	–	1.3
1995–1996	Bowhead whale	–	–	–	–	–	16	525,413	–	–	44.0
1995–1996	Caribou	–	–	–	–	–	2,155	293,094	–	–	24.5
1995–1996	Bearded seal	–	–	–	–	–	431	181,146	–	–	15.2
1995–1996	Walrus	–	–	–	–	–	74	51,520	–	–	4.3
1995–1996	Ducks	–	–	–	–	–	12,118	50,200	–	–	4.2
1995–1996	Ringed seal	–	–	–	–	–	345	25,530	–	–	2.1
1995–1996	Broad whitefish	–	–	–	–	–	5,130	13,337	–	–	1.1
1995–1996	Whitefish	–	–	–	–	–	6,005	12,610	–	–	1.1
1996–1997	Bowhead whale	–	–	–	–	–	28	803,891	–	–	68.1
1996–1997	Caribou	–	–	–	–	–	1,158	157,420	–	–	13.3
1996–1997	Bearded seal	–	–	–	–	–	192	80,766	–	–	6.8
1996–1997	Walrus	–	–	–	–	–	78	54,320	–	–	4.6
1996–1997	Broad whitefish	–	–	–	–	–	6,684	22,726	–	–	1.9
1996–1997	Least cisco	–	–	–	–	–	–	16,519	–	–	1.4
1996–1997	Ringed seal	–	–	–	–	–	180	13,298	–	–	1.1
2000	Bowhead whale	–	–	–	–	–	18	472,651	–	–	30.3

Study Year	Resource[a]	Percent of Households Use	Percent of Households Trv to Harvest	Percent of Households Harvest	Percent of Households Give	Percent of Households Receive	Estimated Harvest Number[b]	Estimated Harvest Total Pounds[c]	Estimated Harvest Average HH	Estimated Harvest Per Capita Pounds	Percent of Total Harvest
2000	Caribou	–	–	–	–	–	3,359	456,851	–	–	29.3
2000	Bearded seal	–	–	–	–	–	729	306,012	–	–	19.6
2000	Walrus	–	–	–	–	–	115	80,710	–	–	5.2
2000	Broad whitefish	–	–	–	–	–	21,318	72,480	–	–	4.6
2000	Ringed seal	–	–	–	–	–	586	43,334	–	–	2.8
2000	Goose	–	–	–	–	–	7,818	32,564	–	–	2.1
2000	Ducks	–	–	–	–	–	7,827	31,257	–	–	2.0
2001	Bowhead whale	–	–	–	–	–	27	545,558	–	–	50.4
2001	Caribou	–	–	–	–	–	1,820	247,520	–	–	22.9
2001	Bearded seal	–	–	–	–	–	327	137,340	–	–	12.7
2001	Walrus	–	–	–	–	–	123	86,380	–	–	8.0
2001	Ringed seal	–	–	–	–	–	287	21,216	–	–	2.0
2001	Goose	–	–	–	–	–	4,146	17,214	–	–	1.6
2003	Bowhead whale	–	–	–	–	–	16	476,693	–	–	38.3
2003	Bearded seal	–	–	–	–	–	776	325,962	–	–	26.2
2003	Caribou	–	–	–	–	–	2,092	284,444	–	–	22.8
2003	Ringed seal	–	–	–	–	–	413	30,525	–	–	2.4
2003	Walrus	–	–	–	–	–	313	29,380	–	–	2.4
2003	Broad whitefish	–	–	–	–	–	8,207	27,905	–	–	2.2
2003	Goose	–	–	–	–	–	3,629	14,369	–	–	1.2
2014	Caribou	70	38	33	38	52	4,323	587,897	371	111	30.6
2014	Bowhead	70	24	12	43	67	18	546,085	345	103	28.4
2014	Bearded seal	44	22	15	27	32	1,070	306,097	193	58	15.9
2014	Broad whitefish	54	22	20	29	40	43,962	140,679	89	26	7.3
2014	Walrus	31	11	4	17	27	135	103,602	65	19	5.4
2014	Goose	46	26	24	22	29	35,642	35,642	23	7	1.9
2014	Ringed seal	19	10	8	11	11	428	24,402	15	5	1.3
2014	Belukha	15	4	0	9	14	25	24,341	15	5	1.3
2014	Chum salmon	24	13	11	10	15	4,039	24,312	15	5	1.3
2014	Sockeye salmon	29	9	9	11	23	4,630	18,667	12	4	1.0

Source: 1995–1996, 1996–1997, 2000, 2001, 2003 (Bacon, Hepa et al. 2009); 1995–1996, 1996–1997, 2000, 2001, 2003 (Brown, Braem et al. 2016); 1992 (Fuller and George 1999); 1987, 1988, 1999 (SRB&A and ISER 1993).

[a] Except in the case of ducks and goose, which are lumped into more general species categories, this table shows individual species unless they are not available for a given study year. For all resources study years (1987, 1988, 1989, 1992, 1995–1996, 1996–1997, 2000, 2001, 2003) species are listed in descending order by percent of total harvest and are limited to species accounting for at least 1.0% of the total harvest; for single-resource study years, species are listed in descending order by total estimated pounds (or total number harvested, in the case of salmon study years) and limited to the five top species. Years lacking "% of total harvest" data were not comprehensive (i.e., all resources) study years.

[b] Estimated numbers represent individuals in all cases except vegetation, where they represent gallons. The estimated harvest numbers for the 1995–1996, 1996–1997, 2000, 2001, and 2003 data were derived by summing individual species in each resource category.

[c] Estimated pounds include only edible pounds and therefore do not include estimates for resources that are not typically eaten by community residents (e.g., furbearers). The estimated harvest pounds for the 1995–1996, 1996–1997, 2000, 2001, and 2003 data for total pounds were derived from conversion rates found at ADF&G (2018), and total (usable) pounds for bowhead whales were calculated based on the method presented in SRB&A and ISER (1993). These estimates do not account for whale girth and should be considered approximate; more exact methods for estimating total whale weights are available in George et al. (n.d.).

[d] Household participation for the 1992 study year based on Table A5 in Fuller and George (1999).

1.2.2.2.1 Direct Effects Analysis Area

Utqiaġvik harvesters primarily use the direct effects analysis area to hunt for wolf, wolverine, and caribou; a small number of Utqiaġvik harvesters have reported using the area for harvests of seal and goose. As shown in Table E.16.13, caribou are among the top species harvested, in terms of edible weight, by the community of Utqiaġvik. During the most recent study year (2014), over one-third (38%) of Utqiaġvik households participated in the hunting of caribou (the percentage would likely be higher among Native households only). Similar to Nuiqsut, wolf and wolverine hunting is practiced by a smaller proportion of households; 6% of households participated in harvest of small land mammals in 2014 (again, this percentage was likely higher among Native households). However, furbearer hunting and associated income and activities are an important component of Iñupiaq culture, and Utqiaġvik furbearer harvesters often expend substantial time, money, and effort in their pursuits. Data on harvest amounts specific to the direct effects analysis area are not available for Utqiaġvik.

Based on data from SRB&A (2010b), which collected subsistence use areas for key resources for the 1997–2006 time period, the direct effects analysis area is used by wolf and wolverine hunters (26% of harvesters for that resource), and caribou hunters (22%) (Table E.16.14). A small number of individuals have reported traveling to the direct effects analysis area for harvesting of bearded seal, ringed seal, and goose (2% of harvesters or less). For resources as a whole, approximately one-quarter (24%) of Utqiaġvik harvesters reported using the direct effects area for subsistence purposes during the 1997–2006 time period (Table E.16.14).

Table E.16.14. Percent of Utqiaġvik Harvesters Using the Direct Effects Analysis Area, 1995–2006

Resource Category	Percent of Utqiaġvik Resource Respondents	Total Number of Last 10 Respondents for Resource	Number of Respondents in Direct Effects Area
Wolverine	26%	31	8
Wolf	26%	31	8
Caribou	22%	73	16
Bearded seal	2%	63	1
Ringed seal	2%	48	1
Goose	1%	71	1
Percent of total harvesters	24%	75	18

Source: SRB&A 2010b

1.2.2.3 Timing of Subsistence Activities

Table E.16.15 provides data on the timing of Utqiaġvik subsistence activities, based on reports from the 1980s through the 2010s. Overall, Utqiaġvik harvesters target the greatest number of resources in the months of August and September. These months are a primary time for harvests of non-salmon fish, salmon, caribou, moose and other large land mammals, marine mammals, and plants and berries.

Table E.16.15. Utqiaġvik Annual Cycle of Subsistence Activities

Resource	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Freshwater non-salmon	L	L	L	L	M	M	H	H	H	H	M	L
Marine non-salmon	L	L	L	–	–	L	M	H	H	M	L	–
Salmon	–	–	–	–	L	L	H	H	M	L	–	–
Caribou	L	L	L	L	L	L	H	H	H	H	L	L
Moose	–	L	L	M	M	M	M	H	H	–	–	–
Bear	–	–	–	L	L	L	L	M	H	L	–	–
Dall sheep	–	–	H	–	–	–	–	L	–	–	–	–
Muskox	–	–	H	–	–	–	–	–	H	–	–	–
Furbearers	H	H	H	M	L	L	–	–	L	M	H	H
Small land mammals	–	L	L	H	H	L	M	L	M	L	L	–
Marine mammals	L	L	L	M	M	M	H	H	H	M	M	L
Upland birds	L	L	L	M	H	M	L	L	L	L	L	L
Waterfowl	L	L	L	M	H	M	L	L	L	L	L	L
Marine invertebrates	–	–	–	–	–	M	L	M	H	L	L	–
Plants and berries	–	–	–	–	L	L	L	H	M	–	–	–
Total number of resource categories by month	7	9	11	9	12	13	12	13	14	11	9	6

Source: (Bacon, Hepa et al. 2009; Braem, Kaleak et al. 2011; Brown, Braem et al. 2016; EDAW Inc., Adams/Russel Consulting et al. 2008; Schneider, Pedersen et al. 1980; SRB&A 2010b; SRB&A and ISER 1993)
Note: "–" (no documented activity and/or harvests); H (high activity and/or harvests); L (limited activity and/or harvests); M (moderate activity and/or harvests)

The spring subsistence season (April and May) in Utqiaġvik is primarily dedicated to hunting bowhead whales with some additional harvests of other marine mammals including seals and polar bears. Hunting of waterfowl such as eiders and white-fronted goose begins during these spring months (Brown, Braem et al. 2016) and, particularly for eiders, continues into the summer months. Harvests of goose peak in May, and eider hunting occurs offshore during the spring whaling season (generally when leads are closed and whaling crews are not actively hunting whales).

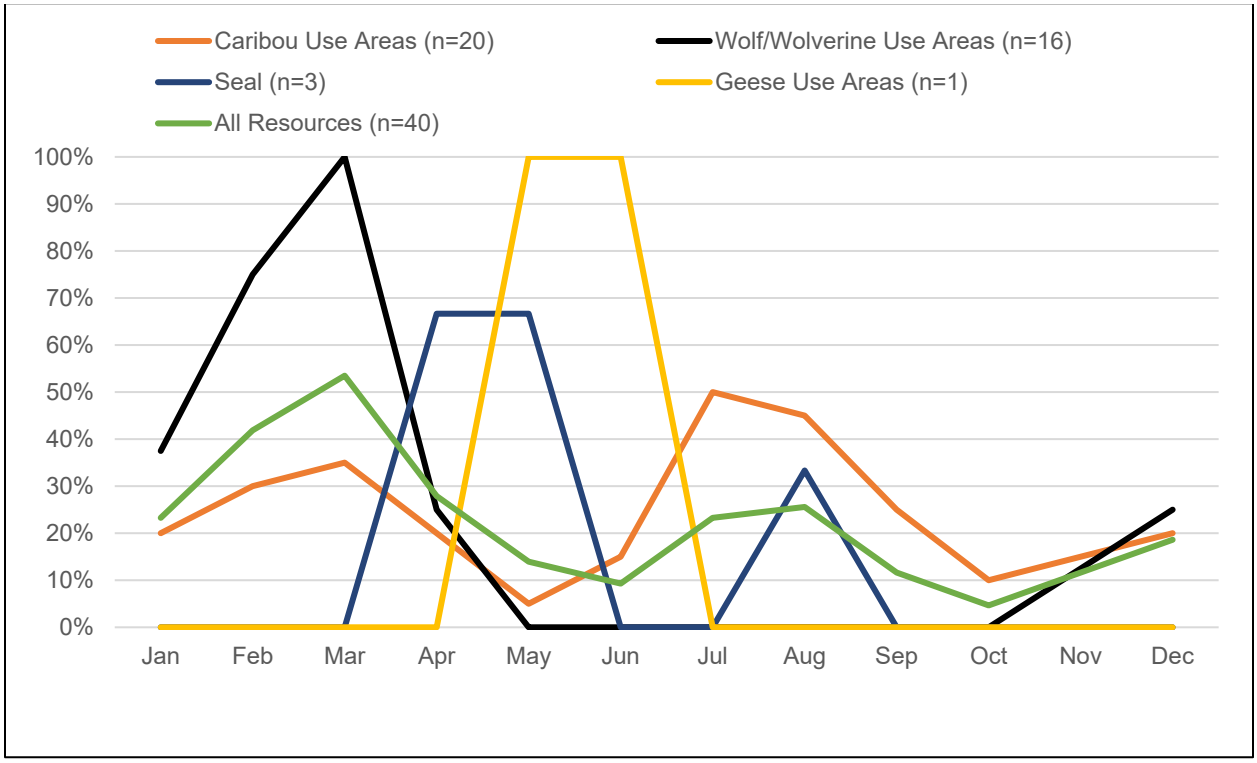
The summer months (June–August) are a time of diversified subsistence activity when residents travel into the ocean and along various river systems in pursuit of marine, terrestrial, and riverine resources. A primary focus during the summer and fall months is hunting marine mammals (e.g., bearded and ringed seals, walruses) offshore as they migrate north with the floe ice, with eiders often a secondary target. Residents travel along the coast and inland during the summer months to hunt caribou and harvest a variety of fish in lagoons and rivers. The peak caribou hunting season is in July and August when they are available to hunters traveling by boat along the coast and local waterways. Residents also harvest berries and other vegetation during these boating trips.

The fall bowhead whale hunt is a major focus during the months of September and October. In addition, caribou, fish, and birds remain sought after resources throughout the fall. During August and September, some Utqiaġvik residents may travel to the Colville River to harvest moose and berries (Brown, Braem et al. 2016; Fuller and George 1999). Bacon et al. (2009) and SRB&A (2010b) also show some eider duck harvesting continuing into these fall months. The subsistence fish harvest generally peaks in October (under-ice fishery) when whitefish and Arctic grayling are concentrated at over-wintering areas. Winter months (November–March) are primarily spent hunting and trapping furbearers, in addition to harvesting caribou, ringed seals, upland birds (ptarmigan), the occasional polar bear, and fish.

1.2.2.3.1 Direct Effects Analysis Area

Utqiaġvik harvesters use the direct effects analysis area at varying levels throughout the year (Figure E.16.21). For resources as a whole for the 1997–2006 time period, use of the direct effects analysis area is highest in the winter months of February and March, with lower levels occurring throughout the rest of the year. Caribou hunting in the direct effects area peaks both during the winter (February and March) and summer (July and August). Wolf and wolverine hunters use the direct effects analysis area solely during

the winter months of November through April, with a peak in February and March, when snow conditions allow for extensive overland travel and furs are prime. The limited seal and goose hunting reported by Utqiaġvik harvesters occur primarily during the spring (April and May for seal; May and June for goose).



Source: SRB&A 2010b

Figure E.16.21. Utqiaġvik Subsistence Use Areas by Month in Direct Effects Analysis Area, by Resource

1.2.2.4 Travel Methods

Table E.16.16 shows primary travel methods used for key species as documented in SRB&A (2010b). Boat is the primary method of travel used by Utqiaġvik residents for subsistence pursuits of certain non-salmon fish, caribou, bowhead whale, seals, walrus, and eider. Snow machine is the primary method for late fall and winter pursuits of Arctic cisco, burbot, moose, wolf, wolverine, and goose. To a lesser extent, Utqiaġvik residents also travel by foot, car/truck, ATV, and plane to access subsistence use areas.

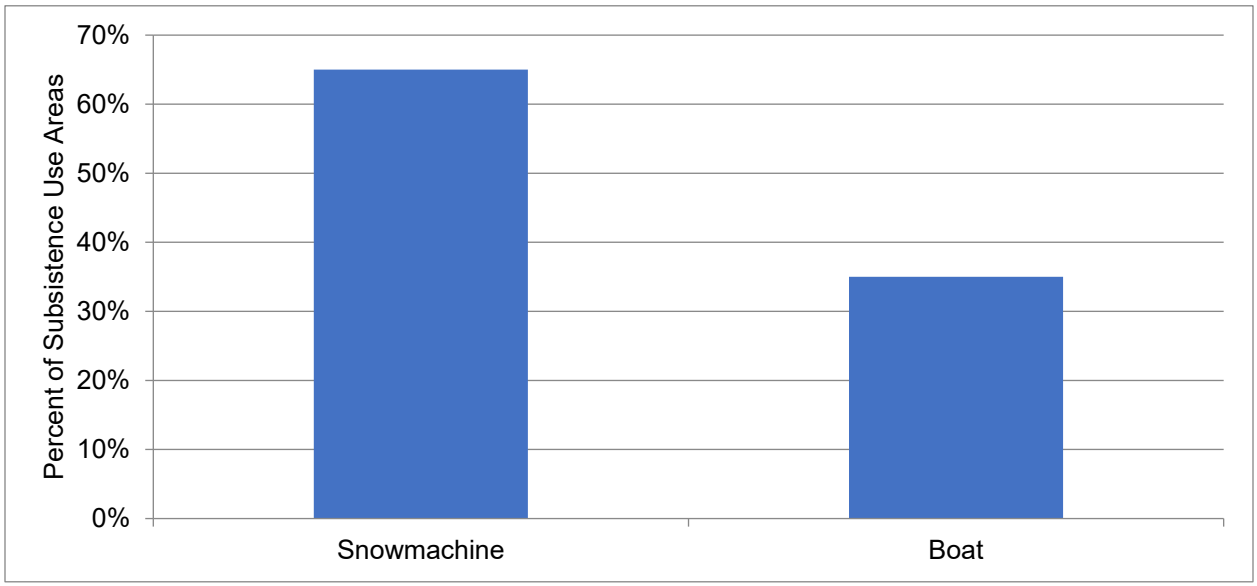
Table E.16.16. Utqiaġvik Travel Method to Subsistence Use Areas

Resources	Boat	Snow Machine	Foot	Car/Truck	ATV	Plane
Arctic cisco and burbot	M	H	–	L	L	M
Arctic char/Dolly Varden and broad whitefish	H	M	–	M	M	L
Caribou	H	M	L	L	M	L
Moose	M	H	–	–	–	–
Wolf and wolverine	–	H	–	–	–	–
Bowhead whale	H	M	–	–	–	–
Seals	H	M	–	–	–	–
Walrus	H	L	–	–	–	–
Goose	M	H	L	L	M	L
Eider	H	M	L	M	L	–

Source: 1996–2007 (SRB&A 2010b)
Note: "–" (no documented use of travel method); ATV (all-terrain vehicle); H (high use of travel method); L (limited use of travel method); M (moderate use of travel method)

1.2.2.4.1 Direct Effects Analysis Area

As shown in Figure E.16.22, for the 1997–2006 time period, snow machine was the primary method used to access the direct effects analysis area (65% of use areas), followed by boat (35%). Snow machine/overland travel generally occurs between November and April (Figure E.16.21), whereas coastal and riverine boat travel generally occurs from June through September.



Source: SRB&A 2010b

Figure E.16.22. Utqiaġvik Travel Methods, Direct Effects Analysis Area

1.2.2.5 Resource Importance

An analysis of resource importance for Utqiaġvik based on harvest (percent of total harvest), harvest effort (percentage of households attempting harvests) and sharing (percent of households receiving) variables is provided in Table E.16.17. Based on this analysis, resources of major importance in Utqiaġvik are bearded seal, bowhead whale, and caribou.

Table E.16.17. Relative Importance of Subsistence Resources Based on Selected Variables, Utqiaġvik[a]

Resource Importance	Resource	Average Percent of Total Harvest	Percent of Households Trying to Harvest	Percent of Households Receiving
Major resources[b]	Bearded seal	12	22	32
Major resources[b]	Bowhead whale	42	24	67
Major resources[b]	Caribou	24	53	68
Moderate resources[c]	Arctic cisco	<1	5	33
Moderate resources[c]	Arctic grayling	1	13	17
Moderate resources[c]	Belukha/beluga	<1	4	14
Moderate resources[c]	Blueberry	<1	4	14
Moderate resources[c]	Broad whitefish	4	22	40
Moderate resources[c]	Chinook/King salmon	<1	5	12
Moderate resources[c]	Chum/Dog salmon	<1	13	15
Moderate resources[c]	Coho/Silver salmon	<1	9	20
Moderate resources[c]	King eider	<1	16	14
Moderate resources[c]	Moose	2	2	13
Moderate resources[c]	Pink/Humpback salmon	<1	9	12
Moderate resources[c]	Rainbow smelt	<1	2	18
Moderate resources[c]	Ringed seal	2	10	11
Moderate resources[c]	Salmonberry/Cloudberry	<1	12	30
Moderate resources[c]	Sockeye salmon	1	9	23
Moderate resources[c]	Walrus	7	19	27
Moderate resources[c]	White-fronted goose	1	23	22
Minor resources[d]	Common eider	<1	9	9
Minor resources[d]	Halibut	<1	3	8
Minor resources[d]	Humpback whitefish	<1	7	5
Minor resources[d]	Least cisco	1	6	7
Minor resources[d]	Other birds	<1	9	1
Minor resources[d]	Polar bear	1	2	6
Minor resources[d]	Ptarmigan	<1	9	1
Minor resources[d]	Sheefish	–	–	6
Minor resources[d]	Snow goose	<1	5	2
Minor resources[d]	Wolf	<1	<5	<5
Minor resources[d]	Wolverine	<1	<5	<5

Source: 1995 to 1996, 1996 to 1997, 2000, 2001, 2003 (Bacon, Hepa et al. 2009); 2014 (Brown, Braem et al. 2016); 1992 (Fuller and George 1999); 1987 to 1989 (SRB&A and ISER 1993).

Note: "–" (resource was not harvested or no households attempted to harvest resource)

[a] For space considerations, resources contributed an average of less than 1% of harvest, less than 5% attempting harvests, and less than 5% receiving harvests are categorized as minor and are not be shown

[b] Major resources contribute >9% total harvest, have ≥50% of households attempting harvest, or have ≥50% of households receiving resource.

[c] Moderate resources contribute 2% to 9% of total harvest, have 11% to 49% of households attempting harvest, or have 11% to 49% of households receiving resource.

[d] Minor resources contribute <2% of total harvest, have ≤10% of households attempting harvest, or have ≤10% of households receiving resource. For space considerations, resources contributing an average of less than 1% of harvest, less than 5% attempting harvests, or less than 5% receiving harvests are categorized as minor and may not be shown. While wolf and wolverine fall below the threshold for inclusion (less than one percent of material importance, and less than 5% for cultural importance), they are included because of their relevance to the study areas.

2.0 COMPARISON OF ACTION ALTERNATIVES AND OPTIONS

Tables E.16.18 and E.16.19 summarize and compare impacts to subsistence use areas among the action alternatives and module delivery options.

Table E.16.18. Comparison of Impacts to Subsistence Uses for Nuiqsut

Effects To	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access	Option 1: Proponent's Module Transfer Island	Option 2: Point Lonely Module Transfer
Resources (Importance)	Caribou (Major) Furbearers (Minor)[a] Waterfowl (Major) Fish (Major)	Same as Alternative B	Same as Alternative B	Caribou (Major) Furbearers (Minor)[a] Waterfowl (Major) Seals (Major)	Caribou (Major) Furbearers (Minor)[a] Waterfowl (Major)
Resource Abundance	No impacts to overall abundance expected	Same as Alternative B	Same as Alternative B	No impacts to overall abundance expected	Same as Option 1
Resource Availability	Caribou: Greatest potential for impacts to resource availability Furbearers: High likelihood of reduced furbearer availability near the Project Waterfowl, Fish: Low likelihood as Project does not overlap with areas of high overlapping subsistence use and large-scale contamination events are unlikely	Caribou: Impacts to caribou resource availability reduced from Alt B. Increase in air traffic impacts would be offset by decreased infrastructure and potential for deflection. Furbearers, Waterfowl, Fish: Same as Alternative B	Caribou: Least potential for impacts to resource availability. Increase in air traffic impacts would be offset by decreased infrastructure and potential for deflection. Furbearers, Waterfowl, Fish: See Alt B	Caribou: Impacts minimal due to winter timing of activities Furbearers: High likelihood of reduced availability near ice roads Waterfowl: Moderate likelihood of reduced availability during one spring hunting season Seals: Moderate likelihood of reduced availability to individual hunters during multiple summers	Caribou: Impacts minimal due to winter timing of activities Furbearers: High likelihood of reduced furbearer availability near ice roads Waterfowl: Moderate likelihood of reduced waterfowl during one spring hunting season

Effects To	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access	Option 1: Proponent's Module Transfer Island	Option 2: Point Lonely Module Transfer
Harvester Access	High likelihood of impacts during construction phase due to lack of ice road access on gravel haul and module transport ice roads near the community and barriers to overland travel due to high traffic levels. Moderate likelihood of impacts during operation due to physical obstructions and safety considerations while hunting along roads. Moderate likelihood of increased access although use of roads may decrease with distance from the community.	Same as Alternative B	High likelihood of impacts during construction phase due to lack of ice road access on gravel haul and module transport ice roads near the community and barriers to overland travel due to high traffic levels. Lower likelihood of impacts to access during operation due to fewer physical obstructions to access. Impacts related to safety considerations would remain. Low likelihood of increased access although use of roads may decrease with distance from the community.	Caribou, Furbearers, Waterfowl: High likelihood of impacts during construction phase due to lack of ice road access on gravel haul and module transport ice roads near the community and barriers to overland travel due to high traffic levels. Seals: Low to moderate likelihood of impacts as MTI is on periphery of hunting area General: Low likelihood of changes to access in nearshore/coastal areas due to erosion/sedimentation	Caribou, Furbearers, Waterfowl: High likelihood of impacts during construction phase due to lack of ice road access on gravel haul and module transport ice roads near the community and barriers to overland travel due to high traffic levels.
Community-Level Impacts	Impacts are most likely to occur for Nuiqsut harvesters (up to 88% directly affected).	Same as Alternative B	Same as Alternative B	Impacts are most likely to occur for Nuiqsut harvesters (up to 94% directly affected).	Impacts are most likely to occur for Nuiqsut harvesters (up to 94% directly affected).

[a] Despite being characterized as a resource of minor importance based on selected measures, furbearer hunting and trapping is a specialized activity with unique importance to the study communities.

Table E.16.19. Comparison of Impacts to Subsistence Uses for Utqiaġvik

Effects To	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access	Option 1: Proponent's Module Transfer Island	Option 2: Point Lonely Module Transfer
Resources (Importance)	Caribou (Major) Furbearers (Minor)[a]	Same as Alternative B	Same as Alternative B	Caribou (Major) Furbearers (Minor)[a]	Same as Option 1
Resource Abundance	No impacts to overall abundance expected	Same as Alternative B	Same as Alternative B	No impacts to overall abundance expected	Same as Option 1

Effects To	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access	Option 1: Proponent's Module Transfer Island	Option 2: Point Lonely Module Transfer
Resource Availability	Caribou: Low potential for impacts to resource availability Furbearers: Low to moderate likelihood of reduced availability as Project does not overlap with areas of high overlapping subsistence use but occurs to the east of moderate overlapping use	Same as Alternative B	Same as Alternative B	Caribou: Low potential for impacts to resource availability Furbearers: Low to moderate likelihood of reduced availability as Project does not overlap with areas of high overlapping subsistence use but occurs to the east of moderate overlapping use	Furbearers and caribou: Low to moderate likelihood of reduced availability as high volume ice roads would occur directly to the east of high overlapping use to the south of Teshekpuk Lake
Harvester Access	Low likelihood of reduced access as Project does not overlap with areas of high overlapping subsistence use Low likelihood of increased access	Same as Alternative B	Same as Alternative B	Low likelihood of reduced access as Project does not overlap with areas of high overlapping subsistence use	Same as Option 1
Community-Level Impacts	Impacts may occur for Utqiagvik but are less likely (up to 11% directly affected).	Same as Alternative B	Same as Alternative B	Impacts may occur for Utqiagvik but are less likely (up to 12% directly affected).	Impacts are more likely to occur for Utqiagvik harvesters under Option 2 (up to 24% of harvesters) compared to Option 1 (up to 12%). In addition, the Point Lonely option is more likely to cause indirect impacts to Utqiagvik harvesters than the Proponent's option because of its proximity to key Utqiagvik harvesting areas at Teshekpuk Lake.

[a] Despite being characterized as a resource of minor importance based on selected measures, furbearer hunting and trapping is a specialized activity with unique importance to the study communities.

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Appendix E.17
Environmental Justice Technical Appendix

There is no technical appendix for this resource

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Appendix E.18
Public Health Technical Appendix

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List of Tables

List of Acronyms

BLM	Bureau of Land Management
DHSS	Alaska Department of Health and Social Services
HEC	health effects category
NSB	North Slope Borough

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1.0 PUBLIC HEALTH

Table E.18.1 describes the health effects categories (HECs) and Table E.18.2 provides an overview of the technical guidance for evaluating health impacts from resource development used to inform the health impact analysis. Guidance for evaluation comes from:

- Alaska Department of Health and Social Services (DHSS), *Alaska Health Impact Analysis Technical Guidance* (2015)
- North Slope Borough (NSB), *Health Impact Assessment for Natural Resource Development in Alaska Collaborative Guidance* (2015)
- Bureau of Land Management (BLM), *National Petroleum Reserve in Alaska Integrated Activity Plan/Environmental Impact Statement* (2012) health effects analysis

Table E.18.1. Health Effects Category Descriptions

Health Effects Category	Description
HEC1: Social determinants of health	Economic status, educational status, social support systems, employment status, mental health, maternal and child health, substance use, social exclusion, psychosocial distress, historical trauma, and family dynamics
HEC2: Accidents and injuries	Intentional and unintentional injuries with fatal and nonfatal results; traffic patterns, alcohol involvement, emergency services availability, presence of law enforcement, and presence of prevention programs
HEC3: Exposure to potentially hazardous materials	Documented illnesses or exacerbation of illnesses commonly associated with pollutants through inhalation, ingestion, or physical contact
HEC4: Food, nutrition, and subsistence activities	Nutrient levels, malnutrition, or improvements in nutrient intake, diet composition, food security, and consumption of subsistence foods
HEC5: Infectious disease	Rates of increase or decrease for a range of infectious diseases, such as sexually transmitted infections, respiratory illness, or skin infections; immunization rates; and the presence of infectious disease prevention efforts
HEC6: Water and sanitation	Changes to access, quantity, and quality of water supplies; distance to clean water, water fluoridation, indoor plumbing, water treatment facilities, and existence of community facilities, such as washaterias or community showers
HEC7: Non-communicable and chronic diseases	Increases/decreases in mortality and morbidity rates of cancer, cardiovascular and cerebrovascular diseases, diabetes, respiratory diseases, and mental health disorders; smoking rates, rates of alcohol and drug abuse, physical activity levels, presence of recreation centers, and cancer-screening rates
HEC8: Health services infrastructure and capacity	Increase or decrease in the number of medical evacuations, clinic or hospital visit trends, health expenditures, and medication usage; distance to health facilities, medevac facilities/aircraft, the presence of community health aides, and the frequency of physician visits to the area

Source: ADHSS 2015
Note: HEC (health effects category)

Table E.18.2. Health Effect Factors from Relevant Guidance Documents

Alaska HIA Technical Guidance (ADHSS 2015)	HIA for Natural Resource Development in Alaska Collaborative Guidance (NSB 2015)	National Petroleum Reserve in Alaska IAP/EIS Health Effects Analysis (BLM 2012)
HEC1: Social determinants of health	Overall health and well-being Psychological and gender issues Maternal and child health	Acculturative stress Economic impacts on health
HEC2: Accidents and injuries	Accidents and injuries	Safety
HEC3: Exposure to potentially hazardous materials	Contaminant exposure	Environmental exposures
HEC4: Food, nutrition, and subsistence activities	Food, nutrition, and physical activity	Diet and nutrition
HEC5: Infectious disease	Infectious disease	Infectious disease
HEC6: Water and sanitation	Water and sanitation	NA
HEC7: Non-communicable and chronic diseases	Non-communicable/chronic diseases	NA
HEC8: Health services infrastructure and capacity	Health services infrastructure and capacity Occupational/community health interface	Health-care services

Note: HEC (health effects category); HIA (Health Impact Assessment); IAP/EIS (Integrated Activity Plan/Environmental Impact Statement); NA (not applicable)

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Appendix E.19
Cumulative Effects Technical Appendix

There is no technical appendix for this resource

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Appendix F
Consultation Documents

Appendix F.1 Essential Fish Habitat *[Appendix will be included in the Final EIS]*

Appendix F.2 Section 106 Cultural Resources Findings: Process and Analysis

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Appendix F.1 Essential Fish Habitat *[Appendix will be included in the Final EIS]*

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Appendix F.2 Section 106 Cultural Resources Findings: Process and Analysis

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List of Acronyms

AHRS	Alaska Heritage Resources Survey
BLM	Bureau of Land Management
BMP	best management practice
EIS	Environmental Impact Statement
IAP	Integrated Activity Plan
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NPR-A	National Petroleum Reserve in Alaska
NSB	North Slope Borough
Project	Willow Master Development Plan Project
TLUI	Traditional Land Use Inventory

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1.0 CULTURAL RESOURCES FINDINGS: PROCESS AND ANALYSIS

The cultural history of northern Alaska is described in detail in the National Petroleum Reserve in Alaska (NPR-A) Final Integrated Activity Plan/Environmental Impact Statement (IAP/EIS) (BLM 2012). Cultural resources found on the North Slope broadly represent a long prehistory of land use, followed by more recent historic land use by Iñupiat and influences from Euro-Americans beginning in the nineteenth century. Cultural resources on the North Slope can represent a broad variety of types, ranging from distinctly human-made objects and changes to the landscape, to places with less definitive expressions of use by people in the past, albeit with great significance to North Slope communities. Such resources include but are not limited to:

- Prehistoric and historic archaeological sites, features, and artifacts, such as those associated with camps and villages, buildings and structures, dwellings (e.g., sod houses, semi-subterranean houses, and tent rings), production and use of objects (e.g., discarded tools and tool-making debris), subsistence activities (e.g., discarded animal bone accumulations, reindeer herding fences, ice cellars, and caches), and transportation (e.g., boat and sled remains).
- Places significant to Iñupiat heritage and traditional land use (e.g., burial places and hunting, fishing, and trapping and camping areas).
- Cultural landscapes and areas important for reasons of cultural identity or religious significance.

A variety of federal, state, and local regulations govern how cultural resources are described and analyzed. Although compliance requirements for these regulations are similar, the types of cultural resources considered, and the implementation of cultural resources review, differ. The National Environmental Protection Act (NEPA) requires disclosure and consideration of impacts to the human environment, of which cultural resources are considered a subcategory (40 CFR 1508.14). Section 106 of the National Historic Preservation Act (NHPA) (54 USC 306108) and its implementing regulations (36 CFR 800) require federal agencies to consider the effects of their undertakings on historic properties (prehistoric or historic districts, sites, buildings, structures, or objects included in, or eligible for inclusion on, the National Register of Historic Places). Both NEPA and Section 106 of the NHPA require consultation with agencies and key stakeholders (including tribal and municipal governments and members of the public), which affords a reasonable opportunity for consulting parties to comment on the potential for impacts to cultural resources or alert the lead agency to the presence of potentially impacted cultural resources. Other regulatory statutes that protect cultural resources include the Antiquities Act (16 USC 431-433), the Historic Sites Act (16 USC 461-467), the Archaeological and Historic Preservation Act (16 USC 469-469c), the American Indian Religious Freedom Act (42 USC 1996), the Archaeological Resources Protection Act (16 USC 470aa-470ll), the Abandoned Shipwreck Act (43 USC 2101-2106), the Native American Graves Protection and Repatriation Act (25 USC 3001 et seq.), Executive Order 13007: Indian Sacred Sites, and the Alaska Historic Preservation Act (AS 41.35). The Project would also require a Certificate of Traditional Land Use Inventory (TLUI) Clearance from the North Slope Borough (NSB), certifying that no TLUI sites would be negatively impacted.

The Office of History and Archaeology's Alaska Heritage Resources Survey (OHA 2018), which contains an inventory of all documented archaeological sites in the state of Alaska, is the primary source of information for archaeological resources in the Willow Master Development Plan Project (Project) area. A subset of the NSB's TLUI within the Project vicinity was acquired from the NSB Department of Iñupiat History, Language, and Culture (NSB 2019); the TLUI is the primary source of information regarding Iñupiat traditional use areas, although the Bureau of Land Management (BLM) pursued additional information through consultation with local and regional tribal and municipal governments and Alaska Native corporations, and the public. Academic literature, agency documents, and cultural resources survey reports (e.g. 611th Civil Engineer Squadron 1999; CEMML 2013; Hall 1978; Hoffman, Libby et al. 1978; Reanier 2001, 2002, 2003a, 2003b; Reanier 2008, 2012, 2013, 2015a, 2015b; Reanier

and Kunz 2010; SRB&A 2004; Yarborough 2001) from other studies conducted within the Project area provided more robust information about sites documented in the area. Recent cultural resource surveys conducted in support of the Project (Reanier 2017, 2018, 2019a, 2019b) provided the most current archaeological site location and condition information for the area.

1.1 Potential Impacts

Direct impacts are those that are caused by, and occur during, the Project (36 CFR 800.5; 40 CFR 1508.8), and are primarily limited to the Project footprint. Ground-disturbing activities (e.g., drilling, gravel mining, etc.) pose the greatest threat of direct impacts to cultural resources, especially archaeological sites, by destabilizing, damaging, or destroying subsurface and aboveground cultural resources and contexts. Support activities (including the transport and staging of materials, heavy equipment, and personnel) and manufacture and use of ice roads and pads could also directly affect surficial and shallowly buried cultural resources through inadvertent ground disturbance, vibration, and compaction.

Indirect impacts are those that occur beyond the Project footprint or after the Project's completion and are reasonably foreseeable. The greatest indirect threats to cultural resources include altering the setting of historic properties and increasing access to otherwise remote and difficult-to-access locations, followed by increased foot or vehicle traffic, and resulting in sensitive areas being eroded, vandalized, or looted.

1.2 Findings

The NSB TLUI (NSB 2019) lists 13 traditional land use sites documented within or overlapping the BLM-recommended 2.5-mile analysis area, none of which fall within the Project footprint. The Alaska Heritage Resources Survey (AHRS) (OHA 2018) lists nine[1] cultural sites documented within or overlapping the 2.5-mile analysis area, none of which fall within the Project footprint. Of these sites, two have been evaluated for their eligibility for the National Register of Historic Places (TES-00028 and HAR-00018); both were determined eligible. There are two documented grave sites (lacking AHRS numbers) within the analysis area.

Surveys to identify cultural resources in the Project area across all action alternatives and Project components were conducted by the Proponent in August 2018 and will be continued in July and August of 2019 (Reanier 2019b; supplemental report forthcoming in November 2019). The results of these surveys initially and provisionally indicate no previously undocumented cultural resources in the Project area.

Areas of traditional subsistence land use are a critical cultural element in the Project area and are addressed in the Willow MDP EIS, Section 3.16, *Subsistence and Sociocultural Systems*. TLUI clearance is required by NSB to ensure avoidance of sensitive Alaska Native cultural sites prior to issuing a Development Permit or Administrative Approval, and the Proponent must seek TLUI clearance prior to receiving a permit from NSB. Potentially undocumented places that are significant to North Slope heritage, but lack definitive expressions of land use, are best identified and assessed through consultation with local and regional tribal and municipal governments and Alaska Native corporations, and other community members. NEPA and Section 106 consultation efforts with these entities within Nuiqsut and the NSB resulted in no expressed concerns for specific cultural resources within the Project area.

Best management practice (BMP) E-13 in the NPR-A IAP/EIS (2013) seeks to avoid adverse impacts to any cultural resources by ground-disturbing activities by requiring field surveys prior to activities. As a

[1] Fifteen documented AHRS sites (TES-00032–TES-00045, and TES-00048) associated with the Point Lonely Distant Early Warning (DEW) Line Station are not included in the analysis. The structures associated with the DEW Line site at Point Lonely were destroyed as part of environmental remediation activities undertaken by the U.S. Air Force (personal communication with K. Leeper 03/18/2019; report pending to the Office of History and Archaeology).

general practice, the BLM seeks to avoid adverse impacts and the need for mitigation by encouraging that activities be conducted away from culturally sensitive areas. After having the Project area surveyed for cultural resources (Reanier 2019b; supplemental report forthcoming in November 2019), the Proponent routed all Project components (including ice roads and pads) 500 feet or farther from known cultural resources to avoid adversely impacting any such areas. To ensure appropriate treatment of inadvertent discoveries, the Proponent maintains a Fossil and Artifact Finds Standard Operating Procedure and requires cultural awareness training as required under BMP I-1 (BLM 2013).

The Proponent opted to route all Project components at least 500 feet from all recorded cultural sites. No cultural resources have been identified within the proposed Project footprint; thus, it is unlikely that the proposed Project would result in direct impacts to historic properties. Cultural resources located outside the Project footprint are also unlikely to be impacted by the proposed undertaking. Access to Project infrastructure is controlled and not accessible to members of the public, and ConocoPhillips Alaska, Inc. staff will undergo cultural awareness training prior to deployment, thus reducing the risk of inadvertent disturbance of culturally significant sites. Although increased access to cultural resources has been documented to correlate strongly with increased instances of vandalism and looting of cultural resources sites (Hedquist, Ellison et al. 2014; Spangler, Arnold et al. 2006), these impacts are improbable due to conditions specific to the Project area and timeline. Ice roads and pads will only be used during winter construction seasons, during which times any nearby cultural resources will be inaccessible due to snow cover. Access to cultural resources areas in the summer months, while possible, is made complicated by the surrounding terrain. Off-road travel in the Project area during summer months is suboptimal by foot or vehicle, as the tundra during this season is uneven, frequently inundated, and spongy. The cultural resources and paleontological sites within 2.5 miles of the Project are also not of the type(s) typically considered valuable to looters and are therefore less likely to warrant illicit transit of the landscape.

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Willow Master Development Plan

Appendix G

DRAFT Alaska National Interest Lands Conservation Act 810 Analysis

August 2019

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List of Figures

List of Acronyms

ANILCA	Alaska National Interest Lands Conservation Act
ATV	all-terrain vehicle
BLM	Bureau of Land Management
BMP	best management practices
BT1	drill site BT1
BT2	drill site BT2
BT3	drill site BT3
BT4	drill site BT4
BT5	drill site BT5
BTU	Bear Tooth Unit
CAH	Central Arctic Caribou Herd
CPAI	ConocoPhillips Alaska, Inc.
CRD	Colville River Delta
DMTS	DeLong Mountain Transportation System
EIS	Environmental Impact Statement
GMT	Greater Mooses Tooth
GMT-1	Greater Mooses Tooth 1
GMT-2	Greater Mooses Tooth 2
IAP/EIS	Integrated Activity Plan/Environmental Impact Statement
Kuukpik	Kuukpik Corporation
MTI	module transfer island
NPR-A	National Petroleum Reserve in Alaska
Project	Willow MDP Project
ROD	Record of Decision
TCH	Teshekpuk Caribou Herd
WAH	Western Arctic Caribou Herd
Willow MDP	Willow Master Development Plan
WOC	Willow Operations Center
WPF	Willow processing facility

ALASKA NATIONAL INTEREST LANDS CONSERVATION ACT SECTION 810 ANALYSIS OF SUBSISTENCE IMPACTS

This analysis of subsistence impacts is for the Willow Master Development Plan (Willow MDP) Draft Environmental Impact Statement (EIS). ConocoPhillips Alaska, Inc. (CPAI) is seeking approval to develop and produce oil from leases in the Bear Tooth Unit (BTU) of the National Petroleum Reserve in Alaska (NPR-A) via five drill sites and pipelines that would connect to the Greater Mooses Tooth 2 (GMT-2) development (currently under construction) and existing Alpine development facilities in the Colville River Delta (CRD). The Willow MDP Project (Project) would include its own processing facility, an operations center, ice and gravel roads, and either one or two airstrips depending on the selected alternative. The Project would be located on the North Slope of Alaska in the northeast section of the NPR-A, west of the Colville River, CRD, and the community of Nuiqsut.

The proposed Project drill sites and the majority of operational infrastructure would be located on federal lands in the NPR-A managed by the Bureau of Land Management (BLM). Some supporting infrastructure (e.g., portions of the gravel access road, temporary ice roads, and pipelines) would be located on lands owned by the Kuukpik Corporation and the State of Alaska. Conveyed and selected Native (Kuukpik Corporation [Kuukpik]) lands would include portions of Project pipelines, roads, and Colville River pipeline crossing pads. State of Alaska lands would include portions of Project pipelines. Two of the three Willow MDP EIS alternatives analyzed include a gravel road connection from the GMT-2 drill site to the Project area. All of the action alternatives include a pipeline that would connect Project drill sites to existing pipeline infrastructure to the east.

The Willow MDP EIS considers three alternatives and two module delivery options, in addition to a No Action Alternative (Alternative A). While the Willow MDP EIS analysis provides an evaluation for the three Willow MDP EIS action alternatives and two module delivery options separately, any final subsistence determinations should consider the implementation of alternatives in combination with each of the module delivery options because one of the two options would occur under any action alternative. The three Willow MDP action alternatives include the Proponent's Project (Alternative B), which includes a gravel access road connecting the Project to the existing GMT-2 and Alpine developments; Disconnected Infield Roads (Alternative C), which reduces the gravel footprint but maintains a year-round gravel road connection to the existing GMT-2 and Alpine developments; and Disconnected Access (Alternative D), which does not include a year-round gravel access road connection to the existing GMT-2 and Alpine developments. The two module delivery option alternatives include the Proponent's Module Transfer Island (MTI) (Option 1) and the Point Lonely Module Transport Island (Option 2). Each of these options would construct ice road connections to the Project area and the man-made island to support gravel hauling and module transport. Either MTI would be located in State of Alaska waters, while other associated infrastructure (e.g., ice roads, ice pads) would be located on federal lands in the NPR-A.

Chapter 3.0, *Affected Environment and Environmental Consequences*, of the Willow MDP EIS describes the current environmental status of the Project area and potential effects of the alternative development scenarios to the physical, biological, and social environment. In particular, Section 3.16, *Subsistence and Sociocultural Systems*, addresses the affected environment and environmental consequences for subsistence, traditional use, and sociocultural systems. Other relevant sections include Section 3.10, *Fish*; Section 3.11, *Birds*; Section 3.12, *Terrestrial Mammals*; Section 3.13, *Marine Mammals*; and Section 3.18, *Public Health*. This analysis uses that information to evaluate potential impacts to subsistence uses and needs pursuant to Section 810(a) of the Alaska National Interest Lands Conservation Act (ANILCA).

A. SUBSISTENCE EVALUATION FACTORS

Section 810(a) of ANILCA, 16 USC 3120(a), requires that an evaluation of subsistence uses and needs must be completed for any federal determination to "withdraw, reserve, lease, or otherwise permit the use, occupancy or disposition of public lands." All of the Project's proposed drill sites, Willow processing

facility (WPF), Willow Operations Center (WOC), gravel roads, air strip(s), and sections of associated pipelines and ice roads would be located on BLM-managed public lands under all action alternatives. Thus, an evaluation of potential impacts to subsistence under ANILCA Section 810(a) must be completed for the Willow MDP EIS. All impacts to subsistence uses and needs are evaluated herein regardless of land status.

ANILCA requires that this evaluation include findings on three specific issues:

1. The effect of use, occupancy, or disposition on subsistence uses and needs.
2. The availability of other lands for the purposes sought to be achieved.
3. Other alternatives that would reduce or eliminate the use, occupancy, or disposition of public lands needed for subsistence purposes (16 USC Section 3120(a)).

Following BLM Alaska guidance (BLM IM No. AK-2011-008), three factors are considered when determining if a significant restriction of subsistence uses and needs may result from the proposed action and alternatives, or in the cumulative case:

1. Reductions in the abundance of subsistence resources caused by a decline in the population or amount of harvestable resources.
2. Reductions in the availability of resources used for subsistence purposes caused by alteration of their normal locations, migration, and distribution patterns.
3. Limitations on access to subsistence resources, including from increased competition for the resources.

Willow MDP EIS Section 3.16.1, *Affected Environment*, and Appendix E.16, *Subsistence Technical Appendix*, provide information on areas and resources important for subsistence use, and the degree of dependence of Nuiqsut and Utqiaġvik (Barrow) on different subsistence populations. The Willow MDP EIS Section 3.16.2, *Environmental Consequences*, provides data on subsistence resource availability and limitations that each action alternative would place on access and is used to determine whether the action alternatives may cause a significant restriction to subsistence uses.

A finding that the proposed action may significantly restrict subsistence uses imposes requirements to notify the State of Alaska and appropriate regional and local subsistence committees, hold hearings in affected communities, and make the following determinations before BLM can authorize the use of public lands:

- Such a significant restriction of subsistence uses is necessary and consistent with sound management principles for the use of the public lands.
- The proposed activity would involve the minimal amount of public lands necessary to accomplish the purposes of the use, occupancy, or other disposition.
- Reasonable steps would be taken to minimize adverse effects upon subsistence uses and resources resulting from such actions (16 USC 3120(a)).

A proposed action or alternative would be considered to significantly restrict subsistence uses if, after consideration of stipulations or protection measures (e.g., lease stipulations and best management practices [BMPs]) included as a part of each alternative, it can be expected to result in a substantial reduction in the opportunity to continue subsistence uses of renewable resources. Substantial reductions in the opportunity to continue subsistence uses generally are caused by large reductions in resource abundance, a major redistribution of resources, extensive interference with access, or major increases in the use of those resources by non-subsistence users (BLM IM AK-2011-008).

When analyzing the effects of Project alternatives, particular attention is paid to Nuiqsut, the community that has the potential to be most directly impacted by the Project. Nuiqsut is located on the Nigliq Channel of the Colville River, and the Project area lies within a substantial portion of the community's subsistence use area (Willow MDP EIS Section 3.16, *Subsistence and Sociocultural Systems*, Figure 3.16.1). Additionally, the analysis considers potential effects to Utqiaġvik because the Project would be in

the eastern portion of the community's subsistence use area and some components would be close to Teshekpuk Lake, a key traditional use area for the community. The cumulative analysis expands the evaluation of potential impacts to consider areas beyond the Project area in which past activities have impacted North Slope subsistence uses, in which current activities are impacting North Slope subsistence uses, or in which future activities could occur that could impact Nuiqsut, Utqiaġvik, or other North Slope communities' subsistence uses or the subsistence resources that rely upon the habitats affected.

In addition to ANILCA, Environmental Justice, as defined in Executive Order 12898, also calls for an analysis of the effects of federal actions on minority populations with regard to subsistence. Specifically, Environmental Justice is:

> *The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including a racial, ethnic, or socioeconomic group should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies.*

Section 4-4 of the Executive Order on Environmental Justice, regarding the Subsistence Consumption of Fish and Wildlife, requires federal agencies to collect, maintain, and analyze information on the consumption patterns of populations who principally rely on fish or wildlife for subsistence, and to communicate to the public any risks associated with those consumption patterns. To this end, the action alternatives subsistence analyses, located in Section 3.16 of the Willow MDP EIS, have been reviewed and found to comply with Executive Order 12898.

B. ANILCA SECTION 810(A) EVALUATIONS AND FINDINGS FOR ALL ALTERNATIVES AND THE CUMULATIVE CASE

Evaluations and findings for Alternatives A, B, C, and D, Module Delivery Options 1 and 2, and the cumulative case are presented individually in the following sections. BMPs established by the 2012 NPR-A Integrated Activity Plan/Environmental Impact Statement (IAP/EIS) Record of Decision (ROD) (BLM 2013) would apply to all Project alternatives. CPAI's leases in the BTU are subject to lease stipulations established in the 2008 Northeast NPR-A Supplemental IAP ROD (BLM 2008). The mitigating effects of these BMPs and lease stipulations are accounted for in the following evaluations and findings.

1. Evaluation and Finding for Alternative A (No Action)

The No Action Alternative of the Willow MDP EIS precludes the currently proposed development in the BTU, and no oil from the BTU field would be produced. Under this alternative, no new roads, airstrips, pipelines, or other oil and gas facilities would be constructed pursuant to CPAI's application for development in the BTU.

Activities that are currently allowed pursuant to the 2013 NPR-A IAP/EIS ROD would continue. These activities include seismic exploration, exploratory drilling of test wells, and the construction of ice roads and pads to support these operations.

a. Evaluation of the Effect of Use, Occupancy, or Disposition on Subsistence Uses and Needs

No additional impacts to subsistence uses and needs would be expected under the No Action Alternative. Impacts in the Project area would be expected from those actions associated with scientific research during the summer and oil and gas exploration during the winter. Numerous studies are conducted on a year-round basis on the North Slope. Aerial surveys are conducted by fixed-wing aircraft or helicopter, and ground surveys are conducted on foot, snow machine, or by all-terrain vehicle (ATV); these activities have the potential to disturb wildlife. However, the effects of these activities on species used by subsistence users are expected to be local and short-term and would have no regional population effects.

b. Evaluation of the Availability of Other Lands for the Purpose Sought to be Achieved

The evaluation for Willow MDP EIS Alternative A (No Action) regarding the availability of other lands is not applicable because Alternative A does not propose the disposition or use of public lands.

c. Evaluation of Other Alternatives that would Reduce or Eliminate the Use, Occupancy, or Disposition of Public Lands Needed for Subsistence Purposes

Alternative A (No Action) would not eliminate the use of public lands needed for subsistence purposes. However, Alternative A does not meet the purpose of the proposed action to produce oil discovered on CPAI's BTU leases. The Willow MDP Appendix D, *Alternatives Development*, Section 3.1.3 (*Alternative Components Considered but Eliminated from Further Analysis*) discusses other alternatives that were considered but eliminated from detailed analysis due to economic or technological feasibility or practicability, or because they did not meet the purpose of the proposed action. Alternative A is included in the analysis for baseline comparison, but the BLM does not have the authority to select this alternative because CPAI's leases are valid and the right to drill is associated with leases.

d. Findings

The effects of the No Action Alternative fall below the level of possibly significantly restricting subsistence uses and needs. The impacts to subsistence resources and access discussed above would be minimal. This finding applies to the entire Project study area.

2. Evaluation and Finding for Alternative B (Proponent's Project)

Development of oil reserves in the BTU would occur under Alternative B, the Proponent's Project. Infrastructure would include five drill sites (BT1, BT2 , BT3, BT4, and BT5), WPF colocated with BT3, WOC near BT3, an all-season gravel road connection extending from the GMT-2 drill site southwest to the WPF, an airstrip, infield and export pipelines, gravel roads (including eight turnouts with subsistence/tundra access ramps and seven associated bridges) connecting the five drill sites to the WPF, and a water source access road near BT5. Gravel roads would cross both the Judy (Iqalliqpik and Kayyaaq) and Fish (Uvlutuuq) creeks. During construction, the Project would also develop the Tiŋmiaqsiġvik gravel mine site (with up to two distinct mine pits), MTI (see Sections B.5, *Evaluation and Findings for Module Delivery Option 1: Proponent's Module Transfer Island*, and B.6, *Evaluation and Findings for Module Delivery Option 2: Point Lonely Module Transfer Island*) at either Atigaru Point or Point Lonely, and associated ice roads for gravel haul and module transport.

In the Willow MDP EIS, the BLM analyzed potential direct impacts on subsistence based on a 2.5-mile buffer of permanent and temporary (e.g., ice roads) infrastructure associated with Alternatives B, C, and D, in addition to the gravel mine site and ice roads (Figure 1). Because the 2.5-mile buffer of the three action alternatives is nearly identical, it was not necessary to provide a separate analysis area for each action alternative. Thus, while the footprint of development infrastructure and activity is similar under all action alternatives, differences in infrastructure design, infrastructure placement, and operational details determine how and to what level subsistence uses would be affected. These differences are discussed qualitatively. The alternatives analysis area includes both permanent infrastructure and temporary infrastructure (e.g., ice roads, ice pads) that would only be present during the construction phase. The difference in impacts between the construction and operations phases are discussed qualitatively. In addition, the alternatives analysis area does not include upgrades to infrastructure or new infrastructure that would occur within the footprint of existing development areas (e.g., new pipelines that would colocate with existing pipelines and roads east of GMT-2), nor does it include all areas where development-related activity, such as air traffic, would occur. These indirect effects are discussed where applicable. While each action alternative would also include a module delivery option and associated ice roads, because there is more than one option for the MTIs, the MTIs and associated ice infrastructure are analyzed separately using a separate 2.5-mile buffer (Sections B.5 and B.6).

The alternatives analysis area allows for more detailed analysis of the area where subsistence users are most likely to experience direct impacts from the Project. Additional direct and indirect impacts that would occur outside the alternatives analysis area are also addressed. In addition to the alternatives

analysis area, a direct effects analysis area, which is defined as a 2.5-mile buffer around all action alternatives and module delivery options, is used in the Willow MDP EIS Subsistence Appendix (Appendix E.16) to characterize the nature of subsistence uses, including timing and transportation methods, within the area of potential direct effects.

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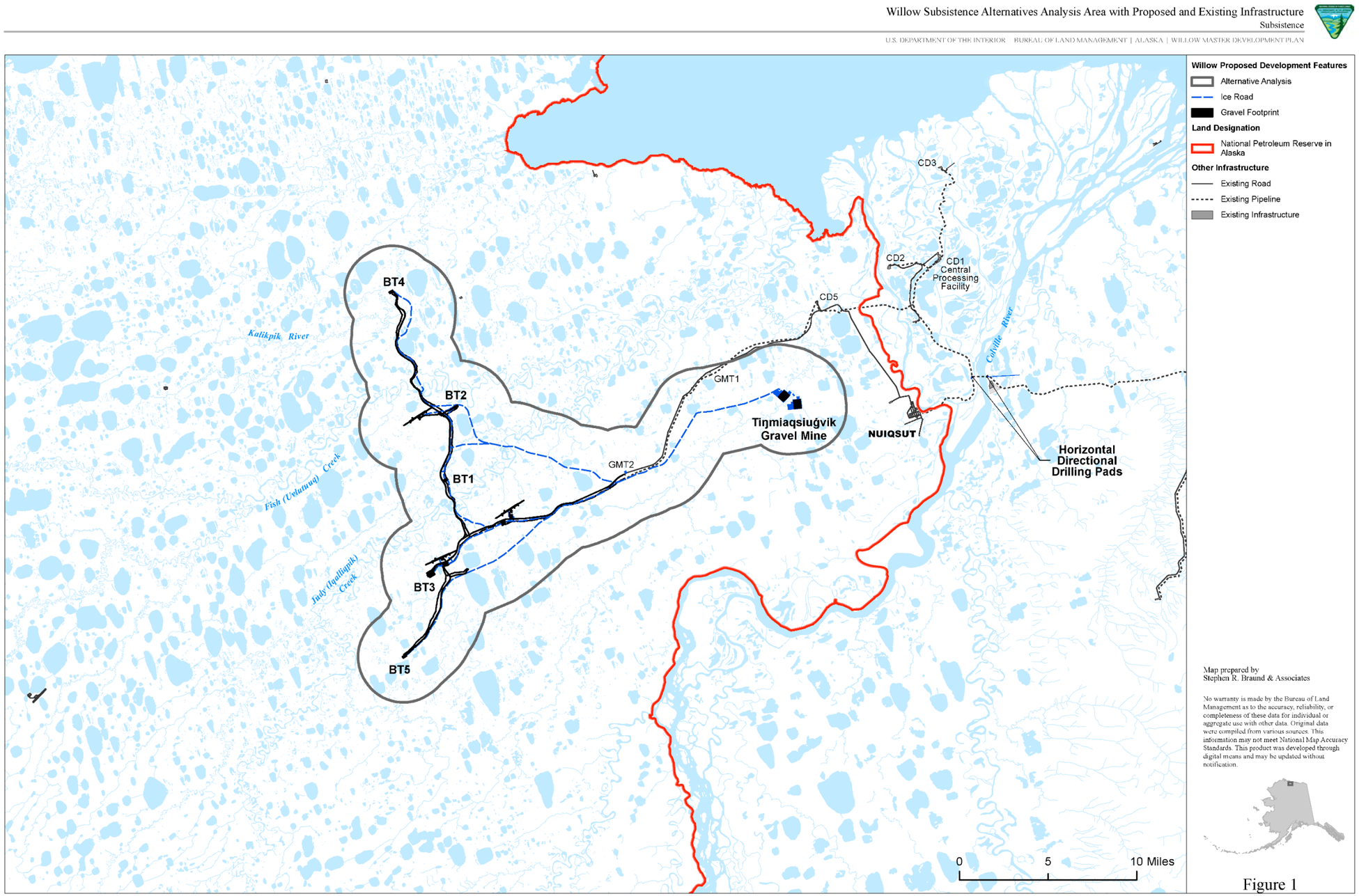

Figure 1. Willow Subsistence Alternatives Analysis Area with Proposed and Existing Infrastructure

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a. Evaluation of the Effect of Use, Occupancy, or Disposition on Subsistence Uses and Needs

The Willow MDP alternatives analysis area (Figure 1) lies within areas heavily used by Nuiqsut residents for subsistence, particularly for harvesting of caribou and furbearers (wolf and wolverine); limited goose hunting also occurs within the alternatives analysis. The alternatives analysis area lies within the eastern periphery of Utqiaġvik subsistence use areas for wolf, wolverine, and caribou. During interviews with Nuiqsut active harvesters for the 1995 through 2006 time period, 88% of harvesters reported using the alternatives analysis area, with wolf, wolverine, and caribou being the primary targeted resources (Table 3.16.5 in the Willow MDP EIS Section 3.16.2.3, *Alternative B: Proponent's Project*). Based on annual data for the Nuiqsut Caribou Subsistence Monitoring Project for the 2008 through 2016 time period, use of the alternatives analysis area for caribou hunting on an annual basis appears somewhat lower (between 29% and 61% during individual study years, Table 3.16.6 in the Willow MDP EIS Section 3.16.2.3). The percent of total caribou harvests occurring within the alternatives analysis area throughout 9 years of the Nuiqsut Caribou Subsistence Monitoring Project has ranged from 5% to 19%. In the area directly east of the analysis area and directly west of the community of Nuiqsut, harvests have ranged from 14% to 43%, with recent years showing an increase in harvests coming from this area. Eleven percent of Utqiaġvik harvesters reported using the alternatives analysis area, primarily for wolf and wolverine, during the 1997 through 2006 time period.

For Nuiqsut, caribou is a resource of major importance, both culturally and as a food source, and the alternatives analysis area includes lands that are highly used for caribou hunting or lands that are directly west of areas highly used for caribou hunting (Figures 2 and 3). While furbearers generally are not a food source for the community, furbearer hunting and trapping has cultural value as it is a specialized activity, often among highly active harvesters, which contributes to the local economy and provides materials for Native crafts and clothing. The alternatives analysis area is heavily used by furbearer hunters in Nuiqsut (Figure 4).

Thus, impacts to both caribou and furbearer resources are considered in this ANILCA Section 810 evaluation, in addition to indirect and cumulative impacts to other harvesting activities, such as fishing, where applicable. Nuiqsut lies on the eastern periphery of the Teshekpuk Caribou Herd (TCH) range and the western periphery of the Central Arctic Caribou Herd (CAH) range. Estimates based on the timing and location of harvests indicate that a majority of Nuiqsut's caribou harvest is from the TCH, which is the primary herd that occurs within the alternatives analysis area (Braem, Kaleak et al. 2011). The CAH also contributes to the community's overall harvest, and caribou from this herd may cross to the west of the CRD on occasion. However, the CAH generally occurs east of the alternatives analysis area and impacts to harvests to this herd resulting from Alternative B would likely be minimal.

The alternatives analysis area is on the periphery of Utqiaġvik subsistence use areas but is directly east of the Teshekpuk Lake area, which is a key traditional use area for many Utqiaġvik residents (Figure 5). The alternatives analysis area is used during some years for hunting of wolf and wolverine and may be particularly important during years when these resources are less available elsewhere. Caribou may also be harvested during these furbearer hunting trips, but the alternatives analysis area is generally not used specifically for Utqiaġvik caribou hunting (SRB&A 2010b). Thus, the ANILCA Section 810 evaluation focuses on potential impacts to furbearer harvesting for Utqiaġvik, in addition to indirect or cumulative impacts to other resource harvesting activities. Like Nuiqsut, furbearer hunting is practiced by a relatively small proportion of households, but it is a culturally important and specialized activity in Utqiaġvik.

Subsistence Resource Abundance

As noted above, the TCH is the primary herd that occurs in the alternatives analysis area, with seasonal migrations occurring through the area during the spring and fall, and large numbers of caribou sometimes occurring in the area during the oestrid fly season (July through August), a peak hunting time for Nuiqsut (Willow MDP EIS Section 3.12.1, *Affected Environment*). The alternatives analysis area occurs in areas of relatively low caribou calving density. Impacts to caribou populations could occur through direct mortality (e.g., vehicle strikes) or through decreased calf survival resulting from impacts to calving

grounds or to the behavior of maternal caribou. Injuries and mortality resulting from vehicle collisions may occur but are not expected to have population-level effects (Willow MDP EIS Section 3.12.2.3.3, *Injury or Mortality*). In addition, while the Project may result in displacement of some calving caribou because the alternatives analysis area is located in low density calving areas for the TCH, displacement would likely not have population-level effects (Willow MDP EIS Section 3.12.2.3.2, *Disturbance or Displacement*). Thus, the abundance of caribou available for subsistence use would not be impacted under Alternative B.

The alternatives analysis area does not have a high density of wolves or wolverines, although the area is heavily used by Nuiqsut furbearer hunters who generally cover large areas in pursuit of these resources. While wolf and wolverine would likely be displaced by infrastructure and human activity and some individual mortalities of wolverine may occur, overall population levels are not expected to be affected by the project (Willow MDP EIS Appendix E.12, *Terrestrial Mammals Technical Appendix*). Thus, the abundance of wolf and wolverine available for subsistence use would not be impacted under Alternative B.

While generally not harvested within the alternatives analysis area, other subsistence resources that could experience direct or indirect impacts from the Project include waterfowl and fish. Waterfowl hunting occurs to the north and east of the alternatives analysis area, while fishing of broad whitefish and other fish species occurs downriver from the alternatives analysis area in Fish (Uvlutuuq) Creek. Habitat loss and degradation could displace or cause individual mortalities of these resources, but the Project is not expected to cause population-level effects. A large oil spill could have population-level effects but is not expected to occur (Willow MDP EIS Sections 3.10, *Fish*, and 3.11, *Birds*).

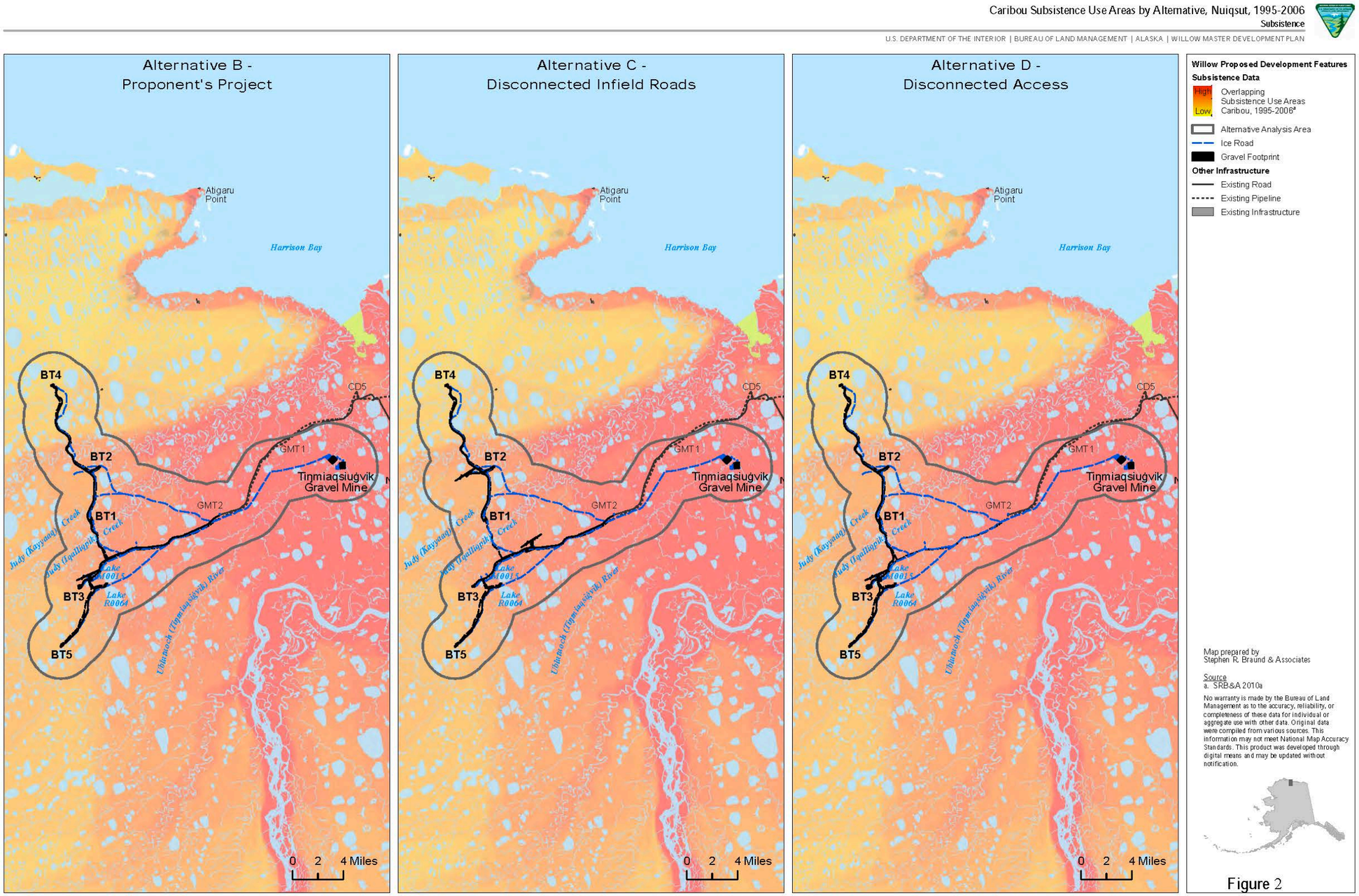

Figure 2. Willow Subsistence Alternatives Analysis Area with Nuiqsut Caribou Subsistence Use Areas, 1995 to 2006

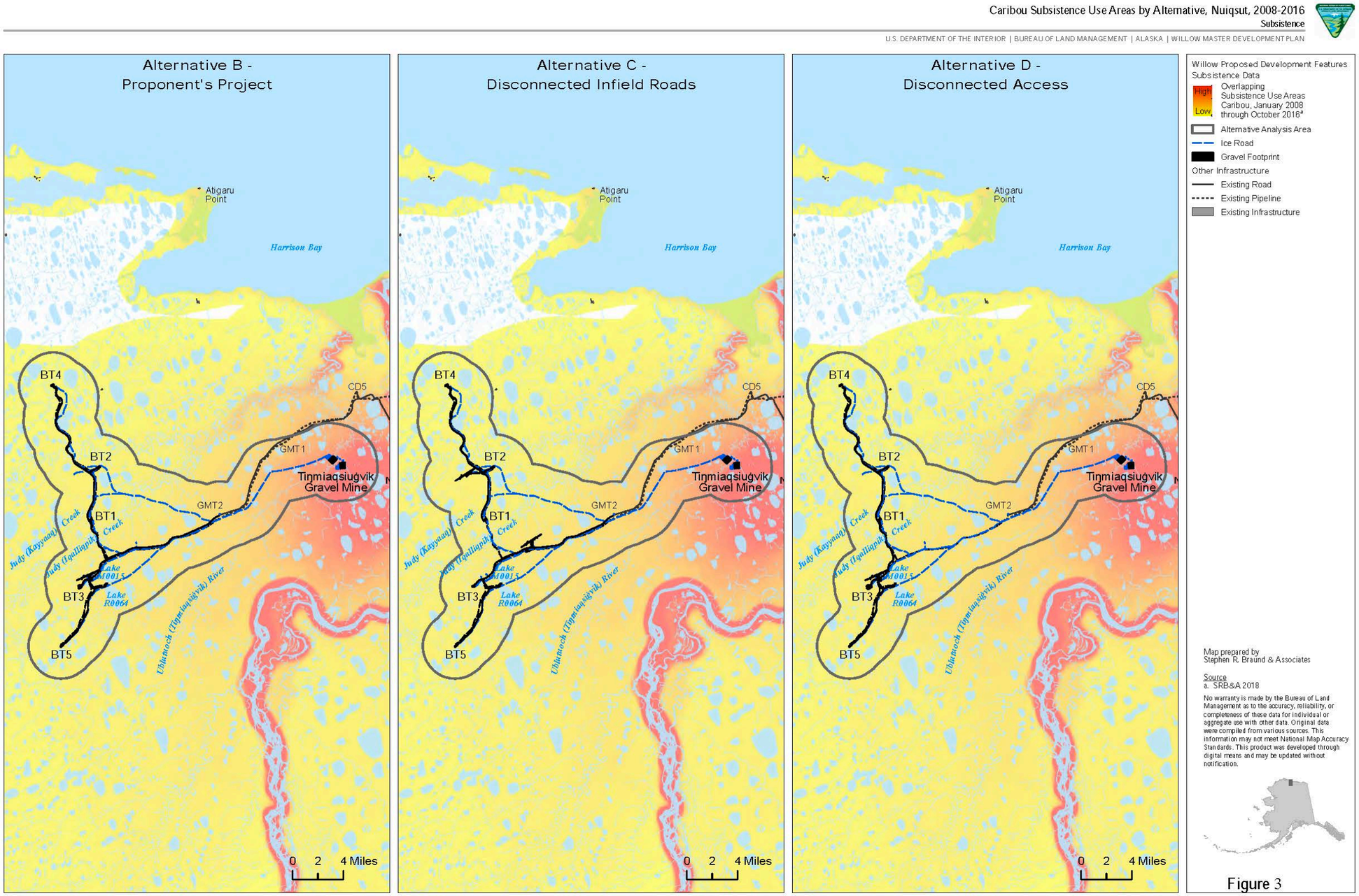

Figure 3. Willow Subsistence Alternatives Analysis Area with Nuiqsut Caribou Subsistence Use Areas, 2008 to 2016

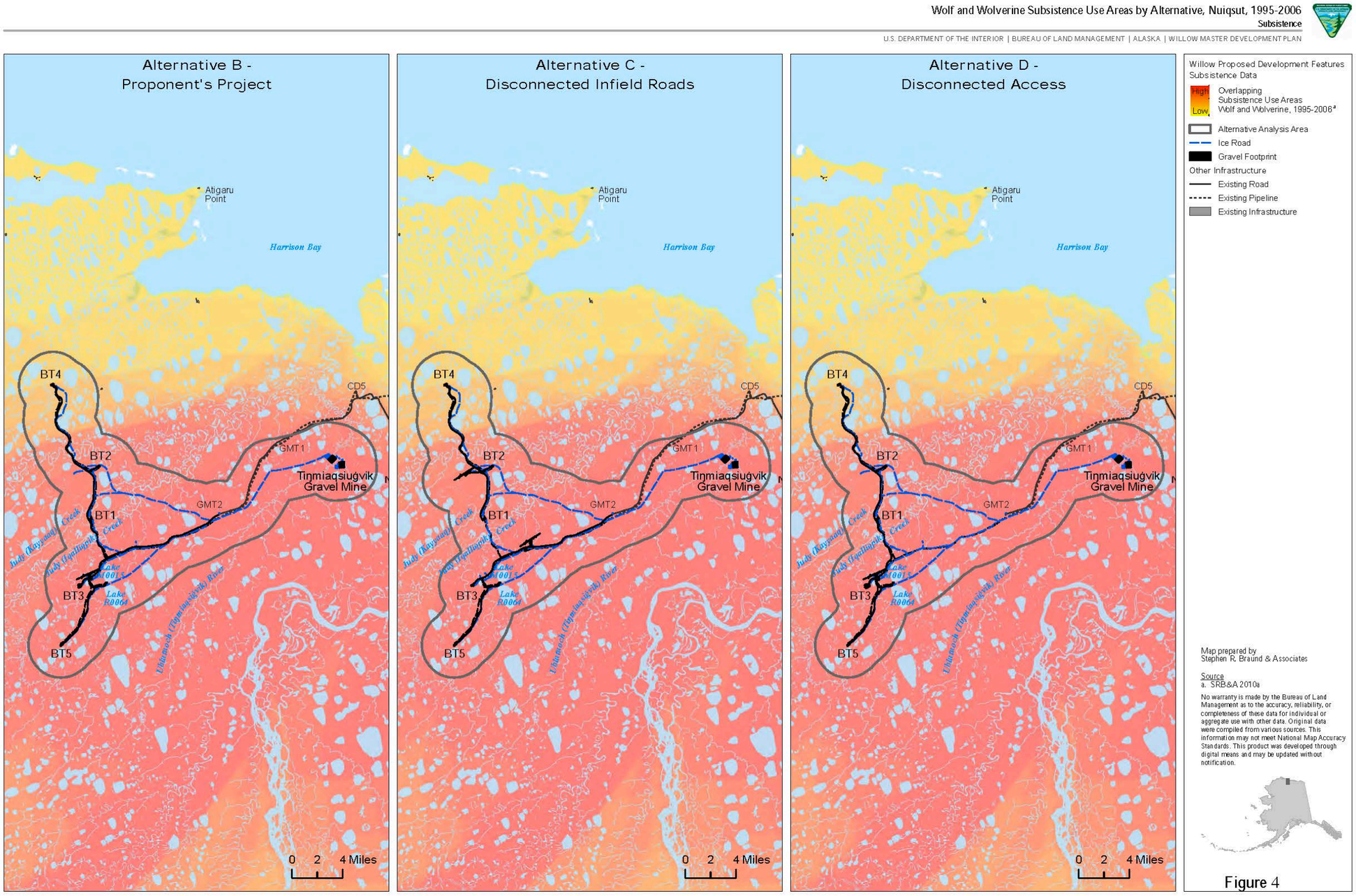

Figure 4. Willow Subsistence Alternatives Analysis Area with Nuiqsut Wolf and Wolverine Subsistence Use Areas, 1995 to 2006

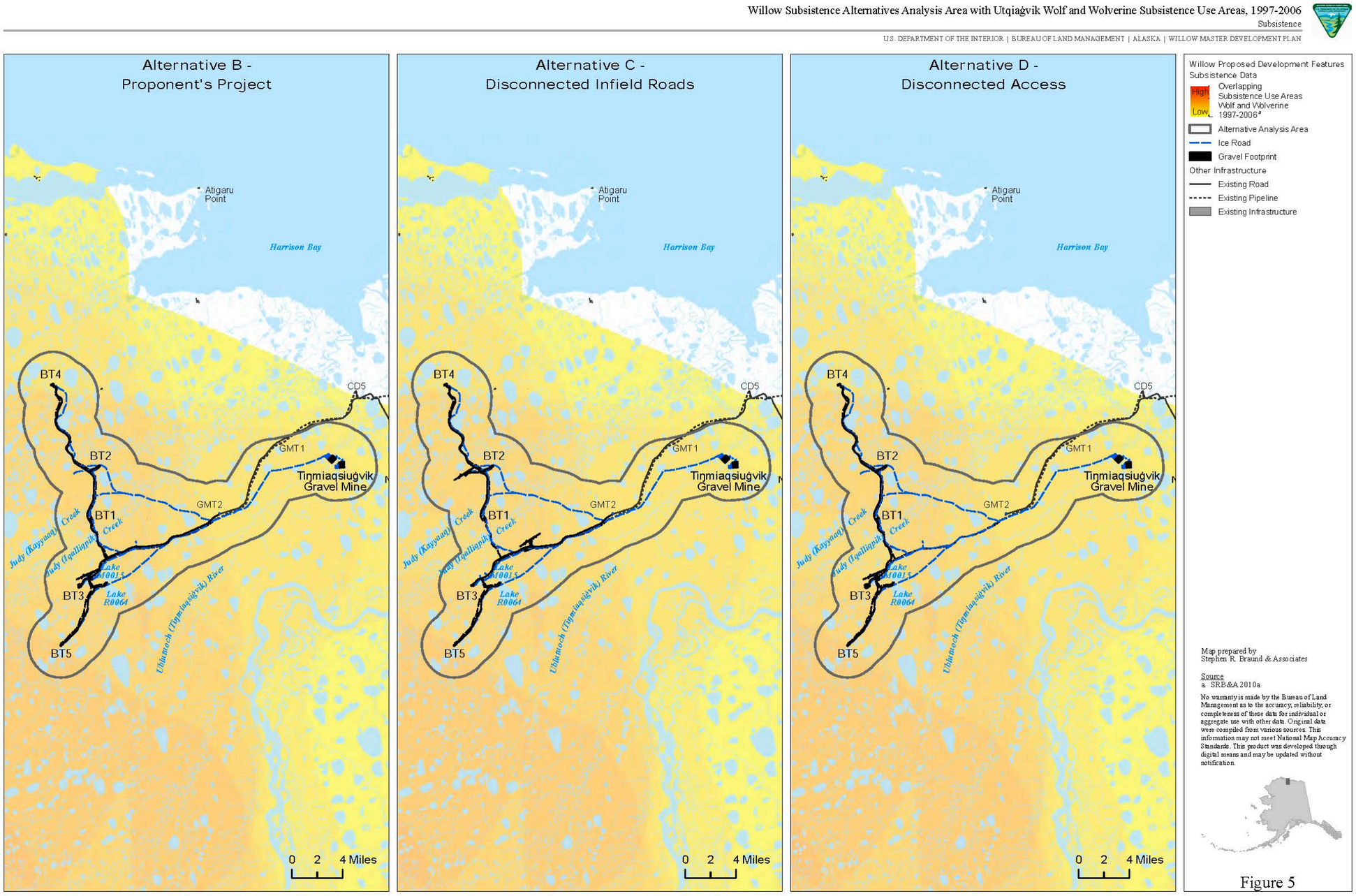

Figure 5. Willow Subsistence Alternatives Analysis Area with Utqiaġvik Wolf and Wolverine Subsistence Use Areas, 1996 to 2007

Subsistence Resource Availability

A description of subsistence uses for Nuiqsut and Utqiaġvik is provided in Willow MDP EIS Section 3.16.1, *Affected Environment*, and in Willow MDP EIS Appendix E.16, *Subsistence Technical Appendix*. Nuiqsut caribou hunting primarily occurs along the Colville River drainage, including the Nigliq and East channels, as well as in overland areas to the west, southwest, and northwest of the community. While boat is the primary method of travel to caribou hunting areas along the Colville River, overland areas west of the community are primarily accessed by ATV, snow machine, and, since construction of the Spur, CD5, and Greater Mooses Tooth 1 (GMT-1) roads, by automobile. Use of the area west of Nuiqsut for caribou hunting has increased somewhat in recent years, partially due to increased access from recently constructed gravel roads. The increase in subsistence use to the west of the community correlates with decreased use of other areas including Nigliq Channel, East Channel, and the Fish (Uvlutuuq) Creek drainage, which has been commonly reported as places of avoidance by local hunters due to development, environmental, and personal factors (SRB&A Forthcoming). Nuiqsut caribou hunting activities in the direct effects analysis area peak from July through September, as does hunting directly east and south of the alternatives analysis area (Willow MDP EIS Appendix E.16). The majority of the use of the alternatives analysis area for caribou hunting occurs in the eastern portion of the area surrounding the proposed gravel mine and access road. Data for the 1995 through 2006 time period shows greater use of the alternatives analysis area; recent years have seen a decrease in use of snow machines and increased use of ATVs, which may partly explain the relatively smaller use areas shown on Figure 3 compared to Figure 2 (SRB&A 2018a). During years with adequate snow cover, use of the area may be higher. Nuiqsut caribou hunters often target caribou in the area west of the community while caribou are most available in the area during the oestrid fly season (July and August) and fall migration (August and September). During these time periods, caribou may cross through the Project and alternatives analysis area before being hunted to the west of the community.

Nuiqsut wolf and wolverine hunting is a winter subsistence activity that occurs in large overland areas to the west, south, and southeast of the community. For the 1995 through 2006 time period, 88% of wolverine harvesters and 87% of wolf harvesters reported using the alternatives analysis area. The majority of the alternatives analysis area is used heavily for wolf and wolverine hunting by Nuiqsut harvesters. Wolf and wolverine hunting in the area peaks from November through March and occurs by snow machine (Willow MDP EIS Appendix E.16, *Subsistence Technical Appendix*).

Potential impacts to the abundance of subsistence resources are discussed above. The primary sources of potential impacts to resource availability of caribou, wolf, and wolverine to subsistence users include:

1. Displacement resulting from habitat loss (roads, pipelines, and/or other oil and gas facilities).
2. Displacement resulting from road disturbance.
3. Displacement from air traffic.
4. Displacement from other infrastructure and sources of disturbance.

These impacts are discussed in further detail below.

Displacement of Caribou Due to Habitat Loss

Impacts on caribou related to habitat loss are discussed in Willow MDP EIS Section 3.12, *Terrestrial Mammals*. The Project area is to the east and south of the TCH primary calving grounds which, in recent years, occur with the greatest density to the southeast of Teshekpuk Lake. Alternative B would remove 656.6 acres of terrestrial mammal habitat due to gravel mining and construction of gravel infrastructure. Additional habitat loss or alteration would result from gravel spray and dust deposition. The habitats that would be affected by Alternative B are not unique, and similar habitats would be available nearby. Thus, habitat loss and alteration associated with the Project would likely cause caribou to move to similar habitats nearby and would not have overall impacts on subsistence resource availability for Nuiqsut harvesters.

Displacement of Caribou Due to Road Disturbance

Impacts on caribou and caribou hunting resulting from road-related disturbance are discussed in Willow MDP EIS Sections 3.16.2.3.2.1, *Resource Availability–Caribou*, and 3.12.2.3.2, *Disturbance or Displacement*. The increasing presence of roads near Nuiqsut has resulted in increased reports of impacts to hunting from roads and road traffic (SRB&A 2016, 2017a, 2018a). As noted above, the Project area would be in the northeastern portion of the range of the TCH. In the spring (May and June), some TCH caribou migrate through the Project area on their way to calving grounds, with males arriving in mid- to late-June when Nuiqsut residents begin traveling by boat to hunt caribou. In the summer oestrid fly season (July and August), caribou sometimes occur in the area of proposed infrastructure in large numbers, and in the fall, large numbers of caribou may move through the Project area as they migrate south to their wintering grounds (Prichard, Macander et al. 2018).

The Alternative B Project access road would bisect a portion of the fall migration corridor and would occur in areas heavily used by TCH caribou in some years (during both the summer and winter months). Residents hunt to the west, northwest, and southwest of the community of Nuiqsut during the summer and fall by ATV, and they hunt to the northwest of the community by automobile. In addition, residents hunt caribou by boat along the Colville River to the southeast of the proposed road corridor in the months of July, August, and September (Willow MDP EIS Appendix E.16). While the majority of this hunting occurs in the eastern portion of the alternatives analysis area near the proposed mine site and directly east of the proposed road, some residents also travel as far as the proposed gravel road, particularly when using the existing road system to access hunting areas. The most heavily used hunting areas are directly east and northeast of the proposed access road. Some caribou may remain in the Project area throughout the winter and are hunted by individuals on snow machine or, in recent years, along the road. While the number of caribou that occur within the alternatives analysis area may represent a small portion of the overall herd, they represent an important source of caribou available to the community of Nuiqsut. Thus, roads associated with the Project have a high potential for disturbance of caribou and Nuiqsut caribou hunting activities. While some Utqiaġvik hunters may venture into the western portion of the alternatives analysis area in some years during winter, the area is not a primary hunting area for caribou for that community. Thus, this discussion focuses on potential impacts to Nuiqsut hunters resulting from road disturbance.

Roads and road traffic are believed to cause behavioral and migratory changes in caribou that can affect hunting success. Deflections or delays of caribou movement from roads and associated ground traffic and human activity have been documented both by active harvesters (SRB&A 2010a, 2011, 2012, 2013, 2014b, 2015, 2016, 2017a, 2018a) and during behavioral studies on caribou (Wilson, Parrett et al. 2016). During the Nuiqsut Caribou Subsistence Monitoring Program, reports of road-related impacts on caribou hunting have steadily increased since road construction began. Year 9 of the study was the first year where impacts related to man-made structures (e.g., roads, pipelines) were as common as impacts related to helicopter traffic (SRB&A 2018a). In Year 10, when constructed roads included the Spur, CD5, and GMT-1 roads, impacts from human-made structures were the most commonly reported impacts (SRB&A Forthcoming). Residents indicate that the roads pose both a physical and visual barrier to the caribou and have observed changes in caribou distribution and behavior around roads, including decreased availability of caribou closer to the community (SRB&A Forthcoming). Residents also note that safety considerations around roads reduce the availability of individual caribou as residents are careful not to shoot toward infrastructure.

Impacts related to roads have also been observed by Noatak and Kivalina caribou hunters in regards to the Red Dog Delong Mountain Transportation System (DMTS) (SRB&A 2014a). Residents have reported that some caribou will stop once they reach the DMTS, sometimes traveling alongside the road before crossing, and other times bypassing the road altogether. Such behavior has also been documented through radio collar observation. A study conducted by Wilson, Parrett et al. (2016) found that the DMTS influenced the movements of approximately 30% of radio-collared Wester Arctic Caribou Herd (WAH) caribou, and the average delay in crossing was 33 days. Caribou from the TCH, which also cross the DMTS during certain years, were not similarly affected, which could be due to greater exposure to

industrial developments on the TCH, as opposed to the WAH. In general, observed caribou behavior in response to the DMTS is variable; in some cases, caribou cross seemingly without delay, while in other cases, herds scatter and migration is delayed for multiple days (ABR Inc. and SRB&A 2014; SRB&A 2014a; Wilson, Parrett et al. 2016).

Avoidance of roads is particularly common for maternal caribou (displacement of between 1.2 and 2.5 miles [2 and 4 kilometers] from roads) (Willow MDP EIS Section 3.12, *Terrestrial Mammals*). Displacement of calving caribou would likely not have direct effects on hunter success, as hunting during the spring calving season is low and the hunting that does occur focuses on males. During the mosquito and oestrid fly seasons, caribou are highly mobile due to insect harassment and regularly approach and cross pipelines; however, deflected movements and delays become common where roads and pipelines are close to one another or where traffic rates exceed 15 vehicles per hour (Willow MDP EIS Section 3.12). Deflections or delays of several hours could have substantial impacts to harvesting success for residents hunting to the east of the road corridor, particularly hunters waiting along river corridors with no means of approaching delayed herds. Traffic rates of over 15 vehicles per hour would be more common during construction, and therefore decreased hunting success resulting from delayed caribou crossings would be more frequent during the construction period. It is likely that caribou deflections would continue during operations but at a lower intensity and frequency than during Project construction. In addition to increased road traffic along Project roads, development of the Project would also increase road traffic along existing roads connecting the Project area to Greater Mooses Tooth (GMT) and Alpine developments. Thus, impacts related to roads would extend beyond the alternatives analysis area.

Effects on caribou movement are most likely to occur where linear structures are placed parallel to the herd's primary movement (Wilson, Parrett et al. 2016), though perpendicular roads may also intercept caribou and cause delayed crossing (BLM 2018; CPAI 2018). The Alternative B access road, where it intersects with infield roads, could create a "pinch point" and deflect caribou away from the road during the fall migration. An overall deflection of migration could have substantial impacts to residents hunting caribou in overland areas during the fall. Temporary changes in distribution have not been shown to alter overall migration patterns or herd distribution (Willow MDP EIS Section 3.12); however, small changes in caribou distribution and movement from a biological perspective can have large impacts on hunter success as residents are generally limited in how far and fast they can travel, particularly during the snow-free season. Because Nuiqsut is on the periphery of the two caribou herds which they rely upon (Prichard, Macander et al. 2018), they are particularly vulnerable to small changes in overall herd distribution or migration.

Caribou responses to roads seem to vary from year to year based on the context in which roads are encountered; thus, while Project roads may not deflect caribou during all seasons or years, in some years, substantial deflections or delays could take place. Based on available data, it is not possible to predict the exact frequency or intensity at which deflections would take place. However, it is reasonable to conclude that resource availability would be affected as a result of the road and subsistence hunters may experience decreased overall hunting success during certain years as a result.

According to CPAI (2018), the TCH may be less habituated to development activity than the CAH due to the relative lack of infrastructure within its range, although the TCH has shown more habituation than the WAH in the case of the DMTS (see above). Thus, TCH caribou may be more prone to disturbance than the CAH (Willow MDP EIS Section 3.12). Impacts on resource availability would most likely occur during the summer and fall months when caribou hunting activity in overland areas and along the Colville River is highest (Table E.16.7 in Appendix E.16). During the oestrid fly season, groups of caribou could gather on gravel pads and gravel roads for insect relief; which may result in increased availability of caribou for individuals hunting along roads but may also increase the likelihood of vehicle strikes and mortalities. Individuals not using roads to access caribou may experience reduced success closer to Nuiqsut, as the caribou are delayed or deflected from crossing roads toward the community's primary hunting area west of the community or along the Colville River toward Ocean Point. Increased hunting

along the road corridor could also reduce the availability of caribou for hunters along river corridors or to the east of the road corridor.

Overall caribou harvests for the community of Nuiqsut as a whole have remained stable over time (during study years spanning the 1980s through 2017) (SRB&A Forthcoming). Residents have reported that access to roads has offset some of the impacts of increased infrastructure and activity on resource availability by providing hunting access to areas farther from the community, although some report avoiding the roads altogether. While road use, in terms of the percentage of active harvesters, has increased somewhat since road construction began, the percentage of harvests occurring within the developed area has remained relatively stable, suggesting that the presence of roads has not had a net benefit on resource availability (SRB&A Forthcoming). However, this conclusion is based on only 4 years of post-road construction data, and hunting patterns will likely continue to change and adapt to the increasing presence of roads. Consequently, it is difficult to draw conclusions at this time regarding the magnitude of impacts of the CD5, GMT-1, and recently built GMT-2 roads based on existing data. Impacts of roads on resource availability will vary from year to year and will depend on multiple factors including traffic rates, environmental factors affecting caribou movement, and hunter adaptation to changes.

Displacement of Caribou Due to Air Traffic Disturbance

During construction, fixed-wing airplanes would be the primary source of air traffic, with helicopters used to support ice road construction, surveying, and monitoring (CPAI 2018). Once the airstrip is constructed, air traffic to the Project area would likely increase to multiple daily flights throughout the life of the Project, although at slightly lower levels during the drilling and operations phases. Helicopter traffic would occur on a periodic basis throughout the life of the Project.

Caribou responses to air traffic disturbance and related impacts on caribou hunters are discussed in Willow MDP EIS Sections 3.12, *Terrestrial Mammals*, and 3.16, *Subsistence*. Until recently, air traffic, particularly helicopter traffic, has been the most commonly reported impact on caribou hunting to the Nuiqsut Caribou Subsistence Monitoring Project (CPAI 2018; SRB&A 2018a, Forthcoming). Air traffic could cause direct and indirect disturbances to caribou availability both within and outside of the alternatives analysis area. Nuiqsut hunters have observed that caribou behavior often changes in response to air traffic, particularly helicopter traffic and fixed-wing traffic at low altitudes. Observed behavioral responses include caribou "scattering" rather than remaining in groups where they are easier to hunt, acting skittish, and deflecting away from the source of noise or away from riversides (where hunters wait for them) (SRB&A 2010a, 2011, 2012, 2013, 2014b, 2015, 2016, 2017a, 2018a). Hunters have frequently recounted experiences where a potentially successful harvest was disrupted by air traffic overhead, with caribou diverting to locations too far from riversides for hunters to access.

Increased air traffic associated with the Project would likely affect hunting activities in overland areas and along rivers, including the Nigliq Channel and the Colville River upriver toward Ocean Point. The increase in overall air traffic in the region associated with the Project would increase the frequency of disturbances experienced by Nuiqsut hunters. According to SRB&A (SRB&A 2018a), the area west of Nuiqsut accounts for a substantial percentage of Nuiqsut's annual caribou harvest, and increased air traffic within that area could affect Nuiqsut harvesting success during the construction and operation phases. Impacts of air traffic to caribou resource availability would be most likely during the summer oestrid-fly season and in the fall when caribou migrate in an easterly direction, often crossing through the Project area into areas heavily used by Nuiqsut caribou hunters (Willow MDP EIS Figures 3.16.7 and 3.16.8; Figure E.16.2 in Appendix E.16). However, air traffic impacts could occur year-round.

Displacement of Caribou Due to Other Infrastructure and Sources of Disturbance

Other potential sources of impacts to caribou availability include construction noise (including noise associated with gravel mining), drilling noise, general human activity, and contamination events. These potential impacts to Nuiqsut subsistence resource availability are discussed in Willow MDP EIS Section 3.16, *Subsistence and Sociocultural Systems*. Noise associated with gravel mining (including blasting),

mining equipment and machinery, and excavation, could cause caribou to avoid the mine site area or to act skittish. Blasting and excavation would occur over five construction seasons, primarily during the winter months, when caribou hunting levels are reduced. While winter is not the peak caribou hunting season for the community of Nuiqsut, harvests occur when caribou are available in the area and when households are in need of meat. Winter harvests are often an important source of food when stocks of summer and fall subsistence foods begin to run low. Winter caribou harvests have been documented occurring to the west and north of the community, including near the proposed mine site. Access to winter ice roads may help offset some of the impacts to resource availability during this time; however, gravel haul and module transport ice roads, which would be the primary ice roads located within the community's hunting area, would be off-limits to subsistence users. In addition to noise associated with mining, the presence of the mine pits could deflect movement of caribou year-round, resulting in localized changes in distribution. The mine pits would be allowed to fill with water following construction and would therefore no longer be suitable habitat for caribou, thus affecting availability of caribou in the immediate area.

Other disturbances associated with construction noise, general equipment operation, human presence and activity, and drilling noise could result in temporary avoidance behavior or deflection of caribou, thus affecting resource availability. Studies show that caribou, especially females with calves, avoid drilling sites, and caribou that do approach drilling sites spend less time feeding and lying down (NRC 2003).

Resources which are perceived as contaminated by subsistence users are often considered unavailable for subsistence use (SRB&A 2009); during a recent Bureau of Ocean Energy Management–funded study, 47% of Nuiqsut households reported avoidance in the previous year of certain subsistence foods due to concerns about contamination (SRB&A 2017b). Use and storage of hazardous materials, solid waste, and drilling waste; generation of air emissions; treatment and disposal of wastewater; and dust deposition, could result in real or perceived degradation of caribou habitat. If individuals perceive or confirm caribou to be contaminated and avoid harvesting caribou that feed near the Project, they may experience reduced caribou resource availability.

Displacement of Furbearers

Potential disturbances of wolf, wolverine, and other furbearers are discussed in Willow MDP EIS Section 3.16, *Subsistence and Sociocultural Systems*, and in Appendix E.12, *Terrestrial Mammals Technical Appendix*. Wolf and wolverine are the primary furbearer resources harvested by Nuiqsut and Utqiaġvik subsistence users in the Alternative B analysis area. Although a higher number of overall caribou harvesters use the area, a higher percentage of wolf and wolverine harvesters—individuals who generally represent a smaller portion of the population and tend to be particularly active harvesters—use the area. During the construction phase, noise and other potential sources of impacts would be highest in winter, when most construction activities (e.g., pile driving, gravel mining, ice road operation) would occur. These activities would displace furbearers near Project activities.

Furbearer harvesters have observed reduced availability of wolf and wolverine near development and human activity, noting their sensitivity to noise and human activity, and their general tendency to avoid developed areas. Throughout the life of the Project, furbearers are likely to avoid areas with equipment and infrastructure or areas with high levels of human activity, noise, and ground traffic. Ground traffic and construction and mining noise would be highest during the winter construction months when furbearer harvesting activities are at their peak. Construction is expected to occur over a period of approximately 7 years with varying levels of intensity. Because wolf and wolverine hunting areas are generally large, accessible by snow machine, and extend in various directions from the community, residents would likely use different areas where the resources are believed to be more available, particularly during the construction phase. However, in some cases, subsistence users may have to expend more effort or go farther because the area to the west of the community is a commonly used and easily accessible area. Operations impacts would be similar to construction but would continue throughout the life of the Project (30 years) at somewhat lower levels. For Nuiqsut, high numbers of overlapping use areas for wolf and wolverine occur around BT1, BT2, BT3, and BT5, while low to moderate overlapping

use areas occur around BT4. For Utqiaġvik, low to moderate overlapping use areas occur throughout the western portion of the alternatives analysis area, with greater intensity to the west and southwest of the analysis area.

Displacement of Other Resources

While caribou, wolf, and wolverine are the primary resources harvested directly within the alternatives analysis area, goose hunting occurs directly to the east and north of the mine site and to the east of the proposed gravel access road along the Colville River, and fishing (primarily for broad whitefish, a key resource for the community of Nuiqsut) occurs downstream from the alternatives analysis area on Fish (Uvlutuuq) Creek. Waterfowl hunting peaks during the months of April and May when residents travel by snow machine to inland and riverine areas where white-fronted goose is known to be abundant (Willow MDP EIS Appendix E.16). While most construction activity would be complete before goose hunting begins, it is possible the ice road season would overlap with the beginning of the waterfowl hunting season in late April. Additionally, blasting at the gravel mine pits may occur into April. Thus, traffic and mining noise may result in temporary displacement or disturbance of waterfowl at the beginning of the hunting season, potentially causing a temporary decrease in harvester success; however, these disturbances are not expected to cause overall impacts to resource availability for the community as the mine site and ice roads are at a substantial distance from areas of high overlapping use for goose hunting (Willow MDP EIS Sections 3.11, *Birds*, and 3.16, *Subsistence and Sociocultural Systems*).

While the Colville River and CRD are the primary fishing areas for the community of Nuiqsut, a number of families travel to Fish (Uvlutuuq) Creek and stay at fish camps to set nets for broad whitefish during the summer (July and August) and fall (September and October) months (SRB&A 2010b). Other fish resources harvested along Fish (Uvlutuuq) Creek, although in lesser quantities than broad whitefish, include burbot (in winter), Dolly Varden, and Arctic grayling (SRB&A 2010b). While construction activities and infrastructure (e.g., ice roads) may temporarily displace fish upstream and downstream, these impacts would be relatively localized and would not be likely to affect harvesting activities farther downstream along Fish (Uvlutuuq) Creek (Willow MDP EIS Section 3.10, *Fish*). Water withdrawals to support ice infrastructure construction could alter fish habitat, but these alterations would be temporary and are not expected to affect fish populations in Fish (Uvlutuuq) Creek (Willow MDP EIS Section 3.10). The primary potential impacts to fish resource availability would be related to real or perceived contamination of the Fish (Uvlutuuq) Creek drainage. If a spill occurs or if residents perceive that activities upstream from their fish camps are contaminating the water, they may perceive that the fish are unsafe to eat and reduce harvesting activities in the area (Willow MDP EIS Section 3.16).

Several other resource uses have been documented in and around the alternatives analysis area but are not regularly documented and not considered to be primary uses of the area. These include moose hunting and vegetation harvesting along Fish (Uvlutuuq) Creek. Moose are rare within the Project area. Vegetation harvesting has been documented along Fish (Uvlutuuq) Creek; however, it is unlikely that impacts to vegetation resulting from dust deposition would extend to harvesting areas downstream from the Project.

Access to Subsistence Resources

Potential impacts to harvester access are discussed in Willow MDP EIS Section 3.16. A 1,000-foot safety radius around all Willow facilities would be in place and would prohibit the discharge of firearms within those areas; additionally, CPAI asks hunters not to shoot in the direction of work areas, human activity, and infrastructure. The presence of infrastructure and human activity, and associated safety considerations, would reduce the area in which residents can hunt by up to 2.5 miles, depending on the firearm being used (Willow MDP EIS Section 3.16). Thus, a portion of traditional harvesting areas would be inaccessible to subsistence users from construction through the life of the Project. However, Nuiqsut subsistence users would be permitted to use most roads to access subsistence harvesting areas as long as they follow established security protocols. Gravel haul and module transport ice roads would be off limits to Nuiqsut harvesters. Thus, while much of the Project footprint would be legally accessible to subsistence users throughout the life of the Project, certain areas, particularly during construction

activities, would be inaccessible to local residents and may result in residents having to divert around infrastructure to access subsistence harvesting areas, or may act as a physical barrier or obstruction to harvester access. Additionally, the presence of humans and infrastructure would affect subsistence harvesting patterns in and around the development area due to safety concerns, thus rendering some areas unusable for subsistence purposes under certain conditions.

During much of construction, access to the Project area would be limited to overland travel or via ice roads during winter, which would be open from February to April, but would be limited to ice roads not used for gravel hauling or module transport activities. Some residents—particularly those without snow machines—may use ice roads to access caribou herds farther from the community if they are not available closer by. However, the gravel haul and module transport ice roads, which are close to the community's hunting areas, would be off limit to subsistence users, and individuals traveling by snow machine may have difficulty crossing over these ice roads safely due to high traffic volumes. While the winter is not a primary hunting time for caribou, residents do hunt this resource, particularly in February and March (SRB&A 2018a) to supplement their diet as needed throughout the winter. It is unlikely that furbearer hunters would use ice roads for wolf and wolverine hunting, as most individuals would begin snow machine hunting trips directly from the community and are not expected to hunt for these resources near human activity and infrastructure. If wolf and wolverine hunters want to cross over gravel haul and module transport ice roads to access areas farther from the community, they may experience difficulties due to the high traffic volumes and access restrictions. As gravel roads are gradually constructed, year-round access to the Project area via road automobile would increase. Gravel roads would extend the current area accessible by automobile for local residents and would likely be used, to some extent, for summer and fall caribou hunting, as well as during the winter. Use of roads would be particularly likely for residents who do not have access to alternate modes of transportation (e.g., boats, snow machines, ATVs), who have limited time to engage in subsistence activities, or who have health or other issues that make overland travel difficult.

Recently collected data from Nuiqsut households indicate that the percentage of households using roads decreases somewhat with distance from the community, or in areas with high concentrations of drill sites. For example, while 52% of households reported using the Spur Road extending north from the community in 2018, 40% reported using the road between CD5 and GMT-1, and only 10% reported using roads crossing east of the Nigliq Channel toward the CD1 and CD4 developments (Willow MDP EIS Section 3.16). Reasons for the decreased use with distance from the community could include lack of time (residents report using roads due to the ease of access during times when they are unable to take longer trip) and lack of money or fuel to take longer trips. Decreased use of roads to the east of Nigliq Channel could be due to a relatively lower abundance of resources in that area, or due to heightened concerns about safety due to the greater concentration of infrastructure and human activity. Thus, because of the greater distance of Project roads from the community and the relatively higher density of infield roads and drill pads (compared to the GMT and Alpine developments), use of Project roads may be somewhat lower than other industry roads closer to Nuiqsut. Once Project roads and infrastructure are complete, they may introduce additional concerns for residents hunting along existing roads, particularly between GMT-1 and GMT-2, as there would be fewer directions in which to shoot without consideration of human safety.

Roads would act as a physical impediment to those traveling overland, or to those traveling on or off roads to access use areas. Tundra access ramps and road pullouts at regular distances would reduce issues with off-road travel. However, some Nuiqsut hunters report difficulty crossing onto or over existing roads, even using existing tundra access ramps, particularly when hauling a heavy sled (SRB&A 2018a). While tundra access ramps would reduce impacts to access, residents may have to travel extra distances to access crossing areas if they are traversing overland. Ice roads would not include tundra access ramps but would likely have a smaller slope that would pose less of a barrier to travel; however, crossing over ice roads may be difficult due to high traffic volumes and restricted access along certain routes. The mine pits, which would be located on either side of the highly used Ublutuoch (Tiŋmiaqsiuġvik) River drainage, would also act as a physical barrier to harvesters traveling overland; residents traveling by snow machine or ATV would have to divert around the mine site during construction and in subsequent

summers when the mine would fill with water. Pipelines would be placed a minimum of 7 feet above the surrounding ground surface and would generally be high enough for harvesters to cross underneath on snowmachines or ATVs, although large snow drifts may result in harvesters detouring to areas with increased clearance.

b. Evaluation of the Availability of Other Lands for the Purpose Sought to be Achieved

The Naval Petroleum Reserves Production Act of 1976, as amended, instructs the Secretary of the Interior to conduct oil and gas leasing in the NPR-A. Congress authorized petroleum production in 1980 and directed the Secretary of the Interior to undertake a program of competitive leasing of potential oil and gas tracts in the Reserve. In 2012, the NPR-A IAP/EIS analyzed impacts of future development in and around the Alpine development, including potential development in the BTU. In 2018, BLM completed an analysis of the potential impacts of development of the GMT-2 site, including a road connecting the GMT-2 site to the existing GMT-1 site located to the northwest of Nuiqsut. The Section 810 analysis for the GMT-2 project also considered development of the BTU in its Evaluation and Findings for the Cumulative Case. The purpose of the Willow MDP EIS is to analyze impacts specific to the Willow MDP alternatives to aid in differentiation of impacts between the alternatives and to provide information to agencies and other stakeholders so that they can make informed decisions regarding the Project's development. The Project was designed to develop oil from a delineated reservoir on valid leases within the NPR-A. Other lands managed by the BLM are too distant to access the BTU reservoir using current drilling technologies.

c. Evaluation of Other Alternatives that would Reduce or Eliminate the Use, Occupancy, or Disposition of Public Lands Needed for Subsistence Purposes

Alternative A (No Action) would reduce or eliminate the use of public lands needed for subsistence purposes. However, the BLM may not select Alternative A as its preferred alternative. The BLM issued leases to CPAI and is required to allow reasonable development of those leases. The Willow MDP EIS Appendix D, Section 3.1.3, *Alternative Components Considered but Eliminated from Further Analysis*, discusses other alternatives (or alternative components) that were considered but eliminated from detailed analysis due to economic, or technological feasibility or practicability, or because they did not meet the purpose of the proposed action to produce the oil discovered on CPAI's leases.

d. Findings

1. **Reductions in the availability of subsistence resources described above for Alternative B may significantly restrict subsistence uses for the community of Nuiqsut.**
2. **Limitations on subsistence user access described above for Alternative B may significantly restrict subsistence uses for the community of Nuiqsut.**

Because these effects may reach the level of a significant restriction, a positive determination pursuant to ANILCA Section 810 is required at the draft stage and hearings must be held with subsistence users before final determinations (described in ANILCA Section 810(a)(2)) can be made.

This evaluation concludes that development of Willow MDP EIS Alternative B (Proponent's Project) is not expected to result in a large reduction in the abundance (population level) of caribou or any other subsistence resource. Neither is there any expectation that there will be a major increase in the harvest of caribou by non-subsistence users. Therefore, this draft finding of "may significantly restrict" is only triggered by two other primary factors that must be considered:

1. Reduction in the availability of resources caused by alteration of their distribution
2. Limitation of access by subsistence harvesters

The rationale for these findings and the determination of significance are summarized below.

1. Rationale for the Finding of Reductions in the Availability of Subsistence Resources Under Alternative B

The Project is likely to deflect TCH caribou from areas where Nuiqsut hunters harvest them. Caribou are a resource of major importance for Nuiqsut. The majority of caribou hunting in the Project area occurs in the eastern portion of the area surrounding the proposed gravel mine site and access road. Caribou would have to cross through the Project area before being hunted in overland areas west of the community and along the Nigliq Channel and Colville River. Deflection would likely occur due to reduced habitat, roads, road traffic, aircraft traffic (overhead flights and take offs and landings), construction noise (including mining activity), drilling noise, and general human activity.

Project roads have a high potential to disturb TCH caribou. Under Alternative B, the gravel access road would bisect the fall migration corridor for a portion of the herd and would be located in an area heavily used by TCH caribou in some years, both summer and winter. According to Nuiqsut residents, roads pose both physical and visual barriers to caribou and it has been observed that changes in caribou distribution and behavior around roads results in decreased availability of caribou closer to the community. Additionally, when caribou are near roads and pads, the availability of these animals is diminished due to safety considerations as residents do not shoot toward infrastructure or areas of human activity.

Impacts related to roads, and roads collocated with pipelines, would extend beyond the Project area. Although caribou are highly mobile during mosquito and oestrid fly seasons, deflected movements and delays are more common where roads and pipelines are close to one another. Project development would result in a second set of pipelines alongside existing pipelines from the GMT-2 drill site to the Alpine development. Deflected movement and delays would also be more common when traffic rates reach and exceed 15 vehicles per hour. Project development would also increase road traffic along existing roads connecting the Project area to the existing GMT-1, CD5, and Alpine developments. These traffic rates would be more common during construction, but it is likely that caribou deflections would continue at a lower intensity during the operations phase.

The Alternative B access road would create a pinch point where it intersects with infield roads, which could deflect some caribou away from the road during the fall migration. What could be small changes in caribou distribution from a biological perspective could have large impacts on hunter success because hunters are generally limited in how far how fast they can travel, particularly during the snow-free season. Impacts on the availability of TCH caribou would most likely occur during the summer and fall months, when caribou hunting in overland areas and along the Colville River is highest. Deflections or delays of several hours could have substantial impacts to harvesting success for residents hunting east of the road corridor, and particularly to hunters waiting along river corridors.

The location of the proposed gravel mine site could be particularly disruptive to both caribou and hunters. The site is directly west of Nuiqsut in an area commonly reached by hunters traveling overland. Although blasting and excavation would occur during winter when caribou hunting levels are lower, Nuiqsut hunters do harvest caribou in the area in winter and the presence of the mine could deflect caribou movement year-round, resulting in localized distribution changes. The mine site would fill with water after construction and thus would no longer provide habitat for caribou; the mine site would remain as a pond(s) directly overlapping an overland hunting trail that heads west from Nuiqsut.

Air traffic could cause direct and indirect disturbance to caribou availability both within and outside of the Project area. In addition to helicopter traffic throughout the analysis area, the Project would include a new airport with large fixed-wing aircraft taking off and landing directly west of Ocean Point, a common hunting area along the Colville River. Increased air traffic associated with the Project would likely affect hunting activities along the Nigliq Channel and the Colville River, upriver towards Ocean Point and in overland areas west of Nuiqsut. The increase in overall regional air traffic associated with the Project would increase the frequency of disturbances experienced by hunters. This type of disturbance would most likely occur during summer and fall when caribou would migrate in an easterly direction through the Project area into areas heavily used by Nuiqsut hunters.

Project activities, particularly during construction, would reduce the availability of furbearers in the vicinity. The Project area has been reported as being used by 88% of wolverine harvesters and 87% of wolf harvesters. The highest overlapping use areas for wolf and wolverine occur around BT1, BT2, BT3, and BT5; low to moderate use occurs around BT4. Impacts to furbearers would be highest in winter when pile driving, mine site blasting and excavation, and ice road operations would occur. These activities would displace furbearers. Residents would likely use other areas where furbearers would be more available, but hunters would likely have to travel further with greater expense, effort, and risk, because the area west of the community is commonly used and easily accessible. While furbearers generally are not a food source for the community, furbearer hunting and trapping is a specialized activity with unique importance to Nuiqsut.

The BLM anticipates that altered distributions of the TCH caribou and furbearers would occur during construction and operation of the Project. As described above, this altered distribution could have large impacts to hunter success due to how far and fast hunters can travel and because there would be deflections or delays in caribou movement for residents to the east of the road corridor and along the Colville River, which is a high subsistence use area. BLM concludes that this would cause a major redistribution of resources that would affect the existing availability of these resources for Nuiqsut hunters.

2. Rationale for Finding of Limitations on Subsistence User Access Under Alternative B

A portion of traditional harvest areas would be inaccessible to residents during all Project phases, including land permanently overlain by infrastructure. Much of the Project area would be legally accessible, but infrastructure may act as a physical barrier or obstruction to harvester access. Subsistence users would be prohibited from discharging firearms within safety areas (1,000-foot radii surrounding oil and gas exploration, development, and transportation facilities other than roads) (CPAI 2019a, b). Security protocols prohibit shooting towards infrastructure, people, work crews, equipment, and pipelines. The presence of humans and infrastructure would affect subsistence harvesting patterns in and around the Project area due to safety concerns, rendering some areas unusable for subsistence purposes (the range common to hunting with rifles is 0.5 to 3 miles).

Ice roads used for gravel hauling would be off limits for any other use. These roads would only be present during winter construction, which is not a primary caribou hunting period. However, residents do traditionally harvest caribou in winter along overland areas on the west side of Nuiqsut, particularly in February and March, to supplement their diet.

Access to the gravel mine area may be restricted during the construction phase. The mine site would be a physical barrier to harvesters traveling overland either by snowmachine in winter or ATV in summer and fall. After construction, the mine site would be allowed to fill with water, and this would make the area inaccessible for overland travel in summer and fall.

Residents may use non-gravel haul ice roads and permanent gravel roads, once completed, to access subsistence areas. This facilitated access might provide a countervailing effect; however, use of roads declines with distance from the community. The use of Project roads may be lower than the use of roads closer to Nuiqsut (e.g., CD5, GMT-1) due to both the greater distance of Project roads from the community and the relatively high density of Project infield roads and drill sites. Industry road use is subject to standard safety rules, some of which would restrict use for some residents (e.g., no unaccompanied minors). During road construction, residents would not be able to use gravel roads and it may be difficult or impossible to cross them. Once road construction is completed, roads could be a physical impediment to overland travel; gravel roads may also prove to be difficult to gain access to or depart from to access subsistence use areas. Some Nuiqsut hunters have reported difficulty crossing existing gravel roads, even when using specifically constructed tundra/subsistence access ramps, particularly when hauling a heavy sled and in early spring when areas around roads and ramps thaw earlier than the surrounding tundra. Crossing ice roads may be restricted due to heavy traffic and other roads may have periods of overall restricted access.

The totality of limitations on subsistence access associated with the Project, particularly during the 7-year construction phase but lasting through the life of the Project, would constitute a substantial restriction on subsistence access for Nuiqsut residents.

None of these impacts is expected to affect all subsistence hunters equally and many of these impacts are uncertain: caribou movement is highly variable, caribou can habituate to disturbance, and harvesters adapt to resource availability. However, given the importance of caribou availability and access to traditional hunting areas to Nuiqsut hunters, the BLM expects that limitations to subsistence access and the reduced resource availability anticipated to occur over the 30-year Project life, directly and indirectly attributable to Project development, would result in an extensive interference with Nuiqsut hunter access.

BLM guidance on ANILCA implementation includes relevant direction to an evaluation of subsistence impacts for the Community of Nuiqsut:

> *"[T]he determination of significance must be made on a reasonable basis, since it must be decided in light of the total subsistence lands and resources that are available to individuals in surrounding areas living in a subsistence lifestyle."* BLM Instruction Memorandum No. AK-2011-008, Appendix 6.

Nuiqsut residents have experienced limited access to their traditional subsistence lands and resources in large areas to the east, north, and west due to previous oil and gas infrastructure development, and they currently face substantial increasing development in those areas. As a result, their subsistence use areas have shifted away from developed areas. These impacts affect the relative value of remaining undeveloped land, including land that would be overlain by Project infrastructure and lands adjacent to the Project where subsistence value would decrease to Project development.

3. Evaluation and Finding for Alternative C (Disconnected Infield Roads)

The footprint for Alternative C (Disconnected Infield Roads) is similar to that of Alternative B (Proponent's Project), except there would be no gravel road between the WPF and BT1/BT2/BT4, and therefore no road and bridge crossing Judy (Iqalliqpik) Creek. This alternative would eliminate the perpendicular intersection of the access and infield roads included under Alternative B. Alternative C would also locate the WPF, WOC, and primary Project airstrip (south airstrip) approximately 5 miles to the northeast, closer to the community of Nuiqsut but into areas of lower TCH density.

a. Evaluation of the Effect of Use, Occupancy, or Disposition on Subsistence Uses and Needs

The effects of Alternative C on subsistence would be similar to those described for Alternative B with two important differences:

1. Alternative C would reduce impacts to migrating caribou resulting from the elimination of the roadway "pinch point" between BT1 and the WPF and the relocation of the airstrip, WOC, and WPF into areas of lower TCH density.
2. Alternative C would increase the frequency and geographic extents of air traffic due to the need for additional air travel during the ice-free months and the addition of a second airstrip (north airstrip).

Overall, Alternative C would require slightly higher levels of fixed-wing aircraft and helicopter traffic, and slightly lower levels of ground traffic. The lack of a perpendicular road between the WPF and BT1 would decrease the potential for deflection of migrating caribou. The lack of access to the BT1/BT2/BT4 road corridor during the peak caribou hunting season would reduce ground traffic and hunting activity in that area, likely reducing deflection away from the access road and allowing caribou to move more freely along the Judy (Kayyaak) Creek drainage. Because the south airstrip, WOC, and WPF would be moved further east into areas of lower caribou density, impacts from air traffic may affect fewer caribou overall and could reduce deflection of caribou migrating toward the community's primary hunting area. However, moving the airstrip, WOC, and WPF closer to the community and core hunting areas may increase the frequency of disturbances to hunters related to aircraft takeoffs and landings, in addition to

increased human activity. The increase in air traffic would be likely be offset by decreased ground traffic between the WPF and BT4, and lack of gravel infrastructure and associated human activity between the WPF and BT1 during the peak caribou hunting season. The long-term differences in direct impacts between Alternatives B and C are considered minimal because both alternatives would involve similar overall amounts of air and ground traffic, and both would include a year-round access road to the west of the Nuiqsut's core caribou hunting grounds. However, impacts to caribou resource availability would likely be reduced under Alternative C.

b. Evaluation of the Availability of Other Lands for the Purpose Sought to be Achieved

The evaluation of the Willow MDP EIS Alternative C is identical to that provided above in Section B.2.b.

c. Evaluation of Other Alternatives that would Reduce or Eliminate the Use, Occupancy, or Disposition of Public Lands Needed for Subsistence Purposes

The evaluation of the Willow MDP EIS Alternative C is identical to that provided above in Section B.2.c.

d. Findings

1. **Reductions in the availability of subsistence resources described above for Alternative C may significantly restrict subsistence uses for the community of Nuiqsut.**
2. **Limitations on subsistence user access described above for Alternative C may significantly restrict subsistence uses for the community of Nuiqsut.**

Because these effects may reach the level of a significant restriction, a positive determination pursuant to ANILCA Section 810 is required at the draft stage and hearings must be held with subsistence users before final determinations (described in ANILCA Section 810(a)(2)) can be made.

This evaluation concludes that development of Willow MDP EIS Alternative C (Disconnected Infield Roads) is not expected to result in a large reduction in the abundance (population level) of caribou or any other subsistence resource. Neither is there any expectation that there will be a major increase in the harvest of caribou by non-subsistence users. Therefore, this draft finding of "may significantly restrict" is only triggered by two other primary factors that must be considered:

1. Reduction in the availability of resources caused by alteration of their distribution
2. Limitation of access by subsistence harvesters

The rationale for these findings and the determination of significance are summarized below.

1. Rationale for the Finding of Reductions in the Availability of Subsistence Resources Under Alternative C

The rationale for the finding of reduced availability of subsistence resources under Alternative C is similar to that for Alternative B with a few distinct differences. Under Alternative C, the location of the WPF is an area with lower caribou densities, thus impacts to caribou from WPF-related traffic, activity, and noise would be somewhat reduced. The lack of subsistence hunter road access to infield roads between BT1 and BT4 may allow caribou to habituate to linear infrastructure more readily and allow caribou to establish a pattern of movement through (gravel) roadless corridor along Judy (Iqalliqpik) Creek. Ground traffic rates on these infield roads would likely be reduced during summer. Although increased air traffic would likely offset this to some degree, the reduced ground traffic may allow caribou to habituate to linear infrastructure. Overall, impacts to the disturbance of caribou under Alternative C could be reduced compared to Alternative B because more caribou may move north of the GMT-2-WPF access road due to the roadless corridor along Judy (Iqalliqpik) Creek. Currently, the majority of caribou hunting occurs in the eastern portion of the Project area near the proposed gravel mine and access road. Once this area is disturbed, the area north of the access road may have more caribou; however, restrictions on shooting towards pipelines would limit the actual availability of caribou hunting in the area.

Overall, despite the potential for reduced disturbance to caribou under Alternative C, the BLM expects that altered distributions of TCH caribou and furbearers would occur during the Project's construction and operations phases. This altered distribution could have large impacts to hunter success due to how far and fast hunters can travel and because there would be deflections or delays in caribou movement for residents east of the road corridor and along the Colville River, which is a high subsistence use area. The BLM concludes that this would cause a major redistribution of resources that would affect the existing availability of these resources for Nuiqsut hunters.

2. Rationale for the Finding of Limitations on Subsistence User Access Under Alternative C

The rationale for the determination that interference with subsistence access would be extensive under Alternative C is identical to the rationale provided for under Alternative B (Section B.2.d.2) with the exception that under Alternative C, residents of Nuiqsut would not have all-season road access to the infield roads between BT1 and BT4.

4. Evaluation and Finding for Alternative D (Disconnected Access)

The footprint for Alternative D (Disconnected Access) is similar to that of Alternative B except there would be no gravel access road connection between the Project area and the GMT-2 and Alpine developments. Under this alternative, transportation to the Project area would be exclusively by aircraft for approximately 9 months of the year (May through January) and primarily via ice road for 3 months of the year (February through April). Gravel roads would connect the WPF, which would be colocated with BT3, to the other four drill sites and Project infrastructure. This alternative would reduce linear infrastructure on the landscape with the goal of reducing impacts to migrating caribou.

a. Evaluation of the Effect of Use, Occupancy, or Disposition on Subsistence Uses and Needs

The effects of Alternative D on subsistence would be like those described for Alternative B with one important difference: Alternative D would reduce impacts to migrating caribou resulting from the elimination of the gravel access road connecting the Project to the GMT-2 and Alpine developments. Overall, Alternative D would require higher levels of fixed-wing aircraft and helicopter traffic resulting from the lack of year-round road access to the Project. On average, the increase in air traffic would amount to one additional fixed-wing aircraft trip per day for the life of the Project (32 years) and one additional helicopter trip per week during the drilling and operations phases; these trips would be more concentrated during the 9 months when there would be no ice road access. The increase in air traffic could result in a greater frequency of air traffic disturbances to caribou, resulting in decreased harvest success for Nuiqsut hunters during individual hunting trips. The lack of a gravel access road running perpendicular to the fall migration route, in addition to the lack of ground traffic in that area throughout the summer and fall, would decrease the potential for deflection of caribou migrating through the Project area in the fall, or disturbance of caribou that occur in the area in the summer.

The lack of a year-round gravel access road under Alternative D means Nuiqsut residents would not have the benefit of access to the Project area via road for hunting. However, it is unclear how much residents would use the Project road system given its distance from the community and the somewhat higher concentration of drill sites; some evidence shows decreased use of roads with increased distance from the community or in more densely developed areas (Willow MDP EIS Section 3.16, *Subsistence and Sociocultural Systems*). Residents would still be able to use the road system to reach GMT-2 and hunt from those roads by ATV or snow machine.

Per the Willow MDP EIS, Alternative D may result in less impacts on caribou availability due to the lack of a year-round access road. While air traffic levels would be somewhat higher, air traffic generally causes localized disturbances whereas roads can cause larger effects on caribou movement and distribution. The increase in air traffic would not be enough to outweigh the benefits of reduced deflection of caribou as they migrate toward the Nuiqsut's core hunting grounds to the west of the community. Additionally, while the Project area would not be road-accessible year-round for Nuiqsut hunters, they would likely still continue to use existing roads and hunt in the area between GMT-2 and the Project area.

b. Evaluation of the Availability of Other Lands for the Purpose Sought to be Achieved

The evaluation of the Willow MDP EIS Alternative D is identical to that provided above in Section B.2.b.

c. Evaluation of Other Alternatives that would Reduce or Eliminate the Use, Occupancy, or Disposition of Public Lands Needed for Subsistence Purposes

The evaluation of the Willow MDP EIS Alternative D is identical to that provided above in Section B.2.c.

d. Findings

1. **Reductions in the availability of subsistence resources described above for Alternative D may significantly restrict subsistence uses for the community of Nuiqsut.**
2. **Limitations on subsistence user access described above for Alternative D may significantly restrict subsistence uses for the community of Nuiqsut.**

Because these effects may reach the level of a significant restriction, a positive determination pursuant to ANILCA Section 810 is required at the draft stage and hearings must be held with subsistence users before final determinations (described in ANILCA Section 810(a)(2)) can be made.

This evaluation concludes that development of Willow MDP EIS Alternative D (Disconnected Access) is not expected to result in a large reduction in the abundance (population level) of caribou or any other subsistence resource. Neither is there any expectation that there will be a major increase in the harvest of caribou by non-subsistence users. Therefore, this draft finding of "may significantly restrict" is only triggered by two other primary factors that must be considered:

1. Reduction in the availability of resources caused by alteration of their distribution
2. Limitation of access by subsistence harvesters

The rationale for these findings and the determination of significance are summarized below. The rationale for these findings is similar to those described above for Alternative B (Section B.2.d, *Findings*) with key differences summarized below.

1. Rationale for the Finding of Reductions in the Availability of Subsistence Resources Under Alternative D

Alternative D may result in fewer impacts on caribou availability than Alternative B due to the lack of a year-round gravel access road connecting the Project to existing development (e.g., GMT-2, Alpine), however, the BLM still anticipates a major redistribution of resources would occur under this alternative. The lack of a gravel-access road alignment being perpendicular to the fall caribou migration and the lack of ground traffic in that area throughout the summer and fall would decrease the potential for deflection of caribou migrating through the area. Higher levels of fixed-wing aircraft and helicopter traffic resulting from the lack of year-round access would overlap with peak caribou hunting months, which could result in a greater frequency of air traffic disturbances to caribou, resulting in decreased harvester success for Nuiqsut hunters during individual hunting trips. The increase in air traffic would likely not be enough to outweigh the benefits of reduced deflection of caribou as they migrate toward Nuiqsut's hunting grounds to the west of the community. While air-traffic volumes would be somewhat higher, air traffic generally causes localized disturbances whereas roads can cause larger effects on caribou movement and distribution.

Many benefits of reduced deflection from the lack of an access road would be offset by the aircraft traffic (including take offs and landings of large fixed-wing aircraft) in addition to the combined effects of a linear pipeline along the route between GMT-2 and the Project, parallel pipeline racks between GMT-2 and Alpine facilities, Project infield roads, drill sites, and the WPF, the location of and activity at the gravel mine site, and other disturbances described above for Alternative B.

2. Rationale for the Finding of Limitations on Subsistence User Access Under Alternative D

5. Evaluation and Finding for Module Delivery Option 1 (Proponent's Module Transfer Island)

Module Delivery Option 1 (Proponent's Module Transfer Island), would include construction of an MTI near Atigaru Point to support sealift module delivery to the Project. Module delivery by sealift barge to the MTI would occur over two summers; the modules would be stored on the MTI and then transported from the MTI to the WPF via an ice road. Gravel would be hauled from the Tiŋmiaqsiġvik mine site via ice road to the MTI site for construction. During construction, the MTI would house facilities such as an office, break room, and helipad; a temporary 100-person work camp would be located onshore near Atigaru Point. Construction facilities and supplies would be demobilized once construction was complete.

In the Willow MDP EIS, the BLM analyzed potential direct impacts on subsistence based on a 2.5-mile buffer of permanent and temporary infrastructure, including the MTIs and associated module transport and gravel haul ice roads, for each module delivery option (module delivery option analysis area). While the MTI-associated activities would occur solely during the construction phase of the Project, the MTIs themselves would remain after module transport was complete. Differences in impacts between the construction and operation phases are discussed qualitatively. The module delivery option analysis areas do not include all areas where development-related activity (e.g., vessel traffic) or impacts would occur. The analysis area allows for more detailed analysis of the area where subsistence users are most likely to experience direct impacts from the Project. Additional direct and indirect impacts that would occur outside the analysis area are also addressed.

a. Evaluation of the Effect of Use, Occupancy, or Disposition on Subsistence Uses and Needs

The analysis area for Module Delivery Option 1 (Figure 6) lies within areas heavily used by Nuiqsut residents for subsistence. Between 1995 and 2006, a substantial proportion of Nuiqsut harvesters reported using the analysis area for harvesting of caribou, wolverine, and wolf (over 80% of harvesters each); and goose (over 50% of harvesters). These resources are harvested primarily in overland areas crossed by ice roads, particularly where the gravel haul ice road crosses Fish (Uvlutuuq) Creek and terminates at the mine site (Figures 7 through 10). Between 2008 and 2016, the percentage of caribou harvesters using the analysis area for Option 1 ranged from 33% to 78%; caribou harvests within the area ranged from 4% to 15% of the total harvest during individual study years. Nuiqsut harvesters also use the offshore area in Harrison Bay surrounding the MTI for subsistence harvesting of bearded seal (30% of harvesters), ringed seal (22%), and eider (11%). Uses of the area directly to the east of the analysis area for these resources are higher (Figure 11). Twelve percent of Utqiaġvik harvesters reported using the alternatives analysis area, primarily for wolf and wolverine, during the 1997 to 2006 time period (Figure 12). While the bowhead whale hunt is a culturally important subsistence activity and provides a large portion of the Nuiqsut's annual subsistence harvest, the community's whale hunting activities occur a substantial distance east of the potentially affected area, near Cross Island. Thus, impacts to bowhead whale hunting associated with the Project are unlikely.

As discussed in Section B.2.a, both caribou and wolf and wolverine are key resources to the community of Nuiqsut, and the analysis area is heavily used by both caribou and furbearer hunters in Nuiqsut. Other resources of major cultural and/or material importance harvested within the Option 1 analysis area include white-fronted goose and bearded seal (Table E.16.9 in Willow MDP EIS Appendix E.16, *Subsistence Technical Appendix*). Thus, impacts to subsistence activities related to caribou, wolf, wolverine, goose, and seal are considered in the ANILCA Section 810 evaluation of Module Delivery Option 1. The analysis area for Option 1 is on the eastern periphery of Utqiaġvik subsistence use areas for wolf and wolverine but is directly east of the Teshekpuk Lake area, which is a key traditional use area for many Utqiaġvik residents and includes areas of moderate to high overlapping subsistence use. Moderate overlapping subsistence use also occurs to the southwest of the Project toward Ikpikpuk River, which is a key subsistence drainage for the community of Utqiaġvik (Willow MDP EIS Figure 3.16.4). Caribou are also harvested to the west of the Project; however, the analysis area is on the eastern periphery of the herd's range and is not expected to alter caribou migration routes to the extent that they would affect

Utqiaġvik harvesting activities to the west. Thus, the ANILCA Section 810 evaluation for Module Delivery Option 1 focuses on impacts to furbearer harvesting for Utqiaġvik. As discussed in Section B.2.a, furbearer hunting does not provide substantial amounts in terms of food but is a specialized and culturally important activity that contributes to the local economy.

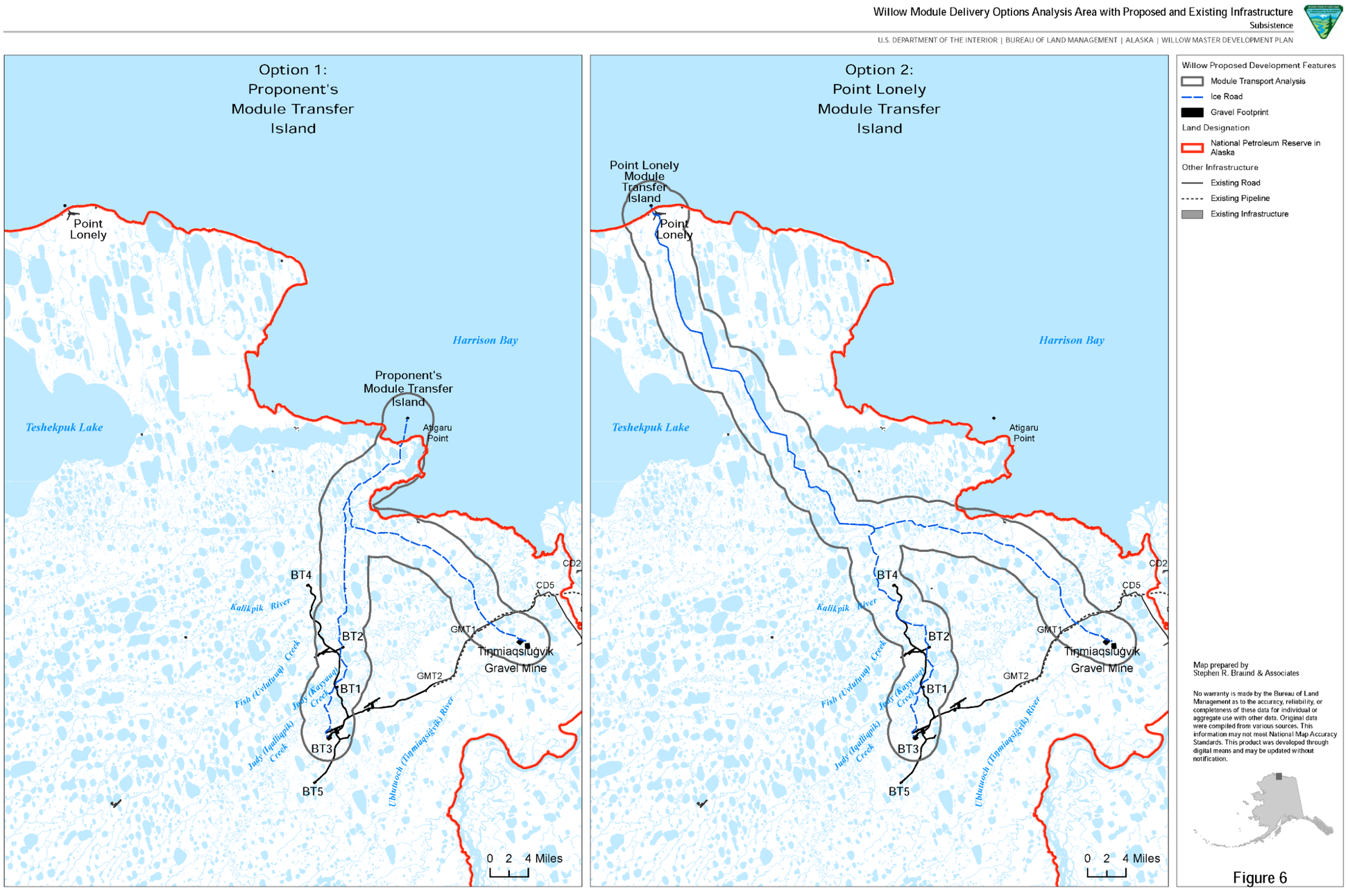

Figure 6. Willow Module Delivery Options Analysis Areas with Proposed and Existing Infrastructure

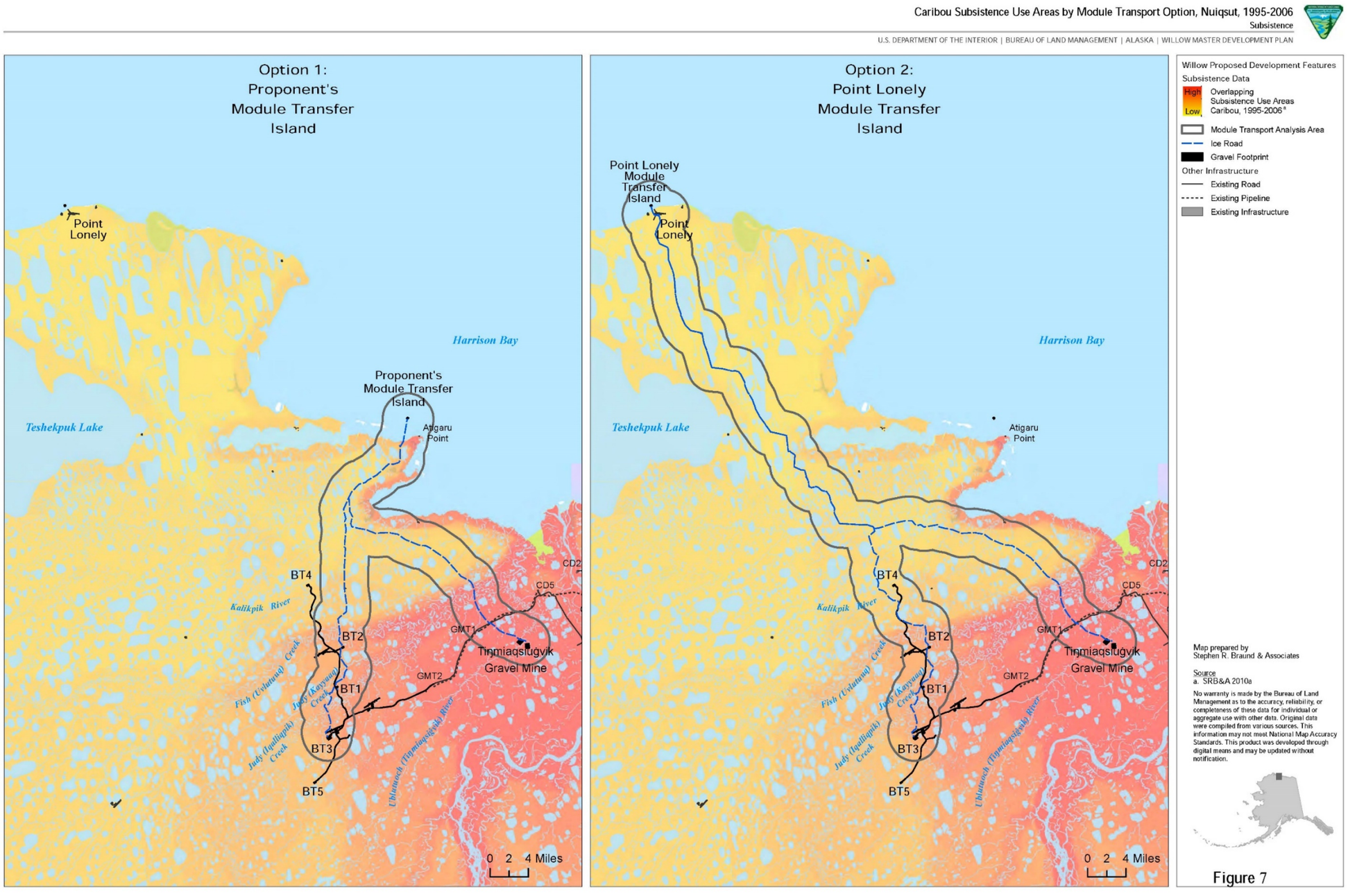

Figure 7. Willow Module Delivery Options Analysis Areas with Nuiqsut Caribou Subsistence Use Areas, 1995 to 2006

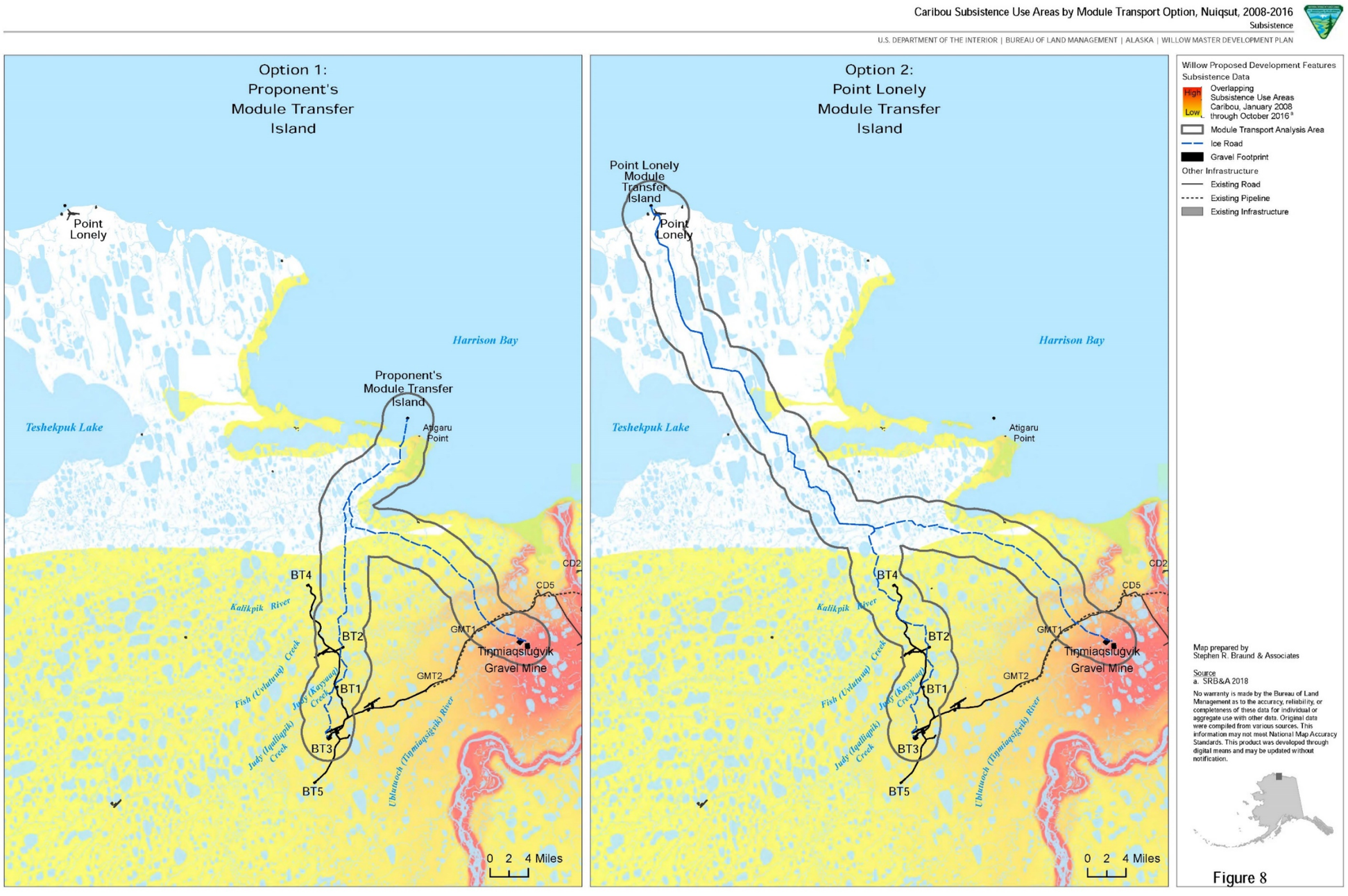

Figure 8. Willow Module Delivery Options Analysis Areas with Nuiqsut Caribou Subsistence Use Areas, 2008 to 2016

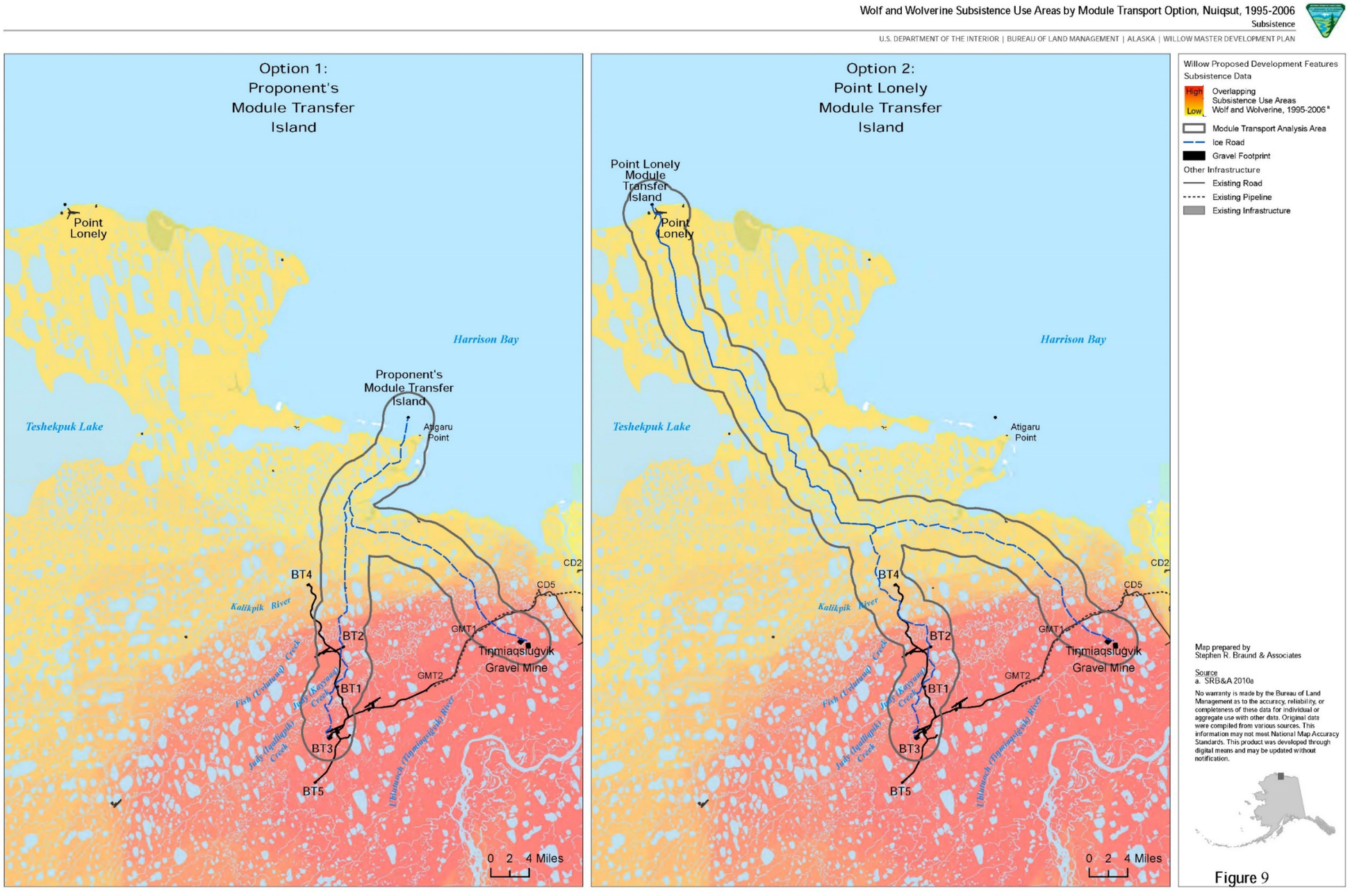

Figure 9. Willow Module Delivery Options Analysis Areas with Nuiqsut Wolf and Wolverine Subsistence Use Areas, 1995 and 2006

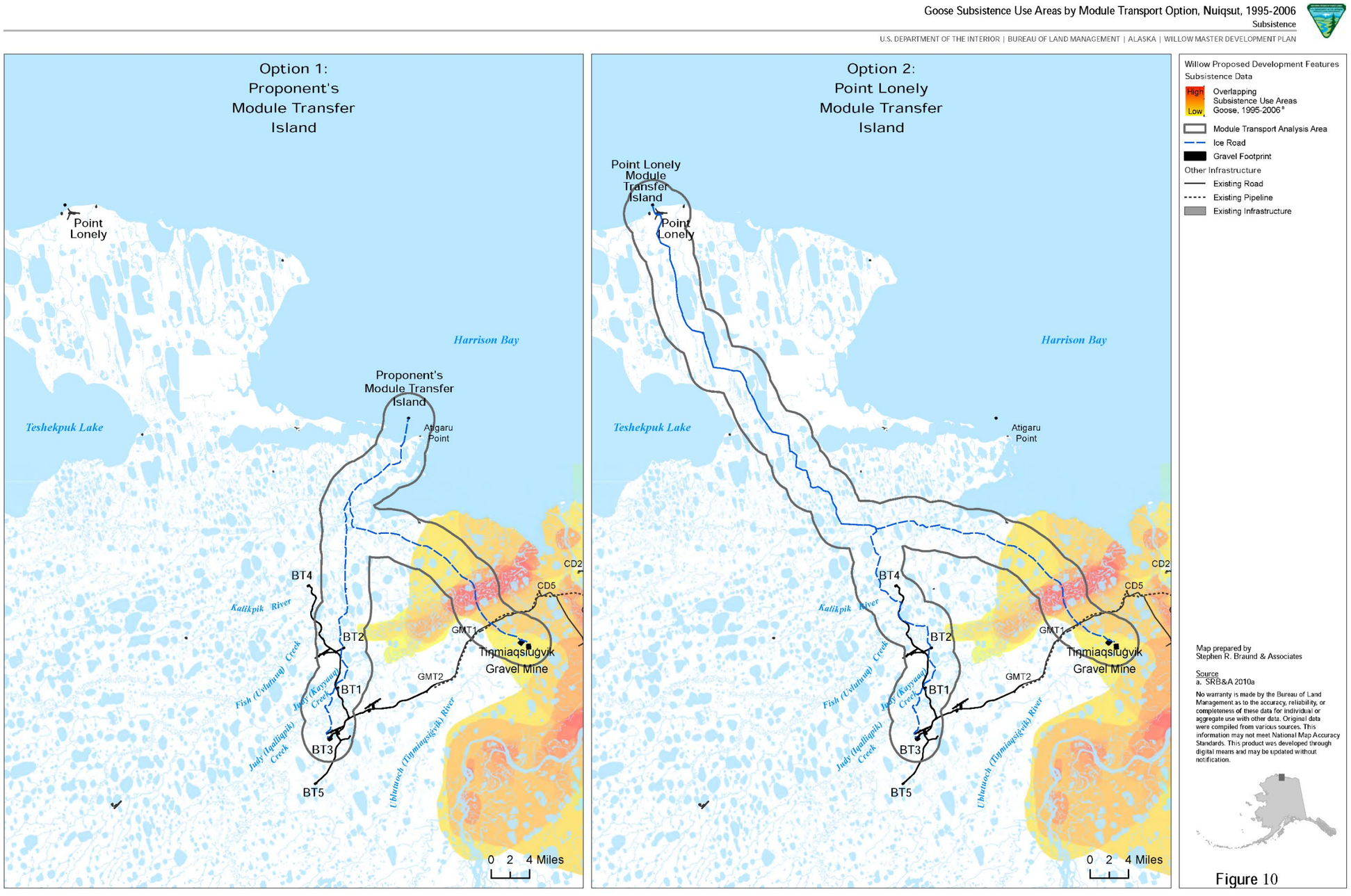

Figure 10. Willow Module Delivery Options Analysis Areas with Nuiqsut Goose Subsistence Use Areas, 1995 and 2006

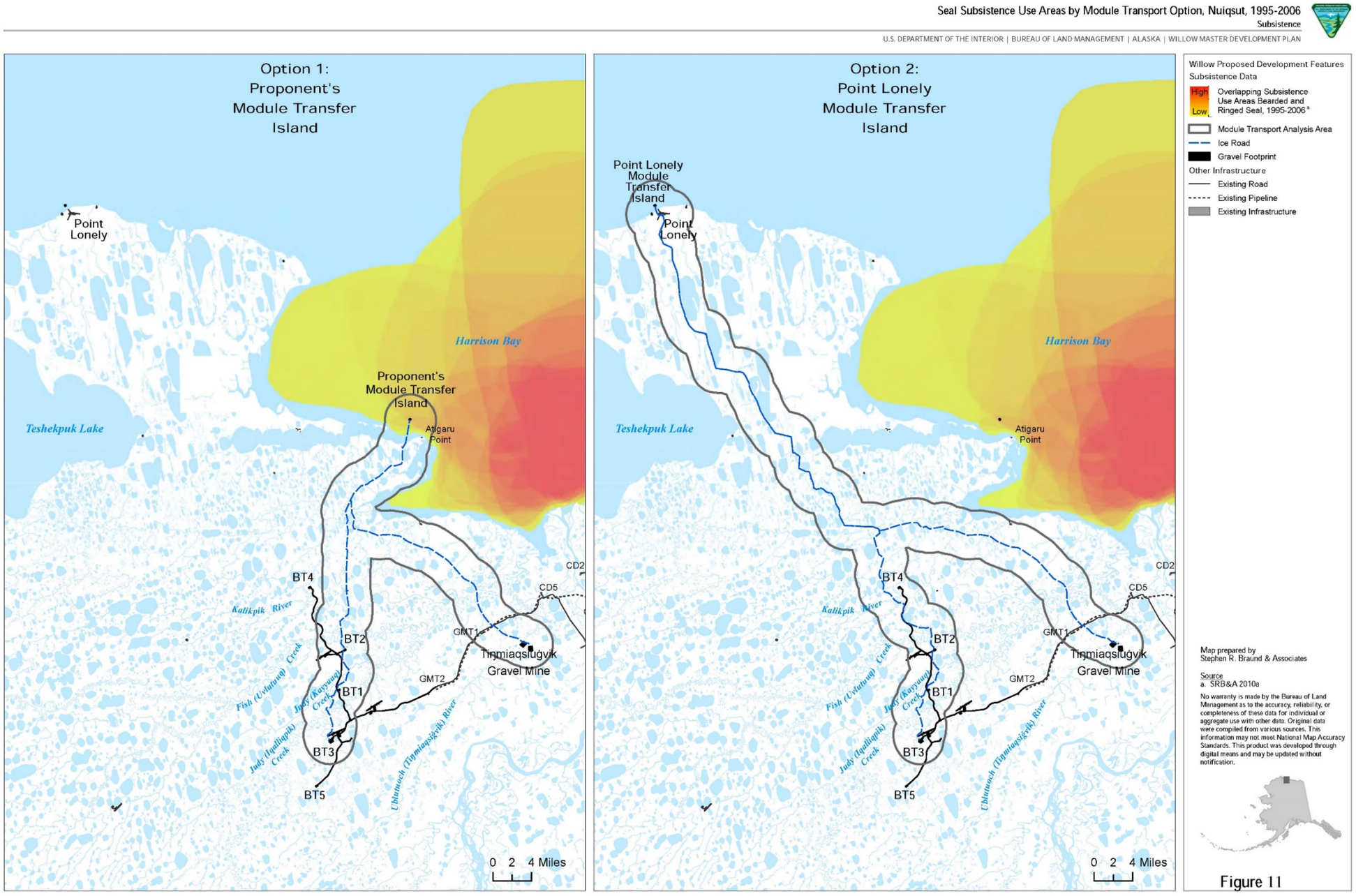

Figure 11. Willow Module Delivery Options Analysis Areas with Nuiqsut Seal Subsistence Use Areas, 1995 to 2006

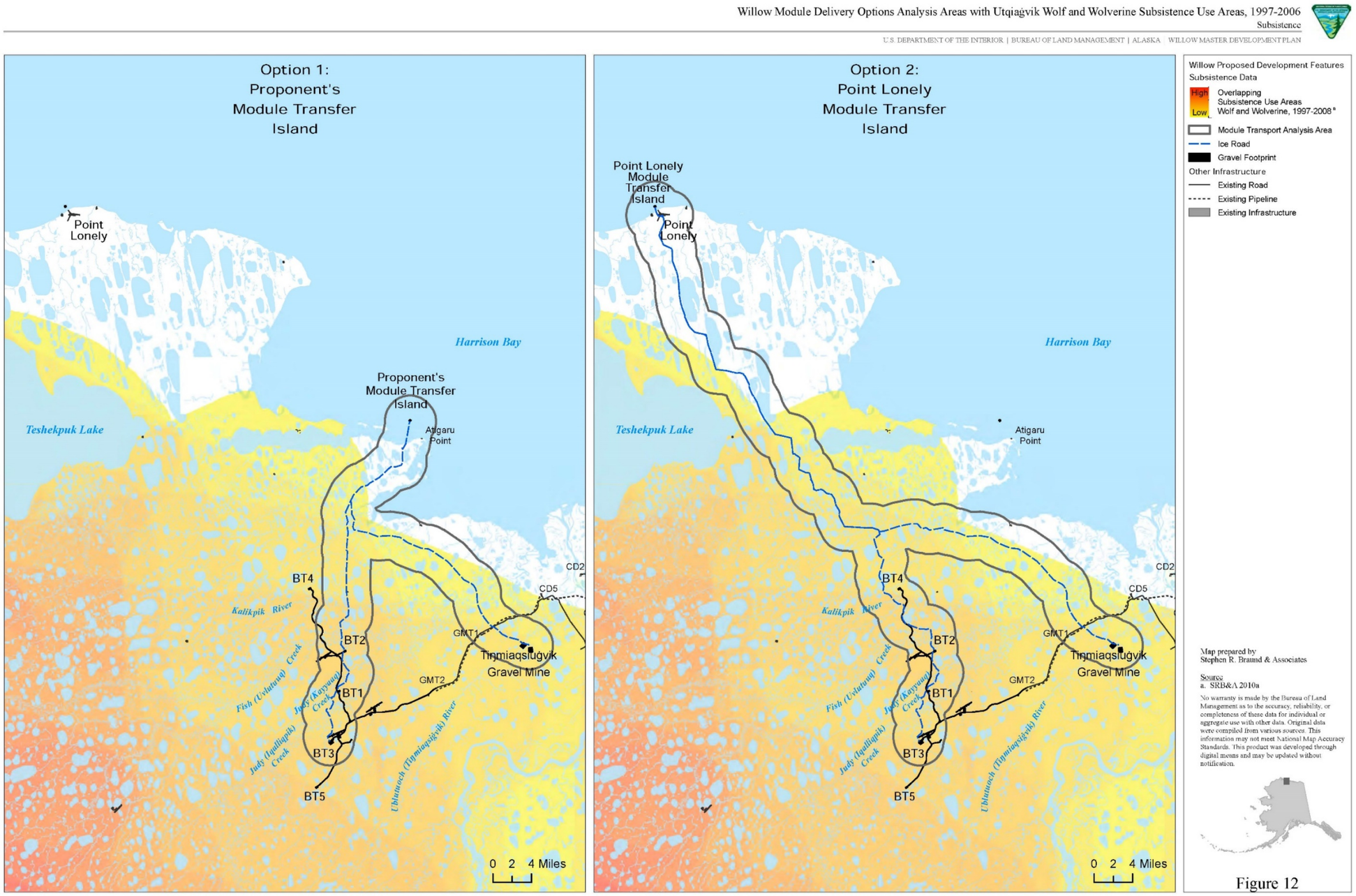

Figure 12. Willow Module Delivery Options Analysis Areas with Utqiaġvik Wolf and Wolverine Subsistence Use Areas, 1997 to 2006

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Subsistence Resource Abundance

While construction activities associated with the MTI, including ice roads, would result in the temporary removal or disturbance of habitat for some resources and could cause direct mortality to individual animals, these are not expected to have population level effects on subsistence resources. Terrestrial mammals, including caribou, generally do not use sea ice habitat and therefore would not be directly affected by the MTI. Ice roads associated with the MTI occur within the TCH range but would be in an area of relatively low calving density (Willow MDP EIS Section 3.12, *Terrestrial Mammals*). Traffic along ice roads, which would exceed 15 vehicles per hour during construction, could result in collisions and direct mortality of individual animals such as caribou. The area is not heavily used by caribou in winter and does not have a high density of wolf or wolverine; thus, the abundance of caribou, wolf, and wolverine available for subsistence use would not be impacted under Module Transportation Option 1.

While goose habitat occurs throughout the analysis area and could experience degradation or alteration, these changes are not expected to affect overall bird abundance. Individual mortalities could occur as a result of collisions with aircraft, vehicles, and infrastructure, but would not cause population-level effects (Willow MDP EIS Section 3.11, *Birds*). Construction of the MTI would result in the direct loss of 12 acres of habitat for seals but is not expected to cause population-level effects to seals (Willow MDP EIS Section 3.13, *Marine Mammals*). Fish, particularly broad whitefish, are harvested downstream from the proposed ice road crossing of Fish (Uvlutuuq) Creek. Nuiqsut residents generally do not harvest fish in Harrison Bay, but instead harvest them from river drainages. Water withdrawals for ice infrastructure could alter fish habitat but these alterations would be temporary and are not expected to affect fish populations in Fish (Uvlutuuq) Creek (Willow MDP EIS Section 3.10, *Fish*). A large oil spill could have larger population-level effects to resource abundance, but such a spill is not expected to occur in association with the MTI or associated barging or ice road traffic (Willow MDP EIS Sections 3.10, 3.11, and 3.13). Thus, the abundance of goose, seal, or fish available for subsistence use would not be impacted under Module Transportation Option 1.

Subsistence Resource Availability

A description of subsistence uses for Nuiqsut and Utqiaġvik is provided in Willow MDP EIS Section 3.16.1, *Affected Environment,* and in Willow MDP EIS Appendix E.16, *Subsistence Technical Appendix*. As noted above, use of the Option 1 analysis area for caribou hunting primarily occurs in the vicinity of ice roads—particularly gravel haul ice roads—associated with the MTI. The gravel haul ice road extending from the Tiŋmiaqsiġvik mine site to Fish (Uvlutuuq) Creek occurs in areas of high overlapping use for Nuiqsut caribou hunting. Hunting along Fish Creek occurs by boat in the summer months; however, overland travel during the winter and summer months also occurs in the area between the mine site and Fish Creek. Hunting along Fish Creek by boat in the summer continues to be an important subsistence activity but the frequency has decreased in recent years; reasons for the decrease in use include difficulty accessing the mouth of Fish Creek due to increasingly shallow waters in nearshore areas near the mouth of the creek, and the high costs associated with traveling to Fish Creek via Harrison Bay (SRB&A Forthcoming). The overland area toward Fish Creek remains a heavily used area by the community of Nuiqsut during the summer and fall caribou hunting season and is primarily accessed by ATV, although residents increasingly access the area by truck along the road system. When traveling by ATV, residents can generally travel as far west as the Ublutuoch (Tiŋmiaqsiuġvik) River; however, access to the road system also allows residents to haul ATVs and travel farther toward Fish (Uvlutuuq) Creek than previously possible. Residents also hunt in coastal areas of Harrison Bay during the summer, with Atigaru Point being an important traditional hunting area where residents target TCH caribou during the insect relief season. In recent years, use of this area has decreased as a result of increased sedimentation and shallow waters along the coast, in addition to a reported decrease in the availability of caribou in the area (Willow MDP EIS Section 3.16) (SRB&A 2018a).

Wolf and wolverine hunting within the Option 1 analysis area, particularly in the southern portions of the gravel haul and module transport ice roads, is similar to that described in Section B.2.a, *Evaluation of the Effects of Use, Occupancy, or Disposition on Subsistence Uses and Needs* (*Subsistence Resource*

Availability, Displacement of Furbearers), and occurs primarily in the winter months to the west, south, and southeast of the Nuiqsut. Hunting of wolf and wolverine is less common in the northern portion of the Option 1 analysis area (Figure 10). For Utqiaġvik, wolf and wolverine hunting occurs primarily around the module transport ice road but extends throughout the southern portion of the analysis area (Figure 12).

Goose hunting in the Option1 analysis area occurs most commonly in areas where the gravel haul ice road intersects with Fish (Uvlutuuq) Creek but also to the north and east of the Tiŋmiaqsiġvik gravel mine site. Most goose hunting along Fish Creek and in overland areas occurs by snow machine in the months of April and May (Willow MDP EIS Appendix E.16). Seal hunting by Nuiqsut residents occurs throughout Harrison Bay by boat, with moderate overlapping use offshore from Atigaru Point; high overlapping use occurs directly east of Atigaru Point in Harrison Bay. Seal hunting peaks in the months of July and August (Willow MDP EIS Appendix E.16).

Noise and traffic associated with the gravel haul and module transport ice roads, and the physical presence of the ice roads themselves, could affect the availability of caribou, wolf, wolverine, and goose for Nuiqsut harvesters, and the availability of wolf and wolverine for Utqiaġvik harvesters. Depending on annual conditions, ice roads may still be present in late April, when goose hunting along Fish (Uvlutuuq) Creek intensifies (Figure E.16.1 in Appendix E.16); thus, goose hunters could experience direct hunting impacts while the gravel haul ice road is operational. This would only occur during a single winter ice road season when gravel haul to the MTI would take place. See Section B.2.a, *Evaluation of the Effects of Use, Occupancy, or Disposition on Subsistence Uses and Needs* (*Subsistence Resource Availability*), for a discussion of how roads and associated road traffic may affect the availability of caribou, furbearers, and other resources. Because MTI gravel haul and module transport ice roads would not be present during the fall caribou migration, it is unlikely they would cause overall changes in caribou distribution or migration; however, caribou may be deflected from ice roads in winter during times of heavy road traffic, affecting resource availability for caribou harvesters. Peak ground traffic levels associated with the MTI would reach up to 8,900 trips daily and could have a high potential for disturbance. If ice roads are still in place and operational at the beginning of the waterfowl hunting season in mid-to-late April, residents may experience decreased harvesting success during this time for the single season during which the gravel haul ice road would be operational. Geese may be more easily disturbed or temporarily displaced due to traffic and noise, resulting in residents having greater difficulty hunting them.

Noise and human activity associated with construction of the MTI, which would occur during both the winter and summer seasons, could temporarily displace seals, periodically resulting in reduced harvest success for Nuiqsut seal hunters in the MTI area during the summer months. Vessel traffic between the MTI and Oliktok Point, which would occur throughout the open water season, may also cause temporary and periodic displacement of seals that could temporarily affect harvester success. The Project would require a total of six sealift barges over the course of two delivery seasons; support vessel traffic would be much higher (an estimated 224 support vessels over the course of three open-water seasons). The presence of the MTI could also affect the distribution of marine mammals within the immediate area of the island (Willow MDP EIS Section 3.13, *Marine Mammals*). However, noise and infrastructure related to MTI construction would not be likely to cause overall impacts to resource availability as most displacement would be temporary and localized; other suitable seal habitat would be available nearby, and residents would likely avoid areas where immediate disturbance is likely (e.g., around barges, support vessels, and the MTI during times of high activity) (Willow MDP EIS Section 3.13). Noise and human activity at the MTI may also affect the availability of caribou along the coast during the summer; however, as discussed above, use of the coastal area in Harrison Bay has been limited in recent years due to access difficulties. Between 2008 and 2016, the Coastal West area has accounted for between zero and 2% of the total harvest (SRB&A 2018a); thus, disruptions to caribou in this area would not likely affect overall resource availability for the Nuiqsut.

The Project would require additional fixed-wing aircraft and helicopter traffic to support Module Delivery Option 1. Most of this traffic would occur between Alpine and Willow. Potential impacts to resource

availability related to air traffic are discussed in Section B.2.a, *Evaluation of the Effects of Use, Occupancy, or Disposition on Subsistence Uses and Needs* (*Subsistence Resource Availability*).

Access to Subsistence Resources

Potential impacts to harvester access are discussed in Willow MDP EIS Section 3.16. Subsistence users would likely be prohibited from accessing the MTI area while it is under construction and operational, and the MTI would likely remain a gravel barrier island after decommissioning. Changes to coastal areas resulting from erosion and sedimentation around Atigaru Point is a key concern voiced by Nuiqsut residents who already have reported difficulty accessing nearshore areas in Harrison Bay in recent years. If construction of the MTI does contribute to the increasingly shallow waters in Harrison Bay, then it could further decrease access to coastal hunting areas. Long-term impacts to access would occur if construction of the MTI results in sedimentation or ocean floor changes that affect access to coastal and nearshore areas; however, the MTI is not expected to cause additional sedimentation or shoaling (Willow MDP EIS Section 3.16). Some individuals may use the MTI after it is decommissioned as a stopover point when hunting in Harrison Bay, similar to their use of other islands such as Thetis Island; however, it is unknown how accessible the island would be by boat.

Gravel haul and module transport ice roads associated with the MTI would prohibit local use. Thus, some Nuiqsut furbearer, caribou, and goose hunters traveling overland by snow machine would likely experience reduced access during the winter and spring months when crossing through areas with ice roads. The gravel haul ice road between the MTI and the Tiŋmiaqsiġvik gravel mine site would bisect high overlapping use areas for goose on Fish (Uvlutuuq) Creek. Thus, residents would likely experience reduced access to a portion of their goose hunting areas when ice roads continue to be operational in April. Impacts to access resulting from ice roads would only occur during the construction phase of the Project.

b. Evaluation of the Availability of Other Lands for the Purpose Sought to be Achieved

The evaluation of the Willow MDP EIS Module Delivery Option 1 is identical to that provided above in Section B.2.b.

c. Evaluation of Other Alternatives that would Reduce or Eliminate the Use, Occupancy, or Disposition of Public Lands Needed for Subsistence Purposes

The evaluation of the Willow MDP EIS Module Delivery Option 1 is identical to that provided above in Section B.2.c.

d. Findings

Module delivery Option 1 (Proponent's Module Transfer Island), in combination with any of the action alternatives (B, C, or D) would not result in any additional significant restriction on subsistence uses for communities in or near the Project area.

6. Evaluation and Finding for Module Delivery Option 2 (Point Lonely Module Transfer Island)

Module Delivery Option 2 (Point Lonely Module Transfer Island), would locate the MTI at Point Lonely, a substantial distance west of Atigaru Point. Option 2 would also include module transport and gravel haul ice roads, but they would extend from the Tiŋmiaqsiġvik gravel mine site and WPF to Point Lonely. This alternative would locate the MTI away from Harrison Bay, a key marine hunting area for Nuiqsut.

a. Evaluation of the Effect of Use, Occupancy, or Disposition on Subsistence Uses and Needs

The effects of Module Delivery Option 2 on subsistence would be like those described for Module Delivery Option 1 with two important differences:

1. Option 2 would reduce potential impacts to Nuiqsut marine subsistence uses for seal and coastal caribou hunting activities.

2. Option 2 would increase potential impacts to winter subsistence uses to Utqiaġvik furbearer harvesting and other activities around Teshekpuk Lake.

For Nuiqsut, impacts related to ice roads would be similar to those described for Option 1, as they would terminate in the same Project area locations (i.e., WPF, mine site), would cross Fish (Uvlutuuq) Creek in a similar area, and would affect similar subsistence uses.

The location of the MTI at Point Lonely would move potential marine impacts out of an area of moderate to high marine subsistence use for Nuiqsut into an area of low to limited use for both Nuiqsut and Utqiaġvik (Willow MDP EIS Section 3.16, *Subsistence and Sociocultural Systems*), thus reducing the likelihood of direct impacts on marine subsistence uses for either community. However, the gravel haul and module transport ice roads would extend farther west, along the east side of Teshekpuk Lake, and terminating to the north of Teshekpuk Lake at Point Lonely. Teshekpuk Lake is a traditional hunting ground for Nuiqsut and is still used by Nuiqsut hunters, particularly during the winter, and it is a key contemporary subsistence use area for many Utqiaġvik families and hunters year-round. While the two module delivery options would affect a similar percentage of Nuiqsut harvesters overall, Option 2 would affect a greater percentage of Utqiaġvik subsistence harvesters of wolf and wolverine (23%) and caribou (22%). The ice road would occur in areas of low to moderate overlapping use for wolf and wolverine for Utqiaġvik and could affect resource availability of furbearers for hunters in the vicinity of Teshekpuk Lake. However, these impacts would only occur for the length of ice road operations during MTI construction module hauling operations and would cause primarily indirect effects.

Overall, Option 2 would reduce direct impacts to Nuiqsut subsistence uses within Harrison Bay but would increase potential direct and indirect impacts to Utqiaġvik wolf and wolverine hunters. In both cases, the impacts would occur during the Project's construction phase. Direct impacts to key subsistence uses would be lower under Option 2 for Nuiqsut due to the decreased impacts to marine and coastal subsistence uses, with a slight increase in potential impacts to furbearer subsistence uses for Utqiaġvik.

b. Evaluation of the Availability of Other Lands for the Purpose Sought to be Achieved

The evaluation of the Willow MDP EIS Module Delivery Option 2 is identical to that provided above in Section B.2.b.

c. Evaluation of Other Alternatives that would Reduce or Eliminate the Use, Occupancy, or Disposition of Public Lands Needed for Subsistence Purposes

The evaluation of the Willow MDP EIS Module Delivery Option 2 is identical to that provided above in Section B.2.c.

d. Findings

Module delivery Option 2 (Point Lonely Module Transfer Island), in combination with any of the action alternatives (B, C, or D) would not result in any additional significant restriction of subsistence uses for communities in or near the Project area.

7. Evaluation and Finding for the Cumulative Case

Willow MDP EIS Section 3.19, *Cumulative Effects*, contains a description of the cumulative case, which evaluates the impacts of the proposed action in conjunction with past, present, and reasonably foreseeable future actions on subsistence. Reasonably foreseeable future actions considered in the cumulative analysis are provided in Willow MDP EIS Appendix E.19, *Cumulative Effects Technical Appendix*, and include oil and gas exploration, pipeline and oil field development, and transportation projects. The cumulative impacts of climate change on subsistence are considered as part of the future condition on the North Slope.

Reasonably foreseeable oil development that could contribute to cumulative impacts on subsistence for Nuiqsut, Utqiaġvik, and other North Slope communities include the Nanushuk Development, Nuna DS2, Liberty Development in the Beaufort Sea, and Alaska LNG or Alaska Stand Alone pipelines. In addition, the BLM is currently developing an oil and gas leasing program in the Arctic National Wildlife Refuge,

which could lead to oil and gas exploration and development in the 1002 (Coastal Plain) area. BLM is also revising the NPR-A integrated activity plan, which could affect oil and gas leasing and development in that area. Reasonably foreseeable transportation projects include the Colville River Access Road and the Arctic Strategic Transportation and Resources Project, which could lead to development of roads linking North Slope communities to each other and ultimately the Dalton Highway.

a. Evaluation of the Effect of Use, Occupancy, or Disposition on Subsistence Uses and Needs

Cumulative effects on subsistence would be similar if Alternatives B or C are selected in the ROD for the Project. If Alternative D is selected, cumulative effects would differ due to the lack of a year-round gravel access road. Construction of the Project without a year-round access road could substantially reduce displacement or deflection of TCH caribou but would result in somewhat higher disturbances related to air traffic and would not provide year-round subsistence access. Both module delivery options would not contribute substantially to the cumulative case as most associated activities would occur solely during construction. While Option 1 would have greater overall direct impacts to Nuiqsut marine and coastal subsistence uses, most of these impacts would cease after the construction phase ended.

Regardless of the alternative selected, cumulative oil and gas activity, transportation projects, and climate change will increasingly restrict subsistence uses and affect the availability of subsistence resources such as caribou. This analysis focuses in part on the impacts that would be associated with an access road to the Project (Alternatives B and C) and assumes access roads to any future development west or south of the Willow development. For the disconnected access road scenario (Alternative D), impacts from access roads as described below would not accumulate from development of the Project, though they may accumulate from other transportation projects in the region. Impacts related to air traffic would accumulate, to a greater degree, under Alternative D because of the slight increase in air traffic required to reach the Project area during the snow-free months.

Since 2000, oil and gas exploration and development has expanded into Nuiqsut's core subsistence use areas, including the CRD (Alpine drill sites CD1 through CD4) and to the north and west of the community toward Fish (Uvlutuuq) Creek (Alpine drill site CD5, GMT-1, and GMT-2). As a result, the frequency of conflicts between subsistence and development activities have increased (SRB&A Forthcoming). The Project, in addition to other reasonably foreseeable future activities such as the Nanushuk development, would contribute to the cumulative effects of development on subsistence resources and activities because it would represent a net increase in the amount of land used for oil and gas and other development, in addition to a related increase in industrial activity, including air traffic.

The Alpine CD5, GMT-1, and GMT-2 development projects are present or presently underway actions that are most closely connected to proposed development in the BTU. These developments were facilitated by previous developments, including Alpine CD5 (for GMT-1) and GMT-1 (for GMT-2). Alpine CD5 was the first major oil and gas development west of the CRD and is connected to Alpine via a bridge and road. Development of BT1 through BT5, particularly in the case of a year-round access road, would likely facilitate future development to the west and southwest of Nuiqsut. Development of these five drill sites, in combination with existing and future developments, would continue a pattern of development infrastructure surrounding the Nuiqsut to the north, west, and southwest of the community. Despite the greater distance from the community, many in Nuiqsut perceive that they are also surrounded to the east by infrastructure associated with the Prudhoe Bay and Kuparuk developments. These areas are now considered off-limits to subsistence uses despite being considered part of the community's traditional use area (SRB&A 2018b). Development of the Nanushuk project would introduce infrastructure directly to the east of the CRD and leave only the southerly direction untouched by oil and gas infrastructure. Despite the lack of infrastructure to the south, oil and gas exploration has occurred to the south of the community and may result in oil and gas development in the future. Finally, development of the BTU would introduce a major oil and gas development within Utqiaġvik's hunting area, although Project development would be located at the eastern edge of the subsistence use area for the community, within an area that provides a minimal amount of subsistence resources compared to land north and west of

Teshekpuk Lake. Development of the BTU could lead to additional future development in the BTU that is within the core harvesting areas for Utqiaġvik and Atqasuk, thus increasing the potential for impacts to subsistence users.

Development activities and infrastructure can change hunting patterns and use areas over time by introducing barriers, impediments, or restrictions to access; by facilitating access to lesser used hunting areas via roads; or by causing changes to the availability of subsistence resources in the vicinity of development. Nuiqsut's core subsistence use area has shifted west over time due to Prudhoe Bay development, and recent research has documented decreased use of traditional use areas, including the Nigliq Channel, in part due to development activities and infrastructure (SRB&A Forthcoming).

Decreased use areas in some development areas have occurred while road-accessible areas have seen increased use. The Kuukpik Spur Road was constructed in 2014 and 2015 to facilitate access for Nuiqsut hunters to the Alpine development's roads. The road has provided access to residents, and the road system has seen increased use in every year since its construction. Despite the increased use, caribou harvests within the road-connected area, as a percentage of the total reported harvest, have not seen a corresponding increase (Willow MDP EIS Section 3.16, *Subsistence and Sociocultural Systems*) (SRB&A Forthcoming). Some hunters indicate that their use of the road system offsets decreased harvests closer to the community, which they believe are a result of deflection from the road itself (SRB&A 2018a). Thus, facilitated access to hunting areas via roads is a countervailing effect that partially mitigates the impacts of roads and associated development on subsistence resource availability; this benefit is particularly prevalent for hunters who are less active, do not have access to other non-road modes of transportation (e.g., snow machines, ATVs), or have limited time to spend harvesting resources. Similar to the Spur Road, the proposed Colville River Access Road would provide increased access to the upriver hunting areas along the Colville River, which could also help to offset impacts resulting from increased development infrastructure to the north and west of the community. Current access to the main channel of the Colville River can be difficult due to shallow river channels. Construction of the Colville River Access Road would be particularly important if the community experiences reduced hunting success to the west of Nuiqsut or in the Nigliq Channel.

Increased development infrastructure on the North Slope would continue to cause alteration and degradation of habitats for key subsistence resources including caribou, furbearers, fish, and goose. Over time, these changes could affect the health and abundance of different subsistence resources on the North Slope. If development continues westward into the core calving area for the TCH, or if it reduces access to key insect relief habitats, then the herd could experience an overall decline in productivity and abundance. Impacts related to the health and abundance of the TCH could extend to other subsistence users of the herd including Atqasuk, Wainwright, and Point Lay. In addition to the additive effects of increasing oil and gas infrastructure in the region, increased activity, including oil and gas exploration and seismic activity, air traffic, vessel traffic, scientific research, recreation, and sport hunting and fishing activities, would also contribute to subsistence impacts on Nuiqsut and Utqiaġvik by increasing the frequency of noise and air traffic disturbances, vessel disturbances, and interactions with non-local researchers, workers, and recreationists. Increased noise disturbances would contribute to existing impacts on subsistence resource availability.

The cumulative effects of current and future activities related to restrictions on access to traditional areas, changes in hunting patterns, and reduced resource abundance and availability are likely to continue as long as oil and gas exploration and development continues on the North Slope.

b. Evaluation of the Availability of Other Lands for the Purpose Sought to be Achieved

The evaluation of the cumulative case is identical to that provided above in Section B.2.b.

c. Evaluation of Other Alternatives that would Reduce or Eliminate the Use, Occupancy, or Disposition of Public Lands Needed for Subsistence Purposes

The evaluation of the cumulative case is identical to that provided above in Section B.2.c.

d. Findings

1. Reductions in the availability of subsistence resources described above for the cumulative case may significantly restrict subsistence uses for the community of Nuiqsut.

2. Limitations on subsistence user access described above for the cumulative case may significantly restrict subsistence uses for the community of Nuiqsut.

Because these effects may reach the level of a significant restriction, a positive determination pursuant to ANILCA Section 810 is required at the draft stage and a hearing must be held with subsistence users before final determinations (described in ANILCA Section 810(a)(2)) can be made.

This evaluation concludes that the cumulative case is not expected to result in a large reduction in the abundance (population level) of caribou or any other subsistence resource. Neither is there any expectation that there will be a major increase in the harvest of caribou by non-subsistence users. Therefore, this draft finding of "may significantly restrict" is only triggered by two other primary factors that must be considered:

1. Reduction in the availability of resources caused by alteration of their distribution
2. Limitation of access by subsistence harvesters

1. The Rationale for the Findings of Reduction in the Availability of Subsistence Resources Under the Cumulative Case

The GMT-1, GMT-2, and Alpine CD5 development projects are present or are presently underway actions that are most closely connected to the proposed Project in the BTU. Development of the Project, in combination with existing and future developments, would continue a pattern of development infrastructure surrounding Nuiqsut to the north, west, and southwest of the community that alter the traditional distribution of caribou within the Nuiqsut core subsistence use area. Additionally, despite the greater distance from the community, many in Nuiqsut perceive that they are also surrounded to the east by infrastructure associated with the Prudhoe Bay and Kuparuk developments. These areas are now considered off limits to subsistence uses despite being considered part of the community's traditional use area.

The BLM concludes that altered distributions of TCH caribou and furbearers that are likely to occur during construction and operation of the Project, together with the existing GMT and Alpine developments, would cause a major redistribution of resources within the Nuiqsut core subsistence area that would affect these resources for Nuiqsut hunters.

2. The Rationale for Findings of Limitations on Subsistence User Access Under the Cumulative Case

Nuiqsut's core subsistence use area has shifted west over time due to the development in Prudhoe Bay and recent research has documented decreased use of traditional use areas, including the Nigliq Channel, in part due to development activities and infrastructure (SRB&A Forthcoming). This shift, together with impacts anticipated to occur from development of the Project (described under Alternatives B, C, and D), the BLM expects that limitations to subsistence access and the reduced resource availability attributable to development of the Project, would result in an extensive interference with Nuiqsut hunter access.

C. NOTICE AND HEARING

ANILCA Section 810(a) provides that no "withdrawal, reservation, lease, permit, or other use, occupancy or disposition of the public lands which would significantly restrict subsistence uses shall be effected" until the federal agency gives the required notice and holds a hearing in accordance with ANILCA Sections 810(a)(1) and (2). The BLM will provide notice in the *Federal Register* that it made positive findings pursuant to ANILCA Section 810 that Alternatives B, C, and D and the cumulative case presented in the Willow MDP Draft EIS, met the "may significantly restrict" threshold. As a result, a

public hearing will be held in the potentially affected community of Nuiqsut in order to solicit public comments from the potentially affected community and subsistence users. Notice of these hearings will be provided in the *Federal Register* and by way of the local media, including the Arctic Sounder newspaper, and KBRW, the local Utqiaġvik (Barrow) radio station with coverage to all villages on the North Slope. Meeting dates and times will also be posted on the BLM's website at www.blm.gov/alaska.

D. SUBSISTENCE DETERMINATIONS UNDER THE ANILCA SECTIONS 810(A)(3)(A), (B), AND (C)

ANILCA Section 810(a) provides that no "withdrawal, reservation, lease, permit, or other use, occupancy or disposition of the public lands which would significantly restrict subsistence uses shall be effected" until the federal agency makes the three determinations required by ANILCA Sections 810(a)(3)(A), (B), and (C). The three determinations that must be made are:

1. That such a significant restriction of subsistence use is necessary, consistent with sound management principles for the utilization of the public lands.
2. That the proposed activity will involve the minimal amount of public lands necessary to accomplish the purposes of such use, occupancy, or other such disposition.
3. That reasonable steps will be taken to minimize adverse impacts to subsistence uses and resources resulting from such actions.

These determinations will be provided in the Final ANILCA Section 810 Evaluation issued in conjunction with the Willow MDP Final EIS, using input from the subsistence hearing conducted in the potentially affected community.

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Appendix H
Spill Summary, Prevention, and Response Planning

August 2019

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List of Tables

List of Acronyms

ADEC	Alaska Department of Environmental Conservation
BLM	Bureau of Land Management
BMPs	best management practices
CPAI	ConocoPhillips Alaska, Inc.
EPA	U.S. Environmental Protection Agency
FLIR	forward-looking infrared
NPR-A	National Petroleum Reserve in Alaska
NSSRT	North Slope Spill Response Team
ODPCP	Oil Discharge Prevention and Contingency Plan
Project	Willow Master Development Plan Project
SPCC	Spill Prevention, Control, and Countermeasure
WOC	Willow Operations Center

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1.0 SPILL SUMMARY

Table H.1.1 summarizes drilling and operations spill types, spill volumes, spill likelihood, duration, and estimated geographic extent for the action alternatives.

Table H.1.1. Potential Spill Types, Spill Volumes, Likelihood, Duration, and Estimated Geographic Extent During the Drilling and Operations Phases for Action Alternatives

Type	Spill Event	Type of Spill	Very Small Oil Spill Classification (<10 gallons)[a]	Small Oil Spill Classification (10 to 99.9 gallons)[a]	Medium Oil Spill Classification (100 to 999.9 gallons)[a]	Medium-Large Oil Spill Classification (1,000 to 9,999.9 gallons)[a]	Large Oil Spill Classification (10,000 to 100,000 gallons)[a]	Very Large Oil Spill Classification (>100,000 gallons)[a]	Likely Duration of Spill	Likely Geographic Extent of Spill
Oil wells	Shallow gas blowout	Drilling fluids (no produced fluids)	VL	VL	VL	VL	VL	VL	1 to 2 days	No crude oil would be spilled, but drilling muds and other drilling fluids could impact an area up to 20 to 25 acres adjacent to the well pad.
Oil wells	Reservoir blowout	Produced fluids and drilling fluids	VL	VL	VL	VL	VL	VL	Few days to a week or two	Modeling results suggest that up to 10% of the discharged oil would remain airborne as an aerosol and 90% would be expected to reach the ground surface in a swath up to 2,953 feet wide and up to 22,310 feet downwind of the well based on typical prevailing wind patterns at the time of the spill. (Details are in Chapter 4.3, *Potential Spills During Drilling and Operations*.)
Oil wells	Wellhead and well-casing leaks	Produced fluids	L	L	L	VL	VL	VL	Few hours for very small spills to a few days for large spills	Spills would be expected to be contained within the immediate vicinity of the well itself and would not be expected to reach areas off the gravel pad.
Pipelines	Facility piping	Produced fluids and various refined products	VH	VH	H	M	L	VL	Very short (less than 1 hour) for very small spills to a few days for large spills	Spills would be expected to be contained to the gravel pad and its immediate margin.

Type	Spill Event	Type of Spill	Very Small Oil Spill Classification (<10 gallons)[a]	Small Oil Spill Classification (10 to 99.9 gallons)[a]	Medium Oil Spill Classification (100 to 999.9 gallons)[a]	Medium-Large Oil Spill Classification (1,000 to 9,999.9 gallons)[a]	Large Oil Spill Classification (10,000 to 100,000 gallons)[a]	Very Large Oil Spill Classification (>100,000 gallons)[a]	Likely Duration of Spill	Likely Geographic Extent of Spill
Pipelines	Infield flowlines	Multiphase produced fluids and produced water	L	L	L	VL	VL	VL	Very short (less than 4 hours) or could continue for days to weeks depending on the size and location of the leak along the flowline	Leaks could occur on gravel pads or on tundra and adjacent waterbodies between pads. Large spills that go undetected for a period of time could spread to an area a few acres in size before the spill is stopped. The area reached by materials from large spills would be influenced by the location and time of year of the spill. If a large spill were to occur in the vicinity of a river or during the spring when water flows are high, the geographic extent of such a spill could be larger.
Pipelines	Process piping	Processed (sales-quality) oil	VH	VH	H	M	L	VL	Very short (less than 1 hour) for very small spills to a few days for large spills before the leak is repaired	Process piping associated with well manifolds and processing at the WPF would be expected to be contained to the gravel pad or its immediate margin, with very little reaching adjacent areas. The area reached by large spills would be influenced by the location and time of year the spill occurred.
Pipelines	Export pipeline	Processed (sales-quality) oil and make-up water (seawater)	VL	VL	VL	VL	VL	VL	Very short (less than 1 hour) or could continue for days to weeks before being detected depending on the size and location of the leak along the pipeline corridor	Leaks could occur on the WPF gravel pad or at the tie-in gravel pad at Alpine CD4N, or on tundra and adjacent waterbodies between pads. Very small spills would be expected to be limited to a small area in the immediate vicinity of the spill; however, larger spills that go undetected for a period of time could extend to an area several acres in size before being stopped. The spill's location and the time of year also influence the extent of the spill. For instance, if a large or very large spill were to occur in the vicinity of a river, the geographic extent of such a spill of this nature could be much higher.

Type	Spill Event	Type of Spill	Very Small Oil Spill Classification (<10 gallons)[a]	Small Oil Spill Classification (10 to 99.9 gallons)[a]	Medium Oil Spill Classification (100 to 999.9 gallons)[a]	Medium-Large Oil Spill Classification (1,000 to 9,999.9 gallons)[a]	Large Oil Spill Classification (10,000 to 100,000 gallons)[a]	Very Large Oil Spill Classification (>100,000 gallons)[a]	Likely Duration of Spill	Likely Geographic Extent of Spill
Aboveground storage tanks	Large aboveground storage tanks	Various refined products and processed (sales-quality) oil	L	L	L	L	VL	VL	Would likely be noticed within a day of the start of the leak, but securing the leak could take a few days depending on where the leak occurred on the tank	Spilled material would be captured within secondary containment. In the unlikely event that a spill escaped the secondary containment, it is expected that the spill would be contained to the pad itself and would not reach the tundra, adjacent waterbodies, or other sensitive habitats.
Spills not specifically associated with petroleum development infrastructure	Spills warehouse activities; storage facilities; equipment maintenance and repair activities; vehicle accidents; and vehicle and equipment refueling activities	Typically a variety of refined products	VH	VH	H	L	VL	VL	On-pad spills would be observed and responded to quickly, be of short duration (less than 0.5 day). Spills from vehicle accidents would happen at the time of the accident and last less than an hour.	Spills would remain on the pad or within secondary containment; damage to areas adjacent to pads would not be anticipated. If a spill occurred from a large bulk-fuel tanker truck accident and the tanker volume was released, the geographic extent would likely include the road and adjacent roadside habitats and possibly waterbodies. The geographic extent of a spill of this size would vary depending location of the accident and the season in which it occurred; however, the spill would be localized and likely affect an area up to 0.5 acre in size.

Note: VH (very high); H (high); M (medium); L (low); VL (very low); WPF (Willow processing facility)
[a] Oil spill size classifications denote the likelihood of a spill or release occurring.

2.0 SPILL PREVENTION AND RESPONSE PLANNING

As described in the Willow MDP EIS, Chapter 4.0, *Spill Risk Assessment*, ConocoPhillips Alaska, Inc. (CPAI) would implement numerous spill prevention and response planning measures as part of the Willow Master Development Plan Project (Project) to help prevent spills and minimize damage to human health and the environment in the unlikely event they occur. Spill prevention measures include the following:

- Specific design features to detect and contain leaks
- Adherence to best management practices (BMPs)
- Systems to notify operators of potential leaks
- Procedures to maintain the pipelines and other infrastructure

Response planning measures include the following:

- Developing numerous response planning documents for a variety of spill scenarios
- Providing necessary equipment to prevent and respond to spills
- Ensuring personnel are trained and knowledgeable about the procedures to efficiently and effectively respond to oil spills and other accidental releases

The Project's facilities would be designed to mitigate spills. In addition, CPAI would implement a pipeline maintenance and inspection program and an employee spill prevention training program to further reduce the likelihood of spills. CPAI's design of production facilities would include provisions for secondary containment for hydrocarbon-based and hazardous materials storage, as required by state and federal regulations. If a spill occurs on a gravel or ice pad, the fluid would remain on the pad unless the spill is near the pad edge or exceeds the retention capacity of the pad. Fuel transfers near pad edges would be limited as much as possible to mitigate this risk. The Project would also be managed under the existing BMPs and lease stipulations for the National Petroleum Reserve in Alaska (NPR-A) (BLM 2013) for solid waste, fuel, and chemical storage.

2.1 Spill Prevention

Spill prevention and response measures that would be used during all Project phases would be outlined in the Project's Oil Discharge Prevention and Contingency Plan (ODPCP) and Spill Prevention, Control, and Countermeasure (SPCC) Plan, which is required by the U.S. Environmental Protection Agency (EPA). The intent of the ODPCP and SPCC Plan is to demonstrate CPAI's capability to prevent oil spills from entering the water and land and ensure a rapid response in the event a spill occurs. The ODPCP would comply with applicable State of Alaska requirements for spill prevention in AS 46.04.030 and 18 AAC 75 and federal regulations outlined in 40 CFR 112(d) (Facility Response Plans). The SPCC Plan would comply with requirements outlined in 40 CFR 112.

CPAI would design and construct pipelines to comply with applicable state, federal, and local regulations. They would also construct the Project's pipelines using high-strength steel and with wall thicknesses that comply with or exceed regulatory requirements. Welds would be validated using nondestructive examination (e.g., radiographic, ultrasonic) during pipeline construction to ensure their integrity, and pipelines would be hydrostatically tested (i.e., tested with pressurized water) prior to operation. The production fluids, water injection, seawater, and export pipelines would fully accommodate pigs for cleaning and corrosion inspection operations.

To prevent a pipeline leak under the Colville River, diesel and seawater pipelines would be installed inside a high-strength casing pipe. Simultaneous failure of both pipelines and the casing pipe would be a very low likelihood event. If diesel fuel or seawater leaked from the pipelines, it would be captured between the outer wall of the pipelines and the inner wall of the high-strength casing pipe rather than reach the subsurface river environment. This design is comparable to secondary containment provided as a spill prevention technique for aboveground storage tanks; the casing is designed to accommodate the external loads that would normally be carried by the individual pipelines. The casing and carrier pipe do not distribute loads between each other due to the spacer design included, which means a deformation of

the casing pipe would not cause deformation of the pipelines carrying diesel fuel or seawater, effectively providing double integrity against external loads. To prevent external corrosion, the casing and pipelines would be protected by a mechanically tough coating in accordance with industry standards. The pipe and casing pipe would meet leak detection standards stipulated in 18 AAC 75.047 and 18 AAC 75.055.

There is an increased potential for pipeline spills where pipelines cross under roads from corrosion of the underground portion of the pipe. Pipeline design and monitoring would decrease the likelihood of corrosion occurring. CPAI would maintain corrosion control and inspection programs that include ultrasonic inspection, radiographic inspection, coupon monitoring, metal loss detection pigs and geometry pigs (applicable to pig-capable pipelines), and forward-looking infrared (FLIR) technology. The inspection programs are American Petroleum Institute Standard 570–based programs that focus inspection efforts on areas with the greatest potential for spills.

2.2 Spill Response

CPAI would implement the Project's ODPCP and the SPCC Plan to minimize accidental oil spills and impacts. Through the ODPCP, CPAI would demonstrate that readily accessible inventories of fit-for-purpose oil spill response equipment and personnel would be available for use at Project facilities. In addition, a state-registered primary response action contractor would serve as CPAI's primary response action contractor and would provide trained personnel to manage all stages of a spill response, including containment, recovery, and cleanup.

Quickly intercepting, containing, and recovering spilled oil near waterway-pipeline crossing points would minimize the threat to rivers and streams. Gravel roads would be used for access and spill response staging, where applicable.

Spill response equipment would be pre-staged at strategic locations across the Project area to reduce the time it would take personnel to respond to a spill and expedite the rapid deployment of equipment as outlined in the ODPCP. A pre-deployed containment boom may also be placed within selected stream channels to mitigate a spill, should one occur. During summer, spill containment equipment would likely be staged or deployed using helicopters. In the event a spill occurs, spill response could include the use of watercraft (e.g., airboats, jetboats) to access affected areas.

2.3 Spill Response Training and Inspections

CPAI provides regular training for its employees and contractors on the importance of preventing oil or hazardous materials spills, such as new-employee orientation, regular safety meetings, annual environmental training seminars, and appropriate certification classes for specific issues. In addition, the CPAI Incident Management Team conducts spill response drills in coordination with federal, state, and local agencies.

Employees are encouraged to participate in the North Slope Spill Response Team (NSSRT) and as part of the NSSRT, members receive regularly scheduled spill response training to ensure the continuous availability of skilled spill responders on the North Slope.

Based on information contained in CPAI's ODPCP for its Alpine Development (CPAI 2018), CPAI would be required to conduct visual examinations of pipelines and facility piping at least monthly during operations using aerial overflights as necessary and FLIR technology when required. FLIR technology, employed with aircraft or from the ground using handheld systems (e.g. drones), allows identification of leaks and spills based on the temperature "signature" resulting from warm fluid leaks. FLIR technology can detect warm fluid leaks in low light conditions or when other circumstances such as light fog or drifted snow limit visibility. FLIR can also identify trouble spots along pipelines, such as damaged insulation, before a problem occurs. CPAI would also conduct regular visual inspections of facilities and pipelines from gravel roads (where available) and ice roads, and with aircraft for pipeline segments not paralleled by gravel roads (Alternatives C [Disconnected Infield Roads] and D [Disconnected Access]).

2.4 Fuel and Chemical Storage

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

Drill sites would have temporary tanks to support drilling activity, including brine tanks, a cuttings and mud tank, and a drill rig diesel fuel tank built into the drill rig structure. Production and operations storage tanks at drill sites would include chemical storage tanks that may contain any of the following depending on Project needs: corrosion inhibitor, methanol, scale inhibitor, emulsion breaker, antifoam, or ultra-low-sulfur diesel. Portable oil storage tanks to support well and pad operational activities and maintenance (i.e., well work and well testing) may be present on an as-needed basis.

Fuel and oil storage would comply with local, state, and federal oil pollution prevention requirements, according to an ODPCP and SPCC Plan. Secondary containment for fuel and oil storage tanks would be sized as appropriate to container type and according to the requirements in 18 AAC 75 and 40 CFR 112. Fuel and chemical storage associated with the Project would be managed under Bureau of Land Management (BLM) lease stipulations and BMPs (Section 2.5 of this appendix, *Compliance with Bureau of Land Management Lease Stipulations and Best Management Practices*).

2.5 Compliance with Bureau of Land Management Lease Stipulations and Best Management Practices

CPAI would comply with applicable lease stipulations related to fuels and hazardous materials handling and storage, spill prevention, and spill response as outlined in BLM (2013). Key existing BMPs include the following:

- A-3: Minimize pollution through effective hazardous-materials contingency planning. This BMP requires that a hazardous materials emergency contingency plan shall be prepared and implemented before the transportation, storage, or use of fuel or hazardous substances occurs in the NPR-A. The plan must include a set of procedures to ensure the prompt response, notification, and cleanup in the event of a hazardous substance spill or threat of release.
- A-4: Minimize the impact of contaminants on fish, wildlife, and the environment, including wetlands, marshes, and marine waters, because of fuel, crude oil, and other liquid chemical spills; protect subsistence resources, subsistence activities, and public health and safety. This BMP requires lessees/permittees to develop a comprehensive SPCC spill plan (per 40 CFR 112) before initiating any oil and gas or related activity or operation, including field research/surveys or seismic operations. The plan must account for the following: sufficient on-site clean-up material availability; fuel storage container requirements; liner materials; permanent fueling stations; proper identification of fuel containers; notification of reportable spills; and identification of oil pans (i.e., “duck ponds”).
- A-5: Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment. This BMP prohibits the refueling of equipment within 500 feet of the active floodplain of any waterbody and provides for conditions which warrant exceptions.
- A-7: Minimize the impacts to the environment from the disposal of fluids recovered during the development phase on fish, wildlife, and the environment. This BMP prohibits the discharge of produced water in upland areas and marine waters.

3.0 REFERENCES

BLM. 2013. *National Petroleum Reserve-Alaska Integrated Activity Plan/Environmental Impact Statement Record of Decision*. Anchorage, AK.

CPAI. 2018. *Oil Discharge Prevention and Contingency Plan—Alpine Field and Satellites and Alpine Pipeline System. Adec Plan No.17-Cp-4140.*

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Appendix I
Avoidance, Minimization, and Mitigation Technical Appendix

August 2019

Appendix I.1
Avoidance, Minimization, and Mitigation

Appendix I.2
ConocoPhillips Road Optimization Memorandum

Appendix I.3
Dust Control Plan (Placeholder for FEIS)

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Appendix I.1
Avoidance, Minimization, and Mitigation

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List of Acronyms

BLM	Bureau of Land Management
BMP	best management practice
EIS	Environmental Impact Statement
IAP	Integrated Activity Plan
LS	lease stipulation
MDP	Master Development Plan
NPR-A	National Petroleum Reserve in Alaska
Project	Willow Master Development Plan Project
ROD	Record of Decision

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1.0 MITIGATION

1.1 Existing Lease Stipulations and Best Management Practices

The 2013 National Petroleum Reserve in Alaska (NPR-A) Integrated Activity Plan (IAP)/Environmental Impact Statement (EIS) Record of Decision (ROD) established performance-based lease stipulations (LSs) and best management practices (BMPs) that apply to oil and gas activities within the NPR-A. Table I.1.1 summarizes the current lease stipulations and BMPs (BLM 2013, Appendix A). The BMPs are organized to address the following topics:

A. Waste prevention, handling, disposal, spills, air quality, and public health and safety
B. Water use for permitted activities
C. Winter overland moves and seismic work
D. Oil and gas exploratory drilling
E. Facility design and construction
F. Use of aircraft for permitted activities
G. Oil field abandonment
H. Subsistence consultation for permitted activities
I. Orientation programs associated with permitted activities
J. Endangered Species Act Section 7 consultation process
K. Additional protections that apply in select biologically sensitive areas
L. Summer vehicle tundra access
M. General wildlife and habitat protection

Table I.1.1. Summary of Lease Stipulations and Best Management Practices for Activity in the National Petroleum Reserve in Alaska

LS or BMP	Intent of LS or BMP	Action Required
BMP A-1	Protect the health and safety of the general public by disposing of solid waste and garbage in accordance with applicable federal, state, and local law and regulations.	Areas of operation shall be left clean of all debris.
BMP A-2	Minimize impacts on the environment from non-hazardous and hazardous waste generation. Encourage continuous environmental improvement. Protect the health and safety of oil field workers and the general public. Avoid human-caused changes in predator populations.	Prepare and implement a comprehensive waste management plan for all phases of exploration and development.
BMP A-3	Minimize pollution through effective hazardous-materials contingency planning.	A hazardous materials emergency contingency plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances.
BMP A-4	Minimize the impact of contaminants on fish, wildlife, and the environment, including wetlands, marshes and marine waters, as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and subsistence activities. Protect public health and safety.	Develop a comprehensive spill prevention and response contingency plan.
BMP A-5	Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment.	Refueling of equipment within 500 feet of the active floodplain of any water body is prohibited. Fuel storage stations shall be located at least 500 feet from any waterbody.
BMP A-7	Minimize the impacts to the environment of disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment.	Discharge of produced water in upland areas and marine waters is prohibited.
BMP A-8	Minimize conflicts resulting from interaction between humans and bears during oil and gas activities.	Prepare and implement bear-interaction plans to minimize conflicts between bears and humans.
BMP A-9	Reduce air quality impacts.	All oil and gas operations (vehicles and equipment) that burn diesel fuels must use “ultra-low sulfur” diesel.

LS or BMP	Intent of LS or BMP	Action Required
BMP A-10	Prevent unnecessary or undue degradation of the lands and protect health.	Air monitoring, emissions inventory, emissions reduction plan, air quality modeling, and possibly mitigation measures.
BMP A-11	Ensure that permitted activities do not create human health risks through contamination of subsistence foods.	Design and implement a monitoring study of contaminants in locally used subsistence foods.
BMP A-12	To minimize negative health impacts associated with oil spills.	Consider immediate health impacts, long-term monitoring for contamination, monitoring of human health, health promotion activities.
BMP B-1	Maintain populations of, and adequate habitat for fish and invertebrates.	Withdrawal of unfrozen water from rivers and streams during winter is prohibited.
BMP B-2	Maintain natural hydrologic regimes in soils surrounding lakes and ponds, and maintain populations of, and adequate habitat for, fish, invertebrates, and waterfowl.	Withdrawal of unfrozen water from lakes and the removal of ice aggregate from grounded areas less than 4-feet deep may be authorized on a site-specific basis depending on water volume and depth and the waterbody's fish community.
BMP C-1	Protect grizzly bear, polar bear, and marine mammal denning and/or birthing locations.	Cross-country use of heavy equipment is prohibited within one-half mile of occupied grizzly bear dens. Cross-country use of heavy equipment is prohibited within 1 mile of known or observed polar bear dens or seal birthing lairs.
BMP C-2	Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.	Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect tundra. Low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. Bulldozing of tundra mat and vegetation, trails, or seismic lines is prohibited. To reduce the possibility of ruts, vehicles shall avoid using the same trails for multiple trips. The location of ice roads shall be designed and located to minimize compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation.
BMP C-3	Maintain natural spring runoff patterns and fish passage, avoid flooding, prevent streambed sedimentation and scour, protect water quality, and protect stream banks.	Crossing of waterway courses shall be made using a low-angle approach.
BMP C-4	Avoid additional freeze-down of deep-water pools harboring over-wintering fish and invertebrates used by fish.	Travel up and down streambeds is prohibited unless demonstrated that there will be no additional impacts to over-wintering fish or the invertebrates they rely on.
BMP C-5	Minimize the effects of high-intensity acoustic energy from seismic surveys on fish.	Follow recommendations, standard marine mitigation measures, and Alaska Department of Fish and Game requirements.
LS D-1	Protect fish-bearing rivers, streams, and lakes from blowouts and minimize alteration of riparian habitat.	Exploratory drilling is prohibited in rivers and streams, as determined by the active floodplain, and fish-bearing lakes.
LS D-2	Minimize surface impacts from exploratory drilling.	Construction of permanent or gravel oil and gas facilities shall be prohibited for exploratory drilling. Use of a previously constructed road or pad may be permitted if it is environmentally preferred.
BMP E-1	Protect subsistence use and access to subsistence hunting and fishing areas and minimize the impact of oil and gas activities on air, land, water, fish, and wildlife resources.	All roads must be designed, constructed, maintained, and operated to create minimal environmental impacts and to protect subsistence use and access to subsistence hunting and fishing areas.
LS E-2	Protect fish-bearing water bodies, water quality, and aquatic habitats.	Permanent facilities, including roads, airstrips, and pipelines, are prohibited upon or within 500 feet as measured from the ordinary high-water mark of fish-bearing waterbodies.
LS E-3	Maintain free passage of marine and anadromous fish and protect subsistence use and access to subsistence hunting and fishing.	Causeways and docks are prohibited in river mouths or deltas. Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas.
BMP E-4	Minimize the potential for pipeline leaks, the resulting environmental damage, and industrial accidents.	All pipelines shall be designed, constructed, and operated under an authorized officer-approved Quality Assurance/Quality Control plan.
BMP E-5	Minimize impacts of the development footprint.	Facilities shall be designed and located to minimize the development footprint.

LS or BMP	Intent of LS or BMP	Action Required
BMP E-6	Reduce the potential for ice-jam flooding, impacts to wetlands and floodplains, erosion, alteration of natural drainage patterns, and restriction of fish passage.	Stream and marsh crossings shall be designed and constructed to ensure free passage of fish, reduce erosion, maintain natural drainage, and minimize adverse effects to natural stream flow.
BMP E-7	Minimize disruption of caribou movement and subsistence use.	Pipelines and roads shall be designed to allow the free movement of caribou and the safe, unimpeded passage of the public while participating in subsistence activities.
BMP E-8	Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.	Gravel mine site design and reclamation will be in accordance with a plan approved by the authorized officer and in consultation with appropriate federal, state, and North Slope Borough regulatory and resource agencies.
BMP E-9	Avoidance of human-caused increases in populations of predators of ground-nesting birds.	Utilize best available technology to prevent facilities from providing nesting, denning, or shelter sites for ravens, raptors, and foxes. Feeding of wildlife is prohibited.
BMP E-10	Prevention of migrating waterfowl, including species listed under the Endangered Species Act, from striking oil and gas and related facilities during low light conditions.	Illumination of all structures shall be designed to direct artificial exterior lighting inward and downward, rather than upward and outward.
BMP E-11	Minimize the take of species, particularly those listed under the Endangered Species Act and BLM Special Status Species, from direct or indirect interaction with oil and gas facilities.	Aerial surveys for species will be conducted prior to construction.
BMP E-12	Use ecological mapping as a tool to assess wildlife habitat before development of permanent facilities to conserve important habitat types during development.	An ecological land classification map of the development area shall be developed before approval of facility construction.
BMP E-13	Protect cultural and paleontological resources.	Conduct a cultural and paleontological resources survey prior to any ground-disturbing activity.
BMP E-14	Ensure the passage of fish at stream crossings.	To ensure that crossings provide for fish passage, all proposed crossing designs shall collect at least 3 years of hydrologic and fish data.
BMP E-15	Prevent or minimize the loss of nesting habitat for cliff-nesting raptors.	Removal of greater than 100 cubic yards of bedrock outcrops, sand, or gravel from cliffs shall be prohibited. Any extraction of sand or gravel from an active river or stream channel shall be prohibited unless a hydrological study indicates no potential impact to integrity of the river bluffs.
BMP E-16	Prevent or minimize the loss of raptors due to electrocution by power lines.	Comply with the most up-to-date industry-accepted suggested practices for raptor protection on power lines.
BMP E-17	Manage permitted activities to meet Visual Resource Management class objectives.	Submit a plan to best minimize visual impacts, consistent with the Visual Resource Management Class for the lands on which facilities would be located. A photo simulation of the proposed facilities may be a necessary element of the plan.
BMP E-18	Avoid and reduce temporary impacts to productivity from disturbance near Steller's or spectacled eider nests.	Activity within 200 meters of occupied nest will be restricted to existing pads and roads from June 1 to August 15; construction is prohibited within 200 meters of occupied nests.
BMP E-19	Provide information to be used in monitoring and assessing wildlife movements during and after construction.	A representation, in the form of ArcGIS-compatible shape-files, of all new infrastructure construction, shall be provided to the authorized officer.

LS or BMP	Intent of LS or BMP	Action Required
BMP F-1	Minimize the effects of low-flying aircraft on wildlife, subsistence activities, and local communities.	Ensure that aircraft used for permitted activities maintain altitudes specified in guidelines. Aircraft shall maintain an altitude of at least 1,500 feet above ground level when within ½ mile of cliffs identified as raptor nesting sites from April 15 through August 15 and an altitude of at least 1,500 feet above ground level when within ½ mile of known gyrfalcon nest sites from March 15 to August 15. Aircraft shall maintain an altitude of at least 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1. Caribou wintering areas will be defined annually by the authorized officer Submit an aircraft use plan that addresses strategies to minimize impacts to subsistence hunting and associated activities, including but not limited to the number of flights, type of aircraft, and flight altitudes and routes, and shall also include a plan to monitor flights. Adjustments, including possible suspension of all flights, may be required by the authorized officer if resulting disturbance is determined to be unacceptable. The number of takeoffs and landings to support oil and gas operations with necessary materials and supplies should be limited to the maximum extent possible. During the design of proposed oil and gas facilities, larger landing strips and storage areas should be considered to allow larger aircraft to be employed, resulting in fewer flights to the facility. Use of aircraft, especially rotary wing aircraft, near known subsistence camps and cabins or during sensitive subsistence hunting periods (spring goose hunting and fall caribou and moose hunting) should be kept to a minimum. Aircraft shall maintain an altitude of at least 2,000 feet above ground level (except for takeoffs and landings) over the Teshekpuk Lake Caribou Habitat Area from May 20 through August 20. Aircraft use (including fixed wing and helicopter) in the Goose Molting Area should be minimized from May 20 through August 20. Hazing of wildlife by aircraft is prohibited. Pursuit of running wildlife is hazing. If wildlife begins to run as an aircraft approaches, the aircraft is too close and must break away. Fixed wing aircraft along the coast shall maintain minimum altitude of 2,000 feet when within a ½ mile of walrus haulouts. Helicopters used along the coast shall maintain minimum altitude of 3,000 feet and a 1-mile buffer from walrus haulouts. Aircraft used along the coast and shore fast ice zone shall maintain minimum altitude of 3,000 feet when within 1 mile from aggregations of seals.
LS G-1	Ensure long-term reclamation of land to its previous condition and use.	Prior to final abandonment, land used for oil and gas infrastructure shall be reclaimed to ensure eventual restoration of ecosystem function.
BMP H-1	Provide opportunities for participation in planning and decision making to prevent unreasonable conflicts between subsistence uses and other activities.	Consult with affected communities per guidelines.
BMP H-2	Prevent unreasonable conflicts between subsistence activities and geophysical (seismic) exploration.	Follow consultation guidelines from H-1, notify search and rescue organizations, notify all potentially affected subsistence-use cabin and campsite users.

LS or BMP	Intent of LS or BMP	Action Required
BMP H-3	Minimize impacts to sport hunting and trapping species and to subsistence harvest of those animals.	Hunting and trapping by lessee's/permittee's employees, agents, and contractors are prohibited when persons are on "work status."
BMP I-1	Minimize cultural and resource conflicts.	All personnel involved in oil and gas and related activities shall be provided information concerning applicable stipulations, BMPs, standards, and specific types of environmental, social, traditional, and cultural concerns that relate to the region and attend an orientation once a year.
LS/BMP K-1	(Rivers) Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas; the loss of spawning, rearing or over-wintering habitat for fish; the loss of cultural and paleontological resources; the loss of raptor habitat; impacts to subsistence cabins and campsites; the disruption of subsistence activities; and impacts to scenic and other resource values.	Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines are prohibited in stream beds and adjacent to rivers listed. Rivers in the Project area that are listed include Colville River (2-mile setback), Fish (Uvlutuuq) Creek (3-mile setback), Judy (Iqalliqpik) Creek (0.5-mile setback), and Ublutuoch (Tiŋmiaqsiuġvik) River (0.5-mile setback).
LS/BMP K-2	(Deep Water Lakes) Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of deepwater lakes; the loss of spawning, rearing or over wintering habitat for fish; the loss of cultural and paleontological resources; impacts to subsistence cabins and campsites; and the disruption of subsistence activities.	Permanent oil and gas facilities are prohibited on the lake or lakebed and within one-quarter mile of the ordinary high-water mark of any deep lake (i.e., depth greater than 13 feet).
BMP K-4a	(Goose Molting Area) Minimize disturbance to molting geese and loss of goose molting habitat in and around lakes in the Goose Molting Area.	Within the Goose Molting Area, no permanent oil and gas facilities, except for pipelines, will be allowed within 1 mile of the shoreline of goose molting lakes.
BMP K-4b	(Brant Survey Area) Minimize the loss or alteration of habitat for, or disturbance of, nesting and brood rearing brant in the Brant Survey Area. None of the area is available for oil and gas leasing or exploratory drilling.	Conduct aerial surveys; development may be prohibited within a half-mile of identified nesting colonies.
BMP K-5	(Teshekpuk Lake Caribou Habitat Area) Minimize disturbance and hindrance of caribou, or alteration of caribou movements through portions the Teshekpuk Lake Caribou Habitat Area that are essential for all season use, including calving and rearing, insect-relief, and migration.	Design and implement and report a study of caribou movement, avoidance design, travel restrictions.
LS/BMP K-6	(Coastal Area) Protect coastal waters and their value as fish and wildlife habitat (including, but not limited to, that for waterfowl, shorebirds, and marine mammals), minimize hindrance or alteration of caribou movement within caribou coastal insect-relief areas; protect the summer and winter shoreline habitat for polar bears, and the summer shoreline habitat for walrus and seals; prevent loss of important bird habitat and alteration or disturbance of shoreline marshes; and prevent impacts to subsistence resources and activities.	Facilities prohibited in coastal waters designated; vessels will maintain 1-mile buffer from aggregation of hauled out seals and half-mile buffer from walruses.
LS/BMP K-7	(Colville River Special Area) Prevent or minimize loss of raptor foraging habitat.	Locate permanent facilities as far from raptor nests as feasible.
BMP K-9	(Teshekpuk Lake Caribou Movement Corridor) Minimize disturbance and hindrance of caribou, or alteration of caribou movements (that are essential for all season use, including calving and rearing, insect-relief, and migration) in the area extending from the eastern shore of Teshekpuk Lake eastward to the Kogru River.	Within the Caribou Movement Corridors, no permanent oil and gas facilities, except for pipelines. Prior to the permitting of permanent oil and gas infrastructure, a workshop will be convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources.
BMP K-10	(Southern Caribou Calving Area) Minimize disturbance and hindrance of caribou, or alteration of caribou movements (that are essential for all season use, including calving and post calving, and insect-relief), in the area south/southeast of Teshekpuk Lake.	Within the Caribou Movement Corridors, no permanent oil and gas facilities, except for pipelines and offshore infrastructure. Prior to the permitting of permanent oil and gas infrastructure, a workshop will be convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources.

LS or BMP	Intent of LS or BMP	Action Required
BMP L-1	Protect stream banks and water quality; minimize compaction and displacement of soils; minimize the breakage, abrasion, compaction, or displacement of vegetation; protect cultural and paleontological resources; maintain populations of, and adequate habitat for birds, fish, and caribou and other terrestrial mammals; and minimize impacts to subsistence activities.	BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during times other than those identified in BMP C-2.
BMP M-1	Minimize disturbance and hindrance of wildlife, or alteration of wildlife movements through the NPR-A.	Chasing wildlife with ground vehicles is prohibited. Particular attention will be given to avoid disturbing caribou.
BMP M-2	Prevent the introduction, or spread, of nonnative, invasive plant species in the NPR-A.	Certify that all equipment and vehicles are weed-free prior to transporting them into the NPR-A. Monitor annually for invasive species, and submit a plan detailing methods for cleaning, monitoring, and weed control.
BMP M-3	Minimize loss of populations of, and habitat for, plant species designated as Sensitive by the BLM in Alaska.	Conduct surveys at appropriate times of the summer season and in appropriate habitats for the Sensitive Plant Species.
BMP M-4	Minimize loss of individuals of, and habitat for, mammalian species designated as Sensitive by the BLM in Alaska.	If development is proposed in an area that provides potential habitat for the Alaska tiny shrew, the proponent would conduct surveys at appropriate times of the year and in appropriate habitats in an effort to detect the presence of the shrew.

Source: BLM 2013
Note: BLM (Bureau of Land Management); BMP (best management practice); LS (lease stipulation); NPR-A (National Petroleum Reserve in Alaska)

1.2 Design Features to Avoid and Minimize Impacts

The Proponent has incorporated measures to avoid and minimize impacts into their Project design. These are listed in Table I.1.2; the measures are part of the Project and were used to evaluate the impacts described in the Willow MDP EIS, Chapter 3.0, *Affected Environment and Environmental Consequences*. The Proponent may propose additional measures in subsequent permitting phases.

Table I.1.2. Design Features to Avoid and Minimize Impacts

No.	Measure	Project Component or Activity	LS, BMP, or Other Stipulation[a]	Primary Affected Resource or Subject
1	Use horizontal directional drilling to reduce the overall gravel footprint for drill site pads.	Gravel infrastructure	BMP E-5 AOGCC	All
2	Construct road surfaces to the minimum width required for Project operations to minimize the placement of gravel fill: 32-feet-wide access and infield roads 24-feet-wide water source access road 18-feet-wide airstrip lighting and secondary access roads	Gravel infrastructure	BMP E-5; ADNR DMLW	All
3	Use 20-foot well spacing (instead of 30-foot well spacing) to reduce the overall gravel footprint for drill site pads.	Gravel infrastructure	BMP E-5; AOGCC; ADNR DMLW	Wetlands and vegetation
4	Share use of existing equipment and facilities (e.g., camps, seawater treatment plant, warehouses, maintenance shops, emergency response equipment) to reduce the overall Project gravel- and ice-pad footprint.	Gravel infrastructure	BMP E-5; ADEC	Water resources; wetlands and vegetation
5	Use an ice road to access the Tiŋmiaqsiuġvik mine site (instead of a gravel road) to reduce the Project's overall gravel footprint.	Gravel infrastructure, mine site	ADNR DMLW	Wetlands and vegetation
6	Use 2:1 side slopes (i.e., gravel road and pad embankment slopes) to reduce the Project's overall gravel footprint.	Gravel infrastructure	BMP E-5	Wetlands and vegetation
7	Locate drill site BT4 (and associated roads and pipelines) outside of the Teshekpuk Lake Caribou Habitat area which would reduce the overall gravel footprint.	Gravel infrastructure, pipelines	BMP K-5; ADNR DMLW; ADEC; AOGCC	Wetlands and vegetation; terrestrial mammals
8	Avoid permanently flooded wetlands by locating Project infrastructure on higher, and relatively drier areas, when practicable.	Gravel infrastructure	None	Wetlands and vegetation; water resources
9	Suspend communications and power cables from horizontal support members to avoid additional fill associated with utility poles and to reduce the potential for bird strikes and perches for predators.	Utilities	BMP E-11	Wetlands and vegetation; birds
10	Use ice roads and pads, including multi-season ice pads, for Project access, pipeline construction, camps, and temporary storage of mine site overburden to reduce the Project's overall gravel footprint.	Construction activity	BMP E-5; ADEC; ADNR DMLW	All
11	Design pipelines to minimize redundant parallel pipelines to the extent practicable. (For example, infield pipelines from drill site BT4 would connect to drill site BT2 infield pipelines at BT2; the drill site BT2 infield pipelines would then tie into drill site BT1 pipelines at BT1; and then drill site BT1 infield pipelines would connect with the WPF. Additionally, the Willow export pipeline would tie into the existing Alpine Sales oil pipeline at the Alpine CD4N tie-in pad to connect the Project to the Trans-Alaskan Pipeline System.)	Pipelines	BMP E-7; AOGCC; ADEC	Wetlands and vegetation; birds; terrestrial mammals; spill risk
12	Colocate the WPF with drill site BT3 to eliminate the need for an additional gravel pad and associated gravel fill.	Gravel infrastructure	BMP E-5; AOGCC	Wetlands and vegetation
13	Construct oil and gas facilities and other Project infrastructure more than 500 feet from fish-bearing waterbodies, to the maximum extent practicable. Only essential pipeline road crossings are proposed for the Project that would encroach on this minimum distance. Construction camps would not be sited on frozen lakes or rivers. (Anticipated deviations are noted in the EIS.)	Gravel infrastructure, pipelines	LS E-2; ADF&G; ADEC; ADNR DMLW	Water resources; fish

No.	Measure	Project Component or Activity	LS, BMP, or Other Stipulation[a]	Primary Affected Resource or Subject
14	Consult with appropriate federal, state, and NSB agencies during mine site design and reclamation. Design mine site to minimize impacts to minimize impacts to wildlife, air quality, and water resources. Mine site operation and reclamation would include the storage and reuse of organic overburden (at the mine site or other disturbed locations on the North Slope) and would consider potential opportunities to provide fish and wildlife enhancement during reclamation.	Gravel source	BMP E-8; ADF&G; ADEC; NSB; ADNR DMLW	Soils, permafrost, and gravel resources; visual resources; water resources; wetlands and vegetation; fish; birds; subsistence and sociocultural systems
15	Do not discharge reserve pit fluids to surface waters or lands.	Waste management	BMP A-6; ADF&G; ADEC	Water resources; wetlands and vegetation; fish; birds; terrestrial mammals; marine mammals; subsistence and sociocultural systems; public health
16	Design, construct, maintain, and operate roads in ways to minimize environmental impacts and protect subsistence use areas and access. Gravel roads and pad layouts would consider topography, maintenance of natural drainage patterns, and the effects of spring breakup and other potential flood events.	Gravel infrastructure	BMP E-1; ADEC; ADNR DMLW	Soils, permafrost, and gravel resources; water resources; subsistence and sociocultural systems
17	Restrict tundra travel for Project personnel to emergency response or to permitted activities required by statute or regulation.	Personnel	BMP L-1; ADF&G; ADNR DMLW	Soils, permafrost, and gravel resources; water resources; wetlands and vegetation; fish; birds; terrestrial mammals; marine mammals
18	Conduct overland (i.e., tundra) moves and similar off-road or cross-country activity use in accordance with NPR-A BMP C-2 to minimize impacts to streambanks, soil substrate, and vegetation.	Off-road vehicle use	BMP C-2; ADF&G; ADNR DMLW	Soils, permafrost, and gravel resources; water resources; wetlands and vegetation; fish; birds; terrestrial mammals; marine mammals
19	Use low-angle approaches for ice road waterway crossings to protect streambanks. Waterway crossings reinforced with additional snow or ice (“bridges”) would be removed, breached, or slotted prior to spring breakup to maintain normal spring runoff patterns and fish passage. All constructed ice ramps and ice bridges would be substantially free of debris (e.g., sticks, brush).	Ice infrastructure	BMP C-3; ADF&G; ADEC; ADNR DMLW	Soils, permafrost, and gravel resources; water resources; fish; terrestrial mammals; marine mammals
20	Prohibit travel along streambeds unless it can be demonstrated that there would be no additional impacts from such travel to over-wintering fish or the invertebrates they rely on. Rivers, streams, and lakes would only be crossed with ice infrastructure at areas where waterbody or waterway ice has grounded, when practicable.	Ice infrastructure	BMP C-4; ADF&G; ADEC; ADNR DMLW	Water resources; fish
21	Inject produced water into the reservoir to support enhanced oil recovery and do not discharge it to surface lands, surface waters, or marine waters.	Waste management	BMP A-7; ADF&G; ADEC	Water resources; wetlands and vegetation; fish; birds; terrestrial mammals; marine mammals; subsistence and sociocultural systems; public health
22	Use recent ecological mapping to assess wildlife habitat types to inform the design, placement, and development of permanent (i.e., gravel) infrastructure.	Gravel infrastructure	BMP E-12; ADF&G	Wetlands and vegetation; fish; birds; terrestrial mammals; marine mammals

No.	Measure	Project Component or Activity	LS, BMP, or Other Stipulation[a]	Primary Affected Resource or Subject
23	Remove, slot, breach, or score ice road stream crossings prior to spring breakup to ensure adequate flow and drainage conditions at stream crossings.	Ice infrastructure	LSs K-1 and K-2; BMPs C-3 and E-6; ADF&G; ADNR DMLW	Soils, permafrost, and gravel resources; water resources; wetlands and vegetation; fish; birds
24	Place gravel roads perpendicular to the general flow direction when crossing natural drainages to maintain the existing flow patterns and characteristics.	Gravel infrastructure	LSs K-1 and K-2; ADNR DMLW; ADF&G	Water resources; wetlands and vegetation; fish; birds
25	Design and construct stream and wetland crossings to ensure the free passage of fish, minimization of erosion, maintenance of natural drainage characteristics, and the minimization of impacts to natural stream flow. Bridges would be used to cross rivers and major streams.	Gravel infrastructure	BMP E-6; ADF&G; ADNR DMLW	Water resources; wetlands and vegetation; fish; birds
26	Collect 3 years of hydrologic and fish data at stream crossings and ensure fish passage at stream crossings.	Gravel infrastructure	BMP E-14; ADF&G; ADEC	Fish
27	Design fish-passage culverts in consultation with the Alaska Department of Fish and Game.	Gravel infrastructure	ADF&G; ADEC	Fish
28	Design cross-drainage culverts to reduce water impoundment by placing culverts approximately every 1,000 feet. (Exact placement would be adjusted based on a field survey of in-field local drainage patterns.)	Construction	BMPs E-6, K-1, and K-2; ADF&G	Soils, permafrost, and gravel resources; water resources; wetlands and vegetation; birds
29	Place bridges and river crossings at narrow river sections, where practicable, to reduce the gravel fill below ordinary high water and reduce the number of piers/pilings.	Gravel infrastructure	ADF&G	Water resources; wetlands and vegetation; fish
30	Construct bridge abutments from sheet pile to reduce the overall gravel footprint and protect the structures from embankment erosion and stream scour.	Construction	BMP E-5; ADF&G; ADEC	Soils, permafrost, and gravel resources; water resources; fish
31	Do not stockpile gravel in Waters of the U.S., including wetlands. Gravel would be stockpiled in upland areas or on ice pads.	Gravel infrastructure	ADF&G; ADNR DMLW	Soils, permafrost, and gravel resources; water resources; wetlands and vegetation; birds
32	Install vertical support members (for pipelines) from ice roads and pads, and ensure drill cuttings are temporarily stored on ice and removed prior to spring breakup to avoid additional impacts to wetlands (e.g., fill).	Construction	AOGCC; ADNR DMLW	Soils, permafrost, and gravel resources; water resources; wetlands and vegetation
33	Conduct trenching activity (e.g., pipeline road crossings) during winter and temporarily store trench spoils on ice roads or ice pads to avoid additional impacts to wetlands (e.g., fill).	Construction	ADNR DMLW	Soils, permafrost, and gravel resources; water resources; wetlands and vegetation
34	Minimize heat transfer and impacts to permafrost from Project infrastructure on gravel pads by: designing flare stack height to reduce radiant heating; filling the gap between well conductors and inner pipes with polyurethane foam; using thermosyphons adjacent to well rows and at-grade structures; and installing insulation below the foundation floors of heated, at-grade structures.	Construction and operations	ADEC; ADNR	Soils, permafrost, and gravel resources
35	Elevate on-pad heated buildings or structure using pilings, to the extent practicable, to prevent or reduce heat transfer to underlying soils and preserve the thermal integrity of the permafrost.	Facilities	ADEC	Soils, permafrost, and gravel resources
36	Implement snow removal management measures to reduce the potential for gravel to be pushed off roads and pads during snow removal operations.	Construction and operations	ADNR DMLW	Soils, permafrost, and gravel resources; water resources; wetlands and vegetation

No.	Measure	Project Component or Activity	LS, BMP, or Other Stipulation[a]	Primary Affected Resource or Subject
37	Implement dust control measures for gravel roads, pads, and mining operations to reduce fugitive dust that can settle on vegetation or snow, which could increase thermal conductivity (i.e., reduce albedo), lead to thermokarsting, and promote earlier spring thaw in affected areas.	Gravel infrastructure	BMP A-10; ADEC	Soils, permafrost, and gravel resources; air quality; visual resources; water resources; wetlands and vegetation; fish; birds; terrestrial mammals; public health
38	Implement strict travel guidelines for ice roads to avoid tundra damage, including requiring ice road driver training, establishing speed and weight limits, and installing road-edge delineators along both sides of roads.	Tundra travel	ADF&G; ADNR DMLW	Soils, permafrost, and gravel resources; wetlands and vegetation; birds; terrestrial mammals
39	Install Colville River pipeline crossings (e.g., diesel, seawater) with insulation and placed within an outer pipeline casing, which would inhibit heat transfer to permafrost, contain fluids in the event of a pipeline leak, and provide structural integrity to the pipeline crossing.	Pipelines	ADEC	Soils, permafrost, and gravel resources; Water resources; Spill risk
40	Design, construct, and use ice roads that are a minimum of 6 inches thick during winter construction to eliminate or minimize impacts to wetlands and tundra.	Ice infrastructure	BMPs C-2, E-1, K-1, M-2, and M-3; ADF&G; ADNR DMLW	Soils, permafrost, and gravel resources; wetlands and vegetation; birds; terrestrial mammals
41	Prepare an erosion control plan to detail ways the Project would prevent or mitigate erosion that would impact terrestrial and aquatic environments. The plan would include CPAI's operations, monitoring, and maintenance procedures that detail the actions CPAI would undertake to monitor, maintain, and if needed, remediate gravel fill impacting surrounding tundra and wetlands.	Erosion control	BMPs C-2, C-3, C-4, E-1, E-3, E-6, E-8, I-1, K-1, K-2, M-2, and M- 3; ADF&G; ADEC; ADNR DMLW	Soils, permafrost, and gravel resources; visual resources; water resources; wetlands and vegetation; fish; birds; terrestrial mammals; marine mammals; subsistence and sociocultural systems
42	Place cleared (i.e., plowed) snow in designated snow-storage areas and manage stormwater from all gravel pads to prevent contaminants from being released during spring breakup. Select snow push areas annually based on avoiding areas of thermokarsting, proximity to waterbodies, and evaluations of areas used the previous year.	Snow management	BMPs A-3, A-4, A-5, A-12, E- 1, K-1, M-2, and M-3; ADNR; ADEC	Soils, permafrost, and gravel resources; water resources; wetlands and vegetation
43	Use a minimum of 5-foot-thick section for gravel pads and roads to maintain a stable thermal regime by insulating the underlying tundra and offsetting the loss of insulating effect caused by the compression of the vegetated tundra beneath the gravel.	Gravel infrastructure	BMP E-5; ADNR DMLW	Soils, permafrost, and gravel resources
44	Route ice roads to avoid shrub areas and large areas of tussock tundra to the extent practicable.	Ice infrastructure	BMPs C-2, E-1, K-1, M-2, and M-3; ADF&G; ADNR DMLW	Wetlands and vegetation; birds; terrestrial mammals
45	Construct pipelines aboveground, to the extent practicable, to minimize permafrost impacts.	Pipelines	BMPs A-3, A-4, A-5, and E-4; ADEC; ADNR	Soils, permafrost, and gravel resources
46	Withdraw unfrozen water from lakes and not rivers and streams during winter to maintain populations of, and adequate habitat for, fish and invertebrates. Ice aggregate would not be removed from areas of grounded ice less than or equal to 4 feet in depth without authorization from the BLM, on a site-specific basis.	Water withdrawal	BMP B-1; ADNR DMLW; ADEC	Water resources; fish

No.	Measure	Project Component or Activity	LS, BMP, or Other Stipulation[a]	Primary Affected Resource or Subject
47	Do not construct causeways or docks in any river mouth or delta. Causeways, docks, artificial islands, or other bottom-fast structures, if employed, would be designed to ensure free passage of fish and prevent changes to water circulation patterns or water quality.	Gravel infrastructure	BMP E-3; ADNR DMLW; ADF&G	Water resources; fish; birds
48	Maintain air-traffic altitudes consistent with NPR-A BMP F-1 except during takeoffs and landings, and unless doing so would endanger human life or violate safe flying practices, to avoid disturbing caribou, birds, and subsistence users, when feasible. (Some air traffic would be required to support the Project or for regulatory compliance [e.g., wildlife studies, hydrology studies] and to ensure cleanup following the ice-road season could require flying at lower altitudes.)	Air traffic	BMP F-1; ADF&G	Noise; visual resources; birds; terrestrial mammals; marine mammals; subsistence and sociocultural systems
49	Develop a bear-interaction plan for Project personnel to minimize conflicts between bears and humans.	All	BMP A-8; ADF&G	Terrestrial mammals; marine mammals
50	Minimize disruption to caribou movement by maintaining a minimum clearance of 7 feet between the bottom of pipelines and the surrounding ground surface.	Pipelines	BMP E-7; ADF&G; ADEC	Terrestrial mammals; subsistence and sociocultural systems; spill risk
51	Design facilities to minimize nesting, denning, or sheltering opportunities for ravens, raptors, and foxes.	Facilities	BMP E-9; ADF&G	Birds; terrestrial mammals
52	Implement a Project lighting plan that would include measures to minimize the amount of light visible from outside of facilities, including directing artificial exterior lighting inward and downward from August 1 to October 31, which would prevent waterfowl (including species listed under the ESA) from striking facilities during low light conditions.	Facility lighting	BMP E-10; typical ESA conservation measure; ADF&G	Birds
53	Minimize the take of species, particularly those listed under the ESA and BLM Special Status Species, by conducting eider and yellow-billed loon surveys and working with resource agencies to ensure facilities minimize impacts to species found (e.g., ensure off-pad utility lines are either buried or suspended from pipe racks to the extent feasible, locate towers on pads near existing buildings to the extent feasible, minimize the use of tower guy wires, clearly mark guy wires that are used to prevent collisions).	Facilities	BMP E-11; typical ESA conservation measure; ADF&G	Birds
54	Develop a new gravel mine site that would not result in the loss of raptor nesting habitat because it would not take gravel from cliffs, river channels, or stream channels in a manner that would affect river bluffs.	Gravel source	BMP E-15; ADF&G	Birds
55	Minimize the electrocution hazard by suspending electrical distribution lines from pipe racks or burying cables (versus the use of overhead power lines) off pad.	Utilities	BMP E-16; typical ESA conservation measure; ADF&G	Birds
56	Provide the BLM authorized officer with GIS-compatible location information to facilitate agency monitoring and assessment of wildlife movements through the Project area after Project construction.	Facilities	BMP E-19; ADF&G	Birds; terrestrial mammals
57	Adhere to NPR-A BMP K-1 river setbacks for Judy (Kayyaak) Creek, Fish (Uvlutuuq) Creek, and Ublutuoch (Tiŋmiaqsiuġvik) River, except where essential crossings are necessary.	Facilities	BMP K-l; ADF&G; ADEC	Water resources; fish; birds
58	Locate pipelines parallel to new and existing gravel roads and maintain a minimum separation distance of 500 feet (but not exceeding 1,000 feet), where feasible.	Pipelines	BMP E-7; ADF&G	Terrestrial mammals; spill risk

No.	Measure	Project Component or Activity	LS, BMP, or Other Stipulation[a]	Primary Affected Resource or Subject
59	Contract with a state-registered Primary Response Action Contractor to assist with quick spill response impacts in the event of a spill.	Operations	BMPs A-8, C-1, F-1, I-1, and M-1; ADEC	Spill risk
60	Align pipe racks installed adjacent and parallel to existing pipeline racks so vertical support members for each pipe rack are in line, to the extent practicable, to reduce obstructions to caribou and subsistence user movements.	Pipelines	BMPs E-4 and E-7; ADEC	Birds; terrestrial mammals; subsistence and sociocultural systems
61	Use a muted (i.e., non-reflective) coating on pipelines to avoid glare.	Pipelines	BMPs E-4, E-7, and M-1; ADEC	Visual resources; birds; terrestrial mammals; marine mammals; subsistence and sociocultural systems
62	Implement policies, procedures, and training to prevent wildlife attraction to Project facilities, including use of predator-proof dumpsters for food waste collection; a strict policy prohibiting the feeding of wildlife; and the use of Ziploc bags or other sealed containers for meals-on-the-go to conceal food odors.	Waste management and wildlife interaction	BMPs A-8, I-1, and M-1; ADEC	Birds; terrestrial mammals; marine mammals
63	Produce a Wildlife Avoidance and Interaction Plan that would include procedures to eliminate, minimize, and mitigate bear interactions. CPAI conducts training on waste management practices and would conduct Project-specific training on waste management to guide employees and contractors on managing predators.	Waste management	BMPs A-1, A-2, A-8, C-1, I-1, and M-1; typical ESA conservation measure; ADF&G; ADNR; ADEC	Birds; terrestrial mammals; marine mammals
64	Protect grizzly and polar bear denning sites by prohibiting cross-country travel or use of heavy equipment within 0.5 mile of a grizzly bear den and within 1.0 mile of a polar bear den or seal birthing lairs. Where necessary, CPAI would conduct surveys near coastal areas to locate potential polar bear dens and seal-birthing lairs, in consultation with the U.S. Fish and Wildlife Service and/or the National Marine Fisheries Service, as appropriate, before initiating activities in coastal habitat between October 30 and April 15.	All	BMP C-1; typical ESA conservation measure; ADF&G; ADNR DMLW	Terrestrial mammals; marine mammals
65	Conduct training for Project personnel on NPR-A BMPs, standards, and environmental, social, traditional, and cultural concerns specific to the Project region, including training on community interactions. This training would be designed to ensure strict compliance with local and corporate drug and alcohol policies.	Personnel	BMP I-1; NSB	Subsistence and sociocultural systems; cultural resources
66	Prohibit Project employees from hunting and trapping activities while employees are on active work status to reduce the potential for increased competition for subsistence and recreational wildlife resources.	Personnel	BMP H-3 ADF&G	Subsistence and sociocultural systems
67	Use the results of cultural and paleontological resource surveys to inform project design and facilities placement. The Project would avoid known cultural and paleontological resources during ground-disturbing activities, including the construction of ice roads.	Construction	BMP E-13; ADNR	Cultural and paleontological resources
68	Implement a Visual Resources Management Plan to minimize visual resource impacts, consistent with the Visual Resources Management Class for the lands on which Project facilities would be located.	Project infrastructure	BMP E-17; ADNR	Visual resources
69	Prohibit the disturbance of caribou and strictly prohibit the harassment of wildlife with vehicles.	Personnel	BMP M-1; ADF&G	Birds; terrestrial mammals; marine mammals; subsistence and sociocultural systems

No.	Measure	Project Component or Activity	LS, BMP, or Other Stipulation[a]	Primary Affected Resource or Subject
70	Continue to consult with affected subsistence communities, tribes, Alaska Native Corporations, and the NSB, as well as the Kuukpikmuit Subsistence Oversight Panel, to ensure impacts to subsistence activities would be minimized. Plans would be maintained to ensure these consultations continue both periodically and robustly. CPAI would also continue to consult with the Alaska Eskimo Whaling Commission, the Nuiqsut Whaling Captains, and the Barrow Whaling Captains regarding the proposed module transfer island.	All	BMP H-1; NSB	Subsistence and sociocultural systems
71	Continue to consult with the Kuukpik Subsistence Oversight Panel, the Native Village of Nuiqsut, and Kuukpik Corporation to ensure Project activities do not adversely affect subsistence activities. CPAI would continue to hold public community meetings. Travel would be scheduled with flexibility and managed through the use of speed limits, rerouting, and traffic stoppages to avoid conflict with subsistence use and hunting areas during seasonal periods.	All	BMPs A-11, A-12, E-1, E-7, F- 1, H-1, H-3, I-1, K-1, K-2, and M-1; NSB	Subsistence and sociocultural systems
72	Continue to provide annual funding for Kuukpik Subsistence Oversight Panel to help support the executive director and coordinate panel activities.	All	BMPs A-11, A-12, E-1, E-7, F- 1, H-1, H-3, I-1, K-1, K-2, and M-1; NSB	Subsistence and sociocultural systems
73	Conduct high-disturbance construction activities such as gravel mining and placement, and pipeline and facility construction, primarily during the winter months when subsistence activity levels are relatively low and disruptions to water flows can be managed.	Construction	LSs K-1 and K-2; BMP E-6; ADF&G	Water resources; fish; birds; terrestrial mammals; subsistence and sociocultural systems
74	Include subsistence tundra access ramps and pullouts on gravel roads with locations based on community input. The pullouts would allow local residents and subsistence users to access the areas adjacent to roadways. The tundra access ramp and pullouts would be designed with considerations of lessons learned from previously constructed versions (as used on the Greater Mooses Tooth 1 and 2 projects).	Gravel infrastructure	ADNR DMLW; NSB	Subsistence and sociocultural systems
75	Prohibit the use of airboats on rivers within BLM-managed lands and within a 50-mile radius of Nuiqsut, except for emergencies and emergency response training.	Operations	BMPs E-1, E-7, H-3, I-1, K-1, K-2, and M-1; ADNR DMLW; ADF&G	Noise; birds; fish; terrestrial mammals; marine mammals; subsistence and sociocultural systems
76	Continue the internship program (CareerQuest) to introduce Nuiqsut high school students to jobs and careers in the oil fields and in their community.	Community outreach	NSB	Economics; subsistence and sociocultural systems
77	Continue to strive to hire qualified Nuiqsut, NSB, and Alaska residents for oil field jobs.	Personnel	NSB	Economics
78	Ensure current communications protocols for CPAI helicopter, fixed-wing aircraft, and marine-vessel traffic are adequate to address community (Nuiqsut) concerns about traffic-related impacts to subsistence activities.	Air and vessel traffic	BMPs E-1, E-7, F-1, H-1, H-3, I 1, K-1, K-2, and M-1; NSB	Subsistence and sociocultural systems
79	Establish a Rights of Access Agreement that would guarantee Nuiqsut residents would have the right to use Project roads to access subsistence use areas throughout the life of the Project.	Gravel infrastructure	BMPs E-1, E-7, H-1, H-3, I-1, K-1, K-2, and M-1; NSB; ADNR DMLW	Subsistence and sociocultural systems

No.	Measure	Project Component or Activity	LS, BMP, or Other Stipulation[a]	Primary Affected Resource or Subject
80	Implement avoidance measures to ensure protection of cultural resource sites during Project activity by establishing a 500-foot avoidance buffer consistent with NSB regulations.	All	NSB	Cultural resources
81	Reduce and minimize air pollution through air quality monitoring and modeling, as appropriate. Develop an emissions inventory and apply additional mitigation measures and activity modifications, as appropriate, in response to the air quality information generated. Make reports generally available to the NSB and local communities.	Air emissions	BMP A-10; ADEC; NSB	Air quality; public health
82	Adhere to the BLM's oil and gas air resources BMPs, as applicable. These practices would minimize air emissions resulting from both Project construction and operations and would include: watering gravel roads to minimize fugitive dust, using clean fuels such as ultra-low sulfur diesel and natural gas, and the use of low emissions emitting equipment (including maximum use of electrical power, Tier 2 and higher combustion engines, storage tank closed vent systems to the extent practicable, and green completions).	All	ADEC	Air quality; water resources; wetlands and vegetation; public health
83	Use ultra-low sulfur diesel fuel (as defined by the Alaska Department of Environmental Conservation) in all diesel-fueled vehicles and equipment.	Vehicles and equipment	BMP A-9; ADEC	Air quality; public health
84	Use completely enclosed or otherwise acoustically packaged permanent electric power generator sets to abate noise.	Generators	ADEC	Noise; birds; terrestrial mammals; marine mammals
85	Generate Project power using the WPF following facility startup and provide power to drilling rigs except during periods when power from the facility is unavailable. Use ultra-low-sulfur diesel powered portable generators to supply Project power prior to facility startup or during periods of facility maintenance, shutdown, or upsets.	Utilities	BMP A-10; ADEC; AOGCC	Air quality; public health
86	Power off vehicles and heavy equipment used for oil and gas operations when not in active use, to the extent practicable.	Vehicles	BMPs A-10 and E-1; ADEC	Air quality; public health
87	Equip vehicles with engine block heaters and institute Project practices to power off and plug in vehicle engines when temperatures are -30°F or above to conserve fuel and reduce emissions.	Vehicles	BMPs A-10 and E-1; ADEC	Air quality; public health
88	Use Finewater Mist for process module fire protection and a non-ozone depleting agent for drill site and non-process module fire protection in lieu of Halon, a substance believed to damage the environment.	Fire protection	BMPs A-10 and E-1; ADEC	Air quality; water quality
89	Manage all waste in accordance with a comprehensive waste management plan to reduce impacts to human health and safety and to minimize potential effects to subsistence resources, including fish and wildlife. This would be accomplished using the Alaska Waste Disposal and Reuse Guide (the "Red Book"). This guide addresses: waste prevention and reduction, recycling, treatment, and disposal. The waste management plan would include measures to avoid attracting wildlife, disposal of putrescible waste, disposal of pumpable waste, and disposal of wastewater. As allowed, injectable waste would be injected into the subsurface via disposal wells or used for enhanced oil recovery.	Waste management	BMP A-2; ADEC	Water resources; wetlands and vegetation; birds; terrestrial mammals; marine mammals; subsistence and sociocultural systems
90	Audit contractor' health, safety, and environment performance to ensure safe practices are followed.	Personnel	BMPs A-2, A-3, A-4, and A-5; ADEC	Water resources wetlands and vegetation; fish; birds; terrestrial mammals; marine mammals; subsistence; public health

No.	Measure	Project Component or Activity	LS, BMP, or Other Stipulation[a]	Primary Affected Resource or Subject
91	Audit the Project on a scheduled basis to ensure compliance with all environmental laws, regulations, and local requirements, company policies and procedures, and other regulations regarding safety, land use, fire codes, etc.	All	ADNR DMLW; ADEC	All
92	Employ Field Environmental Coordinators to monitor compliance with permits and other Project requirements.	All	ADNR	All
93	Evaluate environmental considerations when purchasing new storage tanks or adding new emissions sources that may affect the environment or operating permits.	All	BMPs A-10 and E-1; ADEC	All
94	Review new chemicals being considered for use on the Project to ensure the materials would minimize the generation of hazardous waste or risk to employees.	Operations	BMPs A-2, A-3, A-4, and A-5; ADEC	All
95	Develop and implement a spill prevention and response contingency plan for the Project (in accordance with 40 CFR 112) to reduce impacts to human health and safety and to minimize potential effects to subsistence resources, including fish and wildlife. The Plan would cover Project operations and describe spill prevention measures and on-site cleanup materials for permanent fueling stations, use of proper storage containers and liner materials, proper container identification, and notice of reportable spills. Identification of drip pans (i.e., "duck ponds") would be addressed through Project operating procedures.	Spill prevention and response	BMP A-4; ADEC	All
96	Use a hazardous materials contingency plan (also known as a spill prevention and response contingency plan), prepared pursuant to NPR-A BMP A-3, that would detail response actions, drills, and responder training.	Spill prevention and response	BMP A-3; ADEC	All
97	Build and operate pipelines with the best available technology for detecting and preventing corrosion or mechanical defects to minimize impacts related to point source pollution from oil spills or leaks.	Pipelines	BMP E-4; ADEC	All
98	Install pipeline valves on produced fluid pipelines at each side of Judy (Kayyaak) and Fish (Uvlutuuq) creek crossings, which would isolate sections of the pipelines between the valves to minimize potential spill impacts in the event of a leak or break. These valves would reduce subsistence user concerns related to downstream contamination from the Project. Pipeline valves or vertical loops would be installed on the Willow (sales oil) pipeline at crossings of the Ublutuoch (Tiŋmiaqsiuġvik) River, the Nigliagvik Channel, the Nigliq Channel, and lakes L9341 and L9323 and on the seawater and diesel pipelines at the Colville River.	Pipelines	ADEC	All
99	Implement CPAI's "Target Zero" spill prevention program, which is designed to raise awareness around spill prevention and pass on lessons learned, for the Project.	Spill prevention and response	BMPs A-3, A-4, and A-5; ADEC	All
100	Implement a fuel transfer standard operating procedure and use secondary containment on regulated oil and hazardous materials storage tanks.	Spill prevention and response	BMPs A-3, A-4, and A-5; ADEC	All
101	Continue to implement an extensive corrosion inspection program which includes ultrasonic inspection, radiographic inspection, coupon monitoring, metal loss detection pigs and geometry pigs (applicable to pig-capable pipelines), and infrared (heat signature detection) technology. The inspection programs are API Standard 570-based programs that focus inspection efforts on areas of greatest potential for spills.	Spill prevention and response	BMPs A-3, A-4, and A-5; ADEC	All
102	Continue CPAI's operating practice to immediately and completely clean up all spills, recovering 100% of spilled material for recycling when possible.	Spill prevention and response	BMPs A-3, A-4, A-5, and A-12; ADEC	All

No.	Measure	Project Component or Activity	LS, BMP, or Other Stipulation[a]	Primary Affected Resource or Subject
103	Periodically treat pipeline fluids, as appropriate to product types, with chemicals to limit corrosion potential.	Pipelines	LS K-1; BMPs A-3, A-4, A-5, and E-4; ADEC	All
104	Equip and maintain oil spill response equipment intended for use in winter conditions for effective use in Arctic conditions (i.e., in a manner to prevent the freezing or icing of the equipment).	Spill prevention and response	BMPs A-3, A-4, and A-5; ADEC	All
105	Hydrostatically test pipelines prior to placing them into operation.	Pipelines	BMPs A-3, A-4, A-5, and E-4; ADEC	All
106	Stage spill response equipment in strategic locations (e.g., drill sites) for initial spill response. On-site staged equipment would facilitate the rapid deployment of response personnel and may minimize or reduce the overall impacts associated with a spill or other accidental release.	Spill prevention and response	BMPs A-3, A-4, A-5, and A-12; ADEC	All
107	Designate Spill Response Teams and Hazardous Materials Response Teams, consisting of trained volunteer spill and hazardous materials response personnel on site.	Spill prevention and response	BMPs A-3, A-4, A-5, and A-12; ADEC	All
108	Continue to participate in the Mutual Aid Agreement among North Slope operators to supply labor and equipment for immediate spill response. Spill response drills and exercises would ensure response readiness and awareness; these drills would be scheduled according to the National Preparedness and Response Exercise Program guidelines and typically involves production, drilling, or pipeline spill response scenarios	Spill prevention and response	BMPs A-3, A-4, A-5, and A-12; ADEC; NSB	All
109	Do not refuel equipment within 500 feet of the active floodplain of any waterbody unless approved by the BLM authorized officer. Fuel-storage stations, except as approved by the BLM authorized officer, would be located at least 500 feet from waterbodies except for small caches (up to 210 gallons) for fueling motor boats, float planes, and small equipment.	Spill prevention and response	BMP A-5; ADNR DMLW; ADEC	All
110	Design well cellars to contain fluid drips and leaks.	Spill prevention and response	BMPs A-3, A-4, and A-5; ADEC	All

Note: °F (degrees Fahrenheit); ADEC (Alaska Department of Environmental Conservation); ADF&G (Alaska Department of Fish and Game); ADNR (Alaska Department of Natural Resources); AOGCC (Alaska Oil and Gas Conservation Commission); BMP (best management practice); CPAI (ConocoPhillips Alaska, Inc.); DMLW (Division of Mining, Land, Water); EIS (environmental impact statement); ESA (Endangered Species Act); GIS (geographic information system);LS (lease stipulation); No. (number); NPR-A (National Petroleum Reserve in Alaska); NSB (North Slope Borough); WPF (Willow processing facility). All cited lease stipulations and best management practices are from the National Petroleum Reserve in Alaska Integrated Activity Plan/Environmental Impact Statement Record of Decision (BLM 2013).

[a] Other stipulations include typical State of Alaska or NSB permit stipulations for North Slope activities or typical ESA conservation measures or BMPs. The table lists the agency from which the typical stipulation would arise.

1.3 Additional Suggested Best Management Practices or Mitigation

In addition to Project design features, LSs, and BMPs already applicable to the Project, the EIS also considers additional suggested BMPs and mitigation measures designed to further avoid, reduce, or compensate for impacts from the Project. These measures are discussed in the relevant resource sections in the Willow MDP EIS, Chapter 3.0, *Affected Environment and Environmental Consequences,* and are summarized in Table I.1.3. They were developed based on suggestions from cooperating agencies, stakeholders, and BLM staff. The decision whether to adopt each new mitigation measure will be made in the BLM's Willow MDP ROD.

Table I.1.3. Additional Suggested Best Management Practices and Mitigation

Section Number and Resource	Best Management Practice or Mitigation Measure
3.2 – Climate and Climate Change	None
3.3 – Air Quality	None
3.4 – Soils, Permafrost, and Gravel Resources	Use the following in design of roads and embankments: Separate native soils from Project fill materials using geotextiles or fabrics Use thick embankments and shallow slopes Monitor thermokarsting, depth of active layer, and compression of soil and vegetation in annual resupply ice road footprint, for footprints that are used consecutively each year
3.5 – Contaminated Sites	None
3.6 – Noise	Alter flight paths to avoid sensitive areas (such as Nuiqsut) Use snow berms to dampen noise Conduct noise monitoring during construction and operations
3.7 – Visual Resources	Ensure structures are a color that blends in with the background colors of the natural landscape. All colors would be pre-approved by the BLM. Non-glare, self-weathering steel, or a BMP, would be used on all metal structures not otherwise painted, including but not limited to pipelines, communications towers and drill rigs.
3.8 – Water Resources	Unless a more appropriate method is available, when estimating flood-peak discharge at locations within the Fish (Iqalliqpik) Creek, Judy (Iqalliqpik) Creek, and Ublutuoch (Tiŋmiaqsiġvik) River basins, use a weighted average from a single station analysis of the BLM long-term monitoring station data on each of these streams and the Shell regression equations (Appendix E.8). Weight the results of the two computations based on the uncertainty associated with each estimate. As appropriate, consider both 1) snow- and ice-impacted conditions and 2) ice-free conditions in the hydraulic design of bridges, culverts, and pipeline river crossings. Cross-section data at the time of the peak stage and peak discharge that are available for many rivers and streams indicate that the WSE was affected by snow and/or ice blockage. Based on the available information, develop designs that would perform satisfactorily during the design event considering both the possibility of open water conditions and the possibility that snow and ice blockage is occurring at the time of the design event. At a minimum, the magnitude of the blockage used in the designs should be similar to the magnitude of the blockage that has been observed. At a minimum, design culverts to perform satisfactorily for all flood events up to and including the 50-year event. The headwater to diameter ratio at the maximum design condition should be no greater than 1.0. Identify the locations requiring cross-drainage culverts during spring breakup prior to construction, by noting all locations where water is flowing over the proposed alignment. This is necessary because it is often not possible to determine where water flowing in polygon troughs will cross the alignment during a summer or fall inspection. At the same time, identify the ends of the proposed culverts and the invert elevation of the ends of the culvert in order to maintain the flow in the historic flow path. At a minimum, design road bridges to pass the 50-year flood-peak discharge with a minimum of a 3-foot freeboard (assuming snow and ice conditions have been considered in estimating the design water surface elevation). Design for bridge foundation scour equal to the maximum scour depth produced by floods up through a magnitude equal to the 100-year flood event, and a geotechnical design practice safety factor of from 2 to 3. Check the bridge design using a superflood and a geotechnical design practice safety factor of 1. The superflood is defined as the 500-year event, 1.7 times the magnitude of the 100-year event, or the overtopping flood, whichever is the least. These are standard criteria used by Alaska Department of Transportation and Public Facilities for bridges on the North Slope in non-designated flood hazard areas. At a minimum, design pipeline river-crossings to perform satisfactorily for all floods up to and including the 200-year event (including crossings on bridges or VSM). This is the magnitude of the design event that has typically been used for commercial pipelines on the North Slope and a higher level of design than is being proposed for the Project.

Section Number and Resource	Best Management Practice or Mitigation Measure
	Start bridge and culvert hydraulic computations sufficiently downstream so that the downstream boundary assumptions do not affect the performance of the proposed design. Consider the USACE (1986) report "Accuracy of Computed Water Surface Profiles" in determining the location of the downstream boundary for hydraulic computations. If the highest observed WSE or high-water mark is higher than the predicted 50-year WSE at a culvert, bridge or pipeline, re-evaluate the design water surface elevation to confirm that snow and ice blockage, and other details of the computation are accurate. Given the conditions on the North Slope, it is unlikely that high water marks from a 50-year flood or greater would be recognizable unless it occurred in the last 10 to 20 years. Additionally, it is improbable that a 1- to 5-year field program would experience a 50-year flood. It is more likely that snow and ice blockage greater than accounted for in the model used to predict the 50-year WSE or an error in the downstream boundary condition used in the model has occurred. Use a freeboard at bridges and pipeline crossings which considers the uncertainty in the magnitude of the design flood, the uncertainty in the hydraulic computations, and the height of the ice and debris that may be carried by the flood, but is not less than 3 feet. Where an aboveground pipeline crossing is immediately upstream from a road, backwater from the road during the pipeline design event should be considered when setting the bottom of pipe elevation. Additionally, if the road is designed for a smaller flood than the pipeline, the changes in hydraulic conditions at the pipeline as a result of the road wash-out should be considered (i.e., changes in location of the concentrated flow and the impact on erosion at the VSM). Where an aboveground pipeline crossing is immediately downstream from a road, the impact of the road on where water would be flowing and the velocity of the water at the pipeline VSM should be considered. Additionally, if the road is designed for a smaller flood than the pipeline, the changes in hydraulic conditions at the pipeline as a result of the road wash-out should be considered (i.e., changes in the location of the concentrated flow and the impact on erosion at the VSM). Breach ice road crossings sufficiently that ice from crossing would not contribute to ice jams or increase snow and ice blockage during spring breakup. Avoid placing multi-season ice pads in floodplains (e.g., construction pads at the mine site) Prior to HDD construction, provide a monitoring and response plan for determining if drilling mud is being lost to formation or making it to the river or groundwater during drilling. Should any spills occur on the MTI, the affected gravel would be addressed immediately and removed prior to MTI abandonment. Provide annual surveillance of bridge, culvert, and pipeline river crossings to confirm that structures are functioning properly and provide maintenance as required.
3.9 – Wetlands and Vegetation	Monitor vegetation damage, and compression of soil and vegetation in annual resupply ice road footprint (footprints that are used consecutively each year). Provide stations to clean footwear and gear so they are free from soils, seeds, and plant parts. Provide training to employees and contractors in identification, control, and prevention of known invasive plant species. Restrict use of heavy equipment in summer to pads (established BMPs are available at: http://www.nae.usace.army.mil/Portals/74/docs/regulatory/StateGeneralPermits/MA/ConstructionMatBMPs.pdf) Confine loading and unloading of soils for gravel stockpiles to the downwind side of the pile; if piles would be on-site for longer periods of time, seed with appropriate vegetation to reduce wind erosion. Wind barriers (such as snow fences) may also be appropriate in some situations.
3.10 – Fish	As agencies determine is appropriate, the mine site could be reclaimed to create overwintering habitat that is connected to anadromous streams. The site is approximately 266 feet from Bills Creek and 310 feet from the Ublutuoch (Tiŋmiaqsiġvik) River. Overwintering habitat is limited in the analysis area and could benefit multiple fish species and aquatic organisms. Adopt BMPs suggested by National Marine Fisheries Service for essential fish habitat for invasive species (Limpinsel, Eagleton et al. 2017): Uphold fish and game regulations of the Alaska Board of Fisheries (AS 16.05.251) and Board of Game (AS 16.05.255), which prohibit and regulate the live capture, possession, transport, or release of native or exotic fish or their eggs. Adhere to regulations and use BMPs outlined in the State of Alaska Aquatic Nuisance Species Management Plan (ADF&G 2002). Encourage vessels to exchange ballast water in marine waters (in accordance with the U.S. Coast Guard's voluntary regulations) to minimize the possibility of introducing invasive estuarine species into similar habitats. Ballast water taken on in the open ocean would contain fewer organisms, and these would be less likely to become invasive in estuarine conditions.

Section Number and Resource	Best Management Practice or Mitigation Measure
	Discourage vessels that have not exchanged ballast water from discharging their ballast water into estuarine receiving waters. Require vessels brought from other areas over land via trailer to clean any surfaces (e.g., propellers, hulls, anchors, fenders) that may harbor non-native plant or animal species. Bilges should be emptied and cleaned thoroughly by using hot water or a mild bleach solution. These activities should be performed in an upland area to prevent the introduction of non-native species during the cleaning process. Prior to the start of construction, undertake a thorough scientific review and risk assessment regarding impacts associated with the introduction of non-native species.
3.11 – Birds	Locate mast poles away from the pad edge Use lighting fixtures with lamps contained within the reflector Shade externally facing windows on buildings to minimize impacts on visual aesthetics and the potential for bird strikes. Shield lighting downward to reduce attraction and disorientation of birds in poor visibility conditions Minimize the number of tall towers Limit water withdrawal to lakes without sensitive fish or breeding yellow-billed loons Restrict speed limits to minimize collision hazard and dust production (35 miles per hour except in areas of congestion, on bridges, and on pads, which should be slower) Haze birds out of blast area before blasting Monitor lake levels to ensure sufficient recharge is occurring and adjust future withdrawals accordingly to allow for sufficient recharge Minimize noise impacts between June 1 and July 15 when birds on nests would be unable to move away from the disturbance Minimize air traffic during the nesting period when the movements of incubating birds are restricted, and the molting period when birds may be energetically stressed and sensitive to disturbance Require aircraft fly at altitudes higher than 1,500 feet to minimize effects to birds; consult with BLM to determine altitude Avoid routine use of helicopters during drilling and operations activities to minimize noise and impacts related to birds Consider revising traffic pattern altitude and location to minimize conflicts with nesting and foraging birds Avoid preferred habitats, where possible Minimize barge and support vessel speed to reduce potential for bird strikes
3.12 – Terrestrial Mammals	BMP E-7 describes requirements related to caribou ramps over pipelines or buried pipelines. The Project could designate specific locations for these, such as northeast of the airstrip in Alternative B. The decision to add a crossing ramp over a buried pipeline should consider potential negative effects of reduced access to the pipeline for oil spill detection and response and thermokarst or changes in surface flow due to the resulting long-linear ditch that would fill with water.
3.13 – Marine Mammals	BMP F-1 stipulates minimum altitudes for aircraft flying near specified locations in NPR-A. Though the Willow area is not specified, all air traffic for the Project could maintain altitudes of 1,500 feet (except during takeoff and landing) to minimize effects to marine mammals. Potential mitigation measures to further reduce impacts to marine mammals include: Avoid preferred habitats, where possible.
3.14 – Land Ownership and Use	None
3.15 – Economics	None
3.16 – Subsistence and Sociocultural Systems	None

Section Number and Resource	Best Management Practice or Mitigation Measure
3.17 – Environmental Justice	Establish a Nuiqsut coordination group (or continue to use the Kuukpik Subsistence Oversight Panel) to continue meaningful engagement in the Project and identify continuing concerns and specific Project impacts. Determine a schedule for periodic meetings to present concerns to CPAI and discuss potential resolution strategies. Conduct community outreach programs to inform the Nuiqsut community about Project decisions and impacts, address user concerns, identify topics for additional review, and determine possible solutions for implementation. Provide regular Project updates to the community and leadership in Nuiqsut throughout construction and operations.
3.18 – Public Health	None
3.19 – Cumulative Effects	None

Note: BLM (Bureau of Land Management); BMP (best management practice); CPAI (ConocoPhillips Alaska, Inc.); HDD (horizontal directional drilling); NPR-A (National Petroleum Reserve in Alaska); MTI (module transfer island); Project (Willow Project); ROD (Record of Decision); USACE (U.S. Army Corps of Engineers); VSM (vertical support member); WSE (water surface elevation)

2.0 REFERENCES

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Willow Master Development Plan

Appendix I.2

ConocoPhillips Road Optimization Memorandum

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ConocoPhillips Road Route Screening Process

June 5, 2019

Introduction

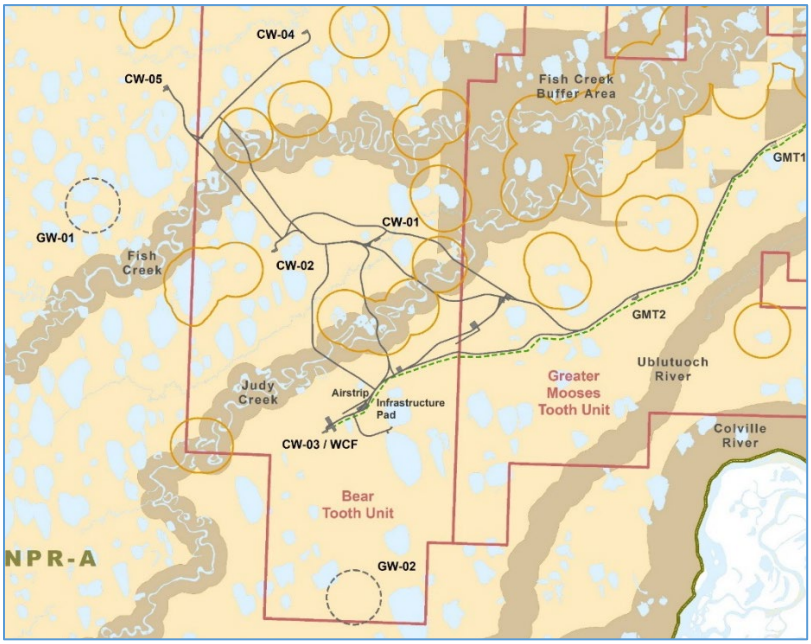
On March 3, 2019, ConocoPhillips Alaska, Inc. (CPAI) hosted a meeting with the Bureau of Land Management (BLM), the U.S. Environmental Protection Agency (EPA), and the U.S. Army Corps of Engineers (USACE). The purpose of the meeting was to review the evolution of road route concepts assessed by CPAI for the Willow development. From 2017 through the first half of 2019, CPAI undertook a significant program of field research and data gathering to inform infrastructure placement and road routing options for the Willow development. CPAI initially considered over 20 road route options, which were screened by CPAI down to three development concepts for analysis in the Environmental Evaluation Document (EED). This memo summarizes the process used by CPAI to generate road route concepts, and to perform screening evaluations of those concepts. This memo also documents information that was discussed during the March 3rd meeting with EPA and the USACE.

Initial Route Creation and Screening

Beginning in 2017, information was compiled and analyzed by a multidisciplinary team of civil engineers, petroleum engineers, environmental scientists, biologists, North Slope operations personnel, geoscientists, and construction planners in order to identify and minimize potential environmental impacts in addition to optimization of the overall road routing.

CPAI personnel and consulting experts identified initial road segments using a combination of satellite imagery and aerial photography, environmental studies (caribou, fish, avian, wetlands, hydrology, and cultural resource surveys), exploration and environmental field expertise, and an awareness of subsistence hunters' perspectives. Twenty-two road segments were developed, which were then organized into eight potential road alignments. Figure 1, below, shows the initial route alignments.

Figure 1. 2017 Initial Willow Road Segments



CPAI screened the road route options considering the following:

- Best Management Practices (BMPs) and Stipulations from BLM's 2013 Integrated Activity Plan for the NPR-A
- Guidelines in the BLM NEPA Handbook

- Section 404 of Clean Water Act and Section 10 of the Rivers and Harbors Act considerations, including a Least Environmentally Damaging Practicable Alternative (LEDPA). Practicability included costs, safety, and logistics.
- National Environmental Policy Act (NEPA) guidelines on alternatives selection
- Key comments from stakeholders on recent developments in the region
- Light Detection and Ranging (LIDAR) survey data, and a preference to avoid higher value wetlands
- Integrated Terrain Unit (ITU) habitat and wetlands mapping
- Avian Studies including yellow-billed loon nest observations
- Fish surveys and lake bathymetry data
- Hydrology studies
- Cultural resource surveys
- Subsistence surveys, including an awareness of locally important resources, methods, and use areas
- Caribou surveys
- Engineering recommendations for suitable bridge crossing locations and bridge span length
- Total road mileage and acreage of gravel fill in wetlands
- Support for future development by potentially reducing impacts from future projects on other CPAI leases
- Spill avoidance, inspection, and response
- Health and safety considerations

During the summer and fall of 2017, CPAI conducted studies to inform initial road routing options from infrastructure in the Greater Mooses Tooth Unit (GMTU) to the early Willow drillsite locations (CW-01 through CW-05).

Note that the early Willow drillsite locations are not the same locations as those now being considered for the Willow Master Development Plan (MDP) Environmental Impact Statement (EIS). Rather, the early locations were determined based on subsurface information known at the time. Drillsite locations have since been refined based on additional information as described below.

The initial eight road alignments were split into three categories:

- Northern routes: The most direct access from GMT2 to the early Willow CW-01 and CW-02 drillsite locations.
- Mid-routes: The most direct access to the full suite of Willow infrastructure including the proposed processing facility location, minimizing road lengths and providing the shortest bridge lengths at stream crossing locations.
- Southern Routes: These routes best complied with stipulations and/or BMPs in the 2013 Integrated Activity Plan (IAP; BLM 2013) and minimized the number of waivers required.

Criteria used to evaluate the eight routes included:

- Total road mileage, used to compare relative wetlands impacts and cost
- Judy Creek bridge crossing location and length, including potential impacts to streams from pier groups.
- Road length within the 3-mile wide Fish Creek setback established by IAP BMP K-1
- Conformance with other BLM stipulations including:
    - Avoidance of yellow-billed loon nest/nesting lake setbacks (IAP BMP E-11)

- Avoidance of 500-foot setback around waterbodies (IAP BMP E-2)
- Avoidance of ¼-mile setback around deepwater lakes (IAP BMP K-2)

- Route uniqueness compared with other routes.

Potential impacts to cultural resources were also considered, however, no impacts to cultural resources were identified for any of the evaluated routes thus it was not a differentiating factor in route selection.

Of the eight routes evaluated, four were screened out by CPAI and the remaining routes were analyzed in in more detail. Table 1 summarizes the eight routes evaluated and additional details are provided in the EED.

Table 1. Initial Road Route Alternatives Evaluated

Route	Road Miles[1]	Judy Creek Bridge (ft.)	Crosses Fish Creek Setback[2]	Crosses YBLO Buffer	Advanced for CPAI Analysis	Notes
North 1	37.6 mi	450	Y	Y	Y	Provides the most direct access from GMT2 to CW-01 and an optimal crossing location of Judy Creek with one of the shortest bridges. Includes essential crossing of the Fish Creek Setback (BMP K-1).
North 2	38.9 mi	-	Y	N	N	Similar to but longer mileage than North 1 and North 3. Places 2 miles of road in Fish Creek Setback (BMP K-1). Route not sufficiently distinct from other routes evaluated (North Route 1) but would require additional deviation from BMP K-1. Other similar routes (North Route 1, North Route 3) further minimize or avoid infrastructure in Fish Creek setback.
North 3	36.9 mi	1,400	N	Y	Y	Provides direct access from GMT2, but it would have a longer bridge crossing of Judy Creek than North 1.
Mid 1	35.5 mi	420	N	Y	Y	Provides shortest overall road length and minimizes tundra footprint.
Mid 2	42.3 mi	420	N	Y	N	Not sufficiently distinct from other routes evaluated (Mid Route 1) and would require additional deviation from BMP E-11. Other similar routes would have a smaller total footprint.
South 1	37.0 mi	1,850	N	N	Y	Conforms to BMPs and stipulations to the maximum extent practicable but has the longest bridge crossings of Judy Creek.
South 2	42.3 mi	1,850	N	N	N	Not sufficiently distinct from other routes evaluated (South Route 1). Other similar routes would have a smaller total footprint.
Southwest	37.3 mi	-	N	N	N	Not sufficiently distinct from other routes evaluated (South Route 1) and would require additional deviation from BMP K-2. Other similar routes further minimize infrastructure near deepwater lakes.

[1] Road mileages evaluated with common crossing of Fish Creek to access northern drillsites
[2] Established by BMP K-1; excluding essential crossings
Y: Yes; N; No; -: not evaluated; ft.: feet; BMP: best management practice

In addition to the eight routes discussed above, two Fish Creek crossing locations were also considered to connect drillsites CW-04 and 05 to the CW-02 area: west and central routes (see Figure 1). Table 2 describes the routes considered.

Route	Road Miles	Fish Creek Bridge (ft.)	Crosses Fish Creek Setback[1]	Crosses YBLO Buffer	Advanced for further CPAI Analysis	Notes
West	12.9	850	N	N	Y	Avoids known yellow-billed loon setbacks (BMP E-11) and provides the shortest alignment to early drillsite locations.
Central	13.4	650	N	Y	N	Provides shortest Fish Creek bridge but requires more road length, gravel fill, and crosses through yellow-billed loon setback (BMP E-11) near Fish Creek.

[1] Established by BMP K-1; excluding essential crossings
Y: Yes; N; No; -: not evaluated; ft.: feet; BMP: best management practice

Figures 2 through Figure 5 show the four road routes that were advanced during the 2017 screening process.

Figure 2. North Route 1 Road Alignment

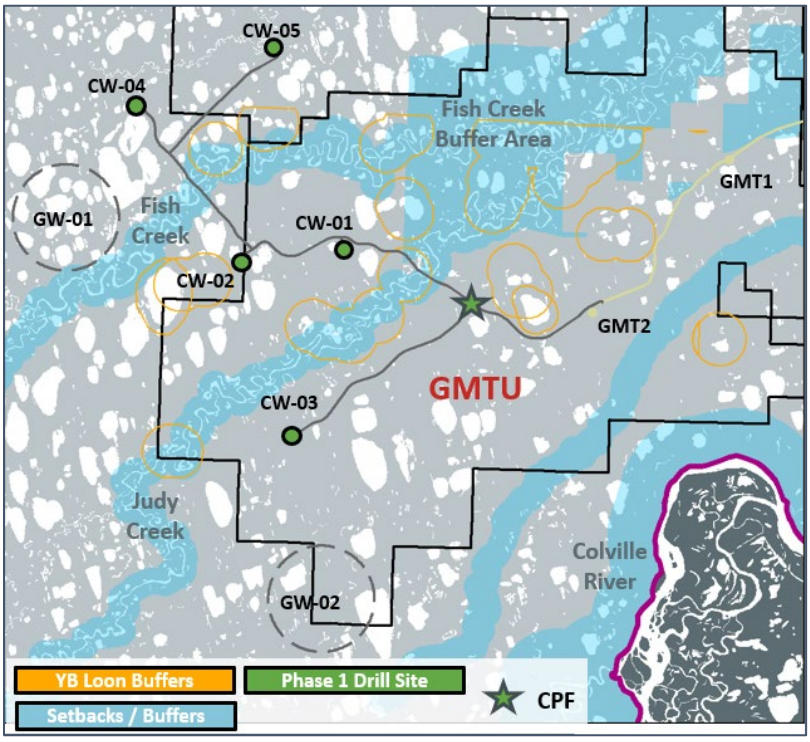


Figure 3. North Route 3 Road Alignment

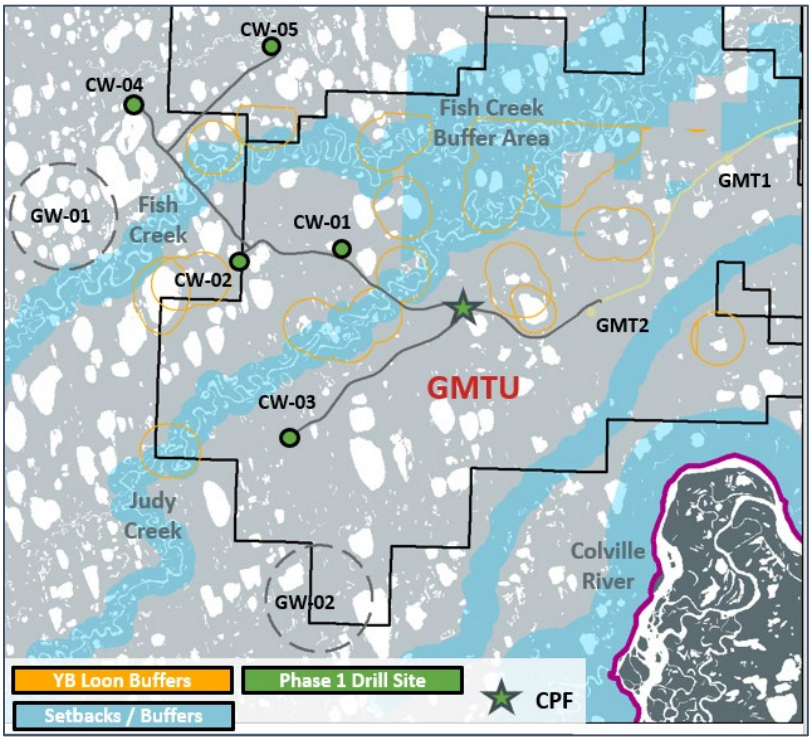


Figure 4. Mid Route 1 Road Alignment

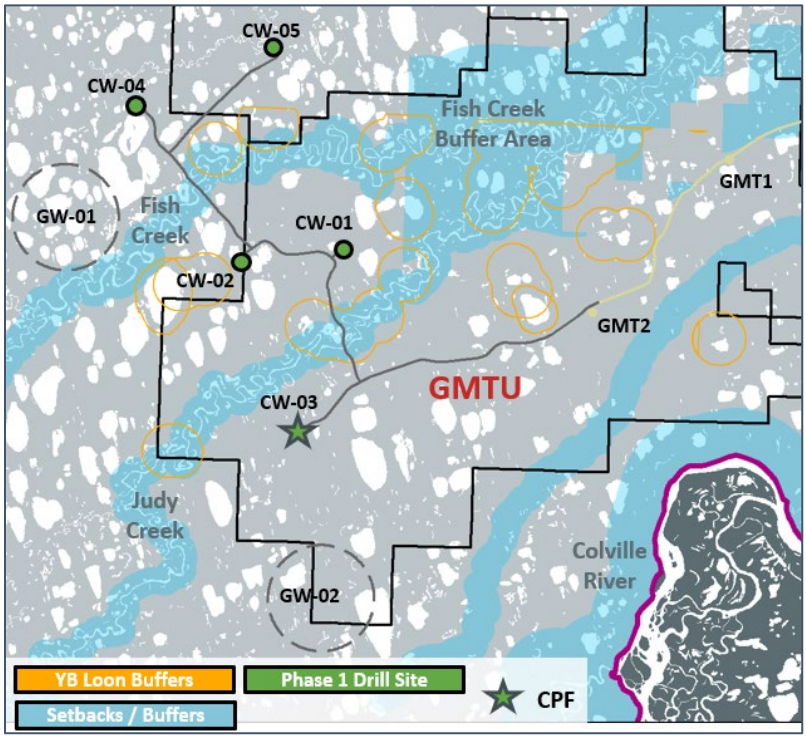
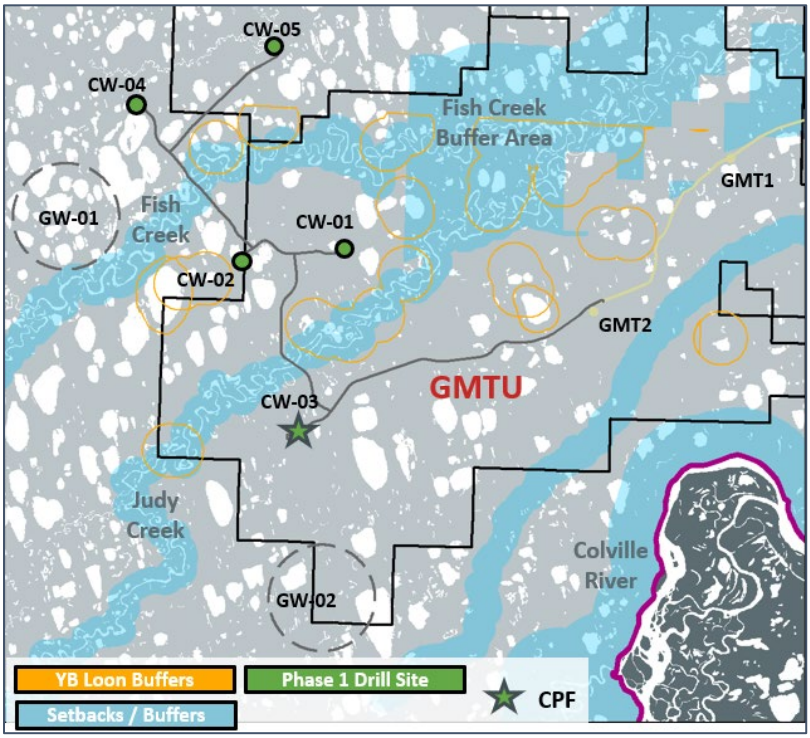


Figure 5. South Route 1 Road Alignment



Drillsite Location Refinement and EED Route Identification

After analyzing subsurface data from the 2018 Willow appraisal drilling season, CPAI refined some drillsite locations to further optimize recovery of the subsurface resource, while minimizing surface disturbance. The updated drillsites were located within the overall geographic area as the original sites, and the road routing evaluation criteria that was used during the previous screening effort was utilized to assess road route options to the new drillsite locations. Project engineers reevaluated the same general alignment corridors, bridge crossing locations, and road segments identified in 2017. During the spring and summer of 2018, LIDAR surveys were conducted throughout the field in order to further refine road routings, stream crossings, and bridge locations. New data from ongoing environmental studies including hydrology, avian surveys, fish surveys, ITU and wetlands mapping, and caribou surveys were also incorporated into route development and evaluation. CPAI shared the initial road alignments with the BLM and other regulatory agencies and received feedback that was also incorporated into road alignment reevaluation.

Route development and evaluation criteria and considerations were similar to those identified during initial route creation and screening but incorporated additional and/or more refined data. Criteria used for route development and evaluation included:

1. Gravel Footprint: Early analysis utilized road mileage as a surrogate for gravel footprint, as it assumed constant road width and depth based on aerial photography. Subsequent analysis used the LIDAR survey data and routings were optimized to avoid significant topographic changes that would increase gravel depth and footprint.
2. Caribou Migration Effects: Care was taken to minimize the potential for corralling effects due to loops or forks in the road.
3. Avoidance of Special Areas: Priority was given to avoidance of the Fish Creek 3-mile buffer (BMP K-1) as well as minimizing roadway length in the Judy Creek and Fish Creek ½-mile buffers upstream of the Fish Creek/Judy Creek confluence (BMP K-1). Additional special area considerations given to the Colville River Special Area and the Teshekpuk Lake Caribou Habitat Special Area (BMP K-5)

4. Stream Crossings: Routes were selected and evaluated with consideration given to the minimization of stream crossing impacts, mainly evaluated by the number of pile groups or pier groups in waterbodies.
5. Yellow-billed Loon Setback: Routes minimized crossing yellow-billed loon setbacks (defined as the area 1-mile from identified nests and 500 meters from the nesting lakes as stipulated in BMP E-11). Some routes may cross buffers where tradeoffs exist between crossing a setback and other potential environmental impacts, such as increased gravel fill. Discussion with BLM personnel in 2018 indicated that a waiver process allows for encroachment into setback, if it avoids causing more substantial impacts elsewhere, and that reducing gravel fill should be prioritized over encroaching within the setback.
6. Waterbodies Setback: Routes maintained waterbodies setback of 500 feet as stipulated in the 2013 IAP (BMP E-2)
7. Deep Water Lakes Setback: Routes maintained deep water lakes setback of ¼ mile as stipulated in the 2013 IAP (BMP K-11)
8. Teshekpuk Lake Caribou Habitat Area: Minimization of footprint in the Teshekpuk Lake Caribou Habitat Area (IAP BMP K-5)
9. General use of higher, drier ground: This is both a good engineering and maintenance practice, as well as use of a general assumption that drier ground was correlated with less highly functioning wetland areas.

Based on this evaluation, two road alignments, generally based on the Mid Route 1 and South Route 1 initial road alignments, were selected for further analysis as part of three alternatives within CPAI's Willow MDP EED.

EED Alternative 1

EED Alternative 1 was based generally on the road alignments evaluated as part of the Mid Route 1 alignment. The overarching goal in developing this road alignment was to minimize wetland impacts by selecting the most direct route from GMTU to proposed Willow facilities. This included the minimization of road length as well as the minimization of road footprint through optimization of topography by locating the road on generally higher, drier ground. It would also minimize wetland impacts by selecting optimal stream crossings to minimize bridge crossing lengths and gravel footprint within floodplains and adjacent wetlands. Alternative 1 would provide the shortest road alignment between drillsites and minimize the length of the Judy Creek bridge (420 feet) but it has the tradeoff of passing through yellow-billed loon nest/nesting lake setbacks near Judy Creek and would have a longer bridge at the Fish Creek crossing (1,100 feet). (Note: please refer to the EED for maps of the EED Alternatives.)

EED Alternative 2

Based on guidance from the BLM, this alternative sought to minimize the number of waivers to the 2013 IAP BMPs but requires tradeoffs of a greater gravel footprint and sub-optimal stream crossings. A major factor in this routing is avoidance of the yellow-billed nest buffers (BMP E-11), which drives additional road length, a longer bridge crossing of Judy Creek stream, the longest road mileage of the routes considered, and substantially more infrastructure in the Teshekpuk Lake Habitat Area (BMP K-5).

EED Alternative 3

This alternative evaluated a development scenario where the Willow area is not connected by gravel road to GMTU. This alternative reduces overall gravel footprint but results in tradeoffs of additional air traffic, freshwater use, subsistence impacts and reduced stakeholder access benefits, and challenges in emergency response (including spill) access. The gravel road alignments from the Willow processing facilities to each drillsite follow the same alignments considered as part of EED Alternative 1.

EED Alternative Evaluation

Table 2 summarizes CPAI's analysis of the road alignments evaluated in the Willow EED (September 2018) based on the evaluation criteria. Based on the overall minimization of gravel fill (and thus minimization of fill in wetlands and other water of the U.S.), minimization of the length of the Judy Creek bridge crossing, and balancing other environmental tradeoffs including compliance with the 2013 IAP BMPs, CPAI selected Alternative 1 as its proposed project for Willow development.

Table 2. Alternative Road Routes Evaluated

Project Component		Alternative 1	Alternative 2	Alternative 3
Gravel Roads		37 miles; 273 acres Eight 0.3-acre turnouts with ramps (2 acres total)	45 miles; 326 acres Nine 0.3-acre turnouts with ramps (3 acres total)	28 miles; 200 acres Six 0.3-acre turnouts with ramps (2 acres total)
Bridges (number)		8	10	7
Bridges (length)	Judy Creek	420 feet	1,850 feet	420 feet
	Judy Creek Kayyaaq	75 feet	Crossing 1: 75 feet; Crossing 2: 75 feet	75 feet
	Fish Creek	1,100 feet	850 feet	1,100 feet
	Kalikpik River	500 feet	550 feet	500 feet
	Willow Creek 2	80 feet	80 feet	NA
	Willow Creek 4	130 feet	130 feet	130 feet
	Willow Creek 4a	90 feet[1]	90 feet[1]	90 feet[1]
	Willow Creek 5	NA	20 feet[1]	NA
	Willow Creek 7	NA	75 feet[1]	NA
	Willow Creek 8	30 feet[1]	NA	30 feet[1]
	Other	Stream and cross drainage culverts as required	Stream and cross drainage culverts as required	Stream and cross drainage culverts as required
Acres in Special Areas	Acres in Colville River Special Area	8 acres	8 acres	NA
	Acres in Teshekpuk Lake Special Area	110 acres	130 acres	103 acres
Compliance with BLM BMPs	Acres in Teshekpuk Lake Caribou Habitat Area (BMP K-5)	19 acres, no deviation anticipated	56 acres, no deviation anticipated	19 acres, no deviation anticipated
	Yellow-billed Loon Nest/Lake Setback Deviations (BMP E-11)[2]	Lake M0151 (nesting lake shoreline setback) Lake M1522 (nesting lake shoreline setback, nest setback) Lake M1523A (nesting lake shoreline setback, nest setback) Lake M1524 (nest setback) Lake M0303 (nest setback)	Lake M0151 (nesting lake shoreline setback)	Lake M1522 (nesting lake shoreline setback, nest setback) Lake M1523A (nesting lake shoreline setback, nest setback) Lake M1524 (nest setback) Lake M0303 (nest setback)
	River Setback Deviations (BMP K-1)	Essential road/pipeline crossing of Judy Creek Essential road/pipeline crossing of Fish Creek	Essential road/pipeline crossing of Judy Creek Essential road/pipeline crossing of Fish Creek	Essential road/pipeline crossing of Judy Creek Essential road/pipeline crossing of Fish Creek
	Deepwater Lake Setback Deviations (BMP K-2)	Lake M0015	Lake M0015	Lake M0015

[1] Bridge versus culvert battery crossing structure to be determined.
[2] 1-mile nest setback and 1,625-foot (500-meter) nesting lake shoreline setback.
Notes: All values are approximate and subject to change; BMP: best management practice.

EIS Alternative Development

A description of the EED Alternatives was submitted to BLM and co-operating agencies in May 2018 and updated in September 2018. CPAI understands that these alternatives were considered by the agencies as part of the EIS alternative development process.

Since submittal of the EED, CPAI has also supported EIS alternative development through technical and engineering support. This has included further refinement and changes to the proposed project based on agency feedback. For example, in October 2018, at the request of BLM and co-operating agencies, CPAI evaluated moving the BT4 drillsite out of the Teshekpuk Lake Caribou Habitat Special Area (K-5) and east of the Kalikpik River. While infrastructure and development are allowed within the K-5 area, the agencies suggested locating the drill site outside of this area if practical. CPAI evaluated this request and was able to accommodate it with an associated negative impact to subsurface resource recovery. The shift of the BT4 drillsite caused another evaluation of the road route between BT2 and BT4 including the elimination of a bridge over the Kalikpik River.

CPAI also continued to advance engineering for the proposed project this spring to further avoid and minimize impacts. The most recent revision to the proposed project (March 2019) optimized the road alignments by incorporating the latest topographic data, gathered in the summer of 2018. Changes to the road alignments were made to avoid wetlands that are permanently inundated (H class water regime) or located within 500 feet of fish bearing waters. These changes were made in locations where design constraints would not be compromised. Updates have also been made to estimates of bridge lengths with specific focus on the Fish Creek crossing, reducing the bridge length from the June 2018 concept of 1,100 feet down to the current concept of approximately 500 feet.

Conclusions

From eight original route routes considered, CPAI screened out five using the criteria described above, and then advanced three for inclusion in the EED. CPAI understands that BLM is including CPAI's proposed project and two alternatives in the draft EIS that is in preparation, and that the three EIS alternatives share similar road alignments. While CPAI anticipates further refinements to road alignment may occur as engineering and the NEPA and permitting processes progress, the substantial analysis already completed demonstrate that the road alignments carried forward in the EIS meet the requirements of the 404(b)(1) Guidelines which requires a LEDPA project. As the routes evaluated by CPAI demonstrate, other road alignments, which are not included in the EIS, are unlikely to meet LEDPA requirements because they would result in greater fill to wetlands and would have a greater impact to the environment compared to the alternatives which are included in the EIS.

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Willow Master Development Plan

Appendix I.3 Dust Control Plan (Placeholder for FEIS)

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