Road Network for Utqiaġvik, Atqasuk, and Wainwright
Arctic Strategic Transportation and Resources Project
North Slope, Alaska

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Prepared for

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ACRONYMS

ADF&G	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
ADOT&PF	Alaska Department of Transportation and Public Facilities
AES Alaska	ASRC Energy Services Alaska, Inc.
ASRC	Arctic Slope Regional Corporation
ASTAR	Arctic Strategic Transportation and Resources
BLM	United States Bureau of Land Management
BMP	Best Management Practice(s)
CFR	Code of Federal Regulations
CWAT	Community Winter Access Trail(s)
DEW	Distant Early Warning
EA	Environmental Assessment
EIS	Environmental Impact Statement
EO	Executive Order
GIS	Geographic Information System
IAP	Integrated Activity Plan
LIDAR	Light Detection and Ranging
MP	milepost
NEPA	National Environmental Policy Act
NGO	Non-governmental organization
NPR-A	National Petroleum Reserve – Alaska
NSB	North Slope Borough
OC	Olgoonik Corporation
ROD	Record of Decision
ROW	right-of-way
Section 106	Section 106 of the National Historic Preservation Act
Section 401/404	Sections 401 and 404 of the Clean Water Act
SME	subject matter expert
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service

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EXECUTIVE SUMMARY

This report presents results of a desktop analysis for an all-season gravel access road network connecting the northern Alaskan communities of Utqiaġvik, Atqasuk, and Wainwright. A year-round road network would broaden and diversify the region's transportation system and create economic, cultural, and subsistence opportunities for local residents of these communities. This study was completed for the Arctic Strategic Transportation and Resources (ASTAR) project.

The objective of this desktop analysis was to provide ASTAR stakeholders with a better understanding of potential benefits that could influence future development of the proposed road network, as well as important engineering, environmental, regulatory, and stakeholder inputs that may affect routing. Additionally, this desktop study can assist stakeholders in identifying and filling potential data gaps necessary to support future phases of the project.

This desktop analysis leverages results of a previous study titled *Atqasuk to Utqiaġvik All Season Access Road, Arctic Strategic Transportation and Resources Project, North Slope, Alaska* (AES Alaska 2019). The previous study concluded that Corridor A – Coastal Route appeared to be the most favorable alignment, offering greater benefits than other options, and setting the stage for a road extension to Wainwright. The study also pointed out that linking together the three communities could open opportunities for development of a regional port for freight and fuel deliveries.

The proposed project comprises a network of 2-lane gravel roads that provide a year-round overland transportation link between the existing community road systems of Utqiaġvik, Atqasuk, and Wainwright. Given that the 2019 study already evaluated options for connecting Utqiaġvik and Atqasuk, this report focuses on route alternatives that extend the road system to Wainwright. The all-season gravel road extending to Wainwright would traverse roughly 63 to 69 miles from Corridor A (depending on the connection point) to the OC Road in Wainwright.

For all three villages, a year-round road access offers the potential for increased economic opportunities, increased social and cultural connections, lower costs for goods and services, enhanced subsistence traditions, improved health and safety, greater access to education opportunities, and greater opportunities for training and workforce development.

To assist in identifying feasible routes for connecting to Wainwright, a group of subject matter experts (SMEs) was convened to research, gather, and analyze available information characterizing the project area and describing features and benefits of the project. Both spatial and non-spatial data and background information were gathered. Spatial data were captured in a Geographic Information System (GIS). The data and information were summarized by SMEs in technical memoranda presented in Appendix A. The memoranda address the following key topics that affect the project:

- GIS Raster Analysis
- Land Status
- River Hydrology
- Geology/Geotechnical
- Existing and Proposed Infrastructure
- Roadway Engineering
- Vehicle Bridges
- Cultural Resources
- Paleontological Resources
- Subsistence Patterns
- Wetlands
- Threatened and Endangered Species
- Terrestrial Mammals
- Fish and Fish Habitat
- Avian Resources and Habitat
- Environmental Compliance & Permitting
- Construction Cost

Spatial data were incorporated into a GIS cost-weighted raster analysis. The analysis was used to identify potential route alternatives that align with likely river crossings and account for features and constraints identified in the other technical memoranda. The following corridors were identified as preliminary route alternatives for the road extending to Wainwright:

- Corridor D – Coastal Route Extension
- Corridor E – Middle Route
- Corridor F – Southern Route

Using information in the technical memoranda, the features and benefits of each route alternative were summarized, and the corridors were compared in a matrix with scoring based on degree of favorability. The scoring matrix was weighted by considering eight different stakeholder viewpoints: Federal Government, State Government, Local Government (NSB), community residents, village corporations (Ukpeaġvik Iñupiat Corporation [UIC]; Atqasuk Corporation; Olgoonik Corporation [OC]), regional corporation (Arctic Slope Regional Corporation [ASRC]), environmental non-governmental organizations (NGOs), and pro-development NGOs. The weighted scores were then summed to identify favorable route alternatives.

Based on the outcome of our preliminary analysis and comparison, Corridor D – Coastal Route Extension is the most favorable alternative for connecting to Wainwright, followed by Corridors F – Southern Route and E – Middle Route in descending order.

The road corridors and analysis presented in this report were developed without the benefit of stakeholder engagement, thus outcomes could change. Before advancing the project further, a stakeholder engagement plan should be developed and implemented to solicit specific input to the project, and use the input for refining the project description and evaluation. Stakeholder involvement is one of the most critical components of project analysis, and despite the preliminary information presented in this desktop study, the stakeholder's preferences could significantly alter the study outcome and preferred routing.

The study concludes by recommending follow-on studies and activities to fill data gaps and advance the project.

1.0 Introduction

This report presents the results of a desktop analysis of a proposed all-season gravel access road network connecting the northern Alaskan communities of Utqiaġvik, Atqasuk, and Wainwright. A year-round road network would broaden and diversify the region's transportation system and create economic, cultural, and subsistence opportunities for local residents of these communities. This study was completed by ASRC Energy Services Alaska, Inc. (AES Alaska) and PND Engineers for the Arctic Strategic Transportation and Resources (ASTAR) project.

This proposed project was evaluated using a cumulative benefits analysis process developed specifically for ASTAR. This evaluation found the proposed project provides numerous regional benefits, enhances community connectivity, and receives broad local support. The process for selecting and evaluating this project follows that set forth in the *Assessment of Potential Tools for Cumulative Benefits Analysis* (AES Alaska 2019) prepared for ASTAR. Specifically, the methods presented here fall under Stage 3 of the process where selected projects are given a more rigorous desktop analysis by subject matter experts (SMEs) to characterize the project scope; describe or quantify expected benefits; and identify feasible alternatives, important constraints, data gaps, and other key factors affecting project success.

1.1 Objective

The objective of this desktop analysis is to provide ASTAR stakeholders with a better understanding of potential benefits that could influence future development of the proposed road network, as well as important engineering, environmental, regulatory, and stakeholder inputs that affect routing. Additionally, this desktop study will assist the stakeholders in identifying and filling potential data gaps necessary to support future phases of the project.

2.0 Project Description

2.1 Project Setting

The project area is on Alaska's North Slope within the Arctic Coastal Plain physiographic province. Permafrost soils underlie almost the entire region. Terrain is characterized by arctic tundra with numerous lakes and meandering streams and rivers. The topography is relatively flat, although terraces and steep riverbanks are found adjacent to the major rivers; ground surface elevation within the project area varies from zero to about 140 feet above sea level. The project area is shown on Figure 2.1-1, along with potential route alternatives for the proposed gravel road network. The project area lies within the northwest portion of the National Petroleum Reserve – Alaska (NPR-A), a vast 23 million acre reserve set aside for oil and gas leasing.

The project lies within the Arctic Climate Zone, an area characterized by long, very cold winters, and cool summers. Average monthly temperatures are below freezing for eight months of the year. The sun does not rise during 9-1/2 weeks of winter (mid-November to late January), and does not set for 7-1/2 weeks of summer (early May through early August). Despite 24 hours of sunshine in the summer, the average low temperature is only a few degrees above freezing in July, and snow may fall in any month of the year. Although the terrain is wet in summer, the amount of precipitation is low – less than 5 inches. Despite the proximity of the offshore ice pack to land for many months of the year, the Arctic Ocean has a moderating effect on coastal temperatures. Surface winds are strong at the coast but weaken and become more variable further inland. In recent years, the area has experienced rapid climate change with rising air and water temperatures, and diminishing sea ice.

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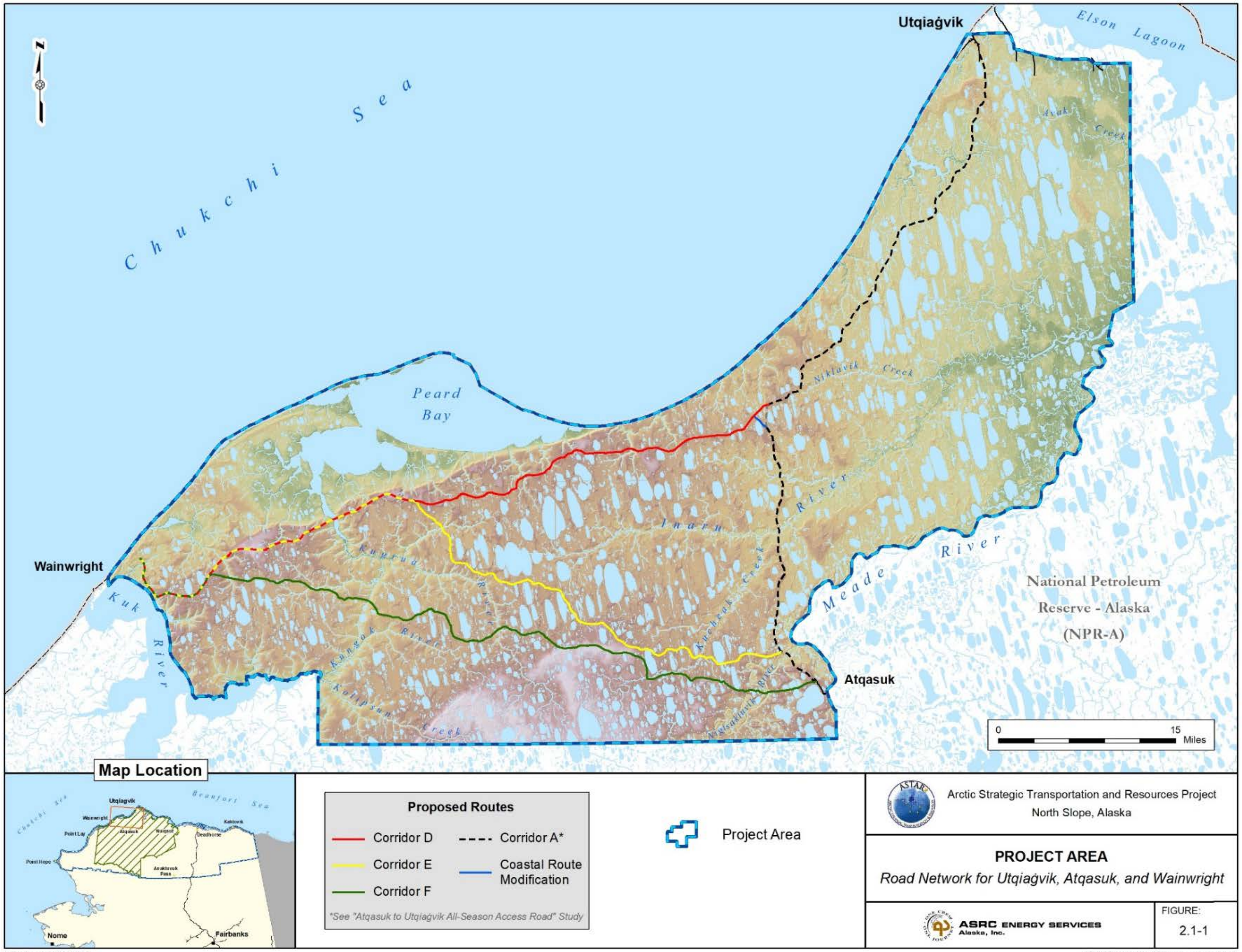
Figure 2.1-1. Project Area Map



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Utqiaġvik (formerly Barrow) is the northernmost community in the United States, at the base of the Point Barrow, and bordered by the Chukchi and Beaufort Seas of the Arctic Ocean (Figure 2.1-2). The surrounding landscape is characterized by tundra with numerous lakes and permafrost soils underlying almost the entire region. The majority of residents are Iñupiat, an indigenous Inuit ethnic group. Utqiaġvik is the largest community on the North Slope with the 2018 population estimate of 5,286 people (North Slope Borough [NSB] 2019). Utqiaġvik is the NSB seat of government where diverse issues converge, among them Native Iñupiat subsistence rights, oil and gas development activity, and the study of climate change in the Arctic (NSB 2015).

Atqasuk is located on the southern extent of the Arctic Coastal Plain, approximately 60 miles south of Utqiaġvik, and 58 miles east of the village of Wainwright. The community is entirely within the boundaries of the NPR-A, managed by the U.S Department of Interior, Bureau of Land Management (BLM). The village lies between Imaġruaq Lake and the Meade River as shown on Figure 2.1-3. The population of Atqasuk has grown steadily over recent years to approximately 261 residents (NSB 2019), with the majority being Iñupiat who practice a subsistence lifestyle.

Wainwright is situated along the Chukchi Sea coastline about 70 miles southwest of Utqiaġvik and 58 miles west of Atqasuk. The community is located on a coastal bluff of a peninsula separating Wainwright Inlet from the Chukchi Sea (Figure 2.1-4). Most Wainwright inhabitants are Iñupiat who practice a subsistence lifestyle. Wainwright is the third largest village in the NSB, and in 2015 had a population of 557 residents (NSB 2019).

2.2 Previous Study

AES Alaska completed a desktop analysis of an all-season road connection between Atqasuk and Utqiaġvik in July 2019, titled *Atqasuk to Utqiaġvik All Season Access Road, Arctic Strategic Transportation and Resources Project, North Slope, Alaska* (AES Alaska 2019). The study concluded that a coastal route appeared to be the most favorable alignment, offering greater benefits than other options (Corridor A – Coastal Route on Figure 2.1-1).

The study also concluded that because the alignment of Corridor A essentially parallels the coastline, it sets the stage for a road extension to Wainwright, offering potential to link together the three communities (Wainwright, Atqasuk, and Utqiaġvik). Connecting the three communities would further enhance the benefits listed in the 2019 study, and could open opportunities for development of a regional port for freight and fuel deliveries. It was also pointed out that simultaneously considering all three communities could result in minor adjustments to portions of the original alignment for Corridor A.

Information from the 2019 study will be leveraged in this report to evaluate an extension of the road system to Wainwright to link the three communities.

2.3 Project Description

Land transportation between the communities of Utqiaġvik, Atqasuk, and Wainwright is limited because there are no year-round road connections. There are historic winter trails between the communities (Figure 2.3-1) for travel by snowmobile or other tundra travel vehicles. The winter trail between Atqasuk and Utqiaġvik has been used to transport fuel to Atqasuk using Rolligons, and to haul gravel from Utqiaġvik with dump trucks outfitted with specialized tires for off-road travel.

In the winter of 2017/2018, the NSB established a Community Winter Access Trail (CWAT) project to allow seasonal movement of goods and services between the communities of Atqasuk and Utqiaġvik, and to connect these communities to the Dalton Highway via the oilfield road network surrounding Prudhoe Bay. In the winter of 2018/2019 the CWAT system was extended to Wainwright. In winter 2019/2020, the CWAT system was again constructed to connect all three communities.

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Figure 2.1-2. Utqiaġvik Area Map

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Figure 2.1-3. Atqasuk Area Map

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Figure 2.1-4. Wainwright Area Map

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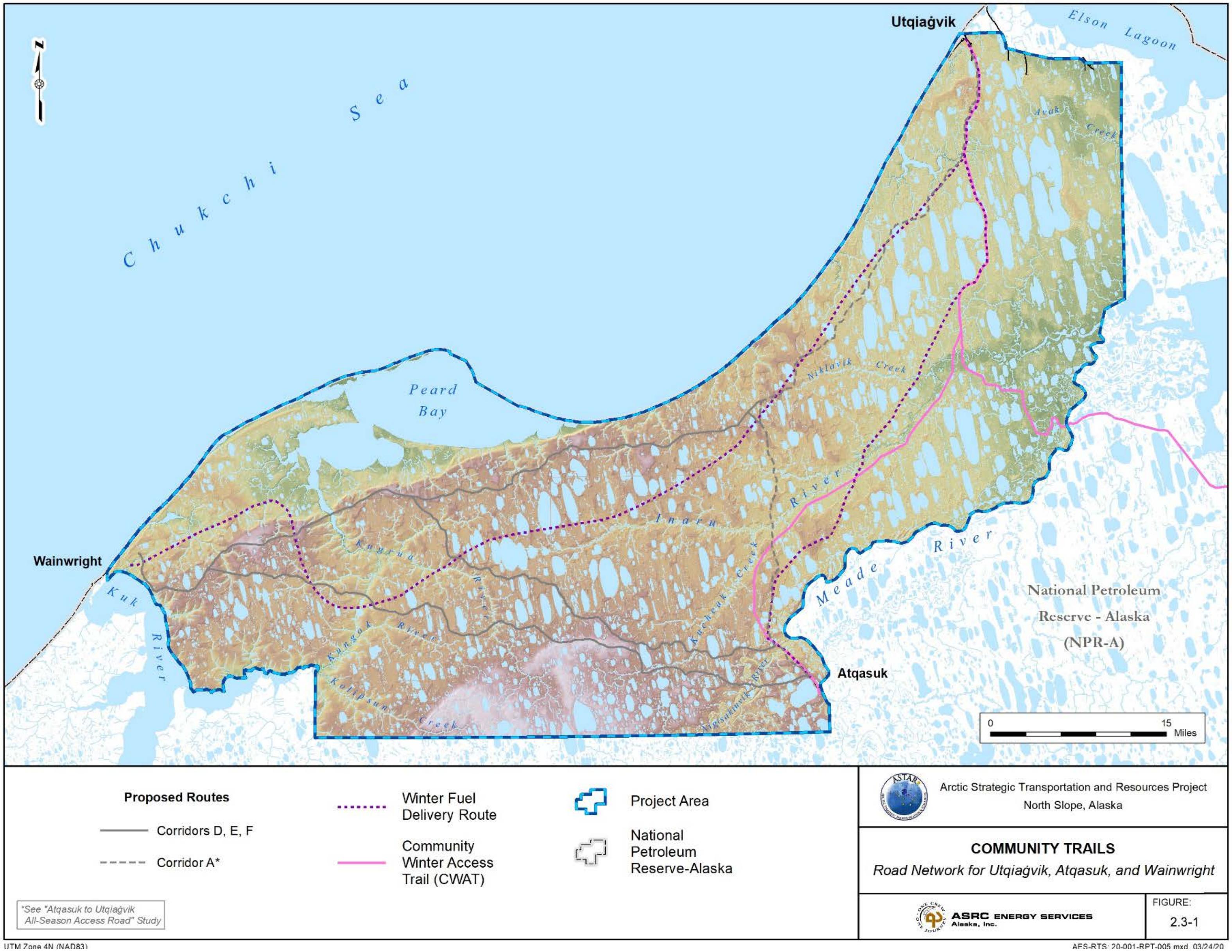
Figure 2.3-1. Community Trails



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As documented in the NSB's Atqasuk Comprehensive Plan (2017), residents of Atqasuk have long sought a gravel road connection to Utqiaġvik and/or Wainwright. Year-round road access offers the possibility of increased economic opportunities, more frequent social and cultural connections, lower costs for goods and services, enhanced subsistence traditions, improved health and safety, access to education opportunities, and enhanced training and workforce development. Each of these benefits is described in greater detail in Section 2.4.

For the purpose of this study, the proposed road network is envisioned as two-lane gravel roads connecting to the existing community road systems of Utqiaġvik, Atqasuk, and Wainwright. Given that the 2019 study already evaluated options for connecting Utqiaġvik and Atqasuk, this report will focus on route alternatives that extend to Wainwright. The all-season gravel road extending to Wainwright would traverse roughly 63 to 69 miles from Corridor A (depending on the connection point) to the Olgoonik Corporation (OC) Road in Wainwright (Figure 2.1-1).

The proposed 2-lane road is expected to be roughly 24.5 feet wide with 2 horizontal to 1 vertical (2H:1V) side slopes and an assumed embankment thickness of 5 feet to protect the underlying permafrost from thermal degradation. The proposed road extension to Wainwright will cross several significant streams and rivers (e.g. Kunarak Creek, Papigak Creek, Walik Creek, Kugrua River, Augman Creek, Sinaruruk Creek, Kucheak Creek, and Nigisaktuvik River), depending on the route selected. These larger crossings will likely require bridges, whereas culverts will be needed for minor drainages along the route. Additional culverts will be required in low-lying areas to facilitate cross drainage during runoff events.

2.4 Benefits of the Proposed Road Network

Table 2.4-1 identifies specific benefits the proposed road provides for residents of Utqiaġvik, Atqasuk, and Wainwright. The list of benefits is not comprehensive, but provides representative examples to highlight key benefits of an all-season road connection. All three communities benefit from the road, however, because Utqiaġvik is larger and already has a wider array of existing services and opportunities, a larger proportion of the benefits are derived by residents of Atqasuk and Wainwright.

Table 2.4-1. Benefits of Proposed Road Network for Utqiaġvik, Atqasuk, and Wainwright

Benefit Category	Representative Examples of Specific Benefits of an All-Season Road
Supports cultural connectivity	Allows more frequent travel between the three communities, enabling additional cross-community connections, increasing the quality of links or bonds among community members, and creating or enhancing the capability to join together in various cultural activities, events, and celebrations. Examples include Inupiaq language workshops, whaling seasons, Kivgiq Festival, Nalukataq, and art workshops (dance, music, and art)
Lowers costs of goods and services	• Allows Atqasuk residents to ship bulk goods by barge or larger aircraft to Utqiaġvik or Wainwright, then retrieve those goods via the all-season road • Sets the stage for a regional port to support shipping for all three communities • Facilitates trucking of gravel to Atqasuk (where gravel is scarce) for expansion or improvements to the airport and community roads • Allows routine transport of bulk fuel from coastal communities to Atqasuk • Permits centralized bulk fuel storage (if desired), decreasing environmental risk and maintenance costs • Facilitates potential installation of gas line from Barrow Gasfields to Atqasuk and/or Wainwright, lowering the cost of power generation and home heating • Alternatively, roads facilitate installation of power line from Utqiaġvik to Atqasuk and/or Wainwright

Benefit Category	Representative Examples of Specific Benefits of an All-Season Road
	• Facilitates potential installation of fiber optic line extension from Wainwright or Utqiaġvik to Atqasuk, allowing high-speed internet connections to the school, facilities, and residences • Lowers the capital cost of infrastructure development like construction of homes, schools, public buildings, commercial buildings, utilities, etc. • Improves accessibility to a greater range of recreational, leisure, entertainment and consumer opportunities like restaurants, hotels, grocery stores, bowling alley, roller rink, etc. • Allows Atqasuk and Wainwright residents access to NSB government offices • Improves access and lowers cost for basic services provided by maintenance technicians, repairmen, skilled labor, etc. • Allows NSB to lower costs of providing and maintaining public services in Atqasuk and Wainwright
Preserves or enhances subsistence traditions	• Allows access to a wider range of subsistence areas for fishing, hunting, and gathering • Allows residents of Atqasuk to more readily participate in whaling or other marine mammal harvest • Allows more access and options for small engine repair, boat repair, snowmachine sales and service, gunsmithing, etc. • Allows more access and options to enhance subsistence economy (e.g. bartering)
Improves health and safety conditions	• Provides an evacuation route from each community in case of natural disaster or emergency • Allows Atqasuk residents to access Samuel Simmonds Memorial Hospital, other healthcare and social service providers, and veterinary services • Provides access to other airports for air ambulance medevac when inclement weather closes one airport • Allows consolidation of waste streams for recycling or disposal • Helps facilitate cleanup of NPR-A legacy wells and other contaminated sites
Improves access to education opportunities	• Allows residents of each community to attend educational events or presentations in the other connected communities • Improves simpler access to participate in or attend competitive sporting events between high schools and middle schools • Allows Atqasuk and Wainwright residents access to Ilisaġvik College • Allows greater access to cultural centers/activities, Simon Paneak Museum, the Iñupiat Heritage Learning Center, and the Residential Learning Center • Allows residents of all three communities to exchange indigenous knowledge (elders/youth; subsistence areas)
Enhances workforce development	• Improves access to more job opportunities for all three communities • Improves access to more skills training and apprenticeship opportunities for all communities • Provides direct jobs for road construction and maintenance • Could provide the catalyst for new business opportunities • Allows opportunities for workers to fill needed local service gaps for auto repair, plumbing, electrical, child care, construction, and many other services

3.0 Data Analysis and Corridor Identification

There are numerous criteria and constraints that affect routing of proposed connecting roads. The preferred routes are often based on a balance of cost, engineering, environmental, and sociocultural factors. In order to assess the most advantageous route alignments, the first step typically involves analysis of available data to recognize and describe key issues, inform stakeholders, and identify data gaps. The following sections outline the methodology used to identify and characterize the key issues for the proposed road extension, develop route alternatives, and analyze those alternatives.

3.1 Project Area Boundaries

The project area is bounded by Atqasuk and Wainwright to the south, Utqiaġvik to the north, the Chukchi Sea coast to the west, and the Meade River to the east (Figure 2.1-1).

3.2 Methodology

To assist in identifying feasible routes for an all-season road, a group of SMEs was convened to research, gather, and analyze available information characterizing the project area and describing features and benefits of the project. Both spatial and non-spatial data and background information were gathered. Spatial data were captured in a Geographic Information System (GIS). The data and information were summarized by SMEs in technical memoranda presented in Appendix A. The memoranda address the following key topics that affect the project:

- GIS Raster Analysis
- Land Status
- River Hydrology
- Geology/Geotechnical
- Existing and Proposed Infrastructure
- Roadway Engineering Considerations
- Vehicle Bridges
- Cultural Resources
- Paleontological Resources
- Subsistence Patterns
- Wetlands
- Threatened and Endangered Species
- Terrestrial Mammals
- Fish and Fish Habitat
- Avian Resources and Habitat
- Environmental Compliance & Permitting
- Construction Cost

Spatial data were incorporated into a GIS cost-weighted raster analysis. The analysis was used to identify potential route alternatives that align with likely river crossings and account for features and constraints identified in the other technical memoranda.

3.3 Corridor Alternatives

The following corridors were identified as preliminary route alternatives for the road (Figure 2.1-1):

- Corridor D – Coastal Route Extension
- Corridor E – Middle Route
- Corridor F – Southern Route

Each of these routes ultimately connect to Route A – Coastal Route identified in the 2019 *Atqasuk to Utqiaġvik All Season Access Road, Arctic Strategic Transportation and Resources Project, North Slope, Alaska* (AES Alaska 2019).

3.3.1 Corridor D – Coastal Route Extension

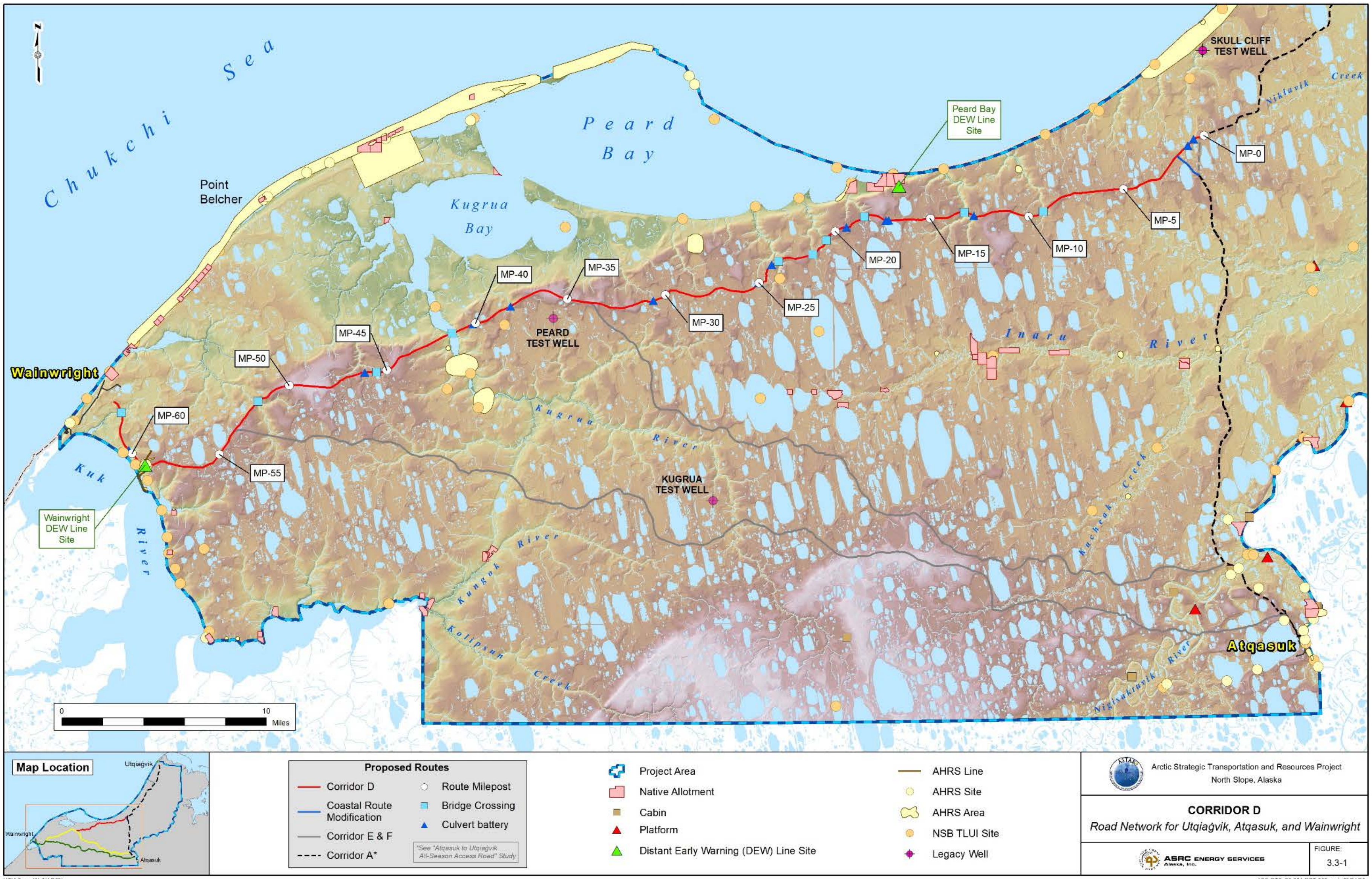
Corridor D is shown on Figures 2.1-1 and 3.3-1. The corridor begins at about Milepost (MP) 39 of Corridor A and heads southwest 62.9 miles where it meets OC's road on the outskirts of Wainwright. The route favors higher ground near the coast, but was pushed back from the coast in some areas in favor of fewer and shorter stream crossings. Corridor D has the greatest potential for material sources as it is routed near or parallel to ancient beach deposits. The Peard Bay Distant Early Warning (DEW) Line site is situated on one of these ancient beaches, about 1.5 miles from the proposed alignment. There is a 2,000-foot long airstrip and 2-acre gravel pad that could serve as a staging area for road construction and material site development. This route minimizes impacts to high-value wetlands since it is generally routed along higher and drier ground, which also results in avoiding potential habitats for loons and eiders.

After departing from Corridor A, Corridor D is generally oriented southwest for its first 3 miles before turning more westerly for 13 miles to a point 1.5 miles south of the Peard Bay DEW Line site. The corridor is approximately 2 to 4 miles inland from the Chukchi Sea coastline along this stretch and traverses two bridge crossings at Kunarak Creek (MP 9) and Papigak Creek (MP 13).

The corridor again turns southwest at MP 18 before making a bridge crossing of an unnamed stream. The corridor trends southwest to MP 26, crossing two minor streams requiring bridge crossings near MPs 21 and 21.5, as well as at Walik Creek (MP 23.5), before turning westward again for approximately 10 miles. At this point, the corridor turns southwest to a major bridge crossing of the Kugrua River beginning at MP 41. The crossing takes advantage of points of land that extend into the floodplain and narrow the bridge span. The corridor continues southwest to MP 48, making one minor bridge crossing at MP 45.6, heads west to MP 50 and then southwest again to MP 56. Along this stretch the corridor encounters a bridge crossing of the Sinaruruk River near MP 52. Beginning at MP 56 the corridor runs west before intersecting with infrastructure associated with the Wainwright DEW Line site. From the DEW Line site the corridor generally runs northwest around the west end of the site and north to a bridge crossing just beyond MP 62 before arriving at its terminus at the OC road.

Corridor D is 5 or 6 miles shorter than Corridors E and F. In conjunction with Corridor A, the distance from Wainwright to Utqiaġvik is 102 miles, approximately 30 miles shorter than travel along Corridor E or F. Consequently, travel from Wainwright to Atqasuk would be 17 miles longer than Corridor E and 22 miles longer than Corridor F. It is also worth noting that in conjunction with the Corridor A, a round trip from Utqiaġvik to Wainwright to Atqasuk and back to Utqiaġvik would be 257 miles; approximately 12 miles shorter than a round-trip incorporating Corridor E, and 10 miles shorter than a round trip incorporating Corridor F. The shortest round-trip distance among the three communities is only accomplished with the construction of Corridors A, D, and F. This would be a 235 mile round-trip, approximately 21 miles shorter than just Corridors A and D. However, providing two routes connecting Wainwright and Atqasuk would likely be cost prohibitive.

Figure 3.3-1. Corridor D – Coastal Route Extension



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3.3.2 Corridor E – Middle Route

Corridor E is shown on Figures 2.1-1 and 3.3-2. The corridor begins at approximately MP 4 of Corridor A just northwest of its crossing of the Nigisaktuvik River and spans approximately 68.8 miles to a junction point with OC's road in Wainwright. Corridor E follows a westerly path for its first 14 miles, crossing Kucheak Creek near MP 7.5, before following a generally northwest course for 24 miles along which it crosses three unnamed streams requiring bridge crossings near MPs 22.5, 25.5 and 36.5. This corridor intersects Corridor D near MP 40, at which point the two corridors are coincident to their common termini at the OC road.

Corridor E negotiates the poorly-drained terrains of numerous thaw lake deposits by attempting to utilize slightly elevated areas predominantly comprised of marine sands. Material sources along this route are anticipated to be of poor quality, and this route will likely require substantially more fill to construct an adequate embankment through saturated ground. As such, high-value wetlands and loon and eider habitat have potential to be compromised. Corridor E crosses three K-1 river setbacks and one K-2 deep-water lake setback as described in BLM's Record of Decision (ROD) for NPR-A. Preliminary construction cost estimates for this route are higher than the other two alternatives.

Corridor E is the longest route at approximately 68.8 miles, and also the longest total travel distance from Wainwright to Atqasuk at 73 miles. Travel from Wainwright to Utqiaġvik via Corridor E and Corridor A is 130 miles; 28 miles longer than Corridor D and 4 miles longer than Corridor F.

3.3.3 Corridor F – Southern Route

Corridor F is shown on Figures 2.1-1 and 3.3-3. The corridor begins at a junction with the Atqasuk Landfill Road and covers approximately 68.2 miles to a junction point with OC's road in Wainwright. Corridor F begins on a westerly path for its first 15 miles, (crossing the Nigisaktuvik River just west of MP 4), before turning north to cross Kucheak Creek near MP 16 and then turning again at MP 17 to follow a generally northwest course for 42 miles. Along this span, the corridor encounters six bridge crossings at the Kugrua River (MP 30.5); unnamed streams at MPs 44.5, 48, 50, and 53; and the Sinaruruk River (MP 57). This corridor intersects Corridors D and E near MP 59, at which point all three corridors are coincident to their common termini at the OC road.

Similar to Corridor E, Corridor F attempts to utilize higher, better drained marine sands but remains encumbered by the numerous thaw lake deposits. This results in poor material site potential and greater fill requirements. There may be slightly better material site potential at one ancient beach deposit near this alignment at MP 18. Corridor F has the most stream crossings of all the routes, and crosses three K-1 river setbacks and one K-2 deep-water lake setback. Impacts to high-value wetlands are likely and will require a greater permitting effort. Loon and eider habitat may be encountered, but slightly less than Corridor E due to its distance from the coast. Despite these drawbacks, Corridor F has the lowest preliminary construction cost estimate. Corridor F also provides access for any remediation at the Kugrua #1 legacy wellsite.

Corridor F starts in Atqasuk and ends in Wainwright, and has the shortest travel distance between the two villages at 68.2 miles. However, the travel distance from Wainwright to Utqiaġvik is 134 miles; approximately 4 miles longer than Corridor E and 32 miles longer than Corridor D.

3.3.4 Coastal Route Modification

The Coastal Route Modification is shown on Figures 2.1-1 and 3.3-1. This alignment represents an alternative connector for joining Corridor D to Corridor A. It begins just beyond MP 24 of Corridor A and traverses approximately 1.5 miles to its intersection near MP 2 of Corridor D. This alignment does not cross any apparent drainage features.

The Coastal Route Modification reduces the travel distance from Wainwright to Atqasuk by approximately 3.5 miles, but increases travel distance from Atqasuk to Utqiaġvik by approximately 2.5 miles.

3.3.5 GIS Cost-Weighted Raster Analysis

Alignment of all three corridors were informed by the results of the GIS cost-weighted analysis, as well as SME consultation, aerial imagery, and other GIS datasets, such as the National Hydrography Dataset for crossing locations and alignment. The process used to generate the three initial GIS cost-weighted routes is described in Technical Memorandum 1 in Appendix A.

All three cost-weighted routes required substantial post-process re-alignment to develop corridors satisfying the evaluation and scrutiny of SMEs. Paramount in this process was evaluation of routes and adjustments required to limit the number and size of river and stream crossings; to place those crossings at reasonable locations; to provide better clearance of geohazards; to locate alignments on better-drained higher ground when possible; and to provide alignments that allow for reasonable travel speeds (i.e. smoothing road curves and improving approaches to bridge crossings).

3.3.6 Summary of Corridor Features and Benefits

More detailed descriptions of the route features are included in the memoranda in Appendix A. Table 3.3-1 presents a summary of features and benefits unique to each of the corridors for comparison and contrast.

Figure 3.3-2. Corridor E – Middle Route

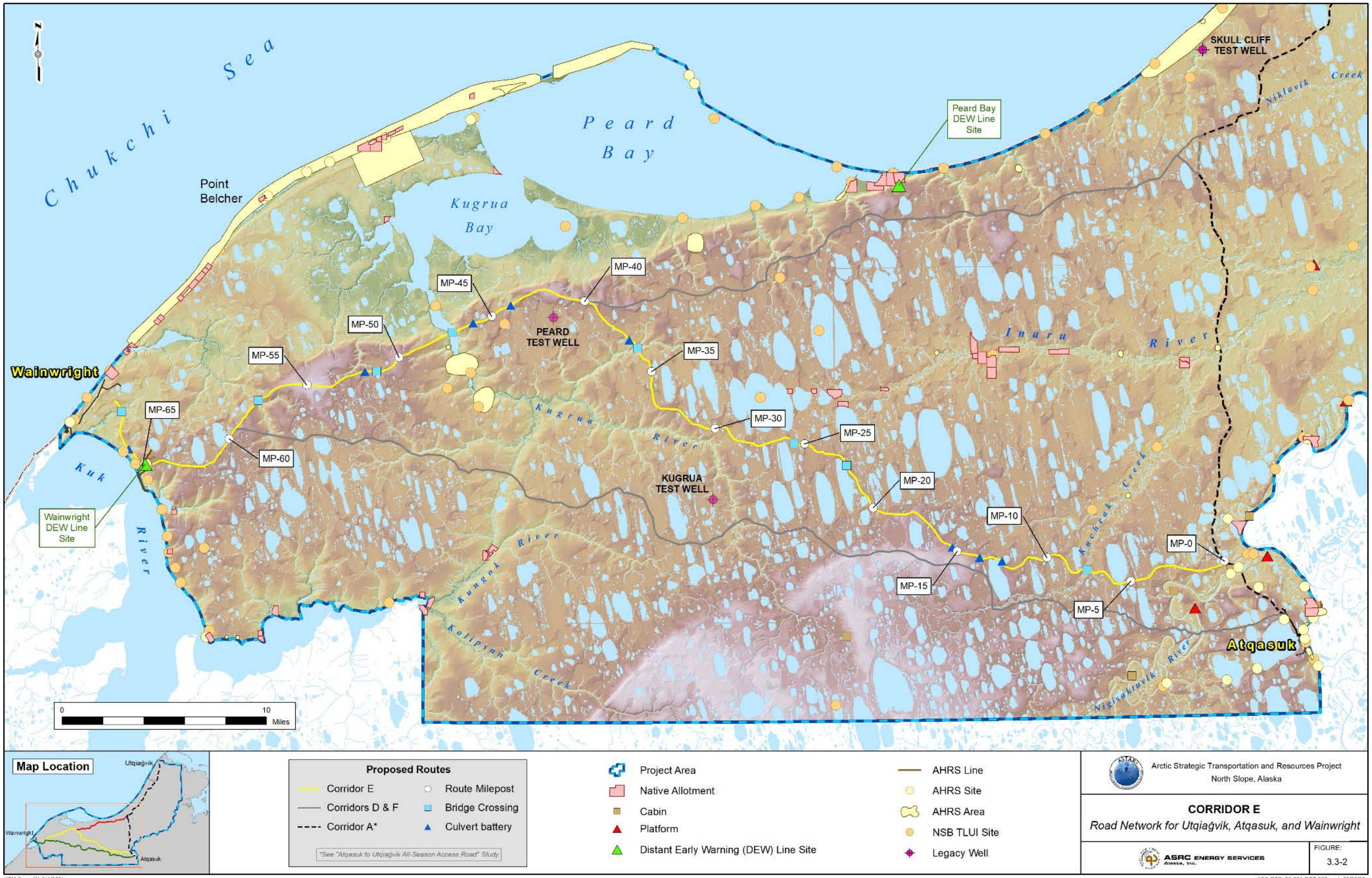

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Figure 3.3-3. Corridor F – Southern Route

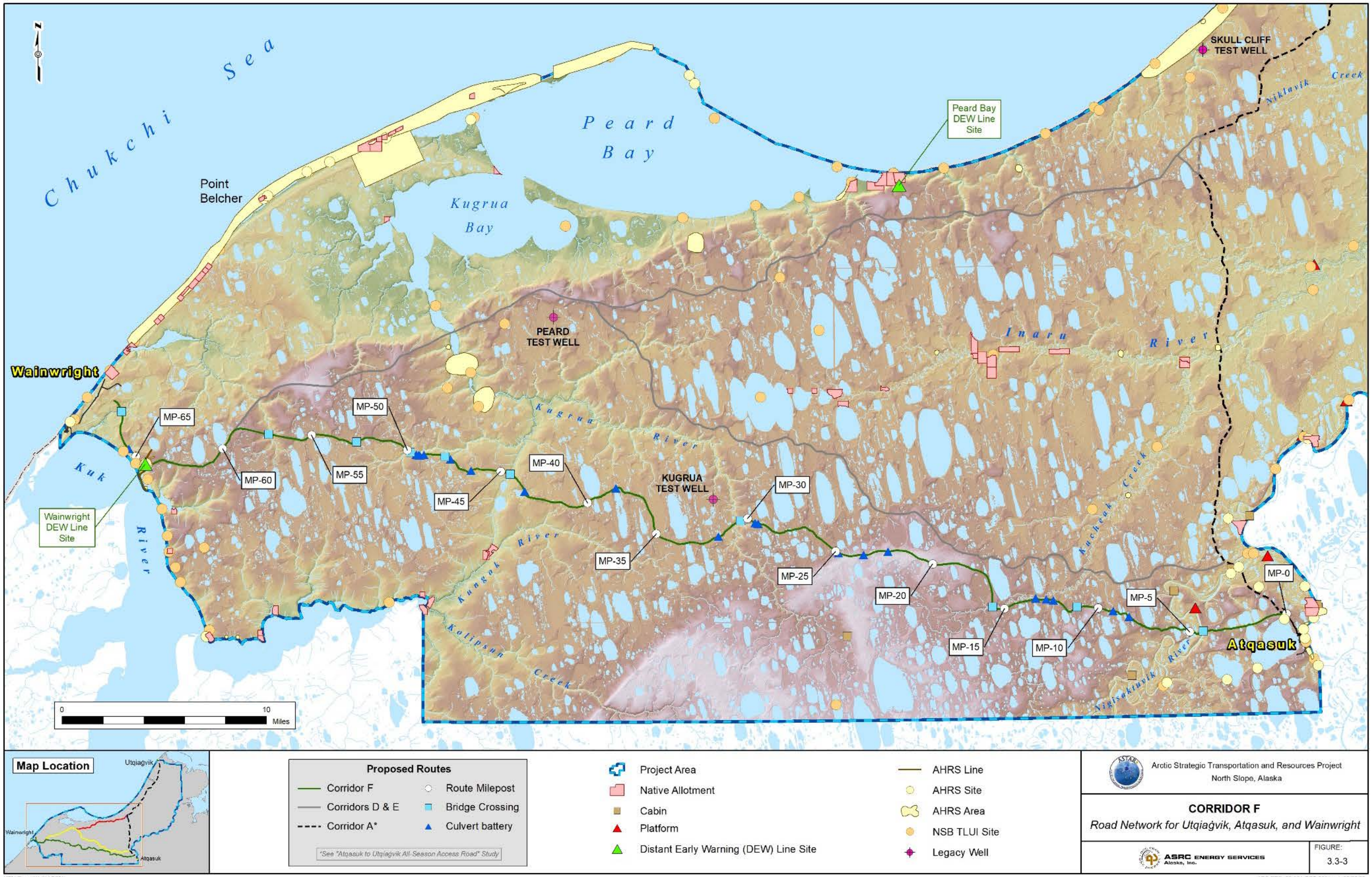

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Table 3.3-1. Summary of Features and Benefits of Each Corridor

Criteria	Reference	Corridor D Coastal Route Extension	Corridor E Middle Route	Corridor F Southern Route
Benefits Overview	Table 2.4-1	In addition to the overall benefits of a road listed in Section 2.4, Corridor D provides the following specific benefits: • Corridor D could help set the stage for development of a regional port facility. Point Belcher north of MP 49 of the route has been considered as a possible deep water port location for marine vessels transiting the area. • Corridor D traverses the Kugrua River, where a boat launch could be constructed to provide access to Kugrua Bay and Peard Bay for marine mammal hunting. • If the road is constructed along Corridor D, it facilitates access to the vicinity of Peard #1 legacy well, significantly reducing the cost of surface cleanup of the well site and proper plugging and abandonment of the well. The well is currently in use as a permafrost temperature monitoring well. • In comparison to the other route alternatives, Corridor D is the most advantageous route for preserving high-value wetlands; potential eider nesting habitat and Yellow-billed loon habitat; and for complying with BLM NPR-A Best Management Practices for lake and river setbacks. • Corridor D traverses the vicinity of the Peard Bay DEW Line site. The site includes a gravel road to the beach, pads, and a 2,000-foot long runway. The site could be used as a staging area for road construction and/or oil and gas exploration activities, and could easily be connected (seasonally or permanently) to the permanent road network. • All three corridor alternatives connect to the Wainwright DEW Line site. Residents of Wainwright have expressed desire for a permanent road connection to the site, to allow use and further development of the runway, pads, and boat launch.	In addition to the overall benefits of a road listed in Section 2.4, Corridor E provides the following specific benefits: • Corridor E could help set the stage for development of a regional port facility. Point Belcher north of MP 54 of the route has been considered as a possible deep water port location for marine vessels transiting the area. • Corridor E traverses the Kugrua River, where a boat launch could be constructed to provide access to Kugrua Bay and Peard Bay for marine mammal hunting. • Corridor E routes in the general vicinity of the Peard #1 and the Kugrua #1 legacy well sites, significantly reducing the cost of surface cleanup of these well sites and proper plugging and abandonment of the wells. Both wells are currently in use as permafrost temperature monitoring wells. • All three corridor alternatives connect to the Wainwright DEW Line site. Residents of Wainwright have expressed desire for a permanent road connection to the site, to allow use and further development of the runway, pads, and boat launch.	In addition to the overall benefits of a road listed in Section 2.4, Corridor F provides the following specific benefits: • Corridor F routes in the general vicinity of the Kugrua #1 legacy well site, significantly reducing the cost of surface cleanup of the well site and proper plugging and abandonment of the well. The well is currently in use as a permafrost temperature monitoring well. • All three corridor alternatives connect to the Wainwright DEW Line site. Residents of Wainwright have expressed desire for a permanent road connection to the site, to allow use and further development of the runway, pads, and boat launch.
Land Status	Appendix A, Tech Memo 2	Route traverses through surface lands owned by OC and the U.S. government (NPR-A). Corridor D traverses one river setback area at the Kugrua River (reference 2013 BLM ROD, K-1 Best Management Practice.	Route traverses through surface lands owned by OC and the U.S. government (NPR-A). Corridor E traverses three river setback areas at the Kugrua River, Nigisaktuvik River, and Kucheak Creek; and one deep-water lake setback area (reference 2013 BLM ROD, K-1 and K-2 Best Management Practice).	Route traverses through surface lands owned by Atqasuk Corporation, OC and the U.S. government (NPR-A). Corridor F traverses three river setback areas at the Nigisaktuvik River, Kucheak Creek, and the Kugrua River; and one deep-water lake setback area (reference 2013 BLM ROD, K-1 and K-2 Best Management Practice).
Hydrology	Appendix A, Tech Memo 3	Coastal Route Extension corridor has approximately 23 river and stream crossings, with the Kugrua River, Kunarak Creek, Papigak Creek, Sinaruruk River, and Walik Creek being the most notable. As described above, the route traverses one K-1 river setback area.	Middle Route corridor has approximately 17 river and stream crossings, with Kucheak Creek, Kugrua River, and Sinaruruk River being the most notable. As described above, the route traverses three K-1 river setback areas, and one K-2 deep-water lake setback.	Southern Route corridor has approximately 30 river and stream crossings, with Kucheak Creek, the Kugrua River, the Nigisaktuvik River, and Sinaruruk River being the most notable. As described above, the route traverses three K-1 river setback areas, and one K-2 deep-water lake setback.
Geology / Geotechnical	Appendix A, Tech Memo 4	Near Wainwright, OC has existing gravel mine sites at Tupkak Bar near Wainwright Inlet, and at the confluence of Omikmuk Creek with the Kuk River. In addition, several other undeveloped potential mine sites lie further south along the Kuk River. Atqasuk has historically dredged gravelly sand from Imagruaq Lake west of the village. Along Corridor D, geologic interpretation suggests there may be gravel or sand sources near MPs 18, 36, and 51; however, field investigation is needed to validate this interpretation. When compared with the other route alternatives, Corridor D appears to have better drained and less icy subgrade soils.	Near Wainwright, OC has existing gravel mine sites at Tupkak Bar near Wainwright Inlet, and at the confluence of Omikmuk Creek with the Kuk River. In addition, several other undeveloped potential mine sites lie further south along the Kuk River. Atqasuk has historically dredged gravelly sand from Imagruaq Lake west of the village. Along Corridor E, geologic interpretation suggests there may be gravel sources near MPs 1, 30, and 58; however, field investigation is needed to validate this interpretation. A significant portion of Corridor E traverses poorly drained and icy subgrade soils.	Near Wainwright, OC has existing gravel mine sites at Tupkak Bar near Wainwright Inlet, and at the confluence of Omikmuk Creek with the Kuk River. In addition, several other undeveloped potential mine sites lie further south along the Kuk River. Atqasuk has historically dredged gravelly sand from Imagruaq Lake west of the village. Along Corridor F, geologic interpretation suggests there may be gravel sources near MPs 6, 25, and 44; however, field investigation is needed to validate this interpretation. A significant portion of Corridor F traverses poorly drained and icy subgrade soils.

Criteria	Reference	Corridor D Coastal Route Extension	Corridor E Middle Route	Corridor F Southern Route
Existing and Proposed Infrastructure	Appendix A, Tech Memo 5	Corridor D traverses near the vicinity of the Peard Bay DEW Line site. The site includes a gravel road to the beach, pads, and a 2,000-foot long runway. The site could be used as a staging area for oil and gas exploration activities. Corridor D intersects with the Wainwright DEW Line site, providing gravel infrastructure that could be used by Wainwright for development of an industrial area or an alternate airport. Corridor D best sets the stage for a regional port facility. Point Belcher (9.5 miles north of MP 49 of the route) has been considered as a possible deep water port location for marine vessels transiting the area. Although Corridor D improves access to the Peard #1 legacy well, the site is considered low risk for contaminants, and the well is currently being used to monitor permafrost temperatures. Nevertheless, the route does improve access and lowers the cost of site cleanup and proper plugging and abandonment of the well.	Corridor E intersects with the Wainwright DEW Line site, providing gravel infrastructure that could be used by Wainwright for development of an industrial area or an alternate airport. Corridor E could also set the stage for a regional port facility. Point Belcher (9.5 miles north of MP 54 of the route) has been considered as a possible deep water port location for marine vessels transiting the area. Although Corridor E improves access to the Peard #1 and Kugra #1 legacy wells, the sites are considered low risk for contaminants, and the wells are currently being used to monitor permafrost temperatures. Nevertheless, the route does improve access and lowers the cost of site cleanup and proper plugging and abandonment of the wells.	Corridor F intersects with the Wainwright DEW Line site, providing gravel infrastructure that could be used by Wainwright for development of an industrial area or an alternate airport Although Corridor F improves access to the Kugrua #1 legacy well, the site is considered low risk for contaminants, and the well is currently being used to monitor permafrost temperatures. Nevertheless, the route does improve access and lowers the cost of site cleanup and proper plugging and abandonment of the well.
Roadway Engineering Considerations	Appendix A, Tech Memo 6	Starting Point: Intersection with Route A MP 39 Ending Point: Wainwright, OC Road Route Length: 62.9 miles Min/Max Elevation: 1 feet / 118 feet	Starting Point: Route A, MP 4 (NW of Atqasuk) Ending Point: OC Road Route Length: 68.8 miles Min/Max Elevation: 1 feet / 118 feet	Starting Point: Atqasuk Landfill Access Road Ending Point: OC Road Route Length: 68.2 miles Min/Max Elevation: 17 feet / 118 feet
Vehicle Bridges	Appendix A, Tech Memo 7	Total River and Stream Crossings: 23 Total Bridges: 10 Aggregate Bridge Length: 2030 feet Major Bridges (>100 feet): 1 Intermediate Bridges (50-100 feet): 3 Minor Bridges (<50 feet): 6 Culvert Batteries: 13	Total River and Stream Crossings: 17 Total Bridges: 9 Aggregate Bridge Length: 2020 feet Major Bridges (>100 feet): 2 Intermediate Bridges (50-100 feet): 0 Minor Bridges (<50 feet): 7 Culvert Batteries: 8	Total River and Stream Crossings: 30 Total Bridges: 10 Aggregate Bridge Length: 1145 feet Major Bridges (>100 feet): 2 Intermediate Bridges (50-100 feet): 4 Minor Bridges (<50 feet): 4 Culvert Batteries: 20
Cultural Resources	Appendix A, Tech Memo 8	Corridor D encounters nine known cultural resource sites in the vicinity of Wainwright, all of them associated with the former Wainwright DEW line station. Future route adjustments or other mitigation measures can be implemented to preserve cultural resources that are currently known or are identified during later project stages.	Corridor E encounters nine known cultural resource sites in the vicinity of Wainwright, all of them associated with the former Wainwright DEW line station. Future route adjustments or other mitigation measures can be implemented to preserve cultural resources that are currently known or are identified during later project stages.	Corridor F encounters nine known cultural resource sites in the vicinity of Wainwright, all of them associated with the former Wainwright DEW line station. Future route adjustments or other mitigation measures can be implemented to preserve cultural resources that are currently known or are identified during later project stages.
Paleontological Resources	Appendix A, Tech Memo 9	Corridor D does not intersect any known paleontological sites	Corridor E does not intersect any known paleontological sites	Corridor F does not intersect any known paleontological sites
Subsistence Patterns	Appendix A, Tech Memo 10	All routes pass through subsistence use areas. Corridor D does not have any known Native allotments, camps, or cabins within the alignment, nor does it traverse within 1 mile of any.	All routes pass through subsistence use areas. Corridor E does not have any known Native allotments, camps, or cabins within the alignment. At the intersection with Corridor A near Atqasuk, Corridor E is approximately 2,500 ft from a cabin located on the northern bank of the Nigisaktuvik River.	All routes pass through subsistence use areas. Corridor F does not have any known Native allotments, camps, or cabins within the alignment. At the intersection with the Landfill Access Road near Atqasuk, Corridor F is slightly less than 1 mile from two Native Allotments that abut the Meade River.
Wetlands	Appendix A, Tech Memo 11	In comparison to the other route alternatives, Corridor D is the most advantageous route for preserving high-value wetlands; potential eider nesting habitat and Yellow-billed loon habitat; and for complying with BLM NPR-A Best Management Practices for lake and river setbacks. Corridor D and E have equal impact to known anadromous waters and intertidal waters.	Corridors E and F are less favorable than Corridor D for avoiding wetlands that may require compensatory mitigation. Based on the current USACE process, Corridors E and F are less favorable than Corridor D because they traverse more high value wetlands; more potential eider and loon habitat; and more lake and river setback areas. Corridors E and D have equal impact to known anadromous waters and intertidal waters.	Corridors E and F are less favorable than Corridor D for avoiding wetlands that may require compensatory mitigation. Based on the current USACE process, Corridors E and F are less favorable than Corridor D because they traverse more high value wetlands; more potential eider and loon habitat; and more lake and river setback areas.
Threatened and Endangered Species	Appendix A, Tech Memo 12	Corridor D traverses through the least amount of lakes and is least likely to encounter potential habitat for Spectacled or Steller's eiders.	When compared with Corridor D, Corridor E traverses through an area of numerous large lakes and is more likely to encounter potential habitat for Spectacled or Steller's eiders.	When compared with Corridor D, Corridor F traverses through an area of numerous lakes and is more likely to encounter potential habitat for eiders.
Terrestrial Mammals	Appendix A, Tech Memo 13	All route alternatives intersect terrestrial mammal habitat. Both the Western Arctic Herd and the Teshekpuk Herd migrate through the project area, and residents are sensitive to potential disruptions of caribou movements. Corridor D is oriented essentially parallel with migration pathways and is less likely to disrupt movements.	All route alternatives intersect terrestrial mammal habitat. Both the Western Arctic Herd and the Teshekpuk Herd migrate through the project area, and residents are sensitive to potential disruptions of caribou movements. The orientation of Corridors E and F will require a greater number of crossings and is more likely to disrupt movements than Corridor D.	All route alternatives intersect terrestrial mammal habitat. Both the Western Arctic Herd and the Teshekpuk Herd migrate through the project area, and residents are sensitive to potential disruptions of caribou movements. The orientation of Corridors E and F will require a greater number of crossings and is more likely to disrupt movements than Corridor D.

Criteria	Reference	Corridor D Coastal Route Extension	Corridor E Middle Route	Corridor F Southern Route
Fish & Fish Habitat	Appendix A, Tech Memo 14	Corridor D crosses one designated anadromous stream (Kugrua River). However, fish surveys will be required at other streams to assess the presence or absence of anadromous fish.	Corridor E crosses one designated anadromous stream (Kugrua River). However, fish surveys will be required at other streams to assess the presence or absence of anadromous fish.	Corridor F does not cross any known anadromous streams. However, fish surveys will be required at stream crossings to assess the presence or absence of anadromous fish.
Avian Resources and Habitat	Appendix A, Tech Memo 15	Corridor D is likely to encounter less nesting habitat than Corridor E, but more than Corridor F. Nesting surveys and potential route adjustments will be required in later stages of the project.	Compared with the other route alternatives, Corridor E is likely to encounter the most nesting habitat. Nesting surveys and potential route adjustments will be required in later stages of the project.	Given its location far from the coast, Corridor F is expected to traverse the least nesting habitat. However, nesting surveys and potential route adjustments will be required in later stages of the project.
Environmental Compliance and Permitting	Appendix A, Tech Memo 16	Compared with the other alternatives, Corridor D encounters the least number of river setbacks, and will require the least permitting effort for wetlands.	When compared with Corridor D, Corridors E and F intersect a greater number of K-1 river setbacks and K-2 deep-water lake setbacks. In addition, Corridors E and F will require greater permitting effort for wetlands impacts.	When compared with Corridor D, Corridors E and F intersect a greater number of K-1 river setbacks and K-2 deep-water lake setbacks. In addition, Corridors E and F will require greater permitting effort for wetlands impacts.
Construction Cost	Appendix A, Tech Memo 17	The cost estimate for Corridor D is higher than Corridor F, but lower than Corridor E (highest)	The estimated construction cost for Corridor E is higher than Corridors D and F	Corridor F is the least costly alternative

Notes:

BLM = United States Bureau of Land Management
DEW = Distant Early Warning
MP = milepost
NPR-A = National Petroleum Reserve – Alaska
ROD = Record of Decision
USACE = United States Army Corps of Engineers

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4.0 Corridor Evaluation

Using the available information, each corridor alternative has been analyzed and ranked in a decision matrix as described in the following sections. The decision matrix is based on the benefits-related criteria and constraints identified in Sections 2.4 and 3.2, respectively, and supported by the information compiled in the technical memoranda (Appendix A).

4.1 Corridor Evaluation Criteria

Table 4.1-1 lists each of the decision matrix criteria along with a brief description of the associated factors and constraints to be considered for evaluation.

Table 4.1-1. Decision Matrix Evaluation Criteria for Road Network

Primary Criterion	Factors and Constraints
Benefits-Related Criteria	**To What Degree Does the Route...**
Supports Cultural Connectivity	Improve physical access between the communities. Create or enhance the capability to join together in various activities
Lowers Costs of Goods and Services	Lower the cost of energy, basic goods, utilities, and other services
Preserves or Enhances Subsistence Traditions	Improve local community access to subsistence resources while protecting those resources from outside pressure
Improves Health and Safety Conditions	Provide direct access to medical facilities and services, search and rescue personnel and law enforcement. Increase sustainability of necessary utilities.
Improves Access to Education Opportunities	Create physical access to education facilities, or facilitate attendance at schools, training centers, campuses, and cultural centers/activities
Enhances Workforce Development	Provide temporary and long-term jobs, identify and fill much-needed local service gaps, provide access to skills training or workplace experience, etc.
Constraints-Related Criteria	**To What Degree Does the Route...**
Land Status	Consider land ownership, leases, rights-of-way, Special Areas, etc.
Hydrology	Minimize river and stream crossings, locate crossings with stable bank conditions, consider BLM Best Management Practices setbacks
Geology/ Geotechnical	Consider granular material sources, avoid geohazards, where possible route over favorable (less icy) in situ soils
Existing and Proposed Infrastructure	Take advantage of existing infrastructure where possible, consider synergies between proposed road and other existing or proposed infrastructure
Roadway Engineering Considerations	Consider topography, bridges, culverts, design criteria, material needs and haul distances
Vehicle Bridges	Minimize the number and length of bridges and culverts
Cultural and Paleontological Resources	Avoid impacts to cultural or paleontological resources
Subsistence Patterns	Consider subsistence patterns and avoid or minimize encroachment on Native allotments, camps, or cabins
Wetlands	Avoid or minimize impacts to wetlands that would require compensatory mitigation
Threatened & Endangered Species	Consider regulatory constraints and Best Management Practices for eiders, Polar Bears, and Yellow-billed Loons
Terrestrial Mammals	Avoid or minimize disturbance to terrestrial mammals and habitat
Fish and Fish Habitat	Consider anadromous streams and crossing modes
Avian Resources and Habitat	Avoid eider and Yellow-billed Loon nesting locations and waterfowl nesting concentration areas
Environmental Compliance and Permitting	Minimize environmental and compliance permitting challenges
Construction Cost Estimate	Minimize overall construction cost to the extent practicable

4.2 Matrix Scoring

Table 4.2-1 presents a summary of the criteria scoring for each corridor. Based on the information in the technical memoranda and on the information presented in Table 4.1-1, each route alternative has been subjectively rated by SMEs with regard to each criterion. Each route has been assigned a score from 1 to 5 for each criterion using the Likert scale below.

Degree of Favorability
1 – Not at all favorable
2 – Low favorability
3 – Moderately favorable
4 – Very favorable
5 – Extremely favorable

Table 4.2-1. Scoring for Each Corridor Based on Criteria

Criteria	Corridor D Coastal Route Ext.	Corridor E Middle Route	Corridor F Eastern Route	Notes
Supports Cultural Connectivity	5	5	5	All three routes support cultural connectivity.
Lowers Costs of Goods and Services	5	5	5	All routes lower the costs of goods and services.
Preserves or Enhances Subsistence Traditions	5	4	3	All routes enhance access to potential subsistence resources while protecting those resources from outside pressure. Given its proximity to the coastline, Corridor D is the most favorable route for enhancing access to potential marine mammal harvest areas, followed by Corridors E and F. Corridors D and E provide access to the Kugrua River where boats could be launched for direct access to Peard Bay. Corridor F intersects the least amount of traditional subsistence use areas. None of the routes encroach on subsistence camps, cabins, or Native allotments.
Improves Health and Safety Conditions	5	5	5	All routes equally improve health and safety conditions.
Improves Access to Education Opportunities	5	5	5	All routes equally improve access to education opportunities.
Enhances Workforce Development	5	5	4	All routes support workforce development. Corridors D and E better set the stage for a potential regional port in the vicinity of Point Belcher.
Land Status	4	4	3	All routes cross federal and village corporation lands. None are within 1 mile of a Native allotment, except Corridor F where it joins the Landfill Access Road near Atqasuk.
Hydrology	4	3	2	The number of crossings for Corridors D, E, and F are 24, 17, and 30, respectively. Corridors E and F cross more poorly-drained terrain. When compared with Corridor D, Corridors E and F cross a greater number of K-1 river setbacks and K-2 deep-water lake setbacks. Each of these factors is reflected in the scoring.
Geology/ Geotechnical	4	2	2	Corridor D has greater access to potential granular material sites, and generally better-drained and less icy in-situ soils.
Existing and Proposed Infrastructure	5	4	2	Corridor D provides close access to the Peard Bay DEW Line Site, an area that could provide staging for oil and gas exploration activities. Corridors D and E provide access to the Kugrua River where boats could be launched to access Peard Bay for subsistence activities. Corridors D and E also set the stage for a spur road to a potential regional port in the vicinity of Point Belcher.

Criteria	Corridor D Coastal Route Ext.	Corridor E Middle Route	Corridor F Eastern Route	Notes
Roadway Engineering	4	2	2	From an engineering perspective, the routes are similar with regard to roadway engineering, design criteria, and topography. Corridor D requires the least gravel, followed by Corridor F, then E. Corridors E and F have more challenging subgrade with more poorly drained and icy soils.
Vehicle Bridges	3	3	5	Corridor D requires 10 bridges (1 major, 1 intermediate, and 8 minor). Sum of total bridge length is 2030 feet. Corridor E requires 8 bridges (2 major, 1 intermediate, and 5 minor). Sum of total bridge length is 2020 feet. Corridor F requires 10 bridges (2 major, 4 intermediate, and 4 minor). Sum of total bridge length is 1145 feet.
Cultural and Paleontological Resources	4	4	4	Based on available information, all three routes encounter an equal number of cultural or paleontological resource sites in the vicinity of Wainwright. Future route adjustments or other mitigation measures can be implemented to preserve cultural and paleontological resources that are currently known or are identified during later project stages.
Subsistence Patterns	5	5	4	None of the routes encroach on Native Allotments, or subsistence camps or cabins. However, MP 0 of Corridor E is approximately 2,500 ft from a cabin located on the northern bank of the Nigisaktuvik River and MP 0 of Corridor F is within 1 mile of two Native Allotments that abut the Meade River.
Wetlands	5	3	3	Corridor D is the most favorable route for avoiding wetlands that will require compensatory mitigation, followed by Corridors E and F.
Threatened and Endangered Species	5	4	4	Based on available data, there appear to be limited impacts on T&E species habitat. However, Corridors E and F encounter more potential habitat for eiders.
Terrestrial Mammals	4	3	3	All three routes pass through caribou range, however, the alignment of Corridor D lends itself to fewer caribou crossings. None of the routes pass through known calving areas.
Fisheries and Fish Habitat	4	4	5	The only known anadromous stream crossed is the Kugrua River by Corridors D and E.
Avian Resources and Habitat	3	2	4	Corridor F encounters the least nesting habitat, followed by Corridor D and E. Nesting surveys and potential route adjustments will be required in later stages of the project.
Environmental Compliance and Permitting	4	3	3	When compared with Corridor D, Corridors E and F intersect a greater number of K-1 river setbacks and K-2 deep-water lake setbacks. In addition, Corridors E and F will require greater permitting effort for wetlands impacts.
Construction Cost Estimate	3	2	4	The cost estimate for Corridor F is lowest, followed by Corridor D, then Corridor E (highest)
TOTAL	**96**	**82**	**83**	

4.3 Criteria Weighting

Each criterion was analyzed from eight societal and landowner viewpoints: Federal Government, State Government, Local Government (NSB), community residents, village corporations (Ukpeaġvik Iñupiat Corporation and Atqasuk Corporation), regional corporation (ASRC), environmental non-governmental organizations (NGOs), and pro-development NGOs. A description of each viewpoint is described below.

Federal Interest: This viewpoint considers which criteria are most and least important for the Federal government, specifically BLM, the primary land manager and lessor within the NPR-A.

State Interest: This viewpoint considers which criteria are the most and least important for the State of Alaska in terms of supporting the people and finances of the State. The State of Alaska is not a landowner within the project area, but does have management authority over some resources (e.g. surface waters, wildlife). In addition, the State is the entity sponsoring the ASTAR project.

NSB Interest: This viewpoint considers which criteria are most and least important for the NSB. The NSB would potentially be responsible for construction and maintenance of the road, and holds mineral rights to some gravel resources that could be used for construction.

Community Interest: This viewpoint considers local issues and needs when considering what criteria are most and least important to the communities and Native landowners in the project vicinity.

Village Corporation Interest: This viewpoint considers which criteria are most and least important to OC and Atqasuk Corporation. Both corporations are landowners affected by the potential road extension.

ASRC Interest: This viewpoint considers which criteria are most and least important to ASRC, a landowner within the region.

Environmental NGO Interest: This viewpoint considers issues important to environmental advocates and what criteria have the most and least effect on the environment.

Pro-Development NGO Interest: This viewpoint considers which criteria are the most and least important from development advocates.

This weighting method is based on a similar multi-disciplinary approach by Atkinson et al. (2005) that is intended to reduce bias in the decision-making process for infrastructure projects of this magnitude. This method was recently used by the Alaska Department of Transportation and Public Facilities (ADOT&PF) in the Foothills West Transportation Access Project to rank corridor alternatives for a proposed road to Umiat (ADOT&PF 2009).

Similar to a public input process, this process involves consideration of different societal viewpoints to evaluate the criteria for each corridor. Since this ranking is subjective, additional effort should be placed into developing "real world" viewpoints through future meetings with local community members, agency personnel, local and state government representatives, and other key stakeholders. As the project advances, these stakeholders should review project criteria and help verify the weightings based on their importance and applicability. The weighting should then be adjusted to reflect the views of the actual project stakeholders.

The objective is to subjectively rate each criterion and assign a score from 1 to 5 for each viewpoint, using the Likert scale below.

Level of Importance
1 – Not at all important
2 – Low importance
3 – Moderately important
4 – Very important
5 – Extremely important

Table 4.3-1 identifies the viewpoints, criteria, and the assigned weights for each criterion. Average weight for each criterion represents averaged importance across all viewpoints (right-most column). Preliminary weightings for each viewpoint were generated in a manner as objective as possible by a multidisciplinary group of SMEs. These weightings may change as public input is gathered for the project.

Table 4.3-1. Interim Criteria Weighting by Viewpoint

Federal	State	NSB	Community	Village Corp.	ASRC	Environ-mental NGO	Pro-Development NGO	Average Weight
Cultural Connectivity 2	Cultural Connectivity 4	Cultural Connectivity 5	Cultural Connectivity 5	Cultural Connectivity 5	Cultural Connectivity 5	Cultural Connectivity 2	Cultural Connectivity 4	Cultural Connectivity 4.00
Lower Costs 1	Lower Costs 3	Lower Costs 5	Lower Costs 5	Lower Costs 5	Lower Costs 5	Lower Costs 1	Lower Costs 5	Lower Costs 3.75
Preserve or Enhance Subsistence 3	Preserve or Enhance Subsistence 4	Preserve or Enhance Subsistence 5	Preserve or Enhance Subsistence 5	Preserve or Enhance Subsistence 5	Preserve or Enhance Subsistence 5	Preserve or Enhance Subsistence 3	Preserve or Enhance Subsistence 3	Preserve or Enhance Subsistence 4.13
Improve H&S Conditions 1	Improve H&S Conditions 4	Improve H&S Conditions 5	Improve H&S Conditions 5	Improve H&S Conditions 5	Improve H&S Conditions 5	Improve H&S Conditions 1	Improve H&S Conditions 4	Improve H&S Conditions 3.75
Improve Education Access Opportunities 1	Improve Education Access Opportunities 4	Improve Education Access Opportunities 5	Improve Education Access Opportunities 5	Improve Education Access Opportunities 5	Improve Education Access Opportunities 5	Improve Education Access Opportunities 1	Improve Education Access Opportunities 4	Improve Education Access Opportunities 3.75
Enhance Workforce Development 1	Enhance Workforce Development 5	Enhance Workforce Development 5	Enhance Workforce Development 5	Enhance Workforce Development 5	Enhance Workforce Development 5	Enhance Workforce Development 1	Enhance Workforce Development 5	Enhance Workforce Development 4.00
Land Status 5	Land Status 2	Land Status 5	Land Status 4	Land Status 5	Land Status 5	Land Status 1	Land Status 3	Land Status 3.75
Hydrology 4	Hydrology 4	Hydrology 3	Hydrology 3	Hydrology 3	Hydrology 3	Hydrology 5	Hydrology 3	Hydrology 3.50
Geology/ Geotech 3	Geology/ Geotech 4	Geology/ Geotech 4	Geology/ Geotech 3	Geology/ Geotech 3	Geology/ Geotech 3	Geology/ Geotech 4	Geology/ Geotech 3	Geology/ Geotech 3.38
Infrastructure 4	Infrastructure 2	Infrastructure 4	Infrastructure 4	Infrastructure 3	Infrastructure 3	Infrastructure 1	Infrastructure 3	Infrastructure 3.00
Roadway Engineering 2	Roadway Engineering 3	Roadway Engineering 5	Roadway Engineering 3	Roadway Engineering 3	Roadway Engineering 3	Roadway Engineering 1	Roadway Engineering 4	Roadway Engineering 3.00
Vehicle Bridges 4	Vehicle Bridges 5	Vehicle Bridges 3	Vehicle Bridges 3	Vehicle Bridges 3	Vehicle Bridges 3	Vehicle Bridges 2	Vehicle Bridges 5	Vehicle Bridges 3.50
Cultural & Paleo Resources 4	Cultural & Paleo Resources 4	Cultural & Paleo Resources 5	Cultural & Paleo Resources 5	Cultural & Paleo Resources 5	Cultural & Paleo Resources 5	Cultural & Paleo Resources 3	Cultural & Paleo Resources 3	Cultural & Paleo Resources 4.25
Subsistence Patterns 3	Subsistence Patterns 4	Subsistence Patterns 5	Subsistence Patterns 5	Subsistence Patterns 5	Subsistence Patterns 5	Subsistence Patterns 2	Subsistence Patterns 3	Subsistence Patterns 4.00

Federal	State	NSB	Community	Village Corp.	ASRC	Environ-mental NGO	Pro-Development NGO	Average Weight
Wetlands 3	Wetlands 4	Wetlands 3	Wetlands 3	Wetlands 3	Wetlands 3	Wetlands 5	Wetlands 3	Wetlands 3.38
T&E Species 5	T&E Species 4	T&E Species 4	T&E Species 4	T&E Species 4	T&E Species 4	T&E Species 5	T&E Species 3	T&E Species 4.13
Terrestrial Mammals 4	Terrestrial Mammals 4	Terrestrial Mammals 4	Terrestrial Mammals 5	Terrestrial Mammals 5	Terrestrial Mammals 4	Terrestrial Mammals 5	Terrestrial Mammals 4	Terrestrial Mammals 4.38
Fish & Fish Habitat 4	Fish & Fish Habitat 5	Fish & Fish Habitat 5	Fish & Fish Habitat 5	Fish & Fish Habitat 5	Fish & Fish Habitat 5	Fish & Fish Habitat 5	Fish & Fish Habitat 3	Fish & Fish Habitat 4.63
Avian Resources and Habitat 4	Avian Resources and Habitat 4	Avian Resources and Habitat 5	Avian Resources and Habitat 5	Avian Resources and Habitat 5	Avian Resources and Habitat 5	Avian Resources and Habitat 5	Avian Resources and Habitat s 3	Avian Resources and Habitat 4.50
Compliance & Permitting 5	Compliance & Permitting 5	Compliance & Permitting 4	Compliance & Permitting 4	Compliance & Permitting 4	Compliance & Permitting 4	Compliance & Permitting 5	Compliance & Permitting 4	Compliance & Permitting 4.38
Construction Cost 1	Construction Cost 3	Construction Cost 5	Construction Cost 2	Construction Cost 2	Construction Cost 2	Construction Cost 1	Construction Cost 4	Construction Cost 2.50

4.4 Weighted Decision Matrix Evaluation

Criteria for each corridor were ranked using the scoring presented in Section 4.2, and by applying the weighting factors developed in Section 4.3. The resulting Weighted Decision Matrix is shown in Table 4.4-1. As shown in the table, the matrix ranks Corridor D – Coastal Route Extension as the most advantageous option, followed by the Corridor E, and then Corridor F in descending order.

Table 4.4-1. Interim Corridor Decision Matrix

Criterion	Weight	Scores for Corridors					
		Corridor D – Coastal Route Extension		Corridor E – Middle Route		Corridor F – Southern Route	
		Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Supports Cultural Connectivity	4.00	5	20.0	5	20.0	5	20.0
Lowers Costs of Goods and Services	3.75	5	18.8	5	18.8	5	18.8
Preserves or Enhances Subsistence Traditions	4.13	5	20.7	4	16.5	3	12.4
Improves Health and Safety Conditions	3.75	5	18.8	5	18.8	5	18.8
Improves Access to Education Opportunities	3.75	5	18.8	5	18.8	5	18.8
Enhances Workforce Development	4.00	5	20.0	5	20.0	4	16.0
Land Status	3.75	4	15.0	4	15.0	4	15.0
Hydrology	3.50	4	14.0	3	10.5	2	7.0
Geology/ Geotechnical	3.38	4	13.5	2	6.8	2	6.8
Existing Infrastructure	3.00	5	15.0	4	12.0	2	6.0
Roadway Engineering	3.00	4	12.0	2	6.0	2	6.0
Vehicle Bridges	3.50	3	10.5	3	10.5	5	17.5
Cultural and Paleontological Resources	4.25	4	17.0	4	17.0	4	17.0
Subsistence Patterns	4.00	5	20.0	5	20.0	4	16.0
Wetlands	3.38	5	16.9	3	10.1	3	10.1
Threatened & Endangered Species	4.13	5	20.7	4	16.5	4	16.5
Terrestrial Mammals	4.38	4	17.5	3	13.1	3	13.1
Fish & Fish Habitat	4.63	4	18.5	4	18.5	5	23.2
Avian Resources and Habitat	4.50	3	13.5	2	9.0	4	18.0
Regulatory & Permitting	4.38	4	17.5	3	13.1	3	13.1
Construction Cost Estimate	2.50	3	7.5	2	5.0	4	10.0
TOTALS			**366.2**		**296.0**		**300.1**

5.0 Summary and Data Gaps

This desktop analysis provides ASTAR stakeholders with a better understanding of potential benefits that could result from development of a road network linking Utqiaġvik, Atqasuk, and Wainwright, as well as important engineering, environmental, regulatory, and stakeholder inputs that affect routing. Linking the three communities together enhances all of the benefits-related features of a road project identified in Section 2.4. In addition, connecting the three communities opens potential opportunities for development of a regional port for freight and fuel deliveries.

The road corridors presented in this report were developed without the benefit of stakeholder engagement. Before advancing the project further, a stakeholder engagement plan should be developed and implemented to solicit input specific to the project, and use the input to refine the project description and analysis. Stakeholder involvement is one of the most critical components of project analysis, and despite the preliminary information presented in this desktop study, the stakeholder's preferences could significantly alter the outcome of this study and the preferred routing. Nevertheless, based on the outcome of our preliminary analysis and comparison, it appears that Corridor D is the most favorable route for extending the road network to Wainwright, followed by Corridors F and E in descending order. Compared to the other alternatives, Corridor D offers significantly greater benefits and fewer environmental constraints.

As indicated by the name – Coastal Route Extension – Corridor D is an extension of Corridor A analyzed in the ASTAR report titled *Atqasuk to Utqiaġvik All Season Access Road* (AES Alaska 2019). Together, Corridors A and D have a total length of 101.9 miles between Utqiaġvik and Wainwright, with the spur to Atqasuk being another 23 miles (assuming use of the Coastal Route Modification shown on Figure 3.3-1). The Coastal Route Modification reduces the travel distance from Wainwright to Atqasuk by approximately 3.5 miles, but increases travel distance from Atqasuk to Utqiaġvik by approximately 2.5 miles.

The BLM is currently in the process of revising the Integrated Activity Plan (IAP) for the NPR-A. When the revision is completed, the IAP should be reviewed to assess whether any changes to stipulations or Best Management Practices (BMPs) affect the proposed Road Network for Utqiaġvik, Atqasuk, and Wainwright. While the BLM IAP offers guidance for projects in the NPR-A, this road network is a community infrastructure project and, pending revision to the IAP ROD, may be exempt from some of the stipulations and BMPs.

Recommended follow-on studies and activities are listed in Table 5.0-1. The list is not comprehensive but provides guidance for initial steps necessary to fill data gaps and advance the project. In order to establish priorities, the lead-time, duration, and inter-relationship of these activities should to be established in a detailed project execution plan.

5.0 Summary and Data Gaps

This desktop analysis provides ASTAR stakeholders with a better understanding of potential benefits that could result from development of a road network linking Utqiaġvik, Atqasuk, and Wainwright, as well as important engineering, environmental, regulatory, and stakeholder inputs that affect routing. Linking the three communities together enhances all of the benefits-related features of a road project identified in Section 2.4. In addition, connecting the three communities opens potential opportunities for development of a regional port for freight and fuel deliveries.

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Recommended follow-on studies and activities are listed in Table 4.0-1. The list is not comprehensive but provides guidance for initial steps necessary to fill data gaps and advance the project. In order to establish priorities, the lead-time, duration, and inter-relationship of these activities should to be established in a detailed project execution plan.

Table 5.0-1. Recommended Follow-On Studies and Activities for Road Network

Item	Objective	Purpose
Corridor Routing		
LIDAR	Obtain LIDAR survey of road corridor(s)	Support preliminary engineering, wetlands pre-mapping, etc.
Route Reconnaissance	Conduct visual reconnaissance overflight of road corridor(s) with subject matter experts.	Validate and refine route(s) selected during desktop analysis. First-hand observations of terrain features, river crossings, etc.
Engineering		
Geotechnical Reconnaissance	Conduct reconnaissance to assess geotechnical and geological conditions.	Support planning for field studies, identify target areas for geotechnical exploration (potential borrow sources, river crossings, etc.).
Geotechnical Exploration	Geotechnical drilling program to characterize soil and permafrost conditions	Support engineering analyses for routing, river crossings, and material site development. Validate terrain unit mapping.
Hydrology Studies	Obtain hydrologic data for river and stream crossings.	Support engineering design and construction planning for bridges and culverts. Support ADF&G requirements for permits to work in waterbodies.
Conceptual Engineering	Perform conceptual-level engineering.	Support initial cost estimates, environmental documentation and financial planning.
Estimate Water Needs	Estimate construction and operational water needs.	Estimate construction water needs for construction-phase ice roads, and operational phase dust control. Support compliance with ADF&G requirements for water withdrawal and ADNR Permits for Temporary Water Use.
Preliminary Construction Execution Plan	Define construction approach and timeline.	Validate and refine cost estimate and schedule with regard to task sequencing, seasonality, logistics, and construction camps.
Cultural		
Cultural Resource Windshield Survey	Conduct visual reconnaissance overflight of road corridor(s) with archaeologists.	Support analyses for routing.
Cultural Resource Surveys	Complete field surveys of high-potential areas.	Support permitting and design of mitigation measures. Support preparation of Alaska Cultural Resource Permit (field studies investigation) and Section 106 Consultation per 36 CFR 800.
Environmental		
Wetlands	Conduct pre-mapping and field delineation of wetlands.	Support USACE Section 404/Section 401 permitting and design of mitigation measures.
Lake Studies	Identify and survey potential water sources.	Identify water sources for construction ice roads and dust control. Support construction cost estimates. Support permitting for temporary water use. Support preparation of permits for water withdrawal, temporary water use, water rights.
Fish Habitat	See Hydrology Studies. Obtain fisheries data and habitat information for stream-crossing method evaluation.	Support stream crossing method selection. Required by Title 16 of the Alaska Statutes. Both resident and anadromous fisheries evaluated. State has responsibilities related to protecting fisheries – rivers, lakes, and streams.
Bird Surveys	Identify nest locations for Threatened and Endangered eiders, and possibly loons.	Support permitting and compliance with Migratory Bird Treaty Act and Endangered Species Act Section 7. Support consultation requirements.

Item	Objective	Purpose
Environmental Evaluation Document	Conduct preliminary environmental evaluation and impacts analysis.	Prepare baseline information that can be used by federal agency. NEPA analysis and preparation of NEPA document (EA, EIS). Major federal permits will trigger NEPA.
Regulatory		
Stakeholder Strategy	Develop stakeholder strategy for engagement.	Support agency requirements for consultation (USFWS, BLM) as well as federal requirements for Environmental Justice (EO 12898, EO 13175)
Agency Coordination	Engage with local, state, and federal agencies.	Solicit agency input. Track development of BLM IAP/EIS for NPR-A. Consult with NSB.
Regulatory Strategy	Develop regulatory strategy for permitting.	Support timely permitting and early identification of potential permit stipulations.
Finance		
Finance	Identify potential funding sources for follow-on studies, engineering, and construction.	Support community desire for all-season road.
Lands		
Land Services	Develop detailed land ownership and boundary information along route(s).	Support right-of-entry permissions for field studies, ROW acquisition, etc.
Right of Way	Identify proposed route, and develop detailed project description.	Support preparation of ROW lease/grant agreements and land use permits.
Access Approvals	Fieldwork access approvals needed across NSB, Native, and federal lands.	NSB, BLM, Atqasuk Corporation, OC and other landowners require prior authorizations for conducting fieldwork on their lands.

Notes:

ADF&G = Alaska Department of Fish and Game
ADNR = Alaska Department of Natural Resources
BLM = United States Bureau of Land Management
CFR = Code of Federal Regulations
EA = Environmental Assessment
EIS = Environmental Impact Statement
EO = Executive Order
IAP = Integrated Activity Plan
LIDAR = Light Detecting and Ranging
NEPA = National Environmental Policy Act
NPR-A = National Petroleum Reserve - Alaska
NSB = North Slope Borough
ROW = right-of-way
Section 106 = Section 106 of the National Historic Preservation Act
Section 401/404 = Sections 401 and 404 of the Clean Water Act
USACE = United States Army Corps of Engineers
USFWS = United States Fish and Wildlife Service

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APPENDIX A
Subject Matter Expert Analysis

- Technical Memorandum 1 – GIS Raster Analysis
- Technical Memorandum 2 – Land Status
- Technical Memorandum 3 – River Hydrology
- Technical Memorandum 4 – Geology / Geotechnical
- Technical Memorandum 5 – Existing and Proposed Infrastructure
- Technical Memorandum 6 – Roadway Engineering
- Technical Memorandum 7 – Vehicle Bridges
- Technical Memorandum 8 – Cultural Resources
- Technical Memorandum 9 – Paleontological Resources
- Technical Memorandum 10 – Subsistence Patterns
- Technical Memorandum 11 – Wetlands
- Technical Memorandum 12 – Threatened and Endangered Species
- Technical Memorandum 13 – Terrestrial Mammals
- Technical Memorandum 14 – Fish and Fish Habitat
- Technical Memorandum 15 – Avian Resources and Habitat
- Technical Memorandum 16 – Environmental Compliance and Permitting
- Technical Memorandum 17 – Construction Cost

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Technical Memorandum 1 – GIS Raster Analysis

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Technical Memorandum 1 – GIS Raster Analysis

Prepared by: Larry Clamp, GIS Department Manager

Reviewed by: Amanda Henry, Principal Scientist

Date: April 2020

Overview

Geographic Information Systems (GIS) methods were used in route alignment selection in order to establish baseline alignments from which additional routing modifications and evaluation could be made by Subject Matter Experts (SME). Following guidelines presented in the *Assessment of Potential Tools for Cumulative Benefits Analysis* (ASRC Energy Services Alaska [AES Alaska] 2018) Stage 3 methodology, SMEs were consulted to define a study area for constraining the extent of the analysis; identification and procurement of appropriate data; scaling and weighting of analysis inputs; and subsequent refinement of analysis outputs. The specifics of this process are described in the following sections.

Analysis Type

Project type (road route alignment) and SME consultation indicated a linear analysis utilizing ESRI's GIS geoprocessing tools for initial route development as the appropriate approach. Subsequent modifications to analysis outputs were performed using heads-up digitizing in the ArcMap desktop application. Once alignments were established, additional data (such as route corridors and river crossings) were derived to assist in route evaluation and comparison.

Analysis Approach and Tools

GIS evaluation and SME consultation for this study established a Cost Distance analysis as the most appropriate approach for developing route alignments. This approach is used in GIS to perform distance analysis by using raster inputs to define the cost of moving through a geographic area between two, or more, identified points. "Cost" in GIS analysis is used to define the level-of-effort needed to move from one pixel cell to another in a raster. Cost can be associated with a variety of inputs, including monetary measures, time, vertical movement, cultural constraints, etc.

Because costs can be associated with often disparate types of data, it is necessary to scale inputs across a common range of values, such as 1 to 5, with 1 being low cost and 5 being high. SMEs are valuable in this exercise wherein their particular expertise is used to define the associated costs of crossing certain spatial feature types for which they are skilled at evaluating. For instance, an engineer can assign a measure of difficulty for road trafficability based on slope by categorizing percentage of slope classes then assigning those classes a value from 1 to 5 based on degree of difficulty to safely ascend or descend, thus establishing a slope "cost" for analysis input. In like manner, a biologist can categorize critical habitats or known bird nesting sites and scale those areas from 1 to 5 based on ability or advisability of constructing a road in proximity to them.

Individual cost inputs must then be consolidated into a single, overall cost raster. This is done by using the *Raster Calculator* contained in ESRI's *Spatial Analyst Tools*. The individual inputs (e.g. slope, cultural sites, wetlands, etc.) must be weighted in consideration of their importance to the overall analysis and these weights used in the *Raster Calculator*. A pairwise comparison survey of inputs was used in conjunction with the *Analytic Hierarchy Process* to obtain weights for this analysis. This is described in more detail later in this document.

Once these input datasets are derived, the *Cost Path as Polyline* tool is used to find the least-cost distance between defined points or areas.

These points or areas are identified as either a "source" or a "destination." The source can be thought of as the place of interest to which routing processes must flow. For this study, sources included both Wainwright and Atqasuk as well as identified likely major river crossing locations. A destination is a terminal point to which a route is desired from the source. In this case, the final destinations were points located along previously determined routes from the *Atqasuk to Utqiaġvik All Season Access Road* study prepared for ASTAR (AES Alaska 2019). See Figure TM1-2 for source and destination points used.

The products of these analyses were discrete line segments from each source to each destination that were then merged into single route alignments. These were then attributed with specific corridor-route names and utilized in other geoprocesses, such as buffering to generate study corridors, creation of measured lines, and development of route mileposts.

Analysis Data Creation

Before analysis input data could be created, the following process steps were performed:

- **Determine appropriate coordinate system.** Universal Transverse Mercator Zone 4N, North American Datum 83 (feet) was utilized due to its good conformity to the study area.
- **Establish analysis area.** A polygon was developed to limit analysis to areas bounded as shown in Figure 1.1-1 of the main report body.
- **Develop required/suggested dataset list from SME consultation.**
    - Specific data types (wetlands, eider habitat, cultural sites, terrain units, etc.)
    - Recommended data sources (National Wetland Inventory, US Fish and Wildlife Service, Alaska Heritage Resources Survey, Division of Geological and Geophysical Surveys, etc.)
- **Research availability of data and procurement of data as available.**
- **Prepare the data for use in spatial analysis.**
- **Establish coarsest dataset to define pixel resolution for analysis inputs.** This was determined to be the digital elevation data available for the area, which was at 5-meter resolution. Two-meter data was available for the project area but its use greatly increased processing time, so the analysis was consequently conducted at the 5-meter resolution.
- **Determine appropriate data handling needed based on type, such as**:
    - Clipping or selecting to constrain data to the analysis area
    - Identifying attributes by which to scale
    - Buffering of features to specified widths
    - Reclassifying of raster data

Table TM1-1 below shows the data considered for use in analysis and the results of data evaluation, including reasons for not including certain suggested data. Since the primary use of this data was for route determination, the primary factor for inclusion of data was whether or not it affected routing itself. Exclusion of data did not indicate it was unimportant in overall project development, only that it would not significantly affect the routing of alignments in the initial stages of routing studies.

Table TM1-1. Data Considered For Route Analysis

Analysis Layer	Potential Inputs	SME	Source	Use ?	Notes
Ecological	Wetlands • Eider habitat • Polar Bear Critical Habitat • *Arctophila fulva* • Impacted wetlands • Wetlands within 500-ft of Fish-bearing and Anadromous Waters • BLM NPR-A ROD Teshekpuk Lake and Peard Bay Special Areas (considered as potential Aquatic Resources of National Importance areas) and K-1 River Buffers	Joe Christopher	NWI, USFWS, North Slope Science Initiative Landcover dataset (Arctic Landscape Conservation Cooperative 2013), ADF&G Anadromous Waters Catalog BLM NPR-A ROD GIS Database	Yes	• Scale wetlands by type based on suitability of routing through those wetlands and/or whether or not they are difficult to replace. • Apply "high cost" VALUE to areas within the Polar Bear Critical Habitat. • Apply 500-ft buffer around rivers and the edges of lakes >25 acres and scale by presence/absence of buffer. Since there are no comprehensive fish surveys for the study area, assume these are potential fish-bearing waterbodies. • Apply 500-ft buffer around anadromous waterbodies and scale by presence/absence of buffer. • Find areas of *Arctophila fulva* using NWI and North Slope Science Initiative landcover data and apply "high cost" VALUE to those areas. • SME to define Aquatic Resources of National Importance area and scale by presence/absence.
	Threatened & Endangered Species • Yellow-billed Loons • Eiders	Kiel Kenning	BLM, USFWS	Yes	• Apply 1-mile buffer around loon nesting sites and 1,625-ft buffer around the edges of lakes >25 acres and scale by presence/absence of buffer. • No eider nesting data available for this area. Also, project area habitat is generally considered to have low density of eider nesting.
	Fisheries & Fish Habitat	Shannon Mason / Stewart Seaberg	ADF&G	No	No ADF&G limitations for routing; use in wetlands data compilation only.
	Polar Bear denning sites	Kiel Kenning	USFWS	No	Only need to consider existing sites, which differ yearly, so no limitation to route planning.
Engineering	Slope	Paul Ramert	DEM	Yes	Use slope as percentage and categorize by ranges.
	Bridges	Paul Ramert	None	No	No existing bridges in area.
	Material Sources	Paul Ramert	AES/DGGS	No	Material sources not used for routing, but considered in post analysis refinements.

Analysis Layer	Potential Inputs	SME	Source	Use ?	Notes
	Existing Oil and Gas Wells	Paul Ramert	AOGCC	No	No significant reason to consider for routing.
	Historic Wells	Paul Ramert	AOGCC	No	No significant reason to consider for routing.
Geotech	Terrain Units	Hans Hoffman	AES/DGGS	Yes	Scale units based on favorability for routing.
	Geohazards	Hans Hoffman	AES / DGGS	Yes	500-ft avoidance buffers around pingos and scale by presence/absence of buffer.
	Materials (sand & gravel)	Hans Hoffman	AES / DGGS	No	Material sources not used for routing, but considered in post analysis refinements.
Hydrology	Crossings	Larry Clamp / Hans Hoffman / PND	AES / PND	Yes	Use crossing points as “source” and “destination” inputs.
	Lakes & Rivers	Larry Clamp	National Hydrography Dataset, NWI	Yes	• Perform line density processing on National Hydrography Dataset flowlines to determine potential crossing density per mile. Scale 1 to 5 based on density values. • Add lakes and other waterbodies to the above dataset with a value of 5.
Land Status	Land Ownership	Paul Ramert	ADNR, BLM	No	Only BLM, State, and Native lands in area, beside allotments. No need to consider for routing at this point.
	Native Allotments	Paul Ramert	ADNR, BLM	Yes	500-ft avoidance buffers around each and scale by presence/absence of buffer.
	Zoning	Paul Ramert	NSB	No	Does not pose a limitation to routing.
	17B Easements	Paul Ramert	NSB	No	Do not use as input, but perhaps examine proximity to derived routes.
	ROWs	Paul Ramert	ADNR, BLM	No	Does not pose a limitation in routing.
	Leases	Paul Ramert	ADNR, BLM	No	Does not pose a limitation to routing.
Regulatory	Polar Bear Critical Habitat	Kiel Kenning	USFWS	No	Does not need to be considered separately from wetlands, considered appropriately within the wetlands inputs.
	Teshekpuk Lake and Peard Bay Special Areas	Paul Ramert / Stewart Seaberg	BLM – NPR-A ROD	Yes	Scale based on presence or absence

Analysis Layer	Potential Inputs	SME	Source	Use ?	Notes
	VRM Management Classes	Paul Ramert / Stewart Seaberg	BLM – NPR-A ROD	No	Does not pose a limitation to routing.
	Areas Unavailable to Leasing	Paul Ramert/Stewart Seaberg	BLM – NPR-A ROD	No	None in this area.
	K-1 River Buffers	Paul Ramert / Stewart Seaberg	BLM – NPR-A ROD	Yes	Scale based on presence or absence of K-1 areas.
	Brant Survey Area	Paul Ramert / Stewart Seaberg	BLM – NPR-A ROD	No	None in this area.
	Deep Water Lakes and 400 meter Buffers	Paul Ramert / Stewart Seaberg	BLM – NPR-A ROD	Yes	Scale based on presence or absence of specified lakes and buffers.
Sociocultural	Camps & Cabins	Ranna Wells	NSB	Yes	500-ft avoidance buffers around each and scale by presence/absence of buffer.
	Traditional Land Use Inventory	Ranna Wells	NSB	No	Data not available at time of analysis. Likely to be coincident to AHRS sites and Native allotments.
	AHRS Cultural Sites	Ranna Wells	AHRS	Yes	500-ft avoidance buffers around each and scale by presence/absence of buffer.
	Subsistence Use	Ranna Wells	NSB	No	Entire area is used for subsistence so difficult to incorporate into routing analysis.

ADF&G	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
AES	Alaska Energy Services
AHRS	Alaska Heritage Resources Survey
AOGCC	Alaska Oil and Gas Conservation Commission
BLM	Bureau of Land Management
DEM	Digital Elevation Model
DGGS	Division of Geological and Geophysical Surveys
ft	foot
GIS	Geographic Information System
NPR-A	National Petroleum Reserve–Alaska
NSB	North Slope Borough
NWI	National Wetland Inventory
PND	Peratrovich, Nottingham & Drage, Inc engineering firm
ROD	Record of Decision
ROW	Right of Way
USFWS	US Fish and Wildlife Service
VRM	Visual Resource Management

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It should be noted that the "Analysis Layer" column denotes the name of the individual raster layer subsequently built from the inputs defined in the other columns. These individual raster layers are later combined in the process to create the overall cost raster.

In addition to these datasets, a 5-meter resolution raster Digital Elevation Model (DEM) developed from files available from the Arctic DEM project (Porter et al. 2018) and the Division of Geological and Geophysical Surveys (DGGS) Elevation Portal (DGGS Staff 2013) was used for topographic inputs (slope) to the Cost Distance geoprocessing of route alignments.

Data Preparation

All data passed on for use in the analysis were vector shapefiles, with the exception of slope, which was derived from the raster DEM. Features were buffered to assigned distances as necessary (see Table B-1), and all were projected to the same coordinate system and clipped to the analysis area to ensure data congruency. A "VALUE" field was added to each shapefile to store the scaled value for each attribute.

The slope data was created using the clipped DEM and running it through the *Surface>Slope* (percent) tool under *Spatial Analyst Tools*.

Data Scaling

SMEs were then asked to assign scaled values to appropriate attributes using a common scale by which all data attributes could be evaluated based on relative "cost" as described above. These were stored in the previously created "VALUE" field of the relevant dataset. The following scale was used for this step:

Table TM1-2. Common Scale for Data

VALUE	Definition
0	No hindrance for routing
1	Extremely favorable for routing
2	Very favorable for routing
3	Moderately favorable for routing
4	Low favorability for routing
5	Not at all favorable for routing

Specific values for each data input are shown in Tables TM1-3 through TM1-5.

After assigning scaled values, vector datasets were converted to rasters with a resolution of 5-meters (again, the same as the elevation data, which was coarsest dataset) using VALUES field.

Slope data was converted to the common 0 to 5 scale by using the Reclassify tool in *Spatial Analyst>Reclass* using the slope scale values presented in Table TM1-4.

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Table TM1-3. Specific Scales for Data

Analysis Layer	Layer Weight	Sublayer Weights	Layer Input(s)	Attribute	Value
Ecological	13%	Wetlands - 25%	Teshekpuk Lake and Peard Bay Special Areas (potential Aquatic Resources of National Importance areas)	Presence or Absence	5
			NWI polygons	Permanently Flooded (H)	5
			NWI polygons	Palustrine Unconsolidated Bottom (PUB)	5
			NWI polygons	All other wetlands	2
			NWI polygons	100-ft buffer of Riverine(R)/Lacustrine(L)	3
			NWI polygons	100-ft buffer of other wetlands ending in F/G/H/L/N	3
			NWI polygons	Upland (U)	0
			NWI polygons and North Slope Science Initiative (NSSI) Landcover dataset	Presence or Absence of *Arctophila fulva*	4
			ALCC Yellow-Billed Loon Database	Presence or Absence of 1-mile buffer of nest sites	0 or 3
			NWI polygons	Presence or Absence of 500-m (1,625-ft) Buffer of Lakes	3
			NPR-A ROD GIS Database	Presence or Absence of K-1 setbacks (Inaru River, Kolipsun Creek, Kucheak Creek, Kugrua River, Kungok River, Maguriak Creek, Meade River, Nigisaktuvik River, and Niklavik Creek)	3
			NPR-A ROD GIS Database	Deep water lakes and 400-meter setbacks	0 or 5
			NWI lake polygons/NHD areas/ADF&G AWC	500-ft buffer of Fish-Bearing Waterbodies	2
			NWI lake polygons/NHD areas/ADF&G AWC	500-ft buffer of Anadromous Waterbodies	2
			USFWS PBCH polygons	Areas designated as PBCH	5
		Threatened & Endangered Species - 75%	ALCC Yellow-Billed Loon Database	Presence or Absence of 1-mile buffer of nest sites	0 or 3
			NWI lake polygons	Presence or Absence of 500-m (1,625-ft) buffer of Lakes	3
			NSSI Landcover	Presence or Absence of 200-m (656-ft) buffer of NSSI *Arctophila fulva* (Pendant Grass) polygons	3
Engineering	3%		Slope	See Table TM1-4	0-5
Geoscience	3%		DGGS (AES) Geohazards	Presence or Absence of 500-ft buffer around Pingos.	0 or 5
			DGGS (AES) Terrain Units	See Table TM1-5	1-5
Hydrology	23%		Density of NHD flowlines Presence or Absence of Lakes & Rivers	Scaled Density Values Presence or Absence of Other Waterbodies	1-5
Regulatory	15%		K-1 River Buffers	Presence or Absence	0 or 3
			Teshekpuk Lake and Peard Bay Special Areas	Presence or Absence of 500-ft	0 or 3
			Deep water lakes and 400-meter setbacks	Presence or Absence	0 or 3
Sociocultural	43%		AHRS	Presence or Absence of 500-ft buffer	0 or 5
			Camps & Cabins	Presence or Absence of 500-ft buffer	0 or 5
			Native Allotments	Presence or Absence of 500-ft buffer	0 or 5

ALCC Arctic Landscape Conservation Cooperative
ADF&G Alaska Department of Fish and Game
AES ASRC Energy Services
AWC Anadromous Waters Catalog
DGGS Division of Geology and Geophysical Surveys
ft foot
GIS Geographic Information Systems
m meter
NHD National Hydrography Dataset
NWI National Wetlands Inventory
NPR-A National Petroleum Reserve–Alaska
PBCH Polar bear Critical Habitat
NSSI North Slope Science Initiative
ROD Record of Decision
USFWS US Fish and Wildlife Service

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Table TM1-4. Scales for Slope Data

Value	Slope
0	0%
1	0.1 to 2%
2	2.1 to 3%
3	3.1 to 4%
4	4.1 to 6%
5	> 6%

Table TM1-5. Scales for Terrain Units Data

VALUE	Terrain Unit
1	Ad
2	Bx
5	Lake
5	Qa
5	Qa/Qsi
5	Qaa
5	Qac
2	Qaf
5	Qai
3	Qam
3	QamC
3	QamD
3	QamE
2	Qat
3	Qat/Qsi
2	QatC
2	QatD
1	QatF
1	Qb
1	Qb/Qe
1	Qb/Qms
3	Qc
3	Qc/Bx
3	Qc/Tg
3	Qc/TKg
3	Qc/Tsg

VALUE	Terrain Unit
4	Qd
2	Qe
3	Qe/Qai
2	Qe/Qam
2	Qe/Qat
3	Qe/Qm
2	Qe/Qms
2	Qe/QTas
4	Qm
2	Qms
2	Qms/Bx
3	Qms/Qm
2	Qsg
5	Qsi
5	Qsi/Bx
5	Qsi/Qa
5	Qsi/Qe
5	Qsi/Tg
5	Qsi/TKg
5	Qsi/Tsg
5	Qt
5	Qt/Qa
5	Qt/Qaa
5	Qt/Qaf
5	Qt/Qai
5	Qt/Qam

VALUE	Terrain Unit
5	Qt/QamC
5	Qt/QamD
5	Qt/QamE
5	Qt/Qat
5	Qt/QatC
5	Qt/QatD
5	Qt/QatE
5	Qt/QatF
5	Qt/Qb
5	Qt/Qd
5	Qt/Qe
5	Qt/Qm

VALUE	Terrain Unit
4	Qt/Qms
5	Qt/Qsg
5	Qt/Qsi
5	Qt/QTas
5	Qt/QTasA
5	Qt/QTasB
4	QTas
4	QTasA
4	QTasB
2	Tgs
2	TKg
2	Tsg

Data Weighting

Once data were converted to rasters, weighting values were needed to provide each input layer with an appropriate level of importance to the overall cost layer. Specific values for weighting of data layers are provided in Table TM1-3.

Please note that "Sublayer Weighting" is given for individual layers that were composed of more complex data inputs. These had to first be compiled into a second-level raster based on their scales and weights before they could be used in creation of the first-level raster. For instance, Wetlands and T&E rasters were combined into a single raster to create the Ecological raster using weights of 25 percent and 75 percent, respectively. This same process was required to create the Regulatory raster from its associated sublayers. Weights for sublayer inputs were derived by SME estimation.

Weights for combining "Analysis Layer" rasters into a single cost raster for use in the Path-Distance tools were derived through group consensus using a pairwise comparison survey as shown in Table TM1-6.

Table TM1-6. Pairwise Comparison Survey

	Layer 1	Extremely More Important	Very Strongly More Important	Strongly More Important	Moderately More Important	Equally Important	Moderately More Important	Strongly More Important	Very Strongly More Important	Extremely More Important	Layer 2
1	Ecological	9	**7**	5	3	1	3	5	7	9	Geoscience
2	Ecological	9	7	5	3	1	3	**5**	7	9	Hydrology
3	Ecological	9	7	5	3	**1**	3	5	7	9	Regulatory
4	Ecological	9	7	5	3	1	**3**	5	7	9	Sociocultural
5	Ecological	**9**	7	5	3	1	3	5	7	9	Slope
6	Geoscience	9	7	5	3	1	3	**5**	7	9	Hydrology
7	Geoscience	9	7	5	3	1	3	5	**7**	9	Regulatory
8	Geoscience	9	7	5	3	1	3	5	**7**	9	Sociocultural
9	Geoscience	9	7	5	3	**1**	3	5	7	9	Slope
10	Hydrology	9	7	5	3	**1**	3	5	7	9	Regulatory
11	Hydrology	9	7	5	3	1	3	5	**7**	9	Sociocultural
12	Hydrology	9	7	**5**	3	1	3	5	7	9	Slope
13	Regulatory	9	7	5	3	1	**3**	5	7	9	Sociocultural
14	Regulatory	9	**7**	5	3	1	3	5	7	9	Slope
15	Sociocultural	9	**7**	5	3	1	3	5	7	9	Slope

Highlighted cells represent the values assigned during the group discussion with SMEs.

Results from this survey were then run through the Analytic Hierarchy Process to derive the weights as show in Table TM1-7.

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Table TM1-7. Analysis Layer Input Weights

Layer	Weight
Sociocultural	43%
Hydrology	23%
Regulatory	15%
Ecological	13%
Geoscience	3%
Slope	3%
TOTAL	100%

Cost Raster Creation

The *Map Algebra>Raster Calculator* contained in ESRI's *Spatial Analyst Tools* was then used to combine the Analysis Layer rasters, using their assigned weights, into the final cost raster using the following equation:

(Sociocultural x 0.43) + (Hydrology x 0.23) + (Regulatory x 0.15) +
(Ecological x 0.13) + (Geoscience x 0.03) + (Slope x 0.03) = COST

The resulting cost raster is shown in Figure TM1-1.

Create Analysis Points

Shapefiles were created for the different points needed to run the Cost Distance tools. The source and destination points were determined by SME input at the locations described above. In similar fashion, likely locations for major river crossings were selected by SMEs and points placed at each, near the channel centerline.

Running the Cost Distance Tools

The cost raster and analysis points were used in the *Spatial Analyst>Distance>Cost Distance* tools to derive the *Distance* (source) and *Backlink* rasters required for use in the *Cost Path as Polyline* tool. An example of a *Distance* (source) is shown in Figure TM1-2. Distance and Backlink rasters were created for each source location, namely for the communities of Wainwright and Atqasuk; distance and backlink rasters were produced for Wainwright and Atqasuk as well.

Once these raster were built, the *Cost Path as Polyline* tool was run to create a line segment from each source to each destination. For instance, a lines were created from Wainwright using the raster built using Wainwright as the source and the identified major river crossings, Atqasuk, and points along previous routes as the destinations. This process was repeated using the raster built using Atqasuk as the source and the identified major river crossings and Wainwright as destinations. These segments were then merged into single line routes for use in additional route refinement and evaluation.

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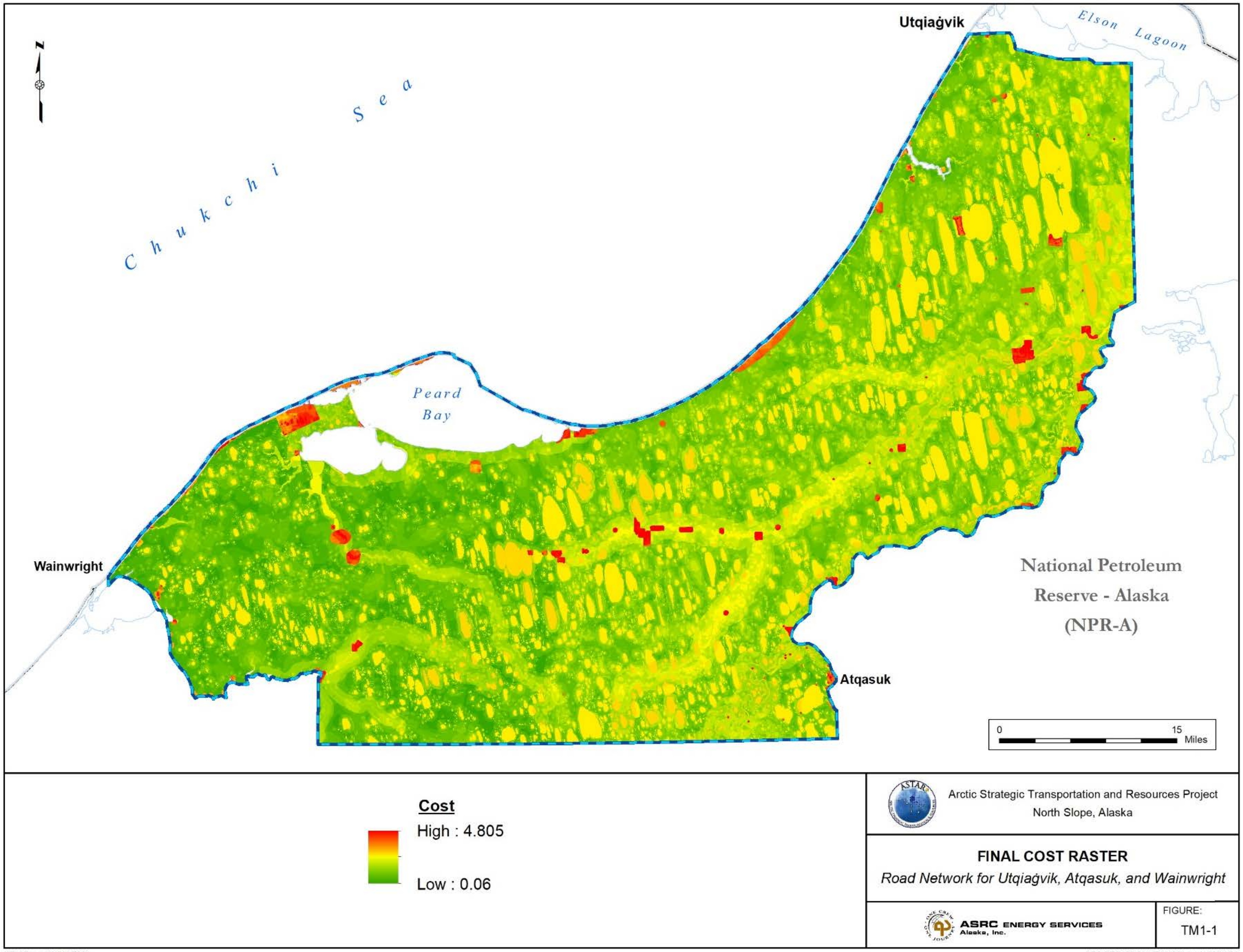
N
Chukchi Sea
Utqiaġvik
Elson Lagoon
Peard Bay
Wainwright
Atqasuk
National Petroleum Reserve - Alaska (NPR-A)
0
15
Miles
Cost
High : 4.805
Low : 0.06
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
FINAL COST RASTER
Road Network for Utqiaġvik, Atqasuk, and Wainwright
ASRC ENERGY SERVICES
Alaska, Inc.
FIGURE:
TM1-1
UTM Zone 4N (NAD83)
AES-RTS: 20-001-TM1-001.mxd, 03/04/20

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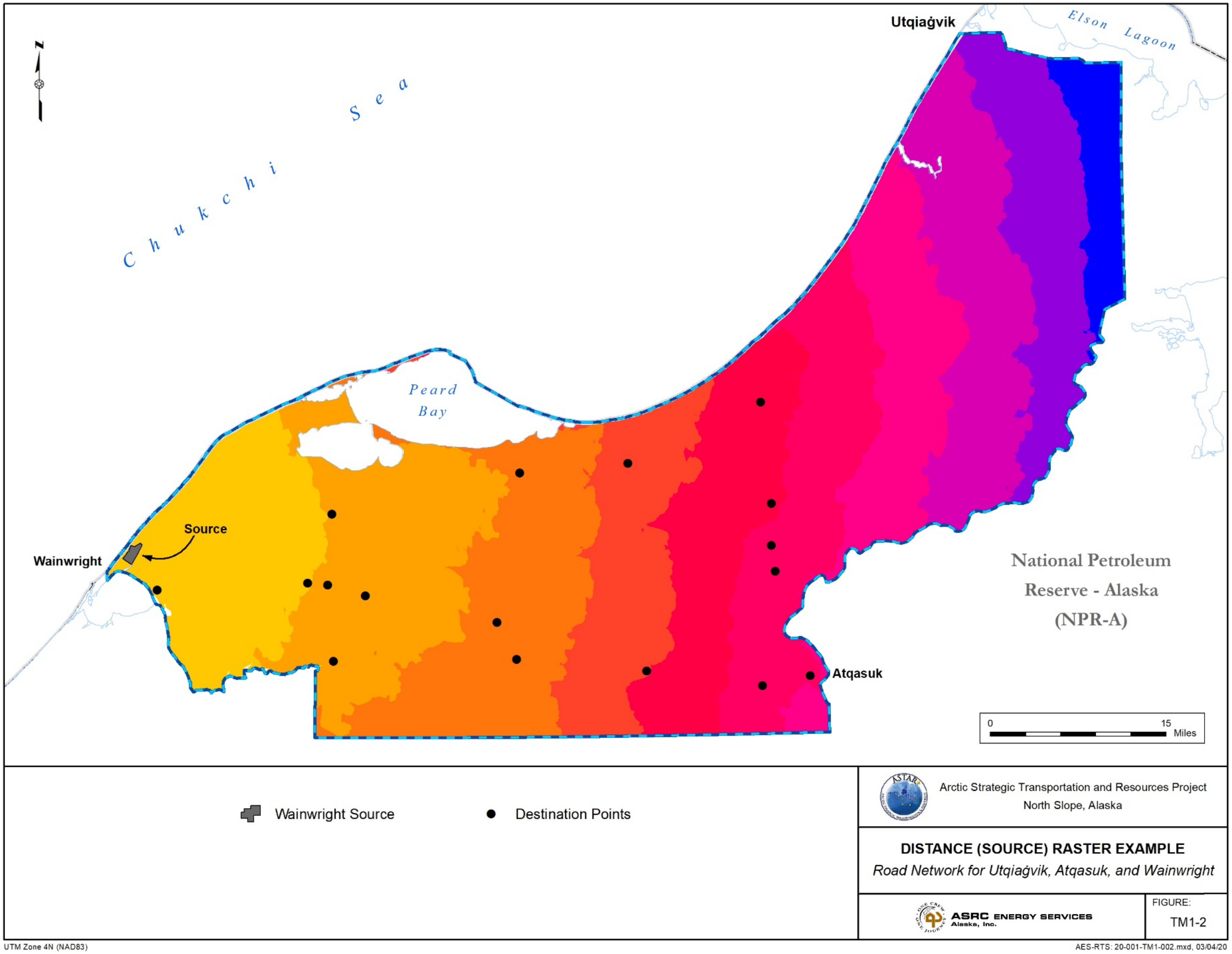
N
Utqiaġvik
Elson Lagoon
Chukchi Sea
Peard Bay
Source
Wainwright
Atqasuk
National Petroleum Reserve - Alaska (NPR-A)
0
15
Miles
Wainwright Source
Destination Points
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
DISTANCE (SOURCE) RASTER EXAMPLE
Road Network for Utqiaġvik, Atqasuk, and Wainwright
ASRC ENERGY SERVICES
Alaska, Inc.
FIGURE:
TM1-2
UTM Zone 4N (NAD83)
AES-RTS: 20-001-TM1-002.mxd, 03/04/20

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Final GIS Data Development

Once the line segments were produced from the *Cost Path as Polyline* tool, the following processes were performed to create final datasets used in corridor assessment and evaluation.

- Individual segments were merged into single lines for each route and named for use in additional route refinement and evaluation.
- Routes were adjusted as necessary according to aerial imagery and other desktop inputs to better align to crossings (approaches and perpendicularity to flow), to minimize number of crossings, address known conflicts, and to account for SME evaluation and routing inputs. *Alterations to the Cost Path as Polyline tool outputs were required to meet the above objectives*.
- Measured lines created for further location of features along routes as necessary.
- Route mileposts were created.
- Buffers of routes were generated 1,000 feet (ft) on either side of route lines to create 2,000-ft wide study corridors.

Additional Analysis

Additional GIS analyses were then performed using these datasets, including:

- Characterization of river crossings (measurement of total width, channel width, and assessment of potential crossing infrastructure type needed).
- Evaluation of wetlands impacts by acreage calculations within corridors.
- Determination of mileage of terrain units crossed (using linear referencing).
- Examination of proximity to:
    - Cultural, paleontological, and Traditional Land Use Inventory sites
    - Existing facilities
    - Proposed facilities

References

ASRC Energy Services Alaska, Inc. (AES Alaska). 2018. *Assessment of Potential Tools for Cumulative Benefits Analysis, Arctic Strategic Transportation and Resources Project, North Slope, Alaska*. July. Executive Summary added February 2019.

______. 2019. *Atqasuk to Utqiaġvik All Season Access Road, Arctic Strategic Transportation and Resources Project, North Slope, Alaska*. July.

Alaska Division of Geological and Geophysical Surveys (DGGS). 2013. Elevation Datasets of Alaska: Alaska Division of Geological & Geophysical Surveys Digital Data Series 4, http://maps.dggs.alaska.gov/elevationdata/. http://doi.org/10.14509/25239 (Accessed January 2020)

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Husby, Steven Foga, Hitomi Nakamura, Melisa Platson, Michael Wethington, Jr., Cathleen Williamson, Gregory Bauer, Jeremy Enos, Galen Arnold, William Kramer, Peter Becker, Abhijit Doshi, Cristelle D'Souza, Pat Cummens, Fabien Laurier, and Mikkel Bojesen. 2018. "ArcticDEM", https://www.pgc.umn.edu/data/arcticdem/ (Accessed January 2020)

Technical Memorandum 2 – Land Status

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Technical Memorandum 2 – Land Status

Prepared by: Larry Clamp, GIS Department Manager

Reviewed by: Amanda Henry, Principal Scientist

Date: April 2020

Overview

The project area is located within Alaska's North Slope Borough in the region inclusive of the villages of Utqiaġvik, Atqasuk and Wainwright. Land ownership within the project area can generally be separated into Native corporation lands, federal lands, and Native allotments (Figure TM2-1). Note that the land ownership and land status information presented in this memorandum is based on records readily available online from public sources. Additional work may be necessary in subsequent phases of the project to verify land ownership and obtain more detailed data on boundaries and land status.

Land Ownership

Village Corporation Lands

Village corporation lands within the project area include Ukpeaġvik Iñupiat Corporation (UIC) lands near Utqiaġvik; Atqasuk Corporation lands near the village of Atqasuk; and Olgoonik Corporation (OC) lands near the village of Wainwright. Figure TM2-1 shows the extent of UIC, Atqasuk Corporation, and OC lands.

UIC, Atqasuk Corporation, and OC lands were conveyed as part of the Alaska Native Claims Settlement Act (ANCSA). As part of ANCSA, the villages were allowed to select all the land in townships where the village was located and additional area, if necessary, to make up the acreage the village was entitled to (43 United States Code [USC] 1611).

Arctic Slope Regional Corporation Lands

Arctic Slope Regional Corporation (ASRC) owns surface lands immediately south of the UIC lands as shown on Figure TM2-1. As with all private properties, authorization must be obtained before accessing or performing work on these lands.

National Petroleum Reserve–Alaska

The project corridor traverses a portion of the National Petroleum Reserve–Alaska (NPR-A), a vast 22.1 million acre area of land on Alaska's North Slope owned by the U.S. government. The Bureau of Land Management (BLM) is responsible for managing the NPR-A. NPR-A is bounded by the Chukchi and Beaufort Seas to the north, the Colville River to the east, and is north of the Noatak National Preserve and the Gates of the Arctic National Park and Preserve (inset, Figure TM2-1). All lands within NPR-A are owned and managed by the federal government, with the exceptions of Native allotments; Native corporation and village lands in the vicinity of Wainwright, Utqiaġvik, Atqasuk, and Nuiqsut; and the Umiat Airfield surface estate, which is owned by Alaska Department of Transportation and Public Facilities.

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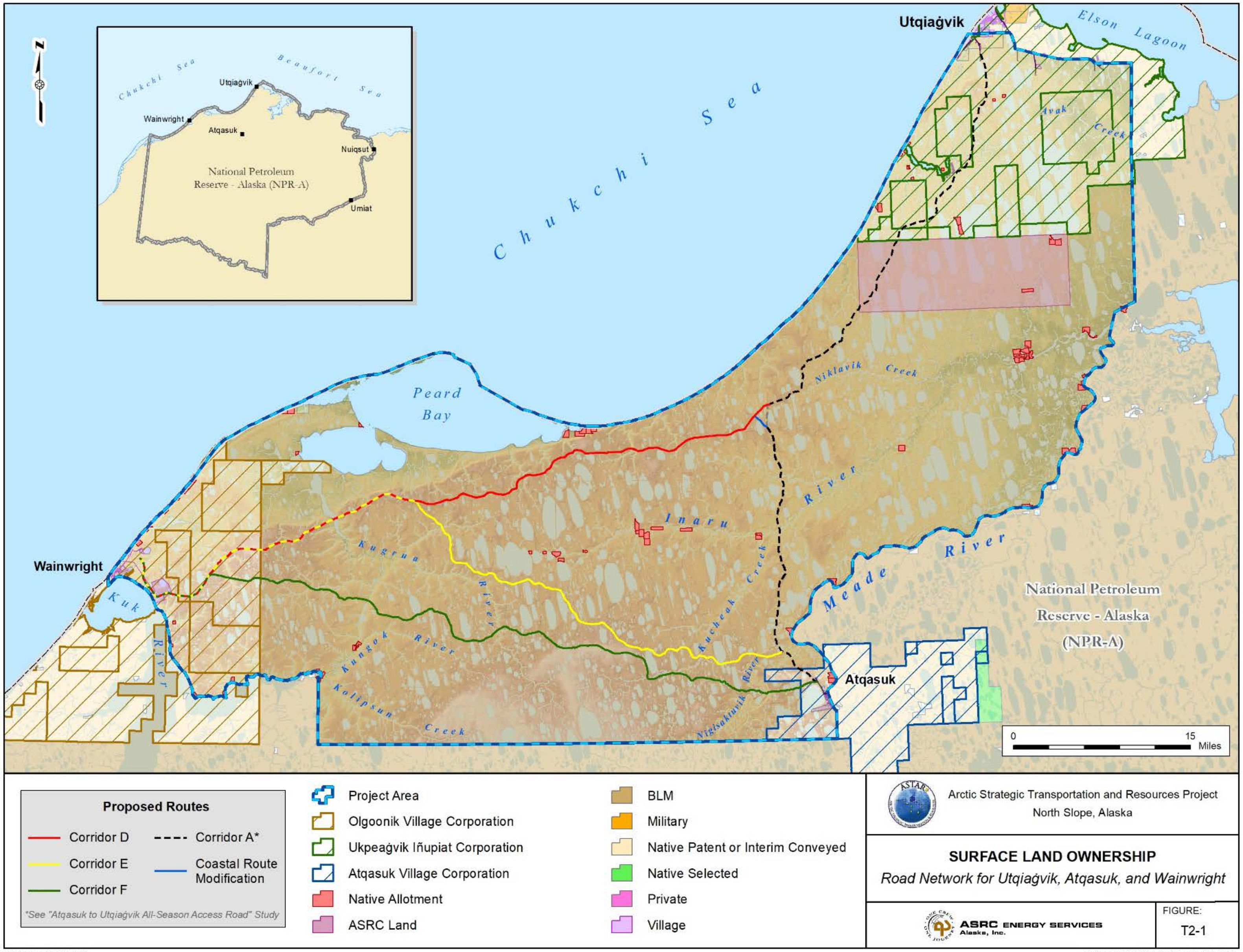
Utqiaġvik
Elson Lagoon
Chukchi Sea
Beaufort Sea
Wainwright
Atqasuk
Nuiqsut
Umiat
National Petroleum Reserve - Alaska (NPR-A)
Chukchi Sea
Peard Bay
Avak Creek
Niklavik Creek
Inaru River
Kugrua River
Kuk River
Kungok River
Kolipsun Creek
Kucheak Creek
Nigisaktuvik River
Meade River
National Petroleum Reserve - Alaska (NPR-A)
0
15
Miles
Proposed Routes
Corridor D
Corridor A*
Corridor E
Coastal Route Modification
Corridor F
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
Project Area
Olgoonik Village Corporation
Ukpeaġvik Iñupiat Corporation
Atqasuk Village Corporation
Native Allotment
ASRC Land
BLM
Military
Native Patent or Interim Conveyed
Native Selected
Private
Village
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
SURFACE LAND OWNERSHIP
Road Network for Utqiaġvik, Atqasuk, and Wainwright
ASRC ENERGY SERVICES
Alaska, Inc.
FIGURE:
T2-1
UTM Zone 4N (NAD83)
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NPR-A includes several designated Special Areas where specific restrictions or stipulations may apply (BLM 2013). Special areas are Colville River Special Area, Utukok River Uplands Special Area, Teshekpuk Lake Special Area, Peard Bay Special Area, and Kasegaluk Lagoon Special Area. The project area intersects two of these special areas; as shown on Figure TM2-2. The Teshekpuk Lake Special Area intersects with the project area east of Utqiaġvik and the Peard Bay Special Area intersects in the vicinity of Wainwright.

Also shown on Figure TM2-2 are setbacks around the Meade River, Inaru River, Niklavik Creek, Kucheak Creek, Nigisaktuvik River, Kugrua River, Kungok River, and Kolipsun Creek. These setbacks are identified in the NPR-A Record of Decision (ROD) under Lease Stipulation/Best Management Practice (BMP) K-1 (BLM 2013). The BMP states that permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited in the streambed and adjacent to the rivers within the setback distance. However, on a case-by-case basis, essential pipeline and road crossings will be permitted through the setback areas.

Additionally, there are several deep water lake setbacks within the project area. These are identified in the NPR-A ROD under Lease Stipulation/BMP K-2 (BLM 2013). Similar to K-1 setbacks, the BMP states that permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited on the lake or lakebed within ¼ mile of the ordinary high water mark of any deep lake as determined to be in lake zone III (i.e., depth greater than 13 feet; Mellor 1985). However, on a case-by-case basis, essential pipelines, road crossings and other permanent facilities may be considered through the permitting process in these areas where it can be demonstrated on a site-specific basis that impacts will be minimal.

Although the proposed road network for Utqiaġvik, Atqasuk, and Wainwright is not related to oil and gas development or facilities, the ROD also states BMPs in the ROD are applicable for all authorized (not just oil and gas) activities in the planning area.

Native Allotments

Figure TM2-1 shows Native allotments within the project area. As with all private properties, authorization must be obtained before accessing or performing work on these lands. Typically, the United States Bureau of Indian Affairs (BIA) is the point of contact for contacting allotees to negotiate access across and to Native allotments. Within the study area, the Iñupiat Community of the Arctic Slope (ICAS) assists BIA in carrying out this function. ICAS is a recognized tribe under the Indian Reorganization Act of 1934 and represents the Iñupiat people of the Arctic Slope (ICAS 2019).

Department of Defense Lands

During the Cold War, the US Department of Defense developed a series of radar and communications sites to support aerial surveillance in Alaska. These Distant Early Warning (DEW) Line sites were designed to provide the earliest possible warning of aircraft invading US airspace from the north. Locations of DEW stations within the study area include those at Wainwright and Peard Bay as shown in Figure TM2-3. In the late 1980s and early 1990s, the DEW Line site was replaced with the North Warning System (NWS), a network of long-range and short-range radar sites. The only NWS site within the study area is located at Wainwright (Piquniq Management Corporation 2012). In 1996, a program was initiated to demolish and remediate facilities at DEW line stations that were no longer necessary (Center for Environmental Management of Military Lands 2008). Many of the DEW Line stations have reverted to BLM or local land ownership, including those at Wainwright and Peard Bay.

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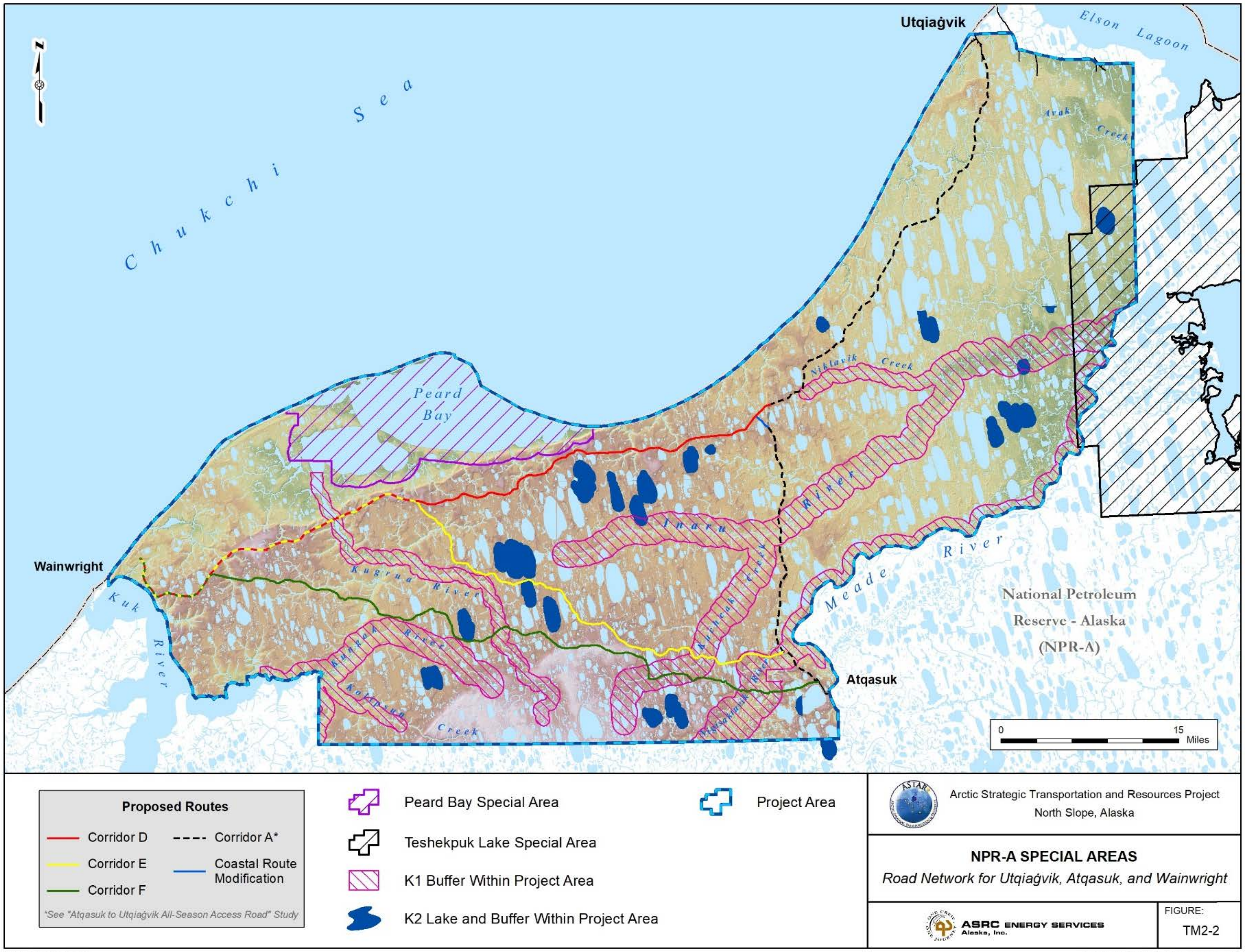
Utqiaġvik
Elson Lagoon
Chukchi Sea
Arak Creek
Peard Bay
Niklavik Creek
Inaru River
Wainwright
Kuk River
Kugrua River
Meade River
National Petroleum Reserve - Alaska (NPR-A)
Atqasuk
Kaolak Creek
0
15
Miles
Proposed Routes
Corridor D
Corridor A*
Corridor E
Coastal Route Modification
Corridor F
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
Peard Bay Special Area
Teshekpuk Lake Special Area
K1 Buffer Within Project Area
K2 Lake and Buffer Within Project Area
Project Area
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
NPR-A SPECIAL AREAS
Road Network for Utqiaġvik, Atqasuk, and Wainwright
ASRC ENERGY SERVICES
Alaska, Inc.
FIGURE:
TM2-2
UTM Zone 4N (NAD83)
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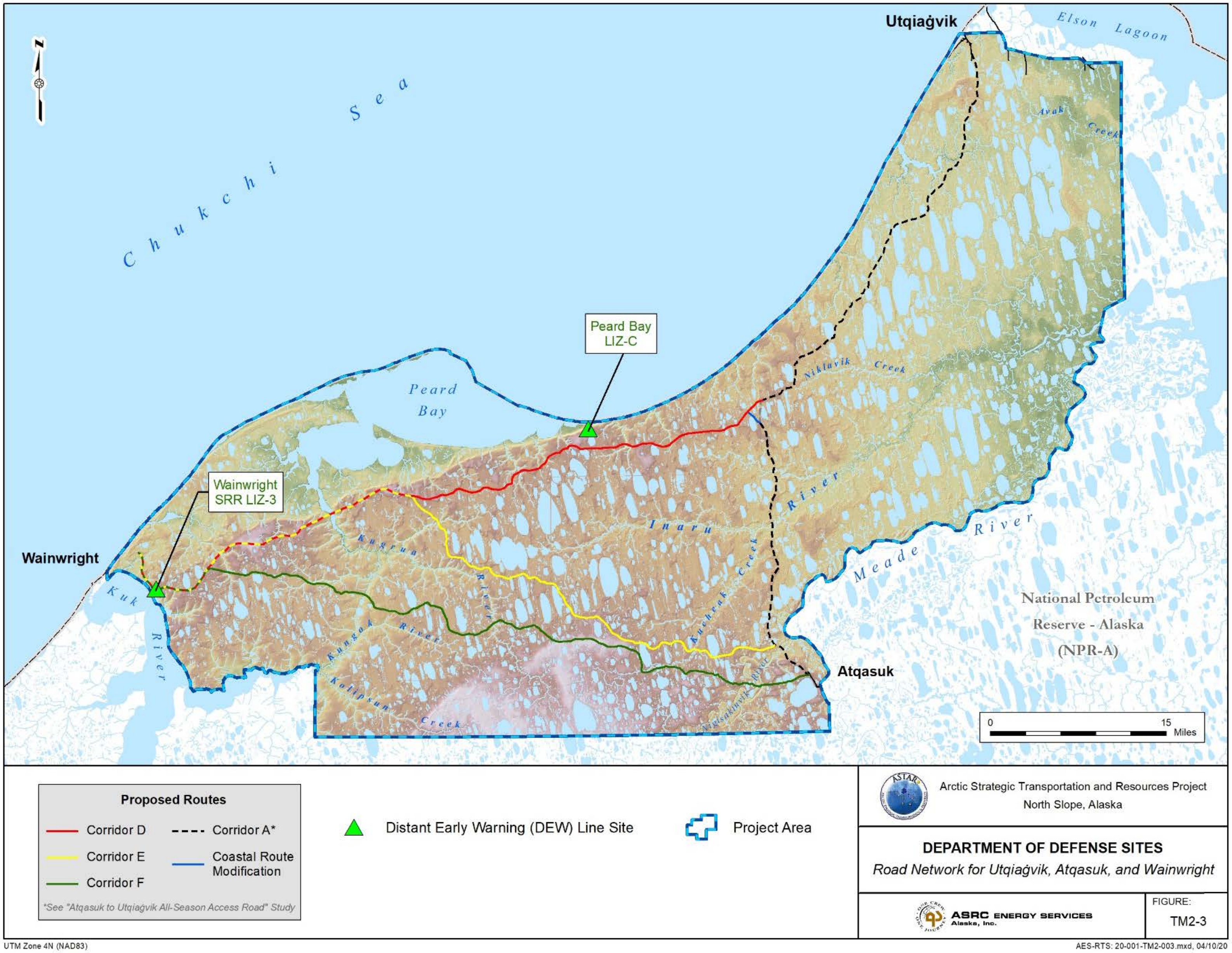
Utqiaġvik
Elson Lagoon
Chukchi Sea
Peard Bay
Peard Bay
LIZ-C
Wainwright
SRR LIZ-3
Wainwright
Atqasuk
Meade River
National Petroleum
Reserve - Alaska
(NPR-A)
Kuk River
0
15
Miles
Proposed Routes
Corridor D
Corridor A*
Corridor E
Coastal Route Modification
Corridor F
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
Distant Early Warning (DEW) Line Site
Project Area
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
DEPARTMENT OF DEFENSE SITES
Road Network for Utqiaġvik, Atqasuk, and Wainwright
ASRC ENERGY SERVICES
Alaska, Inc.
FIGURE:
TM2-3
UTM Zone 4N (NAD83)
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Current Oil and Gas Leases

There are currently no oil and gas leases within the project area.

North Slope Borough

The project area is within Alaska's North Slope Borough (NSB). The NSB, incorporated in 1972, is a Home Rule Borough and is the largest borough in Alaska. It covers nearly 88,000 square miles (more than 15 percent of the state's total land area).

The NSB government is funded by oil tax revenues, which uses these funds to provide public services. Utqiaġvik is the NSB hub where main facilities and services are located, such as the NSB administrative offices (e.g., NSB Mayor's office), regional facilities support, search and rescue, and the regional hospital. The NSB has permitting and land management authority for activities within the region. Typically, permits must be obtained from NSB before initiating development or construction activities.

The NSB also has zoning authority within its boundaries. Zones identified in NSB Title 19 include various districts specific to Utqiaġvik; Village Districts for communities outside Utqiaġvik; and Conservation, Resource Development, Transportation, and Scientific Districts across the NSB. Figure TM2-4 shows the various NSB zoning districts intersected by the potential road corridors. The Utqiaġvik Reserve District is intended to provide protection for environmental resources, local subsistence and recreational opportunities; and to act as a holding area for lands which require urban infrastructure such as roads, sewer, water and power before they can be developed (NSB 2019). The Village District governs the city limits of Atqasuk and Wainwright. The intent of the Village District is to accommodate uses that (1) reinforce traditional values and lifestyles; (2) are in accord with the Borough Comprehensive Plan, Capital Improvements Program, and Comprehensive Development Plan for the village; and (3) are in accord with the desires of the residents of the village (NSB 2019).

Alaska Native Claims Settlement Act 17(b) Easements

ANCSA 17(b) easements are rights reserved to the U.S. and may also be reserved to and from communities, airports, docks, marine coastline, groups of private holdings sufficient in number to constitute public use, and government facilities. They take the form of 60-foot wide roads, 25- and 50-foot wide trails, and one-acre sites for short-term uses. These rights are reserved when the BLM conveys land to an Alaska Native corporation under ANCSA. There are no 17(b) easements across public lands. The purpose of most 17(b) easements are reserved to allow the public to cross private property to reach public lands and major waterways (BLM 2019). Figure TM2-5 shows the alignments for ANCSA 17(b) easements and the location of ANCSA 17(b) sites within the project area.

Data Gaps

Data gaps for land status include:

- More detailed analysis of land status and boundaries along the proposed road corridor will be needed as the project progresses.
- Consultation with the landowners and other stakeholders will be needed as the project progresses to gather input that could affect project outcomes, routing, and design. At a minimum, these stakeholders will include local residents, tribal organizations, UIC, Olgoonik and Atqasuk Corporations, ASRC, BLM, NSB, and subsistence user co-management organizations.

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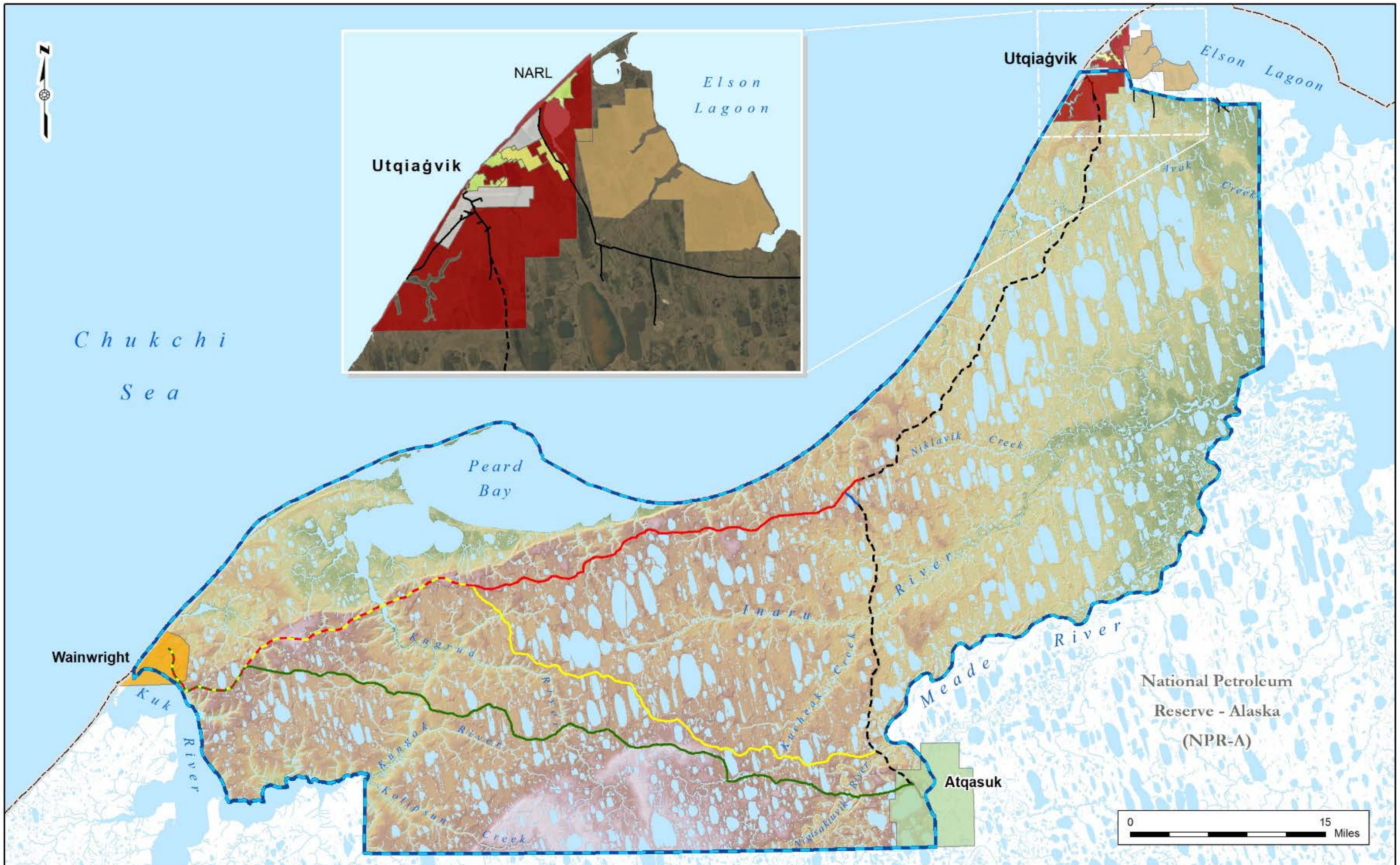

Proposed Routes

- Corridor D
- Corridor E
- Corridor F
- Corridor A*
- Coastal Route Modification

*See "Atqasuk to Utqiaġvik All-Season Access Road" Study

Utqiaġvik Zoning

- Industrial
- Mixed Use
- Reserve
- Suburban
- Science Research District

- Wainwright Village District
- Atqasuk Village District
- Project Area

Arctic Strategic Transportation and Resources Project
North Slope, Alaska

NSB ZONING

Road Network for Utqiaġvik, Atqasuk, and Wainwright

ASRC ENERGY SERVICES Alaska, Inc.

FIGURE: T2-4

UTM Zone 4N (NAD83)

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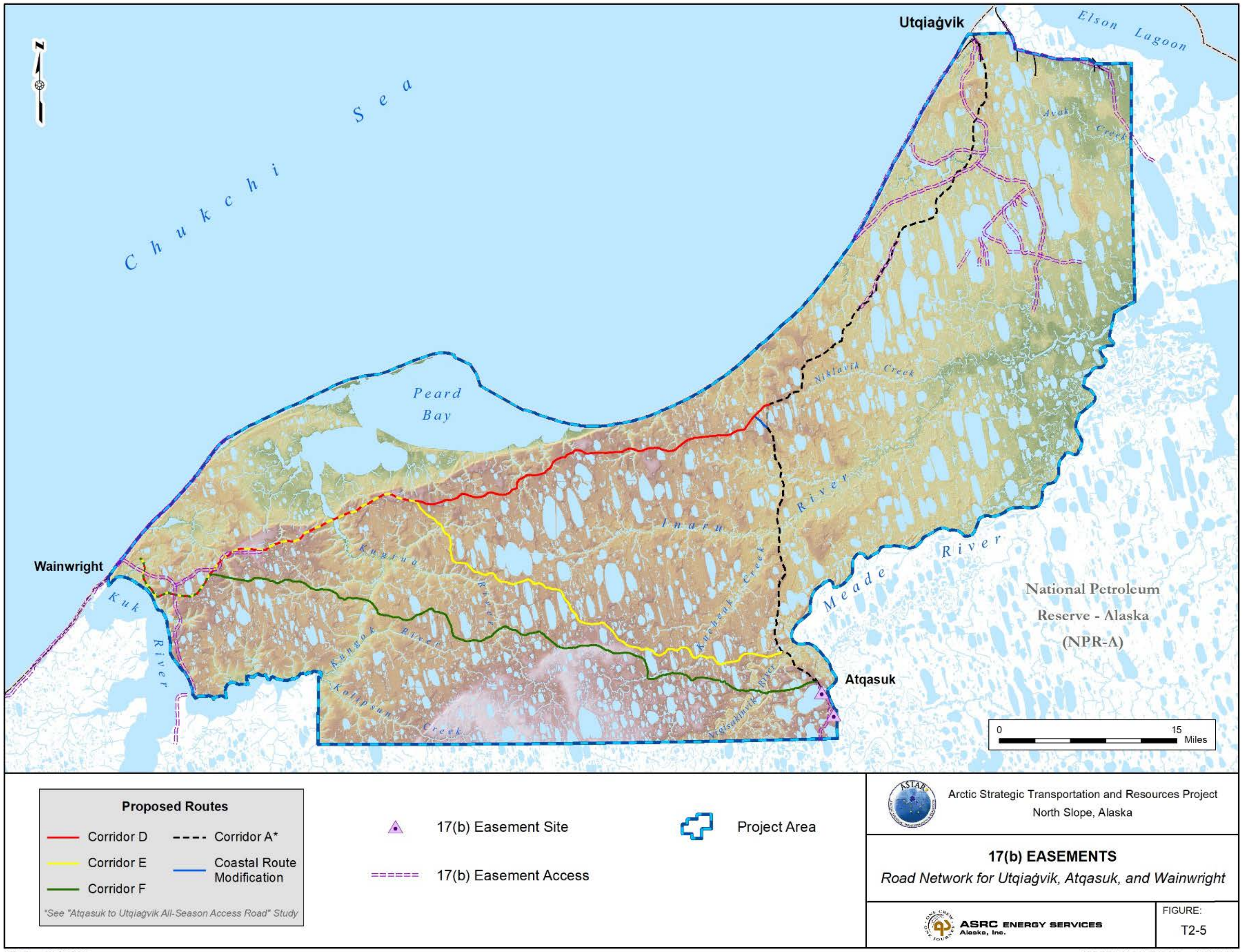
Utqiaġvik
Elson Lagoon
Chukchi Sea
Peard Bay
Wainwright
Kuk River
Atqasuk
Meade River
National Petroleum Reserve - Alaska (NPR-A)
0 15 Miles
Proposed Routes
Corridor D
Corridor E
Corridor F
Corridor A*
Coastal Route Modification
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
17(b) Easement Site
17(b) Easement Access
Project Area
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
17(b) EASEMENTS
Road Network for Utqiaġvik, Atqasuk, and Wainwright
ASRC ENERGY SERVICES
Alaska, Inc.
FIGURE:
T2-5
UTM Zone 4N (NAD83)
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Technical Memorandum 3 – River Hydrology

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Technical Memorandum 3 – River Hydrology

Prepared by: Claire Ellis, EIT & Alexander Khokhlov (PND Engineers, Inc.)

Reviewed by: Alexandra Jefferies, PE & Ethan Perry, PE (PND Engineers, Inc.)

Date: April 2020

Overview

The purpose of this memorandum is to provide a high-level review of the hydrological features within the project area of a proposed all-season gravel road that would provide a roadway link between Atqasuk and Wainwright. This roadway will expand the region's transportation network, providing economic opportunities and improved services for North Slope Borough communities. PND Engineers, Inc. conducted this hydrologic investigation for ASRC Energy Services Alaska, Inc., and the Arctic Strategic Transportation & Resources project team in order to assess crossing locations at all pertinent waterways within the project area. Assessment of river crossings and hydrology was a key factor in informing the presented alternatives. For the purpose of this study, Light Detection and Ranging (LiDAR) was used to evaluate specific routes and crossing locations. No site-specific topographical surveys were conducted. Figure TM3-1 displays the project corridors and stream crossing locations.

The project is located in the Arctic Coastal Plain, which is underlain by continuous permafrost around 820 to 990 feet (ft) thick. The presence of permafrost is the cause of surficial features such as thaw lakes, drained lakes, high- and low-centered polygons, strangmoor ridges, and reticulate-patterned ground which covers the area (Kane et al. 2012). Most small streams and rivers in the project area such as the Kungok and Kikiakrorak rivers originate in the Arctic Coastal Plain, while larger streams such as the Kuk and Meade rivers originate in the Arctic Foothills, and all ultimately outlet to the Arctic Ocean. Permafrost in the area creates an impermeable layer, making the drainages hydraulically tight; however, taliks (or perennial unfrozen sections of ground) create pathways for groundwater seepage to the surface, which can lead to icing and the presence of aufeis.

The project area has a low hydraulic gradient and relatively little precipitation in comparison to the gradient and annual precipitation in the foothills and Brooks Range mountains to the south. These areas to the south account for a significant portion of spring flows in the major river systems. The annual precipitation along the coastal plain receives approximately 4.0 inches, whereas the Brooks Range receives approximately 13.4 inches, according to the National Oceanic and Atmospheric Administration (NOAA 2019).

This report summarizes details of stream crossings along each route and discusses the practical feasibility of construction of each of the three alternative corridors.

Drainage Basins

The open-water hydrologic cycle in the project area within the Arctic Coastal Plain is characterized by a short, intense breakup event followed by quickly-receding flood levels and a prolonged period of low flows, with small occasional rain-induced flow events. In winter months, little to no flow occurs in any of these streams. There is very little available hydrologic data for the rivers in this region; the only long-term stream gages in the area are located on the Meade River near Atqasuk and Nunavak Creek near Utqiaġvik.

The spring breakup flood generally occurs between mid-May and mid-June. The flood peak magnitude and total volume depends on several factors: accumulation of winter snowfall, additional rainfall during breakup, ambient temperature, intensity of sunlight radiation, and ice and snow jamming effects. Ice breakup can be either thermal or mechanical, with mechanical breakups and increased likelihood of ice jams occurring more often in years with rapidly warming temperatures and lots of direct sunshine.

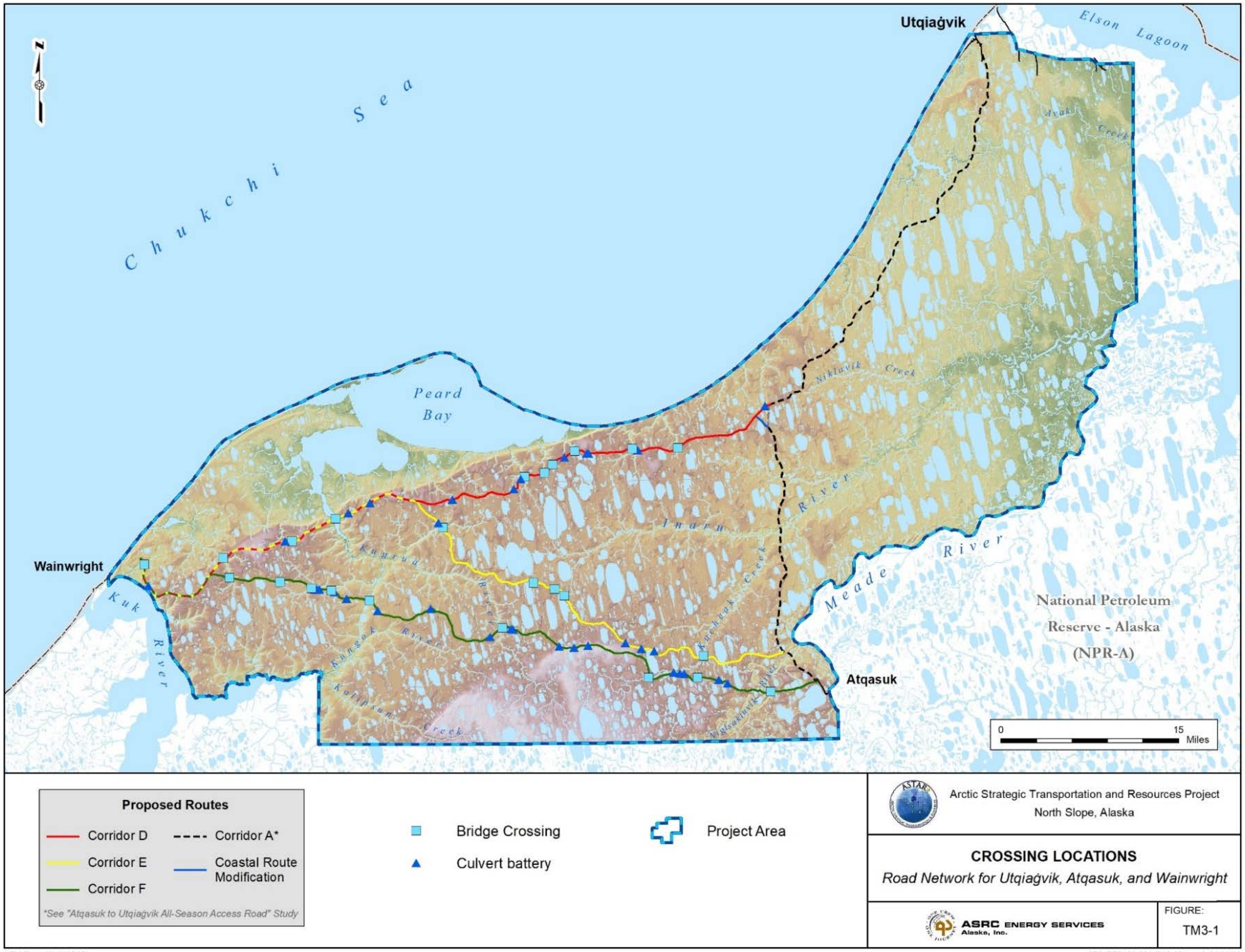
The hydrologic unit codes (HUC) identifying the geographic region, subregion, accounting unit, and cataloging unit for each drainage in the project area are given in Table TM3-1, along with the area of each watershed.

Table TM3-1. Project Area Drainage Basins

Associated Area	HUC	Watershed Area (sq mi)
Meade River[1]	HUC8 - 19060203	5,073
Inaru River[2]	HUC10 – 1906020315, 1906020316 (part of Meade River drainage)	757
Nigisaktuvik River	HUC10 - 1906020310, 1906020311, 1906020312 (part of Meade River drainage)	797
Kucheak Creek	HUC10 – 1906020314 (part of Meade River drainage)	145
Kunarak Creek	HUC12 - 190602020208	15
Papigak Creek	HUC12 - 190602020209	20
Walik Creek	HUC12 - 190602020403	15
Kugrua River	HUC10 - 1906020203	289
Kungok River[2]	HUC10 - 1906020111, 1906020112 (part of Kuk River drainage)	513
Sinaruruk River	HUC12 - 190602020501	62
Kuk River[1]	HUC8 - 19060201	4,175

1. Major stream watersheds are in project area but are not crossed by any of the corridor routes detailed in this memo.
2. Corridor routes cross through watersheds but do not cross main named streams.

The combined drainage areas of all crossed streams is approximately 1,343 square miles (sq mi). In order to simplify the analysis of these drainage basins, the HUCs are provided for drainages of major crossings and other major rivers adjacent to the route or near endpoint communities. In some instances, routes will pass through portions of a watershed without crossing the main stream or streams. The delineated drainage basins for the project area are displayed in Figure TM3-2.


Utqiaġvik
Elson Lagoon
Chukchi Sea
Peard Bay
Wainwright
Kuk River
Atqasuk
Meade River
Inaru River
Niklavik Creek
National Petroleum Reserve - Alaska (NPR-A)
0
15
Miles
Proposed Routes
Corridor D
Corridor A*
Corridor E
Coastal Route Modification
Corridor F
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
Bridge Crossing
Culvert battery
Project Area
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
CROSSING LOCATIONS
Road Network for Utqiaġvik, Atqasuk, and Wainwright
ASRC ENERGY SERVICES
Alaska, Inc.
FIGURE:
TM3-1
UTM Zone 4N (NAD83)
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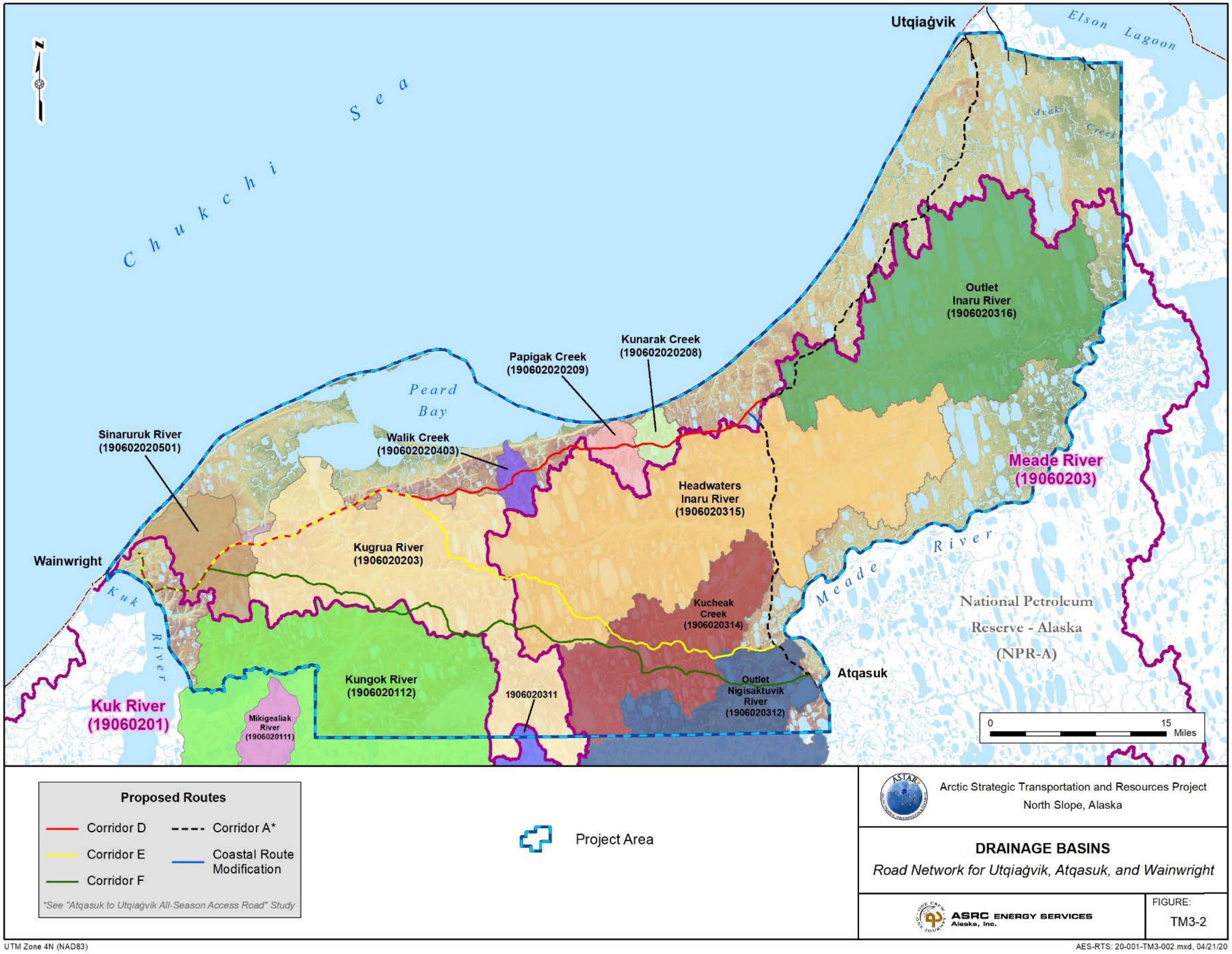
Utqiaġvik
Elson Lagoon
Chukchi Sea
Peard Bay
Sinaruruk River (190602020501)
Walik Creek (190602020403)
Papigak Creek (190602020209)
Kunarak Creek (190602020208)
Outlet Inaru River (1906020316)
Headwaters Inaru River (1906020315)
Kugrua River (1906020203)
Wainwright
Kuk River
Meade River (19060203)
Meade River
National Petroleum Reserve - Alaska (NPR-A)
Kucheak Creek (1906020314)
Atqasuk
Outlet Nigisaktuvik River (1906020312)
Kungok River (1906020112)
1906020311
Mikigealiak River (1906020111)
Kuk River (19060201)
0 15 Miles
Proposed Routes
Corridor D
Corridor A*
Corridor E
Coastal Route Modification
Corridor F
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
Project Area
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
DRAINAGE BASINS
Road Network for Utqiaġvik, Atqasuk, and Wainwright
ASRC Energy Services Alaska, Inc.
FIGURE:
TM3-2
UTM Zone 4N (NAD83)
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Streams, as defined geographically by their HUCs in Table TM3-1 and shown in Figure TM3-2, are further described below. Such streams were generally selected to be discussed in this memo as they are either a significant river adjacent to an endpoint community or a route alternative, or are a named stream basin crossed by one or more of the alternative alignments.

Meade River

The Meade River had a contributing drainage basin area of approximately 5,073 sq mi. At Atqusuk, where the drainage basin is 1,790 sq mi, the peak streamflow recorded in over 14 years of monitoring was measured at 55,900 cubic feet per second (U.S. Geological Survey 2020). It has headwaters along Kulugra Ridge within the foothills of the Brooks Range, and drains into Admiralty Bay in the Beaufort Sea. The Meade River has been documented as having spawning chum salmon as well as Bering cisco and undefined whitefishes present. The Meade River is not crossed by any of the project alternatives, but it is the receiving waterbody for the Nigisaktuvik River with the village of Atqasuk situated on its west bank.

Inaru River

The Inaru River has a drainage basin of approximately 757 sq mi. It flows eastwards from its headwaters in the Arctic Coastal Plain near Lake Tuvak and Lake Itinik, and roughly parallels the coastline of the Chukchi Sea while making its way to its outlet into Admiralty Bay on the Beaufort Sea. The river is tightly meandering in its upper reaches, but begins to widen into larger meandering loops after being joined by Kucheak Creek north of Atqasuk. The river continues to straighten and widen before approaching Admiralty Bay and entering a delta also fed by the Meade River. The river flows through the Sisgravik Lake and Kuyanak Bay to outlet into Admiralty Bay. Little to no known publicly available streamflow or breakup data is available for the Inaru River. Rearing and spawning whitefishes have been documented in the Inaru River.

The Inaru River is not directly crossed by the project alternatives, but is the receiving waterbody of Kucheak Creek and its upper reaches occur between Corridor D–Coastal Route Extension and Corridor E–Middle Route.

Nigisaktuvik River

The Nigisaktuvik River has a drainage basin of approximately 797 sq mi and is deeply channelized. No fish species are documented to be present; however, it is a major tributary of the anadromous Meade River, joining it about 5.5 miles north of Atqasuk. Little to no known publicly available streamflow or breakup data is available for Nigisaktuvik River. This stream is crossed by Corridor F–Southern Route.

Kucheak Creek

Kucheak Creek drains approximately 145 sq mi and runs roughly parallel to Nigisaktuvik River, draining northeastwards to its juncture with Inaru River north of Atqasuk. Kucheak Creek is primarily a meandering stream with little braiding occurring along its path. Little streamflow or breakup data is available for Kucheak Creek. No fish species have been documented on this stream; however, spawning and rearing whitefishes have been documented on the Inaru River at the junction with Kucheak Creek. Kucheak Creek is crossed by both Corridors E and F.

Kunarak Creek

Kunarak Creek drains a basin area of approximately 15 sq mi and releases directly to the Chukchi Sea. This stream, lying in a deep gulley, is typically single channeled with some beading occurring along its length. Little to no known publicly available streamflow or breakup data is available for Kunarak Creek. The presence of fish in Kunarak Creek is unknown. Kunarak is crossed by Corridor D approximately 4 miles inland from its outlet to the Chukchi Sea.

Papigak Creek

Papigak Creek drains a basin of approximately 20 sq mi to flow directly into the Chukchi Sea. It is a single channel stream existing within a deep gulley with minimal meandering along its length. Little to no known publicly available streamflow or breakup data is available for Papigak Creek. Fish presence in Papigak Creek is unknown. Papigak Creek is crossed by Corridor D approximately 2 to 3 miles upstream of its mouth.

Walik Creek

Walik Creek has a basin of approximately 15 sq mi and an outlet in Peard Bay. The stream is a single channel with some meandering and beading along its length. Little to no known publicly available streamflow or breakup data is available for Walik Creek. Fish presence in Walik Creek is unknown. Walik Creek is crossed by Corridor D approximately 3 miles upstream of its mouth.

Kugrua River

The Kugrua River, with a drainage basin of approximately 289 sq mi, flows northward into Kugrua Bay, which opens into Peard Bay. The headwaters of the Kugrua River are generally meandering, transitioning into a "straight" channel stream as the main channel is established and widening substantially as it approaches Kugrua Bay. Little to no known publicly available streamflow or breakup data is available for Kugrua River. Spawning chum and pink salmon have been documented in this stream, just downstream of the Corridor F crossing. This stream is crossed by all three corridors, with one crossing by Corridor F and one crossing by the combined Corridor D and E alignments.

Kungok River

The Kungok River flows westward into the Kuk River, entering opposite the Alataktok River. The Kungok River, which has a drainage basin of approximately 513 sq mi, begins as a predominantly narrow channelized "straight" stream before being joined by several streams (including Kolipsun Creek, Maguriak Creek, Mikigealiak River, and Amagoalik Creek) and widening substantially. Little to no known publicly available streamflow or breakup data is available for Kungok River. Spawning chum and pink salmon have been catalogued on this stream, and broad whitefish, least cisco, and rainbow smelt have been documented. A small tributary to the Kungok is crossed by Corridor F.

Sinaruruk River

The Sinaruruk River has a drainage basin of approximately 62 sq mi. It flows northwestward from its headwaters directly into the Chukchi Sea. For the most part, the river is straight and channelized with minimal meandering along the length of its main channel, though it widens substantially just prior to its outlet. Little to no known publicly available streamflow or breakup data is available for Sinaruruk River, and no fish species have been documented.

The Sinaruruk River is crossed by all three alignments at two crossing locations. The Corridor D and Corridor E routes share an alignment at the crossing location, and Corridor F crosses the Sinaruruk River a little over 1.5 miles upstream.

Kuk River

The Kuk River is approximately 35 miles long and has an approximately 4,175 sq mi drainage basin. Its headwaters are located in the foothills of the Brooks Range. Little to no known publicly available streamflow or breakup data is available for the Kuk River. Rainbow smelt, broad whitefish, least cisco, and spawning chum and pink salmon have been documented in the Kuk basin. While the Kuk River is not directly crossed by any of the project corridors, it is the receiving waterbody of the Kungok River which outlets into the Chukchi Sea adjacent to the terminus of the project at Wainwright.

Stream and River Crossings

Hydrologic conditions along the three proposed corridors were reviewed and analyzed using Global Mapper, a Geographic Information System (GIS)-based program. This analysis consisted of a desktop-only study incorporating GIS data, aerial imagery, and precipitation and stream gage data, where available. Hydrologic conditions of the major stream crossings within the project area are discussed below.

Careful consideration of major crossing locations and orientation was taken into account during development of the three routes. Where feasible, the crossing location was selected to allow for the shortest span within the reach and along a straight section of the stream. Additional consideration for abutment placement included aerial imagery review for bank stability and evidence of lateral stream migration.

Alternatives Comparison

Crossings were organized by size: major crossings, intermediate crossings, minor crossings, and culvert batteries, and are presented in Table TM3-2. Major crossings are seen as multi-span bridges greater than 100 ft in total length. Intermediate crossings are bridges that would span between 50 and 100 ft. Minor crossings are single-span bridges over smaller streams, with spans less than 50 ft. In addition to bridge crossings, smaller streams were identified along the alternatives that would likely not require a bridged crossing and instead could be crossed with large culverts (i.e., culvert batteries).

The typical need for cross drainage culverts on the Arctic Coastal Plain averages out to approximately one per 500 ft of road length. These culverts are intended to facilitate flow through a road corridor during spring breakup, minimizing ponding and disruption of natural drainage patterns. The initial cross-drainage culvert quantity estimate, based on this average, is provided in the last column of the table. More or fewer culverts may be required depending on the microtopography along the route, as well as on the orientation of the road relative to the local terrain and whether the route follows high ground between drainages. Refinement of cross-drainage culvert quantities can be completed based on route walks and topographic survey or LiDAR investigation.

Table TM3-2. Crossing Summary by Alternative

Route	Culvert Batteries	Minor Crossings (<50 ft)	Intermediate Crossings (50 to 100 ft)	Major Crossings (>100 ft)	Cross-Drainage Culverts
Corridor D – Coastal Route Extension	13	6	3	1	660
Corridor E – Middle Route	8	7	0	2	730
Corridor F – Southern Route	20	4	4	2	720

A general discussion of each of the corridor routes is included below. This includes discussion of the general route as it affects drainage, as well as a general discussion of each of the stream crossings identified that are likely to require bridges. In addition to a high-level assessment and identification of stream crossings, each of the major crossing locations were analyzed and evaluated for both stream stability and for any potential alternative crossing locations that may be superior to the currently identified location; however, the majority of this analysis took place prior to the preparation of this memo, during development of the selected routes. The result of that evaluation effort is reflected below for each crossed stream that is likely to require a bridge.

Corridor D

Corridor D connects Wainwright to Corridor A–Coastal Route (assessed in the *Atqasuk to Utqiaġvik All Season Access Road* study [AES Alaska 2019]) via a coastal route paralleling the Chukchi Sea.

This route connects to Corridor A near the headwaters of Tuapktushak Creek, and generally continues west-southwestward, avoiding thermokarst lakes and traversing the headwaters of Kikoligarak Creek and Kikolik Creek. The first two significant stream crossings occur at Kunarak Creek and Papigak Creek, where minor structure types are proposed. The Kunarak Creek crossing occurs near the stream's transition between beaded and continuous channel geometry, and has somewhat steep banks that appear to be stable. Papigak Creek is narrow and relatively straight at the crossing location, residing within a deep gulley. Although both Kunarak Creek and Papigak Creek are relatively small, due to their location within gullies, minor structure types are proposed to cross these single channels with bankfull widths of 25 ft and 15 ft, respectively.

The route continues westward to encounter three more significant crossings of unnamed streams, two crossings necessitating intermediate structure types and one requiring a minor structure. The first intermediate crossing (Cst06) is a single channel with a bankfull width of 40 ft. The remaining two streams (Cst08 and Cst09) have beaded channels with bankfull widths of 15 ft and 30 ft, corresponding to expected minor and intermediate bridge structures, respectively.

As Corridor D heads westward, the route continues around thaw lakes and smaller streams near their headwaters, crossing multiple unnamed streams culvert batteries. The next larger (named) stream crossing is at Walik Creek. This confined stream is somewhat beaded with very few meanders at the crossing location. West of Walik Creek the route winds through roughly 6 miles of densely spaced thaw lakes (both drained and undrained) and small drainages before transitioning to dryer ground, avoiding most thaw lakes and remaining on higher ground for over 10 miles until it crosses the Kugrua River (this crossing location is shared by Corridor D and Corridor E).

The Kugrua River is the largest crossing of the Corridor D route. The river at this location, and extending approximately 1 mile upstream, is generally wide and low-gradient, although the proposed crossing location is at a natural bar, which significantly narrows the river width. The presence of the natural bar suggests tidal influence.

but with the stability of the bar unknown at this time, the bridge should be expected to span the full width of the river channel banks.

To the west of the Kugrua River, the Corridor D route follows along the same band of high ground, crossing smaller streams nearer to their headwaters where channels are typically narrower and channelized, thereby minimizing the need for larger crossing structures. A minor structure is expected at the crossing of Avgumun Creek, where the bankfull width at the crossing location is 30 ft.

Approximately 10 miles west of the Kugrua River crossing, the route crosses the Sinaruruk River. At the crossing location, the Sinaruruk River is a beaded stream that flows in a gully with banks that appear to be stable. The bankfull width is 15 ft and a minor structure type is expected.

Just before this route terminates at the Wainwright Distant Early Warning (DEW) Line Site, it crosses an unnamed stream (Cst17) flowing into Wainwright Inlet. This stream is narrow and straight and flows within a gully. The route crosses the stream just before it opens up into a wide, possibly tidally influenced, reach mostly separated from the inlet by a narrow bar. The bankfull width of the unnamed stream at the crossing is 20 ft, and a minor crossing structure is expected.

Table TM3-3 below lists stream crossings required along the route. Channel type identifies the type of stream channel that is being crossed. The majority of smaller streams throughout the project area consist of beaded streams and drainages flowing through high and low-centered polygon networks. Larger non-beaded streams are often meandering streams with a single channel and are listed as “single.”

Table TM3-3. Corridor D Route Bridge and Culvert Battery Summary

Crossing	Latitude	Longitude	Drainage Area (sq mi)	Structure Type	Channel Type	Bankfull Width (ft)	Fish Present[1,2,3]
Cst01	70° 50' 16.0322" N	157° 37' 26.1977" W	0.4	Culvert battery	Beaded	Too small to determine	Unknown
Cst02	70° 49' 59.3533" N	157° 38' 12.0750" W	<0.5	Culvert battery	Beaded	Too small to determine	Unknown
Kunarak Creek	70° 47' 18.9324" N	157° 57' 00.2454" W	3	Minor	Single	25	Unknown
Cst03	70° 47' 11.1782" N	158° 05' 54.8880" W	<0.5	Culvert battery	Polygon	Too small to determine	Unknown
Papigak Creek	70° 47' 19.9543" N	158° 07' 09.4770" W	14	Minor	Single	15	Unknown
Cst04	70° 47' 01.9771" N	158° 16' 54.9843" W	<0.5	Culvert battery	Polygon	Too small to determine	Unknown
Cst05	70° 47' 01.8751" N	158° 17' 14.6558" W	<0.5	Culvert battery	Polygon	Too small to determine	Unknown
Cst06	70° 47' 12.1621" N	158° 19' 59.3289" W	0.7	Intermediate	Single	40	Unknown
Cst07	70° 46' 45.8001" N	158° 22' 20.5400" W	<0.5	Culvert battery	Polygon	Too small to determine	Unknown

Crossing	Latitude	Longitude	Drainage Area (sq mi)	Structure Type	Channel Type	Bankfull Width (ft)	Fish Present[1,2,3]
Cst08	70° 46' 13.4609" N	158° 24' 54.9985" W	1.3	Minor	Beaded	15	Unknown
Cst09	70° 45' 37.5584" N	158° 26' 42.3416" W	2.2	Intermediate	Beaded	30	Unknown
Walik Creek	70° 45' 20.7063" N	158° 31' 07.5191" W	8.4	Intermediate	Single	15	Unknown
Cst10	70° 45' 12.1209" N	158° 32' 00.4697" W	<0.5	Culvert battery	Polygon	Too small to determine	Unknown
Cst11	70° 44' 26.5195" N	158° 33' 36.8067" W	<0.5	Culvert battery	Polygon	Too small to determine	Unknown
Cst12	70° 43' 42.3946" N	158° 47' 13.1502" W	<0.5	Culvert battery	Polygon	Too small to determine	Unknown
Cst13[4]	70° 43' 28.0474" N	159° 05' 32.1559" W	<0.5	Culvert battery	Polygon	Too small to determine	Unknown
Cst14[4]	70° 42' 43.6262" N	159° 10' 21.2788" W	<0.5	Culvert battery	Polygon	Too small to determine	Unknown
Kugrua[4] River	70° 42' 19.4100" N	159° 13' 03.9456" W	264	Major	Single	890	CHs, Ps, CHp
Avgumun[4] Creek	70° 40' 39.5460" N	159° 22' 41.5246" W	3.4	Minor	Beaded	30	Unknown
Cst15[4]	70° 40' 39.1648" N	159° 24' 11.1416" W	<0.5	Culvert battery	Polygon	Too small to determine	Unknown
Sinaruruk River[4]	70° 39' 22.7668" N	159° 37' 51.1100" W	21	Minor	Beaded	15	Unknown
Cst16[5]	70° 37' 15.1416" N	159° 54' 18.2112" W	<0.5	Culvert battery	Beaded	Too small to determine	Unknown
Cst17[5]	70° 38' 49.5708" N	159° 55' 18.0784" W	8	Minor	Beaded	20	Unknown

1. Fish presence is based on data from the Anadromous Waters Catalog (AWC) (Alaska Department of Fish and Game [ADF&G] 2019).
2. CH – chum salmon; P – pink salmon;W – undifferentiated whitefishes
3. p – present; s – spawning.
4. Crossing is shared by Corridor D and Corridor E.
5. Crossing is shared by Corridor D, Corridor E, and Corridor F.

Corridor D is the shortest of the three alternative routes and generally follows higher ground, resulting in a decreased need for cross-drainage/equalizing culverts along its length. As Corridor D is the closest route to the coast and stream outlets, the streams at the proposed crossing locations are typically more entrenched and although some may be relatively small, they run through deep gullies that will likely require a bridge rather than a culvert battery regardless of the design flow volumes. Corridor D is expected to require 13 culvert batteries, 6 minor structure crossings, 3 intermediate structure crossings, and 1 major structure crossing.

Corridor E

Corridor E links the Atqasuk to Utiqiaġvik route, Corridor A, to Wainwright. The alignment begins just north of Atqasuk and the Nigisaktuvik River, and heads northwestward to join with the Corridor D route south of Peard Bay and approximately 7 miles east of the shared Kugrua River crossing.

From its juncture with Corridor A, the route heads westward before reaching its first stream crossing at Kucheak Creek. At the crossing location, Kucheak Creek is tightly meandering with some beading. The bankfull width is 90 ft and a major structure type is expected.

The route continues westward, following a meandering path to avoid several numerous thermokarst lakes before reaching an area of higher and drier ground and resuming a northwestwardly direction for several miles with no significant stream crossings. As the route approaches the headwaters of the Kugrua River, large elongated lakes become more prevalent and, to avoid them, the route parallels the upstream reaches of the Kugrua for several miles, threading between the river and Lake Itinik.

The corridor redirects northward to intercept the Corridor D route, crossing over a series of unnamed tributaries of the Kugrua River. A total of four minor bridge structures over these tributaries are expected before the Corridor E and D alignments meet. The first three crossings (Cntr04, Cntr05, and Cntr06) are classified as single channel types with bankfull widths of 25 ft, 15 ft, and 20 ft, respectively. The fourth (Cntr07) is beaded with a bankfull width at the crossing location of 10 ft.

The Corridor E alignment joins the Corridor D route at a high and relatively dry location approximately 3 miles south of Kugrua Bay and 7 miles east of Kugrua River.

The combined Corridor D/E routes continue westward to approach and cross the Kugrua and Sinaruruk rivers before terminating at the town of Wainwright, as detailed in the Corridor D description.

Corridor E is the longest of the three alternatives and passes through low-lying ground and lakes for the majority of its length before joining Corridor D’s shared alignment. Therefore, this corridor requires the most cross-drainage/equalizing culverts of the three alternatives. Although the corridor meanders through wet areas, it generally follows high ground, crossing through the headwaters of streams to the south and to the north, thereby reducing the number of larger crossings along the route, with only eight estimated culvert batteries, seven minor crossings, and two major crossings. The bridge crossings and culvert batteries for this corridor are listed in Table TM3-4.

Table TM3-4. Corridor E Route Bridge and Culvert Battery Crossing Summary

Crossing	Latitude	Longitude	Drainage Area (mi^2)	Structure Type	Channel Type	Bankfull Width (ft.)	Fish Present[1,2,3]
Kucheak Creek	70° 32' 02.9893" N	157° 52' 12.6300" W	72	Major	Single	90	Unknown
Cntr01	70° 32' 28.2983" N	158° 02' 59.6078" W	<0.5	Culvert battery	Polygon	Too small to determine	Unknown
Cntr02	70° 32' 38.3643" N	158° 05' 50.9380" W	<0.5	Culvert battery	Polygon	Too small to determine	Unknown
Cntr03	70° 33' 05.8594" N	158° 09' 16.8698" W	<0.5	Culvert battery	Polygon	Too small to determine	Unknown
Cntr04	70° 36' 37.3256" N	158° 22' 38.1052" W	20	Minor	Single	25	Unknown
Cntr05	70° 37' 06.9236" N	158° 24' 42.9805" W	<0.5	Minor	Single	15	Unknown
Cntr06	70° 37' 34.4533" N	158° 29' 21.2748" W	8	Minor	Single	20	Unknown
Cntr07	70° 41' 39.4361" N	158° 49' 17.7992" W	28	Minor	Beaded	10	Unknown
Cntr08	70° 42' 00.3633" N	158° 50' 20.8580" W	<0.5	Culvert battery	Polygon	Too small to determine	Unknown
Cntr 09[4]	70° 43' 28.0474" N	159° 05' 32.1559" W	<0.5	Culvert battery	Polygon	Too small to determine	Unknown
Cntr 10[4]	70° 42' 43.6262" N	159° 10' 21.2788" W	<0.5	Culvert battery	Polygon	Too small to determine	Unknown
Kugrua[4] River	70° 42' 19.4100" N	159° 13' 03.9456" W	264	Major	Single	890	CHs, Ps, CHp
Avgumun[4] Creek	70° 40' 39.5460" N	159° 22' 41.5246" W	3.4	Minor	Beaded	30	Unknown
Cntr 11[4]	70° 40' 39.1648" N	159° 24' 11.1416" W	<0.5	Culvert battery	Polygon	Too small to determine	Unknown
Sinaruruk River[4]	70° 39' 22.7668" N	159° 37' 51.1100" W	21	Minor	Beaded	15	Unknown
Cntr12[5]	70° 37' 15.1416" N	159° 54' 18.2112" W	<0.5	Culvert battery	Beaded	Too small to determine	Unknown
Cntr 135	70° 38' 49.5708" N	159° 55' 18.0784" W	8	Minor	Beaded	20	Unknown

1. Fish presence is based on data from the AWC (ADF&G 2019).
2. CH – chum salmon; P – pink salmon
3. p – present; s – spawning.
4. Crossing is shared by Corridor D and Corridor E.
5. Crossing is shared by Corridor D, Corridor E, and Corridor F.

Corridor F

Corridor F directly connects Atqasuk to Wainwright, linking with the Corridor D/E combined routes a few miles east of the Wainwright DEW Line site.

The corridor begins north of the terminus of Ekosik Street on the Landfill Access Road north of Atqasuk, and routes southwestward, threading between a series of lakes, north of Ikmakrak Lake. The first crossing along the route occurs over the Nigisaktuvik River. The channel at this location is relatively deep and well defined with tall banks. The bankfull width is approximately 235 ft, requiring a major bridge structure.

From there, the route continues by paralleling and then crossing Kucheak Creek with several culvert batteries and one minor structure occurring between the Nigisaktuvik and Kucheak creeks. Kucheak Creek is typically meandering, with a single, well-established channel at the crossing location. The bankfull width at the crossing is approximately 40 ft suggesting that an intermediate bridge structure will be required.

The route continues in a northwesterly direction, weaving between lakes and ponds, and passing over several small unnamed streams before approaching and crossing the Kugrua River. The route crosses the Kugrua River at a relatively straight and channelized location of an otherwise meandering section of the river. The bankfull width is approximately 20 ft; however, with the river’s incised natural and bank geometry, an intermediate structure will likely be required.

The route follows a meandering path to avoid a series of large thermokarst lakes, generally paralleling the headwaters and upper reaches of the Kungok River before nearing a major tributary of the Kugrua River. Four significant crossings are anticipated at this unnamed tributary stream with the first expected to be an intermediate structure type; the second a major structure type; and the third and fourth minor structure types. Additionally, numerous culvert batteries facilitate passage over small single, beaded, and polygonal waterways contributing to the tributary. The stream type at the location of the intermediate structure crossing is beaded with a bankfull width of 25 ft; the stream type at the location of the major structure crossing is single with a bankfull width of 40 ft; and the stream types at the locations of the minor structure crossings are beaded with bankfull widths of 10 ft and 27 ft.

From the Kugrua tributary, Corridor F route enters the Sinaruruk River drainage and, at a distance of less than 2 miles from Corridor F’s juncture with the shared Corridor D/E route (and approximately 7 miles east of Wainwright along the alignment), crosses the Sinaruruk River. This crossing of the Sinaruruk River is approximately 25 feet wider than the downstream crossing by Corridor D/E, and is expected to require an intermediate bridge structure.

After the Sinaruruk River crossing, Corridor F joins with the other two alternate routes (Corridor D and Corridor E) along a shared alignment to pass over the final two stream crossings before terminating in Wainwright.

Corridor F is the most southerly route evaluated and it provides the most geographically direct path from Atqasuk to Wainwright. Unlike the Corridor D and Corridor E alignments, this route does not utilize any of the Corridor A alignment from Atqasuk to Utqiaġvik. The Corridor F route meanders through wet, unavoidable low-lying areas, requiring a similar number of cross-drainage/equalizing culverts as Corridor E, and a similar number of bridge crossings as the other alternatives. This corridor is estimated to require 20 culvert batteries, 4 minor structure crossings, 4 intermediate structure crossings, and 2 major structure crossings. In comparison with Corridor D and E, Corridor F requires the greatest number of crossings--seven more stream crossings than Corridor D, and thirteen more crossings than Corridor E. A summary of the crossings likely required for Corridor F are included in Table TM3-5.

Table TM3-5. Corridor F Route Bridge and Culvert Battery Summary

Crossing	Latitude	Longitude	Drainage Area (mi^2)	Structure Type	Channel Type	Bankfull Width (ft.)	Fish Present[1]
Nigisaktuvik River	70° 29' 20.5020" N	157° 37' 37.3733" W	763	Major	Single	235	Unknown
Sth01	70° 30' 00.7602" N	157° 47' 00.3703" W	<0.5	Culvert battery	Single	20	Unknown
Sth02	70° 30' 15.8173" N	157° 49' 00.6679" W	9	Culvert battery	Beaded	Too small to determine	Unknown
Sth03	70° 30' 27.9343" N	157° 53' 35.0144" W	<0.5	Minor	Single	20	Unknown
Sth04	70° 30' 46.0952" N	157° 56' 33.9599" W	2.5	Culvert battery	Single	Too small to determine	Unknown
Sth05	70° 30' 49.0999" N	157° 57' 27.3292" W	<0.5	Culvert battery	Beaded	Too small to determine	Unknown
Sth06	70° 30' 52.2473" N	157° 58' 48.5155" W	<0.5	Culvert battery	Single	Too small to determine	Unknown
Kucheak Creek	70° 30' 31.8715" N	158° 04' 19.0175" W	47	Intermediate	Single	40	Unknown
Sth07	70° 32' 56.2836" N	158° 17' 29.7233" W	<0.5	Culvert battery	Single	Too small to determine	Unknown
Sth08	70° 32' 48.7460" N	158° 20' 36.3128" W	<0.5	Culvert battery	Single	Too small to determine	Unknown
Sth09	70° 32' 53.9578" N	158° 23' 49.6060" W	<0.5	Culvert battery	Polygon	Too small to determine	Unknown
Sth10	70° 34' 10.3847" N	158° 34' 00.7670" W	<0.5	Culvert battery	Polygon	Too small to determine	Unknown
Sth11	70° 34' 12.5946" N	158° 34' 24.0614" W	<0.5	Culvert battery	Polygon	Too small to determine	Unknown
Kugrua River	70° 34' 18.3661" N	158° 36' 16.3310" W	64	Intermediate	Single	20	Unknown
Sth12	70° 33' 38.1590" N	158° 39' 04.5922" W	<0.5	Culvert battery	Polygon	Too small to determine	Unknown
Sth13	70° 35' 42.7754" N	158° 52' 06.0790" W	<0.5	Culvert battery	Polygon	Too small to determine	Unknown
Sth14	70° 35' 34.5848" N	159° 03' 45.0766" W	<0.5	Culvert battery	Beaded	Too small to determine	Unknown
Sth15	70° 36' 18.0230" N	159° 05' 34.5103" W	3	Intermediate	Beaded	25	Unknown
Sth16	70° 36' 27.3389" N	159° 10' 35.2488" W	<0.5	Culvert battery	Single	Too small to determine	Unknown

Crossing	Latitude	Longitude	Drainage Area (mi²)	Structure Type	Channel Type	Bankfull Width (ft.)	Fish Present[1]
Sth17	70° 36' 56.0199" N	159° 13' 13.5343" W	<0.5	Culvert battery	Beaded	Too small to determine	Unknown
Sth18	70° 37' 02.2264" N	159° 13' 55.1492" W	2	Major	Single	40	Unknown
Sth19	70° 37' 06.8945" N	159° 16' 35.7108" W	<0.5	Culvert battery	Single	Too small to determine	Unknown
Sth20	70° 37' 05.4497" N	159° 17' 08.6027" W	<0.5	Culvert battery	Polygon	Too small to determine	Unknown
Sth21	70° 37' 06.3541" N	159° 17' 19.4506" W	<0.5	Culvert battery	Polygon	Too small to determine	Unknown
Sth22	70° 37' 08.0727" N	159° 17' 36.4499" W	<0.5	Culvert battery	Polygon	Too small to determine	Unknown
Sth23	70° 37' 12.9761" N	159° 18' 21.9015" W	19	Minor	Beaded	10	Unknown
Sth24	70° 37' 38.5687" N	159° 25' 14.6004" W	<0.5	Minor	Beaded	27	Unknown
Sinaruruk River	70° 37' 56.7068" N	159° 36' 28.0272" W	14	Intermediate	Beaded	40	Unknown
Sth25[2]	70° 37' 15.1416" N	159° 54' 18.2112" W	<0.5	Culvert battery	Beaded	Too small to determine	Unknown
Sth26[2]	70° 38' 49.5708" N	159° 55' 18.0784" W	8	Minor	Beaded	20	Unknown

1. Fish presence is based on data from the AWC (ADF&G 2019).
2. Crossing is shared by Corridor D, Corridor E, and Corridor F.

Available Stream Data

Stream data is very limited within the project area. No gages are known to exist on the streams being crossed by the alternative corridors.

Data Gaps

Little historical data, including survey, general research, or streamflow records, is available for the streams within the project area. Future field efforts should gather survey data as well as stage and discharge measurements throughout spring breakup and during summer low-flow conditions. Alternative corridors should also be inspected on-foot with helicopter support, to better identify cross-drainage locations and quantities, find improvements to route centerline alignments based on local topography, and to identify any major flaws in the routes or crossing locations due to unforeseen topography or other challenges that would require adjustments.

The current study was conducted utilizing available aerial imagery and LiDAR. Additional assessment of streambank stability and crossing locations should be conducted, including onsite observation of the crossing locations and potential abutment locations.

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Technical Memorandum 4 – Geology / Geotechnical

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Technical Memorandum 4 – Geology/Geotechnical

Prepared by: Hans Hoffman, Geological Engineer, CPG

Reviewed by: Paul Ramert, Civil Engineer, PE

Date: April 2020

Overview

The project area is on Alaska's North Slope within the Arctic Coastal Plain physiographic province. The Arctic Coastal Plain extends from sea level to an elevation of about 600 feet (ft) and is characterized by gentle topography, ice-bonded permafrost, wet tundra, wind-oriented thaw lakes, and braided and beaded stream channels (Warhaftig 1960). Terraces and steep riverbanks are found adjacent to major rivers. The ground surface elevation within the project area varies from sea level to 140 ft. A surficial geologic map is shown on Figures TM4-1 through TM4-6, along with the proposed alternative routes.

Surficial Geology

Surficial geology within the project area is predominantly comprised of thaw lake deposits (Qt) and marine silts (Qm) and sands (Qms). As shown below in Table TM4-1, Qms/Qm and Qms comprise a majority of the proposed routes. The Qms unit, while variable, has potential to provide construction materials as well as a thaw stable road base. The variability and presence of Qm will need to be investigated to ascertain suitability of materials. Geotechnical investigations may reveal beach deposits where marine sand was interpreted, which would be beneficial for road construction and material site selection.

Detailed terrain unit mapping conducted in the study area delineates 15 individual geologic terrain units. Terrain units are intended to represent the basic soil profile within an estimated 20–30 ft of the surface. Where unit thickness is anticipated to be less than 20 ft thick, terrain units are expressed as a combination of individual units to represent the general vertical series to the interpreted depth of 20–30 ft. For example, thaw lake deposits (Qt) overlying marine silt (Qm) are expressed as Qt/Qm where the thaw lake basin is interpreted to be shallow. This combination of units has resulted in a total of 29 distinct surficial terrains. Terrain unit descriptions are provided below, and their prevalence in the project areas is provided in Table TM4-1.

Anthropogenic Deposits (Ad) **-** Anthropogenic deposits include fill placed by human activities, such as for the construction of roads and airstrips. Features mapped include gravel pads, roads, and airstrips. Road alignments are generally narrower than the mapping tolerance and not all are included as mapped features.

Undifferentiated Bedrock (Bx) **-** Shale, sandstone, conglomerate, clay (including bentonite layers), and coal underlie the unconsolidated sediments west of the Colville River. Bedrock is exposed on ridges and along coastal bluffs and riverbanks, and is frequently weathered with slope failures.

Ice-rich silt overlies bedrock in the southwestern portion of the project area. Areas where bedrock is anticipated to be present within terrain mapping depths are indicated by the unit (Qsi/Bx). Contacts between this unit and marine sand (Qms) are transitional.

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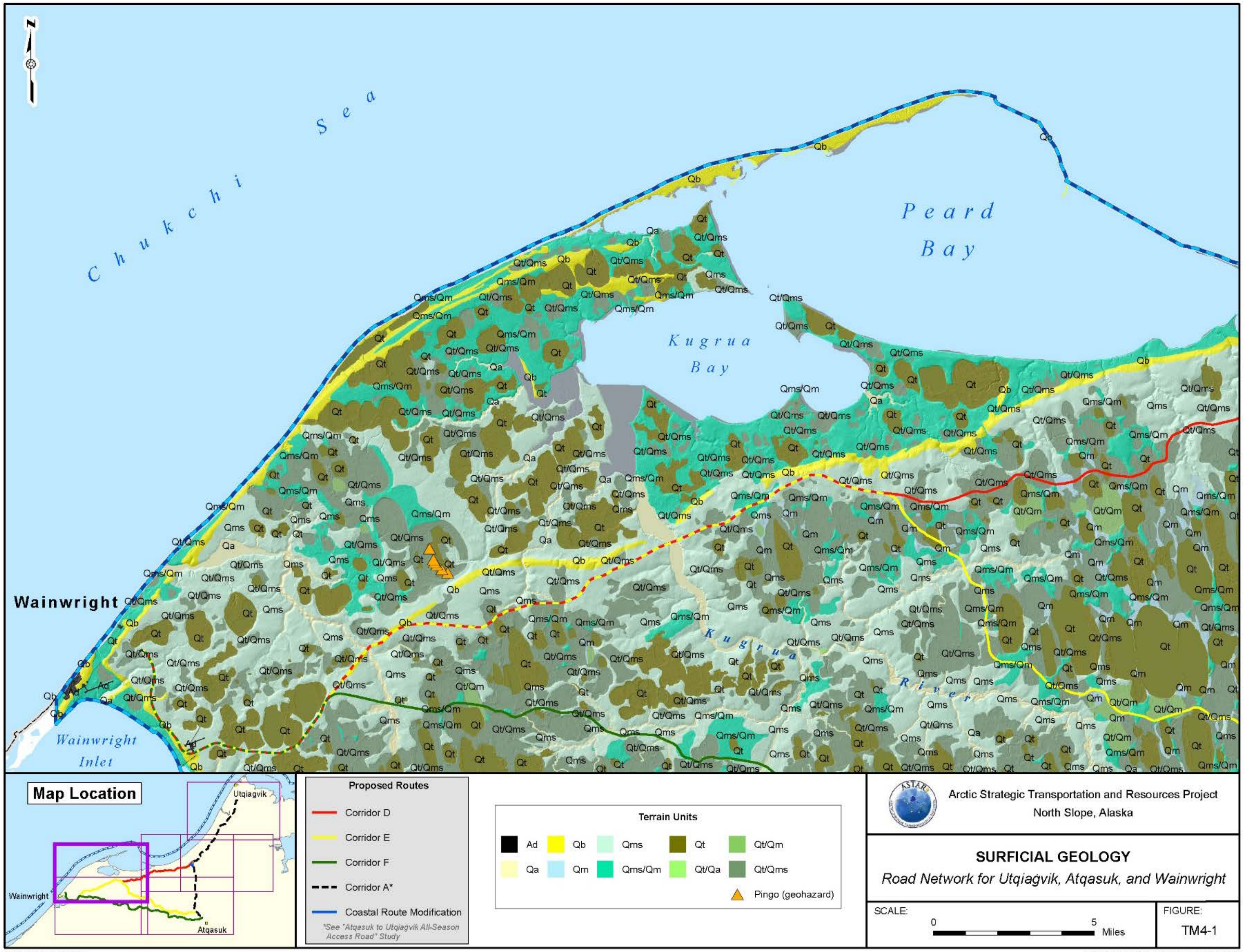
Chukchi Sea
Peard Bay
Kugrua Bay
Kugrua River
Wainwright
Wainwright Inlet
Map Location
Utqiagvik
Atqasuk
Proposed Routes
Corridor D
Corridor E
Corridor F
Corridor A*
Coastal Route Modification
*See "Atqasuk to Utqiagvik All-Season Access Road" Study
Terrain Units
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Qt
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Qa
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Qms/Qm
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Pingo (geohazard)
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
SURFICIAL GEOLOGY
Road Network for Utqiaġvik, Atqasuk, and Wainwright
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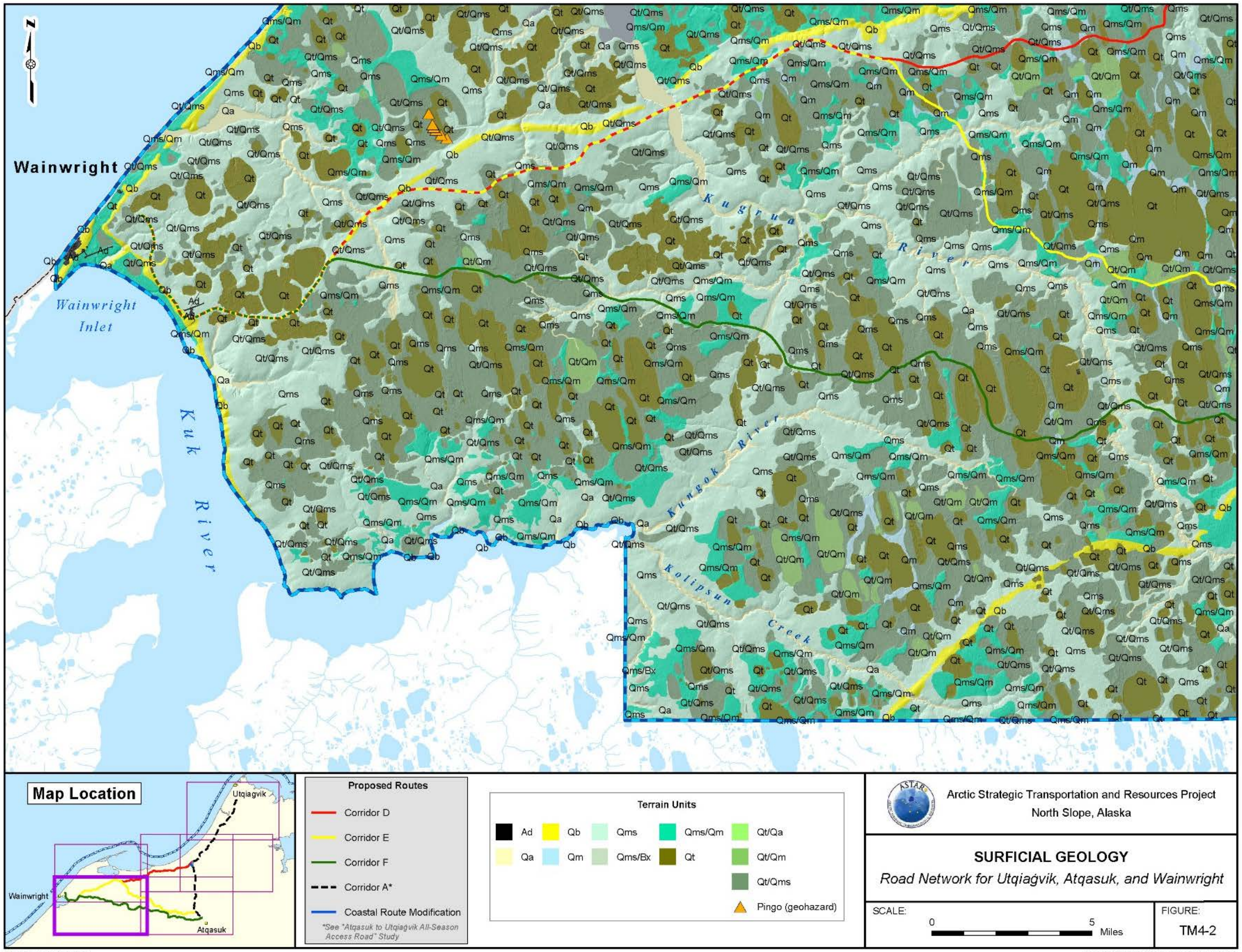
Wainwright
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Kugrua River
Kungok River
Kolipsun Creek
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Proposed Routes
Corridor D
Corridor E
Corridor F
Corridor A*
Coastal Route Modification
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
Terrain Units
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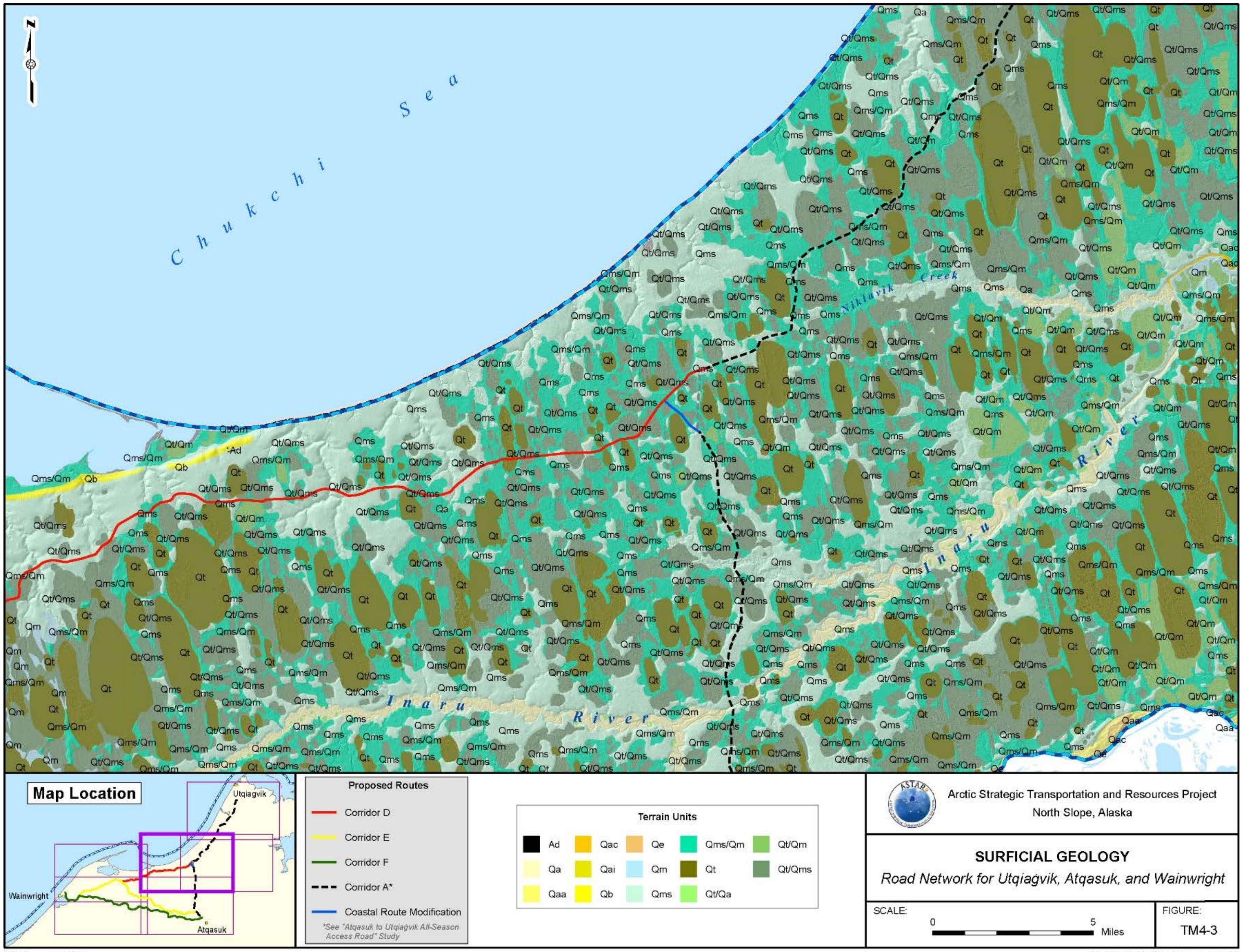

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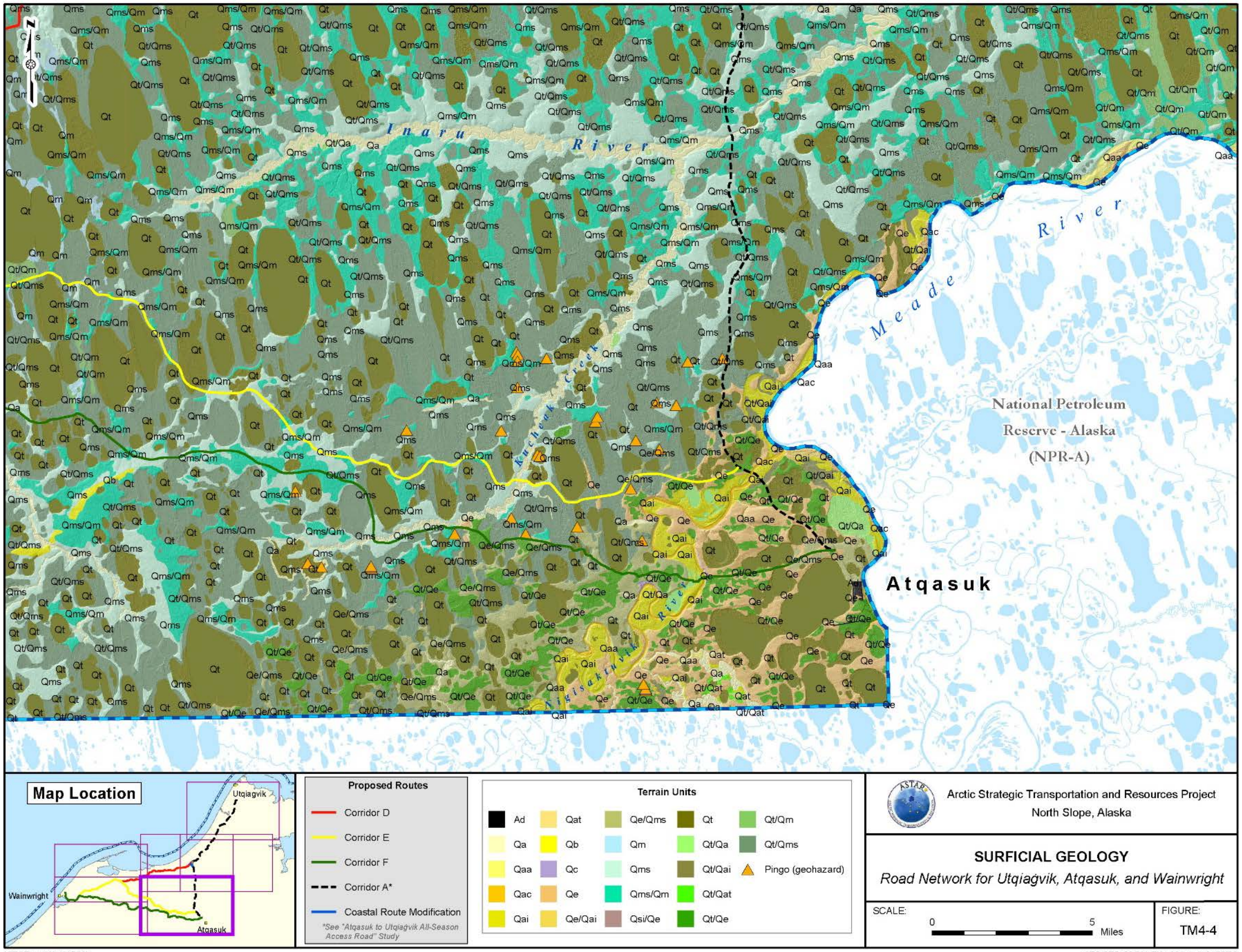
Inaru River
Kucheak Creek
Meade River
Nigisaktuvik River
National Petroleum Reserve - Alaska (NPR-A)
Atqasuk
Map Location
Utqiagvik
Wainwright
Atqasuk
Proposed Routes
Corridor D
Corridor E
Corridor F
Corridor A*
Coastal Route Modification
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
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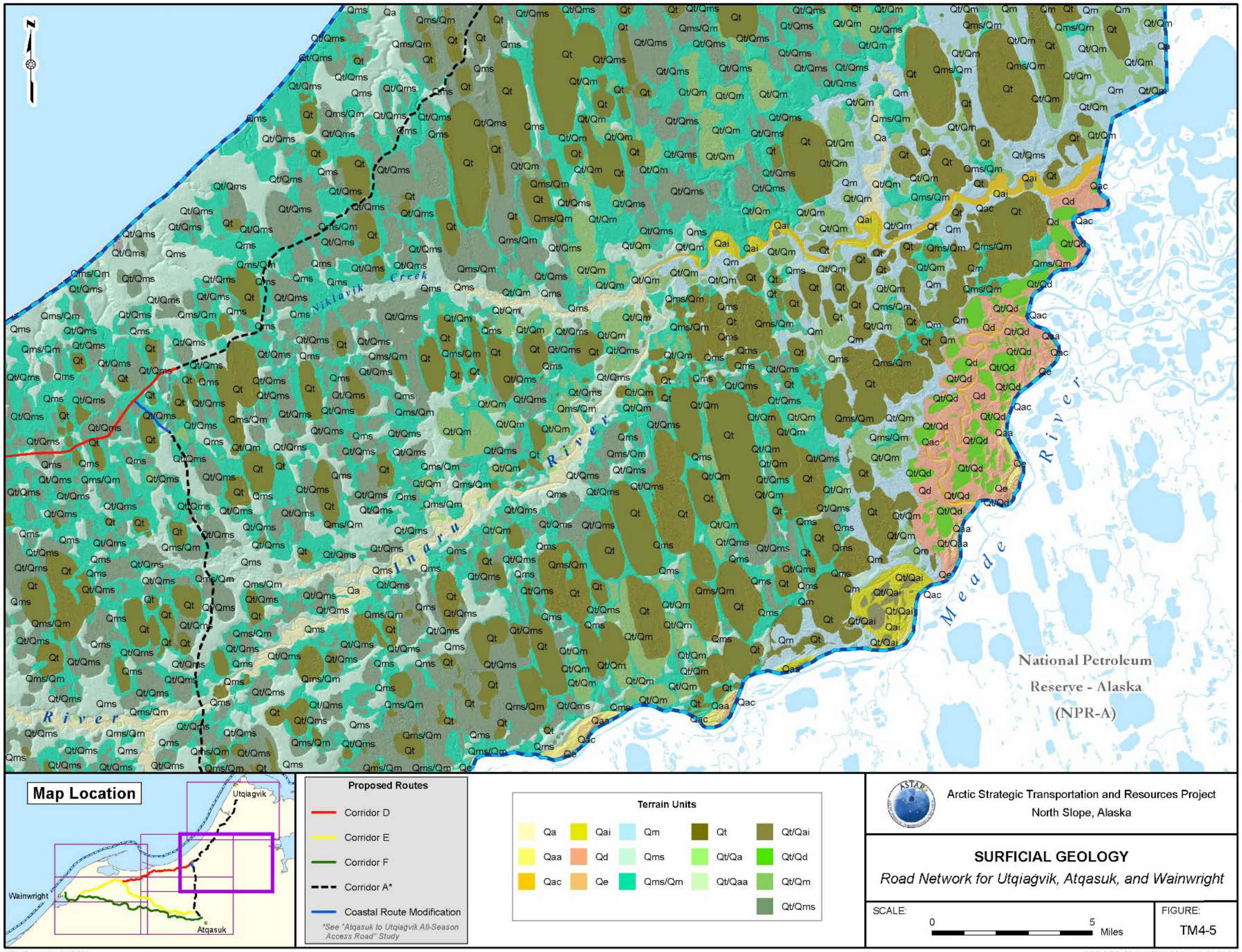
Niklavik Creek
Inaru River
River
Meade River
National Petroleum Reserve - Alaska (NPR-A)
Map Location
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Wainwright
Atqasuk
Proposed Routes
Corridor D
Corridor E
Corridor F
Corridor A*
Coastal Route Modification
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
Terrain Units
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Arctic Strategic Transportation and Resources Project
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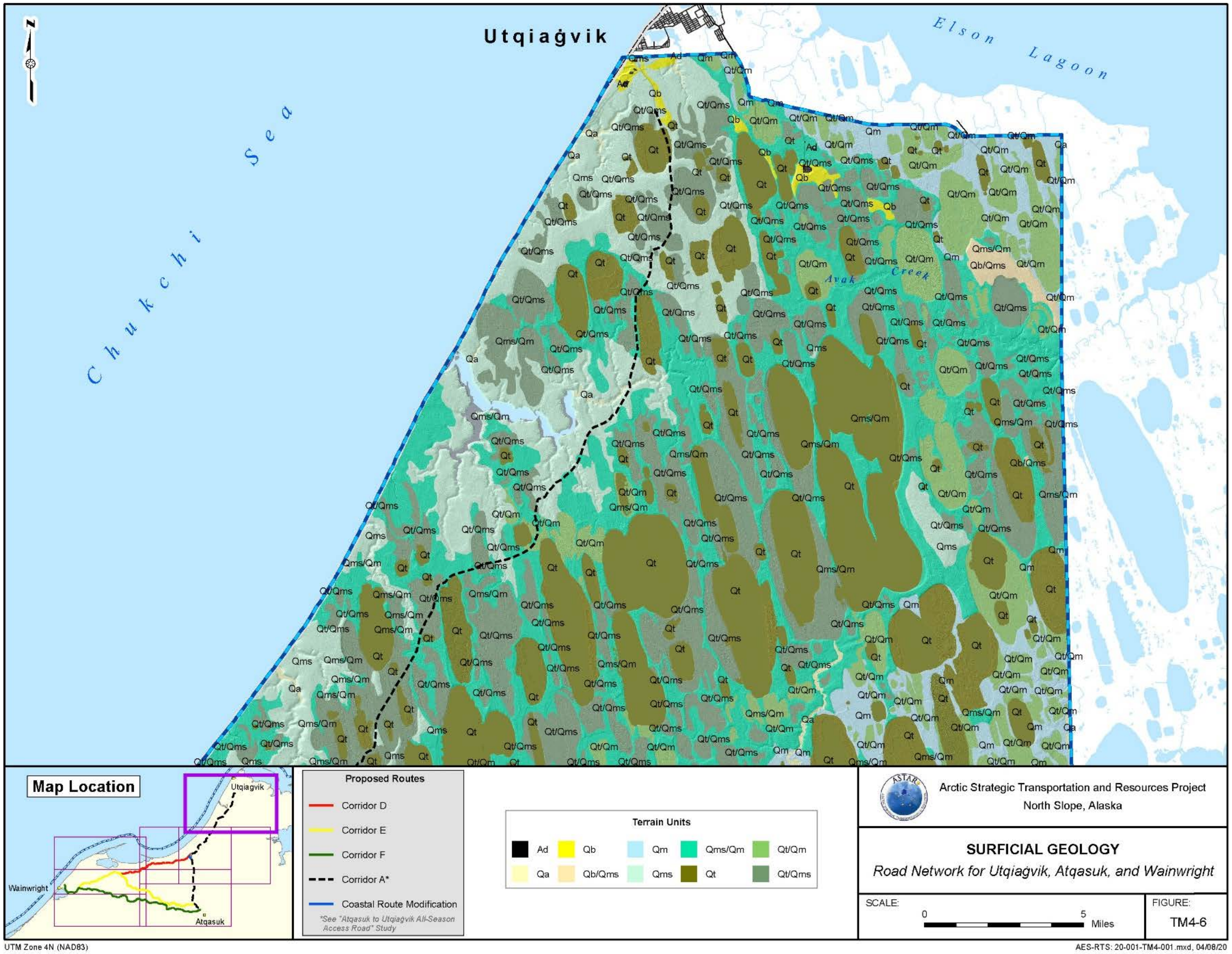
Utqiaġvik
Elson Lagoon
Chukchi Sea
Avak Creek
Map Location
Utqiaġvik
Wainwright
Atqasuk
Proposed Routes
Corridor D
Corridor E
Corridor F
Corridor A*
Coastal Route Modification
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
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Arctic Strategic Transportation and Resources Project
North Slope, Alaska
SURFICIAL GEOLOGY
Road Network for Utqiaġvik, Atqasuk, and Wainwright
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***Undifferentiated Alluvium (Qa)* -** Undifferentiated alluvium consist of silt, organic silt, silty sand, stratified fine to medium-grained sand and gravelly sand, with lag deposits of coarse-grained sand and minor gravel occurring locally. Undifferentiated alluvium represents alluvial deposits along small streams including channel, low-lying active and inactive floodplains, and alluvial terraces that are not able to be differentiated at this map scale. Streams and floodplains with no discernible geologic features greater than 500 ft wide are represented by undifferentiated alluvium. Many streams characterized as undifferentiated alluvium are small beaded drainages that have low velocity flow, while others represent narrow, incised drainages in units such as eolian sand. Undifferentiated alluvium is generally expected to be continuously frozen, however unfrozen ground may be present beneath stream channels. Thaw settlement and frost heave potentials are generally low and unfrozen bearing strength is high within sand and gravel materials, while the frost heave potential is generally high and unfrozen bearing strength low in fine-grained materials.

Alluvium is generally a good source for granular construction materials; however, in this area these units may be predominantly comprised of finer-grained materials due to the low-energy depositional environment of the western Coastal Plain.

***Active Floodplain (Qaa)* -** Active floodplain deposits include areas adjacent to the active channel that appear to be active at least seasonally as defined by sparse vegetation, surficial pattern, and elevation similar to the active channel.

These deposits range in composition from silt and silty sand in small, sluggish streams to sand and gravel in higher energy, larger rivers. Active floodplain deposits are typically overlain by variable thicknesses of organic and fine-grained overbank deposits.

Active floodplain deposits are expected to be continuously frozen, but may have taliks locally. Thaw settlement and frost heave potentials are generally low and unfrozen bearing strength is high within the sand and gravel materials, while the frost heave potential is generally high and unfrozen bearing strength low in fine-grained materials.

These deposits may provide a source for granular material including sand and gravel, depending on local stream energy and grain size.

***Active Channel (Qac)* -** Within the project area, active channel deposits range from silt and sand to sand and gravel. Active channels are potential sources for gravel within the project area.

Taliks, areas of thawed ground surrounded by permafrost, are expected to extend below active layer depths beneath active channel deposits. Thaw settlement and frost heave potentials are generally low and unfrozen bearing strength is high within sand and gravel materials, while thaw settlement and frost heave potentials are generally high and unfrozen bearing strength low in fine-grained materials.

Though active channel deposits may contain sand and gravel, the likely mode of mining would be dredging which would present logistical, environmental, and regulatory challenges.

***Inactive Floodplain (Qai)* -** Inactive floodplain deposits include areas that flood occasionally. Materials range in composition from silt and silty sand to sand and gravel. Inactive floodplains typically form older, higher surfaces than the current active floodplains. These deposits are overlain by organic, fine-grained overbank deposits and wind-blown silt and sand with thicknesses greater than within active floodplain deposits.

Inactive floodplain deposits are expected to be continuously frozen, with localized taliks under lakes. Thaw settlement and frost heave potentials are generally low and unfrozen bearing strength is high within sand and gravel materials, while the frost heave potential is generally high and unfrozen bearing strength low in fine-grained materials.

These deposits are likely sources for granular material.

***Alluvial Terrace (Qat)* -** Alluvial terrace deposits are variable in composition and are typically underlain by marine deposits. Along larger streams, these alluvial deposits consist of interbedded silty sand, gravelly sand, and minor pebble to cobble gravel with clasts of chert, sandstone, and chert-pebble conglomerate. Alluvial terrace deposits along smaller streams and within the eolian deposits may be composed of sand and silt. Detrital wood and peat are locally common. These deposits are overlain by approximately 2–8 ft of eolian sand, silt, and peat and are penetrated and deformed by sand wedges.

Alluvial terrace deposits are identified based on interpretation of both imagery and elevation models. Alluvial terraces are generally gently sloping, with surfaces as much as 20–25 ft above active floodplains. Multiple levels of alluvial terraces are common. The contact between inactive floodplain deposits and alluvial terrace deposits is determined based on relative elevation and surficial pattern. Inactive floodplain deposits have an apparent meander scroll pattern and are subject to occasional flooding, whereas alluvial terraces have obscured meander scrolls. Polygonal ice wedges are typically present in alluvial terraces and more developed than those on inactive floodplains.

Alluvial terrace deposits are expected to be continuously frozen. Thaw settlement and frost heave potentials are generally low dependent on ice content. Unfrozen bearing strength is high within sand and gravel materials, while thaw settlement and frost heave potential is generally high and unfrozen bearing strength low in fine-grained materials.

***Beach and Barrier Island Deposits (Qb)* -** Beach and barrier island deposits are intermittently present along the modern coastline and to a lesser extent inland along wave-cut scarps, representing previous shorelines. Soils range from fine sand and silt to pebbly sand and silt and clay with boulders. Fine sand and pebbly sand are primarily anticipated. Beach deposits form low ridges, while barrier islands form discontinuous chains of ridges. Barrier island deposits are expected to be underlain by marine sand (Qms) and marine silt and clay (Qm). The marine silt and clay is expected to be encountered at an elevation of about 6 ft above sea level.

Paleo-beach and barrier island deposits are identified based on relatively linear to arcuate geometry on digital elevation models, proximity to wave-cut scarps, and a surface appearance indicating well to moderately drained soils. The scarps were cut by erosion occurring at shorelines during times of high sea stands related to marine transgressions.

Beach and spit deposits may be locally unfrozen or thaw stable. Frost heave potential is relatively low and unfrozen bearing strength generally moderate. However, these deposits are likely underlain by materials that are not thaw stable.

***Colluvium (Qc)* -** Colluvium consists of blocky rock fragments in a mix of sand, silt, and organic debris which blankets moderately steep slopes primarily along river bluffs. This unit is mapped only where the horizontal width of the unit exceeds 500 ft on average. Where the exposure is smaller, predominantly along steeper slopes, the deposits are included within the underlying unit.

Colluvium is expected to be continuously frozen and seldom thaw stable. Slope instability is common within this unit.

These deposits are not anticipated to provide a source for granular construction materials.

Deltaic Deposits (Qd) – Deltaic deposits generally consist of a mix of coastal processes and alluvial material near the mouth of the larger rivers. In some locations, old deltas, formed during periods of higher sea stand, have been identified. These older surfaces are apparent based on their elevation and distributary surface texture. These deposits are transitional with fine-grained marine deposits (Qm). Thaw lakes and ice wedges are common.

These deposits range from gravelly sand to fine silt and clay with a surface cover of eolian sand and silt and interbedded organic and peat deposits. Delta deposits are expected to be underlain by marine sand and silt. The overall thicknesses of delta deposits are unknown, and vary by stream, but may exceed 50 ft.

Delta deposits are generally continuously frozen, except taliks under streams. Thaw settlement, frost heave potential, and unfrozen bearing strength will vary with grain size and ice content.

These deposits are not expected to provide a construction material source.

Eolian Deposits (Qe) – Eolian deposits consist of well-sorted/poorly graded silt to fine sand composed of quartz and minor dark minerals, generally containing very little pebble-sized material. Thickness ranges from about 10 to nearly 100 ft. Large-scale crossbedding is present locally. The upper ten feet contains wind-blown silt along with wood and peat beds. This material is highly susceptible to wind erosion, resulting in blowouts, where the surficial organic cover is broken.

Eolian deposits are continuously frozen with ice-rich overburden. Thaw settlement potential varies with silt and ice contents. Silt-rich areas may be susceptible to frost heave, however, the general bearing strength of the material is moderate to good. Thaw lakes and pingos are common within this unit, as are thaw slumps and slope instabilities along riverbanks. Thaw lakes within the eolian deposits appear to be more sandy than in other units. Interbedded layers of silt, sand, and organic material are anticipated within the thaw lakes.

The contacts between the eolian deposits and the marine sand (Qms) are transitional. The surface of the marine sand is typically reworked by eolian processes.

Sand from this unit may be usable for some construction purposes.

Marine Deposits, fine grained (Qm) **-** Marine deposits include primarily gray silt and clay along with minor amounts of fine sand and sandy silt. These deposits are generally present below elevations of 5–6 ft along the Beaufort Sea coastline. These deposits include erratic pebbles, cobbles, and boulders. The marine deposits are extensively reworked by thaw lake processes, and are expected to be overlain by 3–7 ft of peat.

Marine silt is expected to be continuously frozen. These deposits are susceptible to both thaw settlement and frost heave, and generally have low unfrozen bearing strength.

This unit is not expected to provide a source for granular construction materials.

Marine Deposits, Sand (Qms) **-** Marine sand consists of estuarine sand and commonly overlies fine-grained marine deposits (Qm). Sand is typically fine grained and well sorted, however in the western portion of the project area, the sand is generally coarser, ranging from fine to medium, and can contain a significant amount of silt. The upper surface is reworked by wind and covered with pebble-lag sand.

The marine sand is generally separated from younger fine-grained marine deposits (Qm) by deposits of a former barrier island chain (Qb), and overlies older silt and clay marine units (Qm). Contacts between the marine sand

and the marine silt and clay units are transitional, and the terrain unit classification (Qms/Qm) is used to designate the presence of the older marine unit within terrain mapping depths.

These deposits are expected to be continuously frozen, and may be susceptible to both thaw settlement and frost heave depending on silt and ice contents.

Sand from this unit may be useable for some construction purposes.

Ice-rich Silt and Sand (Qsi) – Ice-rich silt and sand deposits are a mix of silt to fine sand, organic debris, and massive ice.

This unit contains yedoma, syngenetic permafrost, which has a very high ice content. It is continuously frozen, and highly susceptible to thermal degradation with a high potential for thaw settlement. Thermokarst, thermal erosion, and thaw slumps are common. The unfrozen bearing strength of this material is expected to be low. These areas are apparent based on the presence of thermokarst and thermo-erosion features observed on imagery and Digital Elevation Models. The ice-rich silt has a distinctive texture owing to incised thaw lake beds and an abundance of small triangular ponds indicating the presence of many ice wedges.

The ice-rich silt is commonly overlain by eolian sand. Contacts between this unit and marine sand (Qms) are transitional. Where Qsi is cut by streams, alluvium may be present.

Ice-rich silt overlies bedrock in the southern portion of the project area. Areas where bedrock is anticipated to be present within terrain mapping depths are indicated by the unit (Qsi/Bx). If the bedrock type is known, the designation is given.

Thaw Lake Deposits (Qt) – Thaw lake deposits are the most common terrain unit in the project area. These deposits contain peat, organic silt, silt, and sand. A combination of lacustrine and eolian processes form interbedded layers of organic-rich deposits and eolian silt and sand. Thaw lakes form when ice within a deposit begins to thaw. This results in thaw-settlement and further thermal degradation. A basin is formed, which then accumulated sequences of lacustrine, eolian, and organic material.

Thaw lakes have been distinguished based on interpretation of imagery and digital elevation models. If the basin is deeply incised such that the upper 20–30 ft of material would be comprised of thaw-lake related deposits, a single designator for terrain unit is used (Qt). Where thaw lakes are not deeply incised, but are interpreted to have greater than 5 ft thickness, a dual designator is used. The interpretation is made irrespective of water content of the thaw lake basin.

Thaw lake deposits are continuously frozen, though taliks are typically present beneath water bodies. The deposits form in ice-rich terrains, have a high potential for frost heave if thawed, and have low thawed bearing strength. Pingos are very common within drained thaw lake basins.

This unit does not have potential to provide granular material sources, nor is it suitable for route alignments. Due the prevalence of these deposits in the project area, care was taken to avoid them where possible.

Terrain Unit Summary

As mentioned above, the project areas is comprised predominantly of thaw lake deposits (Qt) and marine silts and sands (Qm, Qms). The terrain units described above and their prevalence in the project area are summarized in Table TM4-1 below. Table TM4-1 provides the specific terrain units encountered along each proposed alignment.

Table TM4-1. Terrain Unit Prevalence and Characteristics

Terrain Unit	Abbr.	Area (Sq. Mi.)	Area (%)	Frost Heave Potential	Thaw Settlement Potential	Thawed Bearing Strength	Suitability as Material Source	Usable Material	Potential Uses
Anthropogenic Deposits	Ad	0.8	0.03%	Low	Low	High	Good	Sand and gravel	Fill, concrete aggregate
Undifferentiated Alluvium	Qa	41.7	1.79%	Low	Low	High	Good	Sand and gravel	Fill, concrete aggregate
Active Floodplain	Qaa	2.5	0.11%	Low	Low	High	Good	Sand and gravel	Fill, concrete aggregate
Active Channel	Qac	6.0	0.26%	Low	Low	High	Good	Sand and gravel	Fill, concrete aggregate
Inactive Floodplain	Qai	15.3	0.66%	Low	Low	High	Good	Sand and gravel	Fill, concrete aggregate
Alluvial Terrace	Qat	0.3	0.01%	Varies	Varies	Varies	Varies	Sand and gravel	Fill, concrete aggregate
Beach and Barrier Island Deposits	Qb	25.9	1.11%	Low	Low	High	Good	Sand and gravel	Fill, concrete aggregate
Beach and Barrier Island Deposits / Marine Deposits, Sand	Qb/Qms	2.3	0.10%	Low	Low	High	Good	Sand and gravel	Fill, concrete aggregate
Colluvium	Qc	0.1	0.01%	Moderate	Moderate	Low to Moderate	Poor	n/a	n/a
Deltaic Deposits	Qd	14.7	0.63%	Moderate	Moderate to High	Varies	Poor	n/a	n/a
Eolian Deposits	Qe	22.8	0.98%	Moderate	Varies	Moderate	Good	Fine-grained sand	Bedding, slurry, fill
Eolian Deposits / Inactive Floodplain	Qe/Qai	0.3	0.01%	Moderate	Varies	Moderate	Good	Fine-grained sand	Bedding, slurry, fill
Eolian Deposits / Marine Deposits, Sand	Qe/Qms	15.0	0.64%	Moderate	Varies	Moderate	Good	Fine-grained sand	Bedding, slurry, fill
Marine Deposits, fine-grained	Qm	58.1	2.49%	Moderate	Moderate to High	Varies	Poor	n/a	n/a
Marine Deposits, Sand	Qms	460.6	19.75%	Moderate	Moderate	Varies	Moderate	Sand	Bedding, slurry, fill
Marine Deposits, Sand / Bedrock	Qms/Bx	0.2	0.01%	Moderate	Moderate	Varies	Moderate	Sand	Bedding, slurry, fill
Marine Deposits, Sand / Marine Deposits, fine-grained	Qms/Qm	397.4	17.04%	Moderate	Moderate	Varies	Moderate	Sand	Bedding, slurry, fill
Ice-rich Silt / Eolian Deposits	Qsi/Qe	0.0	0.00%	High	High	Low	Poor	n/a	Bedding, slurry, fill
Thaw Lake Deposits	Qt	556.4	23.86%	High	High	Low	Poor	n/a	n/a
Thaw Lake Deposits / Undifferentiated Alluvium	Qt/Qa	3.0	0.13%	High	High	Low	Poor	n/a	n/a
Thaw Lake Deposits / Active Floodplain	Qt/Qaa	0.0	0.00%	High	High	Low	Poor	n/a	n/a
Thaw Lake Deposits / Inactive Floodplain	Qt/Qai	2.8	0.12%	High	High	Low	Poor	n/a	n/a
Thaw Lake Deposits / Alluvial Terrace	Qt/Qat	0.3	0.01%	High	High	Low	Poor	n/a	n/a
Thaw Lake Deposits / Deltaic Deposits	Qt/Qd	8.2	0.35%	High	High	Low	Poor	n/a	n/a
Thaw Lake Deposits / Eolian Deposits	Qt/Qe	17.9	0.77%	High	High	Low	Poor	n/a	n/a
Thaw Lake Deposits / Marine Deposits, fine-grained	Qt/Qm	92.9	3.98%	High	High	Low	Poor	n/a	n/a
Thaw Lake Deposits / Marine Deposits, Sand	Qt/Qms	586.2	25.14%	High	High	Low	Poor	n/a	n/a

Table TM4-2. Proposed Alignment Terrain Unit Summary

Terrain Unit	Abbr.	Utqiaġvik to Atqasuk Coastal Route (Corridor A)		Coastal Route Extension (Corridor D)		Modification to Coastal Route		Middle Route (Corridor E)		Southern Route (Corridor F)	
		Miles	Percent	Miles	Percent	Miles	Percent	Miles	Percent	Miles	Percent
Anthropogenic Deposits	Ad	0.00	0.0%	0.01	0.0%	0.00	0.0%	0.01	0.0%	0.01	0.0%
Undifferentiated Alluvium	Qa	0.11	0.2%	0.40	0.6%	0.00	0.0%	0.72	1.0%	0.90	1.3%
Active Channel	Qac	0.08	0.1%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.06	0.1%
Inactive Floodplain	Qai	0.44	0.7%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.48	0.7%
Beach and Barrier Island Deposits	Qb	0.05	0.1%	3.68	5.8%	0.00	0.0%	3.67	5.3%	1.96	2.9%
Colluvium	Qc	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.04	0.1%
Eolian Deposits	Qe	2.68	4.1%	0.00	0.0%	0.00	0.0%	0.90	1.3%	3.06	4.5%
Eolian Deposits / Marine Deposits, Sand	Qe/Qms	0.50	0.8%	0.00	0.0%	0.00	0.0%	0.70	1.0%	4.84	7.1%
Marine Deposits, fine-grained	Qm	0.00	0.0%	0.82	1.3%	0.00	0.0%	0.79	1.1%	0.26	0.4%
Marine Deposits, Sand	Qms	25.73	39.3%	37.35	59.4%	0.31	17.5%	32.51	47.3%	25.66	37.6%
Marine Deposits, Sand / Marine Deposits, fine-grained	Qms/Qm	18.57	28.4%	7.18	11.4%	1.46	82.5%	7.18	10.4%	6.67	9.8%
Thaw Lake Deposits	Qt	1.80	2.7%	0.69	1.1%	0.00	0.0%	1.96	2.8%	3.06	4.5%
Thaw Lake Deposits / Undifferentiated Alluvium	Qt/Qa	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.08	0.1%
Thaw Lake Deposits / Inactive Floodplain	Qt/Qai	0.13	0.2%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
Thaw Lake Deposits / Eolian Deposits	Qt/Qe	1.38	2.1%	0.00	0.0%	0.00	0.0%	0.97	1.4%	2.60	3.8%
Thaw Lake Deposits / Marine Deposits, fine-grained	Qt/Qm	0.52	0.8%	0.21	0.3%	0.00	0.0%	1.34	2.0%	0.48	0.7%
Thaw Lake Deposits / Marine Deposits, Sand	Qt/Qms	13.41	20.5%	12.56	20.0%	0.00	0.0%	18.01	26.2%	18.00	26.4%

Geologic Hazards

Pingos are the primary geohazard in the project area. Pingos are steep-sided, conical mounds formed by the expansion of freezing water rising from hydrostatic or hydraulic pressure (Rowley et al. 2015). Pingos typically have an ice-rich core with accompanying ice lenses near the top of the mound. Pingos are dynamic in nature and can grow to heights as high as 150 ft in the case of Ibyuk Pino in Canada's Western Arctic. Pingos can also shrink and even collapse on themselves often leaving crater-like depressions on the surface. Due to their dynamic nature, they pose a risk to infrastructure such as roads, pipelines, and foundations.

Pingos are easily mitigated with proper route selection since they often form in thaw lake basins, which are not favorable for construction. There are 6 pingos located 1.5 miles to 2 miles from Corridor D–Coastal Route Extension. There are 43 mapped pingos within 3.5 miles of Corridor E–Middle Route, Corridor F–Southern Route and Corridor A–Coastal Route, the closest of which is still 1,000 ft from the proposed alignment.

Several slope instabilities are encountered in the project area, primarily along smaller incised drainages. River and stream crossing locations are located to avoid these instabilities.

Existing and Potential Gravel Mine Sites

Ideally, a suitable material source will be located every 10–20 miles along the preferred alignment. Figures TM4-7 through TM4-12 highlight terrain units with the best potential for sand and gravel, and propose specific exploration targets close to the alignments.

There are three existing gravel mines near Utqiaġvik (Figure TM4-12). SKW Eskimos, Inc. (SKW), operates a pit on land owned by the City of Utqiaġvik, "City Pit", located at the southwest end of the airstrip. The City Pit produces a silty-sandy-gravel material. The pit is reaching the end of its useful life, although expansion is possible with a potential yield of up to an additional million cubic yards. The Alaska Department of Transportation & Public Facilities mined a pit on state land located between the airstrip and the SKW pit for construction of the airstrip. This pit is reported to have minimal materials remaining on state land with limited expansion opportunities due to Emaiksoun Road bounding the property on the east. Ukpeaġvik Iñupiat Corporation (UIC) operates a pit, "UIC Pit", located four miles southeast of Barrow located off Eastfield Road near the landfill. The UIC Pit produces a silty-sand material with less coarse aggregate. The material quality is reported to contain more fines than the City Pit. None of the existing sources produce non-frost susceptible gravel because of the higher silt content and limited coarse aggregate.

UIC was recently conveyed subsurface rights to 22 Sections within the project area. These sections, as shown on Figure TM4-12, contain ancient beach deposits and marine sands which could provide suitable material sources.

Near Wainwright, Olgoonik Corporation owns the rights to several potential gravel sources including the Tupkak Bar near the Wainwright Inlet, and the confluence of Omikmuk Creek with the Kuk River. These are shown on Figure 4-8.

Atqasuk has historically gotten gravel (sandy) from the lake just west of the village, however for rehabilitation of their airstrip, course material and rock were hauled from Utqiaġvik. There is some potential for material near Atqasuk, but no resources have been proven.

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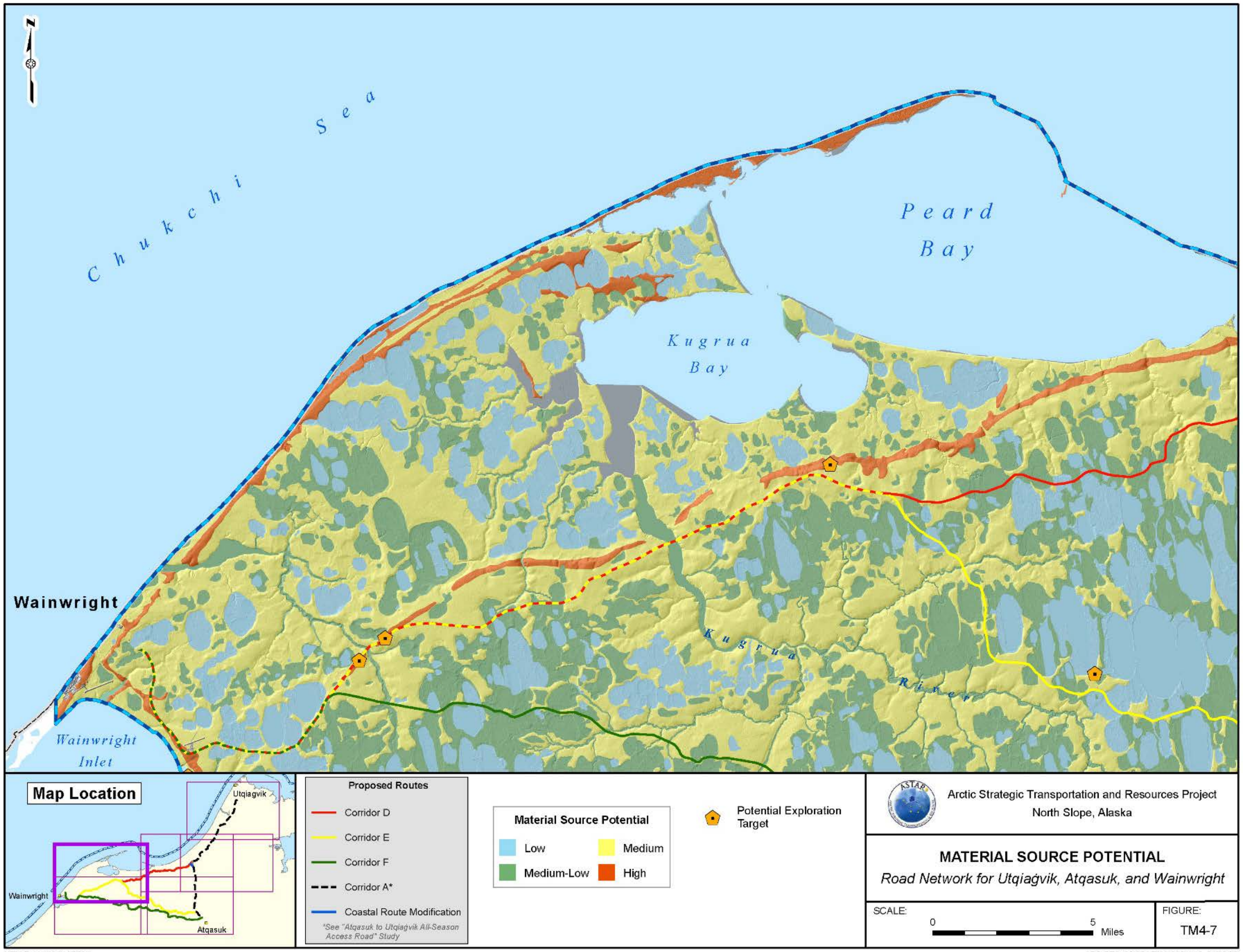
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Peard Bay
Kugrua Bay
Wainwright
Wainwright Inlet
Kugrua River
Map Location
Utqiagvik
Wainwright
Atqasuk
Proposed Routes
Corridor D
Corridor E
Corridor F
Corridor A*
Coastal Route Modification
*See "Atqasuk to Utqiagvik All-Season Access Road" Study
Material Source Potential
Low
Medium
Medium-Low
High
Potential Exploration Target
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
MATERIAL SOURCE POTENTIAL
Road Network for Utqiaġvik, Atqasuk, and Wainwright
SCALE:
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Miles
FIGURE:
TM4-7
UTM Zone 4N (NAD83)
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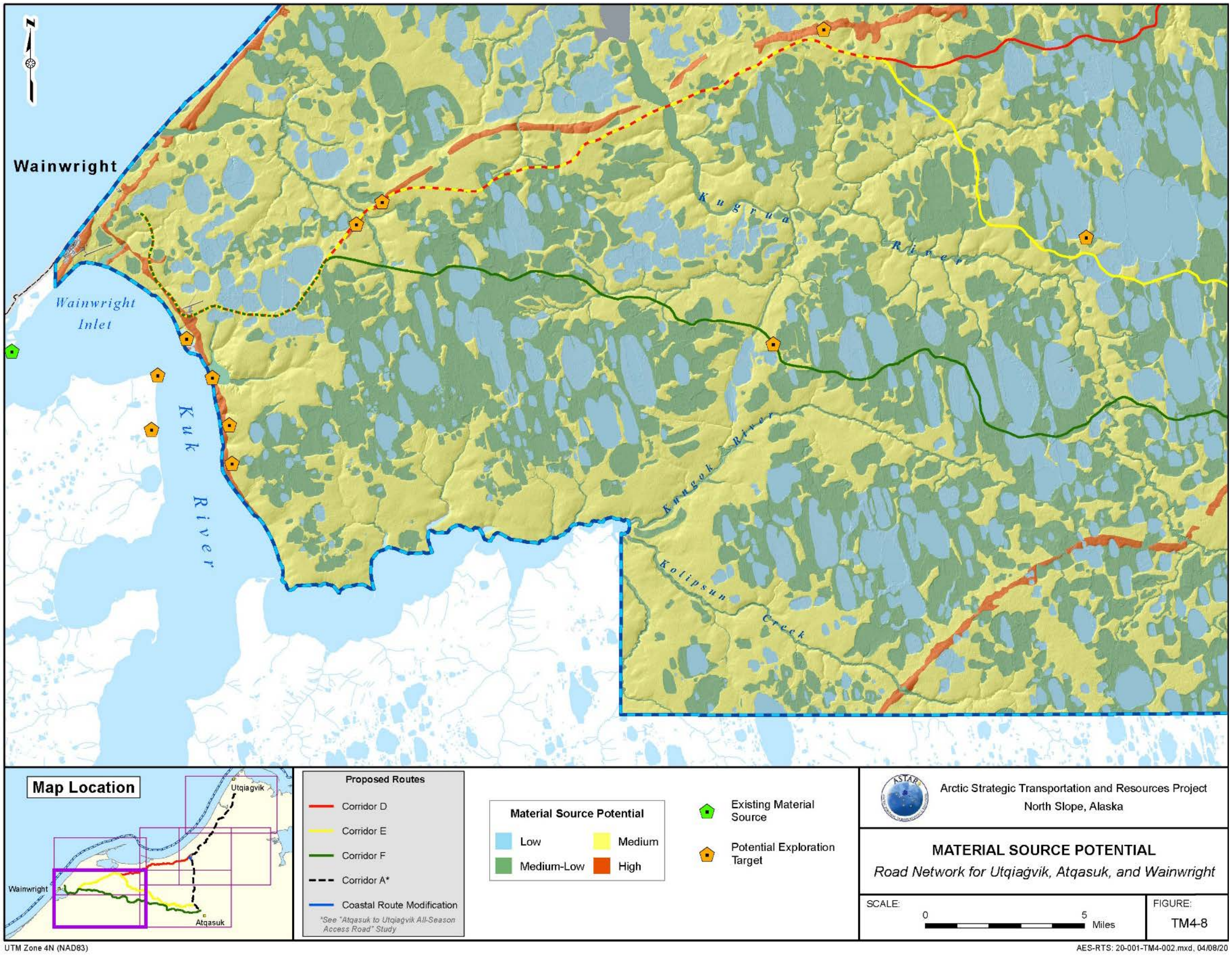
Wainwright
Wainwright Inlet
Kuk River
Kugrua River
Kungok River
Kolipsun Creek
Map Location
Utqiagvik
Wainwright
Atqasuk
Proposed Routes
Corridor D
Corridor E
Corridor F
Corridor A*
Coastal Route Modification
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
Material Source Potential
Low
Medium
Medium-Low
High
Existing Material Source
Potential Exploration Target
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
MATERIAL SOURCE POTENTIAL
Road Network for Utqiaġvik, Atqasuk, and Wainwright
SCALE:
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TM4-8
UTM Zone 4N (NAD83)
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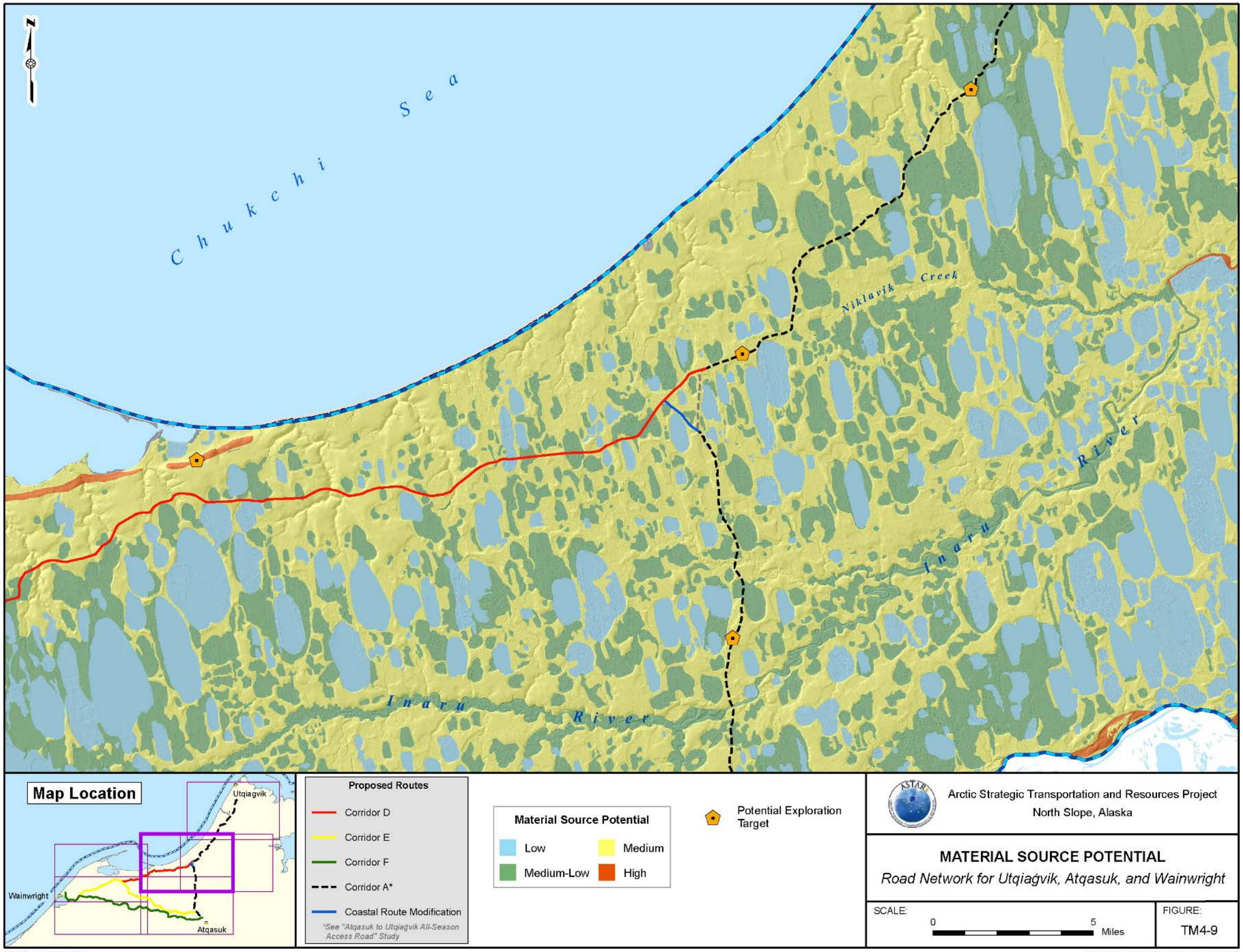
Chukchi Sea
Niklavik Creek
Inaru River
Inaru River
Map Location
Utqiagvik
Wainwright
Atqasuk
Proposed Routes
Corridor D
Corridor E
Corridor F
Corridor A*
Coastal Route Modification
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
Material Source Potential
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Potential Exploration Target
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
MATERIAL SOURCE POTENTIAL
Road Network for Utqiaġvik, Atqasuk, and Wainwright
SCALE:
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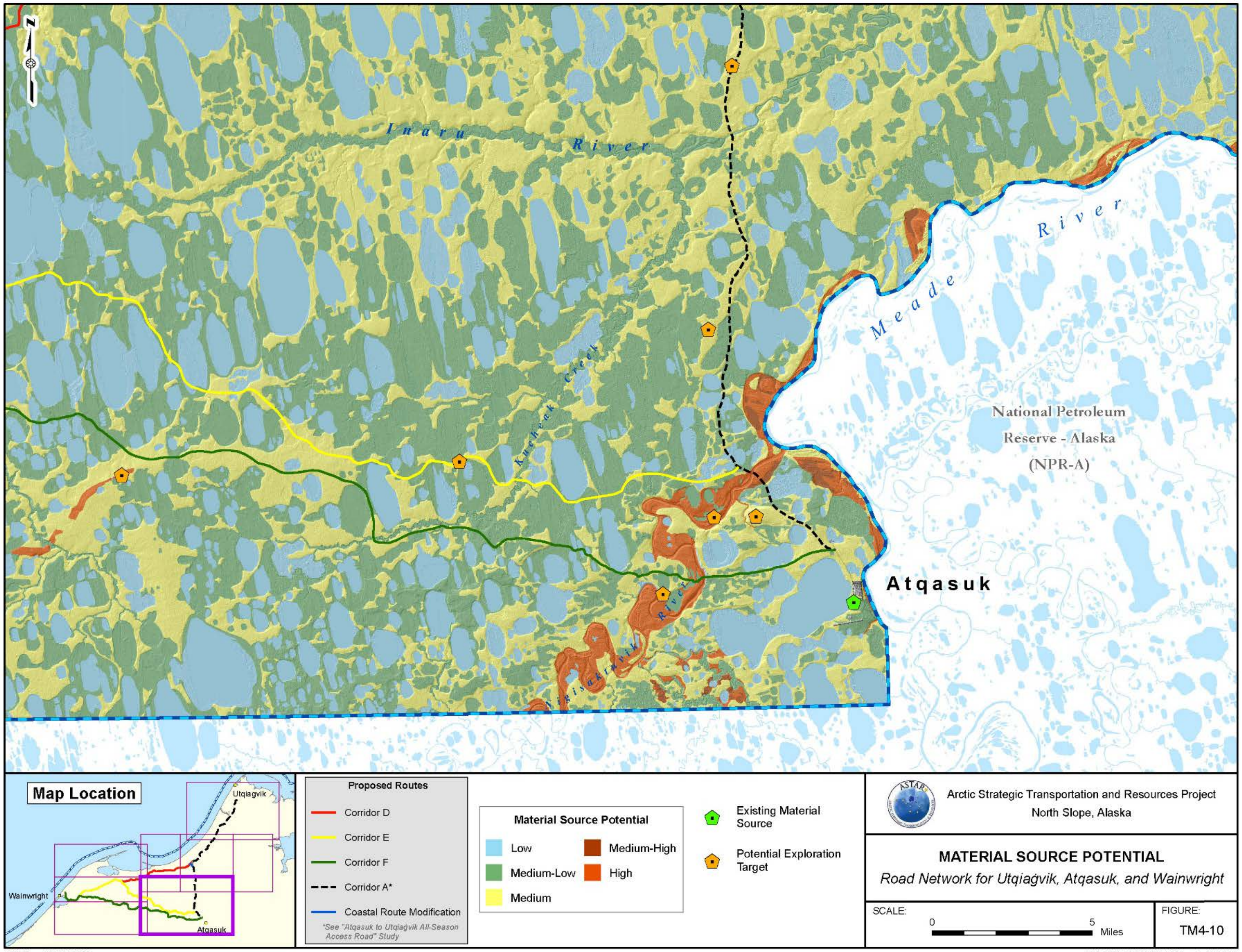
Inaru River
Meade River
Kucheak Creek
Nigisaktuvik River
National Petroleum Reserve - Alaska (NPR-A)
Atqasuk
Map Location
Utqiagvik
Wainwright
Atqasuk
Proposed Routes
Corridor D
Corridor E
Corridor F
Corridor A*
Coastal Route Modification
*See "Atqasuk to Utqiagvik All-Season Access Road" Study
Material Source Potential
Low
Medium-Low
Medium
Medium-High
High
Existing Material Source
Potential Exploration Target
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
MATERIAL SOURCE POTENTIAL
Road Network for Utqiaġvik, Atqasuk, and Wainwright
SCALE:
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TM4-10
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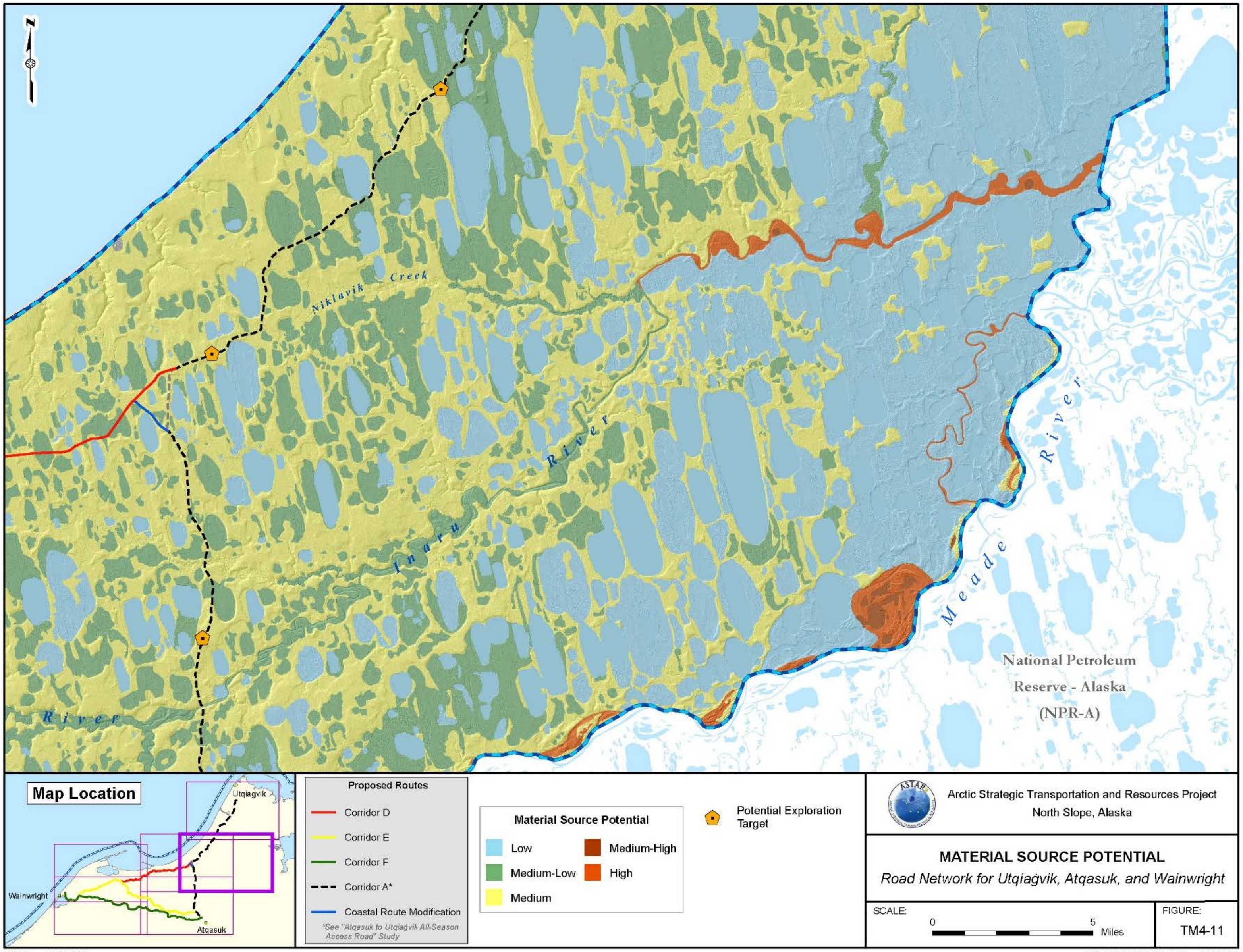
Niklavik Creek
Inaru River
Meade River
River
National Petroleum Reserve - Alaska (NPR-A)
Map Location
Utqiagvik
Wainwright
Atqasuk
Proposed Routes
Corridor D
Corridor E
Corridor F
Corridor A*
Coastal Route Modification
*See "Atqasuk to Utqiagvik All-Season Access Road" Study
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Potential Exploration Target
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
MATERIAL SOURCE POTENTIAL
Road Network for Utqiaġvik, Atqasuk, and Wainwright
SCALE:
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FIGURE:
TM4-11
UTM Zone 4N (NAD83)
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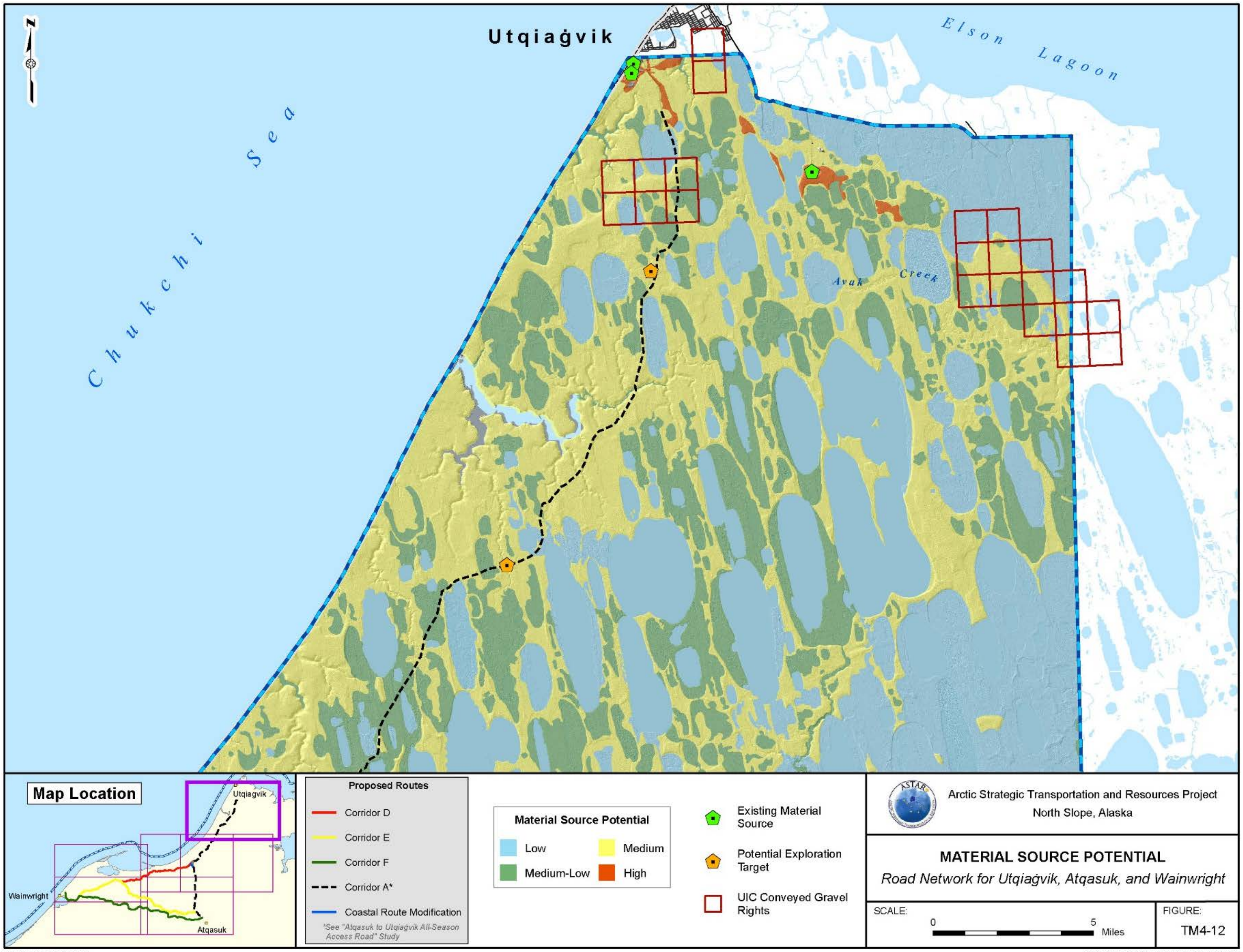
Utqiaġvik
Elson Lagoon
Chukchi Sea
Avak Creek
Map Location
Utqiagvik
Wainwright
Atqasuk
Proposed Routes
Corridor D
Corridor E
Corridor F
Corridor A*
Coastal Route Modification
*See "Atqasuk to Utqiagvik All-Season Access Road" Study
Material Source Potential
Low
Medium
Medium-Low
High
Existing Material Source
Potential Exploration Target
UIC Conveyed Gravel Rights
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
MATERIAL SOURCE POTENTIAL
Road Network for Utqiaġvik, Atqasuk, and Wainwright
SCALE:
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FIGURE:
TM4-12
UTM Zone 4N (NAD83)
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Data Gaps

Following is a list of data gaps that will need to be filled to advance the project to the next phases of design.

- Quantify material sources identified by village corporations
- Conduct geotechnical investigation along proposed alignments and potential materials sources

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Technical Memorandum 5 – Existing and Proposed Infrastructure

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Technical Memorandum 5 – Existing and Proposed Infrastructure

Prepared by: Paul Ramert, PE, Principal Civil Engineer

Reviewed by: Hans Hoffman, CPG, Associate Geologic Engineer

Date: April 2020

Overview

The following pages briefly describe existing infrastructure that lies within the project area, including:

- Utqiaġvik
- Atqasuk
- Wainwright
- Defense Early Warning (DEW) Line Sites
- Barrow Gas Fields
- National Petroleum Reserve – Alaska (NPR-A) Legacy Wells
- Community Winter Access Trail (CWAT) and other Winter Trails
- Rogers-Post Site
- Oil and Gas Exploration Wells
- Subsistence Camps and Cabins

Infrastructure that has been proposed and could be constructed in the reasonably foreseeable future is also described, as listed below:

- Atqasuk Transmission Line
- Arctic Slope Telephone Association (ASTAC) Fiber Optic Line
- Arctic Port

Existing Infrastructure

Utqiaġvik

Utqiaġvik (formerly Barrow) is the northernmost community in the United States, situated at the base of the Point Barrow peninsula and bordered by the Chukchi and Beaufort Seas of the Arctic Ocean (Figure TM5-1). The surrounding landscape is characterized by tundra with numerous lakes and permafrost soils underlying almost the entire region. The majority of residents are Iñupiat, an indigenous Inuit ethnic group. Utqiaġvik is the largest community on the North Slope with the 2018 population estimate of 5,286 people (North Slope Borough [NSB] 2019). Utqiaġvik is the NSB seat of government where diverse issues converge, among them Native Iñupiat subsistence rights, oil and gas development activity, and the study of climate change in the Arctic (NSB 2015).

Facilities in the community include various government and business offices (e.g. NSB offices, National Weather Service office, Arctic Slope Regional Corporation [ASRC] offices, Ukpeaġvik Iñupiat Corporation offices), educational facilities (Ipalook Elementary School, Hopson Middle School, Barrow High School, Kiita Learning Community alternative high school, and Illisaġvik College), police station, fire stations, search and rescue facility, Samuel Simmonds Memorial Hospital, a senior citizens center, Arctic Women in Crisis women's shelter, Children and Youth Services center, Tuzzy Consortium Library, hotels, recreational facility, and many other public and commercial buildings. Other infrastructure includes the Barrow Airport, landfill, tank farms, and public utility systems for gas, electric, water, sewer, telecommunications, cable television, fiber optic communications, and refuse. Additional details about the community are included in *Soaring to the Future: Barrow Comprehensive Plan, 2015-2035* (NSB 2015).

The community includes about 52 miles of roads (NSB 2015). For the purpose of this study, the proposed inter-village road network between Utqiaġvik, Atqasuk, and Wainwright would connect to existing roads on the outskirts of Utqiaġvik; either Emaiksoun Road or Gasfield Road (Figure TM5-1).

Atqasuk

Atqasuk is located on the southern extent of the Arctic Coastal Plain, approximately 60 miles south of Utqiaġvik, and 58 miles east of the village of Wainwright. The community is entirely within the boundaries of the NPR-A. The village lies between Imaġruaq Lake and the Meade River as shown on Figure TM5-2. The majority of residents are Iñupiat and the community has grown steadily over recent years to approximately 261 residents (NSB 2019).

Public facilities and key infrastructure in the village include the Meade River School, police department, fire station, volunteer search and rescue facility, airport, landfill, tank farm, and public utility systems for electric, water, sewer, telecommunications, and refuse hauling. Additional details about the community are included in *2017 – 2037 Atqasuk Alaska Comprehensive Plan* (NSB 2017).

Atqasuk includes about 6.4 miles of gravel roads (NSB 2017). We have assumed that the inter-village road network between Utqiaġvik, Atqasuk, and Wainwright would connect to the landfill access road where it extends from Ekosik Street (Figure TM5-2).

Wainwright

Wainwright is situated along the Chukchi Sea coastline about 70 miles southwest of Utqiaġvik and 58 miles west of Atqasuk. The community is located on a coastal bluff of a peninsula separating Wainwright Inlet from the Chukchi Sea (Figure TM5-3). Most Wainwright inhabitants are Iñupiat who practice a subsistence lifestyle. Wainwright is the third largest village in the NSB, and in 2015 had a population of 557 residents (NSB 2020).

Public facilities and key infrastructure in Wainwright include Alak School, the public safety office, fire station, vehicle maintenance facility, health clinic, hotel, restaurant, community store, teacher housing, airport, landfill, tank farm, and public utility systems for electric, water, wastewater, and refuse hauling. Additional details about the community are included in *Wainwright Comprehensive Plan* (NSB 2014).

The community includes about 10 miles of developed gravel roads (NSB 2014). We have assumed that the inter-village road network between Utqiaġvik, Atqasuk, and Wainwright would connect to the existing road system near the landfill or via a road extension through the Distant Early Warning (DEW) Line site southeast of the village (Figure TM5-3). Residents have expressed an interest in developing the DEW Line site for industrial use (NSB 2014).


Beaufort Sea
Chukchi Sea
Elson Lagoon
NARL
Utqiaġvik
Cakeeater Rd
Emaiksoun Road
Gasfield Road
Corridor A*
Road
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
ASRC ENERGY SERVICES Alaska, Inc.
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
UTQIAĠVIK
Road Network for Utqiaġvik, Atqasuk, and Wainwright
SCALE:
0 1 2 3 Miles
FIGURE:
TM5-1
UTM Zone 4N (NAD83)
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Corridor F

Corridor A*

*See "Atqasuk to Utqiaġvik All-Season Access Road" Study

ASRC Energy Services Alaska, Inc.

Arctic Strategic Transportation and Resources Project
North Slope, Alaska

ATQASUK

Road Network for Utqiaġvik, Atqasuk, and Wainwright

SCALE: 0 1,000 2,000 3,000 Feet

FIGURE: TM5-2

UTM Zone 4N (NAD83)

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Chukchi Sea
Landfill
Landfill Road
Wainwright
Airport
Boat Launch
Wainwright DEW Line Site
Wainwright Inlet
bing
Proposed Routes
Corridor D
Corridor E
Corridor F
ASRC Energy Services Alaska, Inc.
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
WAINWRIGHT
Road Network for Utqiaġvik, Atqasuk, and Wainwright
SCALE:
0
2,000
4,000
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TM5-3
UTM Zone 4N (NAD83)
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DEW Line Sites

To support aerial surveillance during the Cold War, a chain of 58 radar and communications sites, termed the DEW Line, was constructed along the Arctic border in the 1950s. Covering 3,000 miles of coastline in Alaska, Canada, and Greenland, the DEW Line provided the US and Canada with the earliest possible warning of incoming, over-the-pole, aircraft invasions from the Soviet Union. Of the 22 sites constructed in Alaska, three fall within the project area: the Point Barrow Long Range Radar Site (LRRS), the Peard Bay DEW Line Site, and the Wainwright Short Range Radar Site (SRRS) (Figure TM5-4).

The Point Barrow LRRS lies northwest of the main population center of Utqiaġvik near Point Barrow, thus the site has no direct effect on routing of the road network between Utqiaġvik, Atqasuk, and Wainwright, and no further discussion of the site is included in this memorandum.

The Peard Bay DEW Line Station was constructed in 1957 near the Chukchi Sea coastline east of Peard Bay. Operations at the station ceased in 1963, and the radars and other military buildings were removed around 2000, returning the site to a natural condition. The gravel roads and airstrip for the station remain. The site is not listed in the Alaska Department of Environmental Conservation's (ADECs) Contaminated Sites database (ADEC 2020).

The Wainwright SRRS is located three miles southeast of the existing Wainwright airport, and includes a 3,600-feet (ft) long runway. The DEW Line site was constructed in 1953 and occupies approximately 1,518 acres of land. Fourteen of those acres have been conveyed to Olgoonik Corporation (OC), including the runway and associated airport tarmac areas. OC has worked with the USAF to clean the site of contamination issues, and disassembled many of the previous structures located there. The ADEC Contaminated Sites database indicates that cleanup is complete at the site (ADEC 2020).

Barrow Gas Fields

The Barrow Gas Fields (BGF) provide natural gas to the community of Utqiaġvik for power generation, heating for the majority of homes in the community, and cooking. BGF consists of four fields, South Barrow Gas Field, East Barrow Gas Field, Sikiluk, and Walakpa Gas Field. The NSB owns the gas field wells, pipelines, buildings, equipment, and related infrastructure, including the right to access, explore, develop, and produce subsurface hydrocarbons. The gas fields are currently operated and maintained under a contract with CONAM Construction Co./Tikigaq Native Corporation, a Joint Venture.

The East Barrow Gas Field is accessible via existing gravel roads. The Walakpa Gas Field is currently accessed by helicopter and/or a Rolligon trail. The South Barrow Gas Field has both gravel road accessible locations, and some wells only accessible by trails. Figure TM5-5 shows the layout of Barrow Gas Fields infrastructure in relation to the proposed Atqasuk to Utqiaġvik Road alignment alternatives.

Federal contractors discovered the three fields on separate expeditions in the region between the late 1940s and 1980s. The fields have generally required minimal development, aside from a $92 million rejuvenation program launched in 2011 to combat declining production (Lidji 2018).

Infrastructure for the gas fields consists of wells, well houses on the tundra, infield pipelines, several structures comprising the Walakpa Gas Field Complex, and a Central Processing Facility located at the South Barrow Gasfield. The 6-inch infield gas pipelines are typically mounted on vertical support members that extend several feet above the tundra surface.

NPR-A Legacy Wells

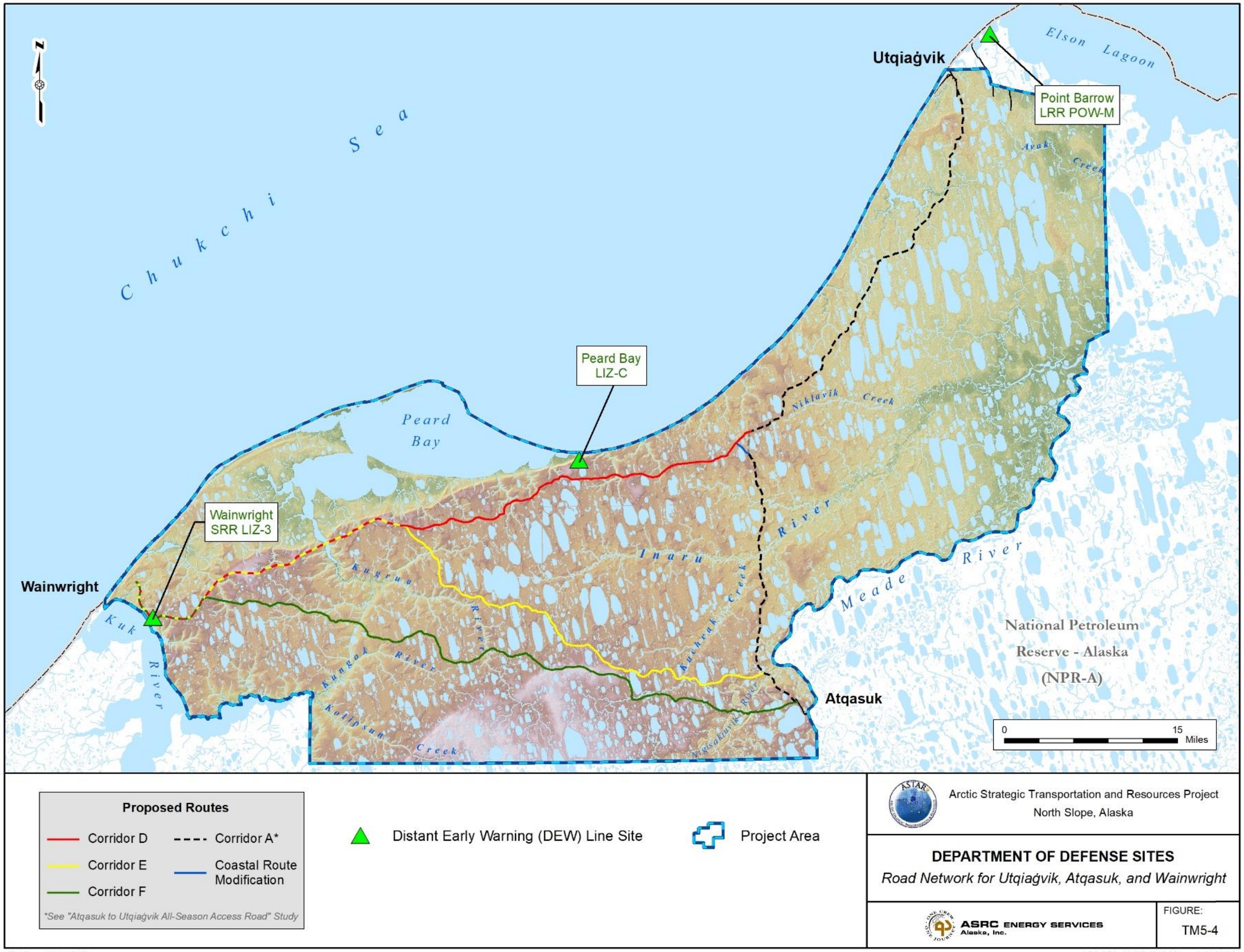
Legacy wells were drilled within and adjacent to the NPR-A prior to 1982, when the Bureau of Land Management (BLM) held its first lease sale. A total of 136 test holes were drilled under two distinct drilling periods, both sponsored by the U.S. Government to explore for oil and gas resources. In the first period, from 1944 to 1952, the U.S. Navy drilled 91 holes, locating eight small oil and gas fields (Fish Creek, Gubik, Meade, Simpson Peninsula, South Barrow, Square Lake, Umiat and Wolf Creek). In the second period, from 1975 to 1981, Husky Oil Corporation, working under contract for both the U.S. Navy and U.S. Geological Survey (USGS), drilled 36 holes. The remaining nine holes were drilled in the Utqiaġvik area between 1953 and 1974. These holes are categorized as an exploratory oil well, core test, or temperature monitoring well. In 1982, the BLM inherited the responsibility to assess, plug, and clean up the wells that the U.S. Navy and USGS left behind (BLM 2019).

Several of the NPR-A Legacy Wells are situated within the project area: Kugrua #1, Peard #1, Skull Cliff Core Test #1, South Barrow #3, and Walakpa #1 and #2 (Figure TM5-6). The disposition of these wells is summarized in Table TM5-1 (BLM 2013b).

Table TM5-1. NPR-A Legacy Wells within Project Area

Name	Subsurface Risk[1]	Surface Risk[1]	BLM Strategic Plan Action	Well Category
Kugrua #1	Low	Low	Monitor for changing conditions	Cased well, USGS temperature monitoring well
Peard #1	Low	Low	Monitor for changing conditions	Cased well, USGS temperature monitoring well
Skull Cliff Core Test #1	Moderate	High	Monitor, surface cleanup by Potentially Responsible Party	Cased well
South Barrow #3	Moderate	Moderate	Barrow Area Phase 1 Plug & remove solid waste	Cased well
Walakpa #1 and #2	NA	NA	No Action	Transferred to NSB by Barrow Gas Field Transfer Act

1. Risk as determined by the BLM's *National Petroleum Reserve in Alaska: 2013 Legacy Wells Strategic Plan.*



UTM Zone 4N (NAD83)

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Chukchi Sea
Elson Lagoon
NARL
Utqiaġvik
Central Production Facility
Cakeater Road
Emaiksoun Road
East Field Gathering Line
Gasfield Road
South Barrow Gas Field
East Barrow Gas Field
Sikulik Pool
Walakpa Gathering Line
Walakpa Gas Field
Corridor A*
Gas Reservoir
Gas Pipeline
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
ASRC ENERGY SERVICES Alaska, Inc.
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
BARROW GAS FIELDS
Road Network for Utqiaġvik, Atqasuk, and Wainwright
SCALE:
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Alaska State Plane Zone 6 (NAD83)
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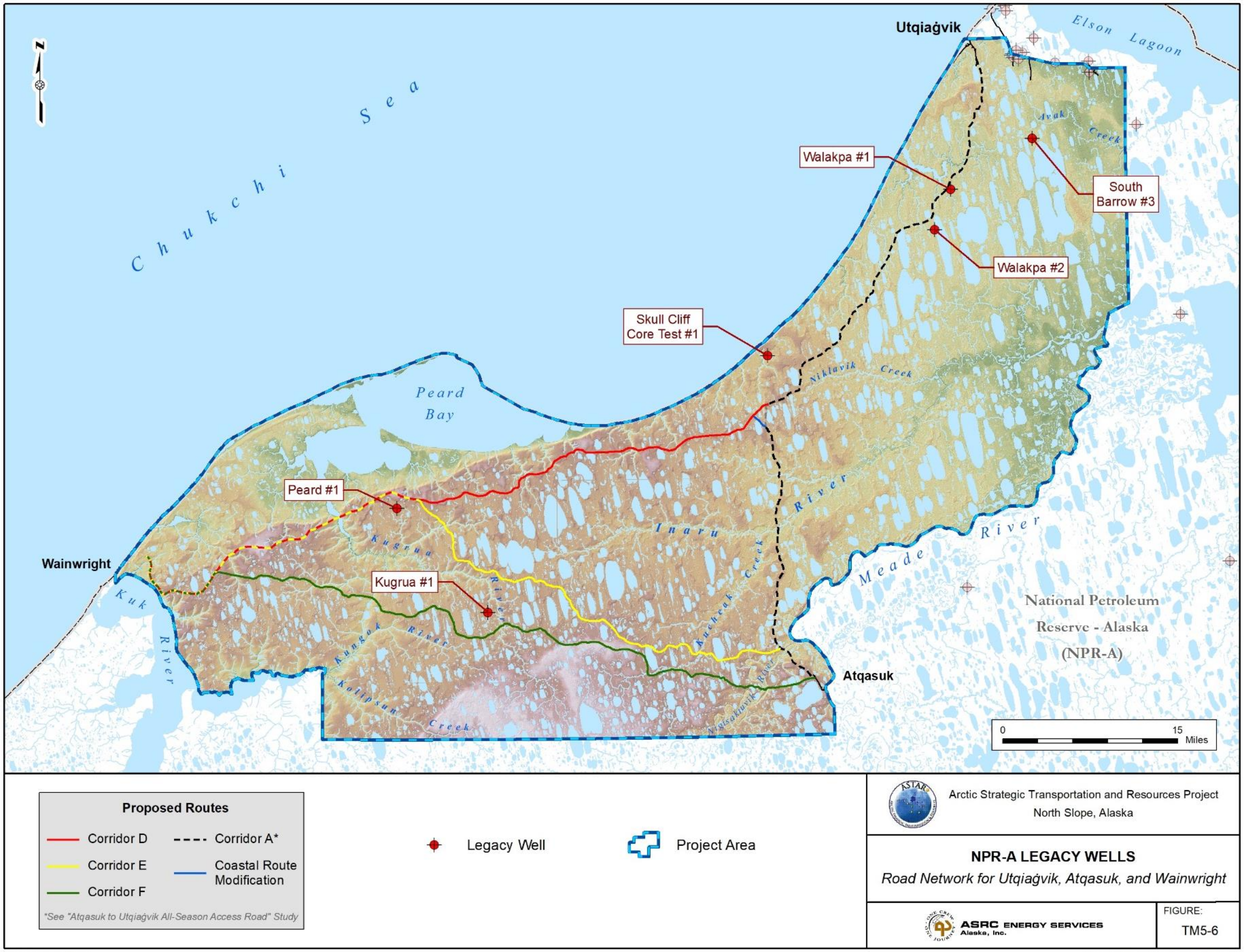
Utqiaġvik
Elson Lagoon
Chukchi Sea
Walakpa #1
South Barrow #3
Walakpa #2
Skull Cliff Core Test #1
Peard Bay
Peard #1
Kugrua #1
Wainwright
Atqasuk
Meade River
National Petroleum Reserve - Alaska (NPR-A)
0 15 Miles
Proposed Routes
Corridor D
Corridor A*
Corridor E
Coastal Route Modification
Corridor F
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
Legacy Well
Project Area
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
NPR-A LEGACY WELLS
Road Network for Utqiaġvik, Atqasuk, and Wainwright
ASRC ENERGY SERVICES
Alaska, Inc.
FIGURE:
TM5-6
UTM Zone 4N (NAD83)
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The Kugrua #1 site is 31 miles west of Atqasuk, 33 miles east of Wainwright, and 65 miles south of Utqiaġvik. The Kugrua #1 site was constructed in 1978 and consists of a well inside a constructed wooden cellar, a pad, a reserve pit, a flare pit, and a fuel pit (Figure TM5-7). The pad is made up of sand material that was excavated while creating the reserve pit. The pad is approximately 5 ft thick with insulation placed between the sandy layers. Pilings remain from drilling operations and extend to the south. Two mud piles are visible on either side of the wellhead next to the reserve pit. Most of the pad is revegetated with grasses, mosses, and sedges. The site has no known contaminants (BLM 2013a).

Figure TM5-7. Aerial view of Kugrua #1

The Peard #1 site is 26 miles east Wainwright, 41 miles west-northwest of Atqasuk, and 64 miles southwest of Utqiaġvik. Peard #1 is 12 miles northwest of Kugrua #1 described above. The Peard Bay #1 site consists of a well inside a wooden cellar, a pad, and a reserve pit (Figure TM5-8). Wooden pilings extend eastward from the wellhead. The pad was created from excavated pit material and spread across an operations area. As Peard #1 did not use insulation for the pad, the pad area has degraded and now exhibits polygonal features consistent with thermokarst terrain. The pad is vegetated approximately 60% with mosses and a little grass. The reserve pit and adjacent flare pit have joined a nearby pond. There are no known contaminants at the Peard #1 site (BLM 2013a).

Figure TM5-8. Aerial view of Peard #1. The wellhead and pilings are visible at the center right of the reserve pit.

The South Barrow #3 well is located approximately 10 miles south of Utqiaġvik. This well is on lands owned by UIC, with the oil and gas reserved to NSB. However, the well remains in Federal ownership, as it was specifically excluded from conveyance in the Barrow Transfer Act of 1984 (BLM 2013a). Figure TM5-9 shows a photograph of the South Barrow #3 location. The site requires removal of solid waste and the well requires plugging.

Figure TM5-9. View of South Barrow #3 well. The well has a concrete cellar and steel beams stacked on pilings that were cemented into the cellar. The well is cut off at ground level inside the cellar (BLM 2013a).

The Walakpa #1 and #2 wells were conveyed to the NSB in the Barrow Gas Field Transfer Act of 1984. The act conveyed specific oil and gas estates along with the wells, facilities, pipelines, and equipment to the NSB (BLM 2013a). No action is required for these well sites.

Skull Cliff Core Test #1 is approximately 1 mile from the Chukchi Sea coastline, 30 miles southwest of Utqiaġvik, and 60 miles east of Wainwright. A large area of activity roughly 150 ft by 200 ft is evidenced by about 200 drums, metal tracks, wood debris and various other metal hardware that litter the site. There are no known contaminants at the site, however, the large amount of solid waste is considered a public safety risk to local residents and needs to be removed. No cement plugs were set in Skull Cliff Core Test #1. The moderate subsurface risk ranking is due to approximately 54 ft of diesel (approximately 16 barrels) sitting on top of drilling muds within the wellbore. A cut plug prevents water from entering the wellbore and overtopping the casing (BLM 2013a). Figure TM5-10 shows the wellhead and surrounding area.

Figure TM5-10. Skull Cliff Core Test #1 and cellar. Note wooden plug at top of well casing and drums scattered around the site.

Winter Trails

In the winter of 2017/2018, the NSB established a CWAT project to allow seasonal movement of goods and services between the communities of Atqasuk and Utqiaġvik; and in winter 2018/2019 the CWAT system was extended to Wainwright. In winter 2019/2020, trails were again constructed to connect all three communities. The trail system has no permanent infrastructure components; however, trail markers are installed each winter. In addition to the CWAT, there are historical winter trail alignments between Utqiaġvik and Atqasuk, and Utqiaġvik and Wainwright. Before the CWAT was established, the winter trail between Utqiaġvik and Atqasuk was periodically used for gravel hauling and fuel hauling. Figure TM5-11 shows the CWAT and the historical winter trail alignments.

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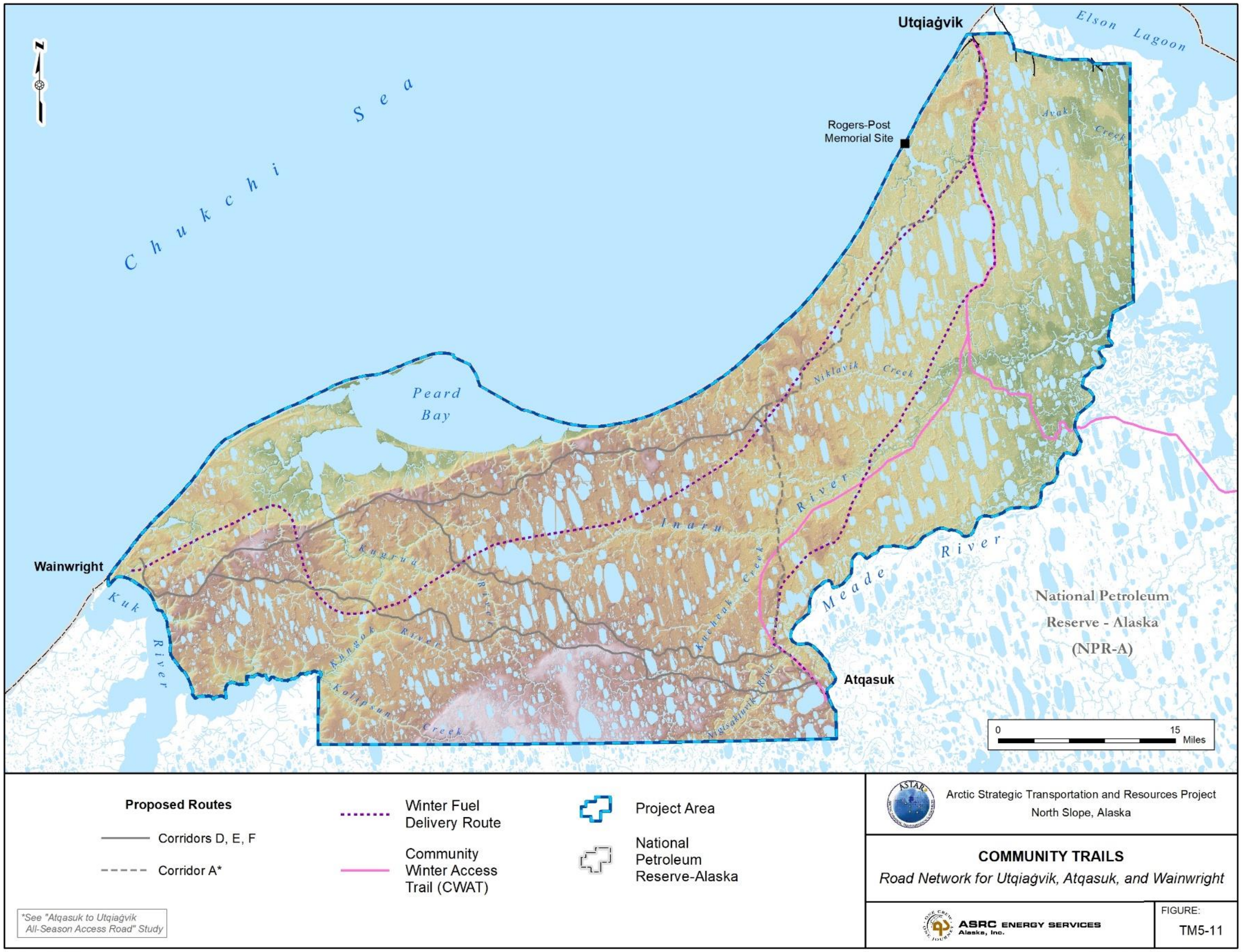
Utqiaġvik
Elson Lagoon
Chukchi Sea
Rogers-Post Memorial Site
Avak Creek
Peard Bay
Niklavik Creek
River
Inaru
Wainwright
Kuk River
Kugrua River
Kungok River
Kolipsun Creek
Kucheak Creek
Meade River
Atqasuk
National Petroleum Reserve - Alaska (NPR-A)
0
15
Miles
Proposed Routes
Corridors D, E, F
Corridor A*
Winter Fuel Delivery Route
Community Winter Access Trail (CWAT)
Project Area
National Petroleum Reserve-Alaska
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
COMMUNITY TRAILS
Road Network for Utqiaġvik, Atqasuk, and Wainwright
ASRC ENERGY SERVICES
Alaska, Inc.
FIGURE:
TM5-11
UTM Zone 4N (NAD83)
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Rogers-Post Site

The Rogers-Post Site is the location of a plane crash that killed humorist Will Rogers and aviator Wiley Post on August 15, 1935, during an aerial tour of Alaska. The site, listed on the National Register of Historic Places, is about 11 miles southwest of Utqiaġvik, on the north side of Walakpa Bay near the mouth of Walakpa River. Two concrete monuments are located at the site as shown in Figure TM5-12, and the site location is shown on Figure TM5-11.

Figure TM5-12. Two monuments make the Rogers-Post Site (photo from National Register collection)

Oil and Gas Exploration Wells

The project area has more than 7 oil and gas exploration wells as shown on Figure TM5-13. Most of these wells were drilled from ice pads during winter and have been plugged and abandoned, thus no visible infrastructure remains at the site. An example is the Brontosaurus Test Well No. 1, a private well drilled in 1985 by ARCO. Brontosaurus has no existing pad, no existing pit, and no cellar (Figure TM5-14).

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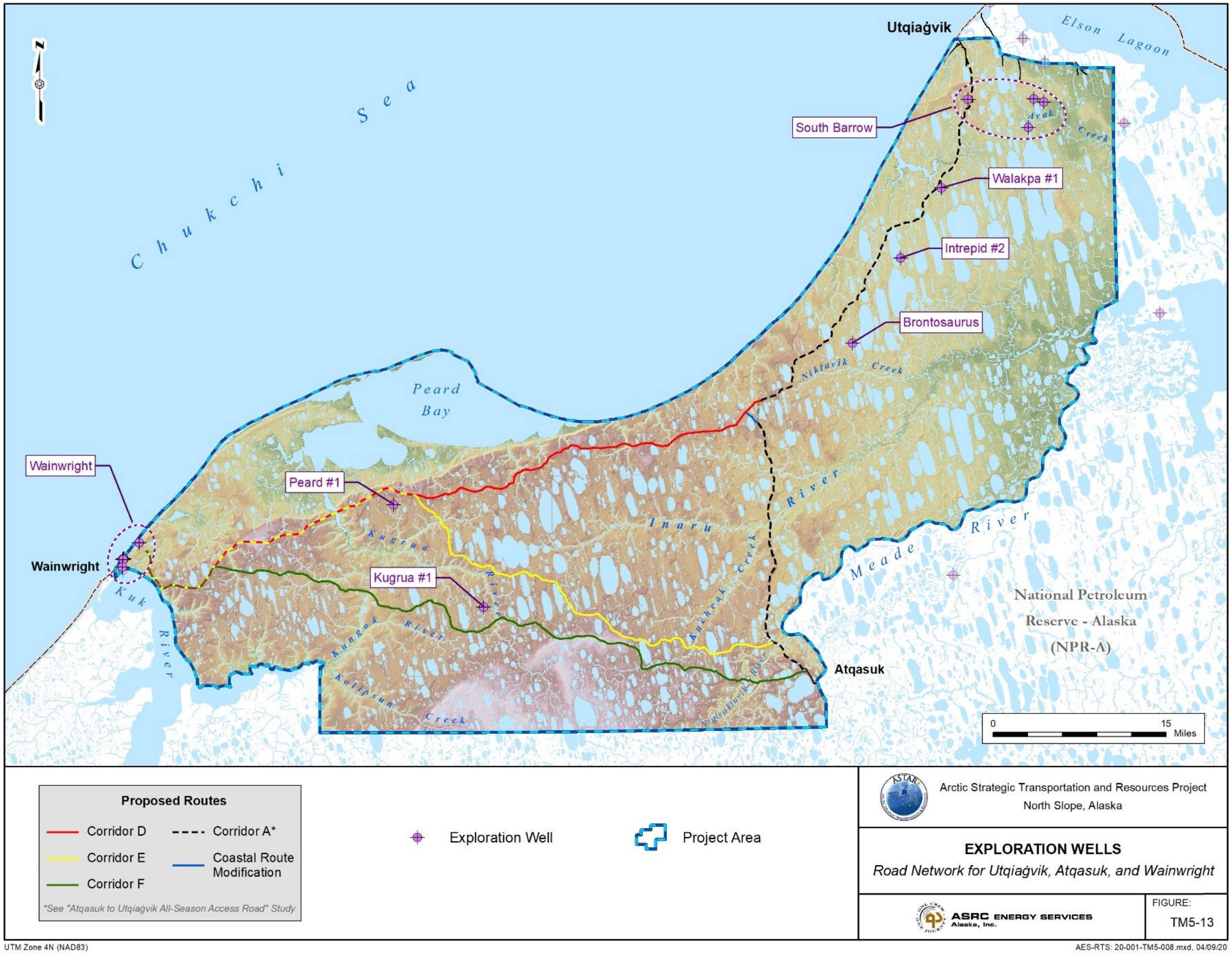
Utqiaġvik
Elson Lagoon
Chukchi Sea
South Barrow
Walakpa #1
Intrepid #2
Brontosaurus
Niklavik Creek
Peard Bay
Wainwright
Peard #1
Kugrua #1
Wainwright
Inaru River
Meade River
National Petroleum Reserve - Alaska (NPR-A)
Atqasuk
Kuk River
0 15 Miles
Proposed Routes
Corridor D
Corridor A*
Corridor E
Coastal Route Modification
Corridor F
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
Exploration Well
Project Area
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
EXPLORATION WELLS
Road Network for Utqiaġvik, Atqasuk, and Wainwright
ASRC ENERGY SERVICES Alaska, Inc.
FIGURE:
TM5-13
UTM Zone 4N (NAD83)
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Figure TM5-14. View of Brontosaurus Well

Subsistence Camps and Cabins

As described in Technical Memorandum 10, there are at least 40 subsistence camps or cabin sites within the project area, as shown on Figure TM5-15.

Proposed Infrastructure

Atqasuk Transmission Line

The escalating cost of imported diesel prompted the NSB to explore alternative energy, which focused on a proposed electrical intertie between Utqiaġvik and Atqasuk. The intertie was envisioned as a method to reduce Atqasuk's fuel needs, by displacing local diesel consumption with natural gas-fired power generation from Utqiaġvik to meet both power and space heating requirements. Two feasibility studies commissioned by the NSB concluded that it is technically and economically feasible to build a transmission line with minimal social and environmental impact (Sakeagak 2013). The line was recommended as a pole-mounted 69 kilovolt transmission line. The route shown on Figure TM5-16 was considered the preferred route for the line.

ASTAC Fiber Optic Line

In January 2018, ASTAC presented information to the NSB Planning Commission about a possible fiber optic line between Utqiaġvik and Atqasuk to provide the community of Atqasuk with high-speed internet access and communications. The proposed route presented by ASTAC is shown on Figure TM5-16

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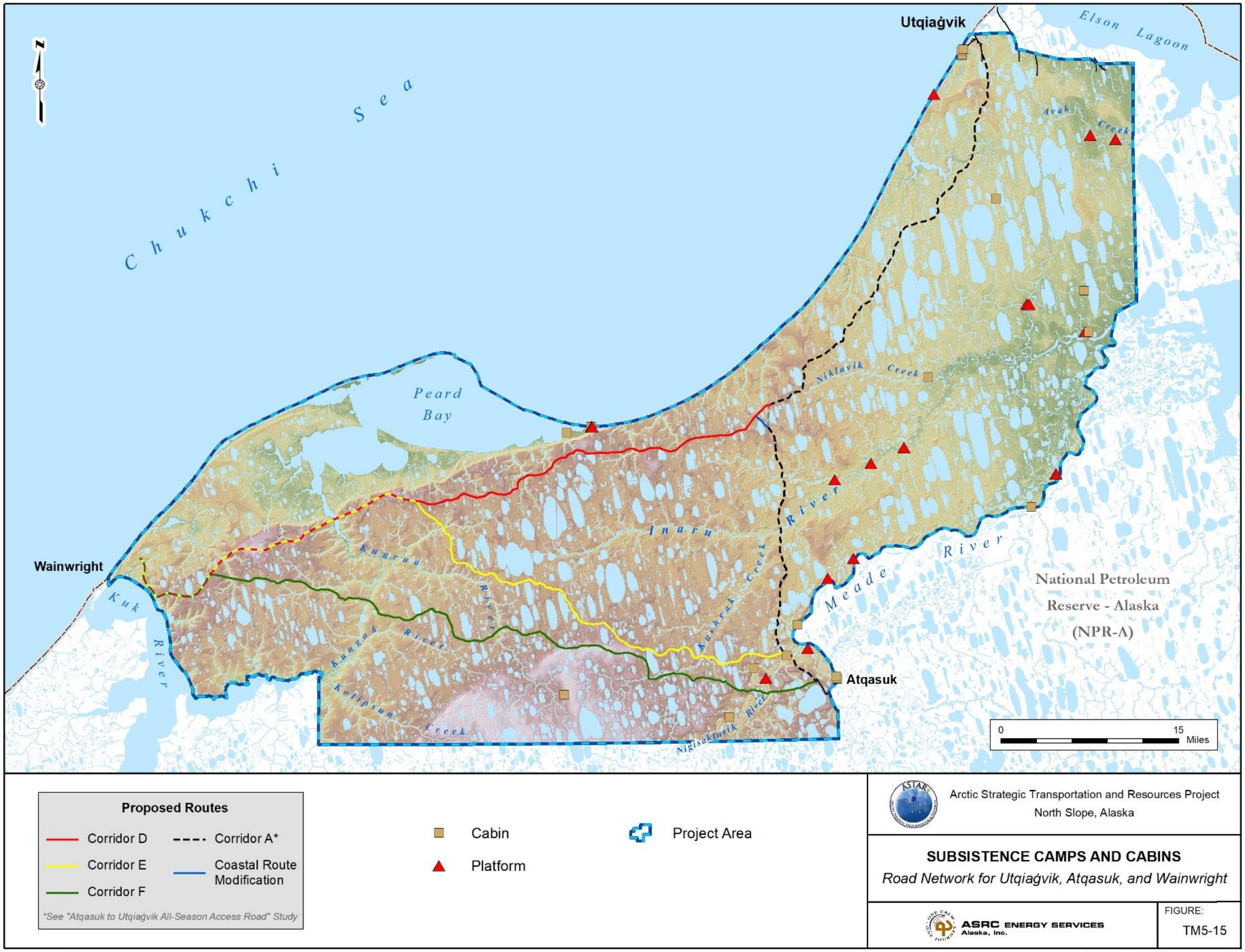
Utqiaġvik
Elson Lagoon
Chukchi Sea
Peard Bay
Avak Creek
Niklavik Creek
Inaru River
Kugrua River
Kaolak Creek
Meade River
Kuk River
Kungok River
Kolipsun Creek
Nigisaktuvik River
Wainwright
Atqasuk
National Petroleum Reserve - Alaska (NPR-A)
0 15 Miles
Proposed Routes
Corridor D
Corridor A*
Corridor E
Coastal Route Modification
Corridor F
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
Cabin
Platform
Project Area
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
SUBSISTENCE CAMPS AND CABINS
Road Network for Utqiaġvik, Atqasuk, and Wainwright
ASRC ENERGY SERVICES
Alaska, Inc.
FIGURE:
TM5-15
UTM Zone 4N (NAD83)
AES-RTS: 20-001-TM10-002.mxd. 03/27/20

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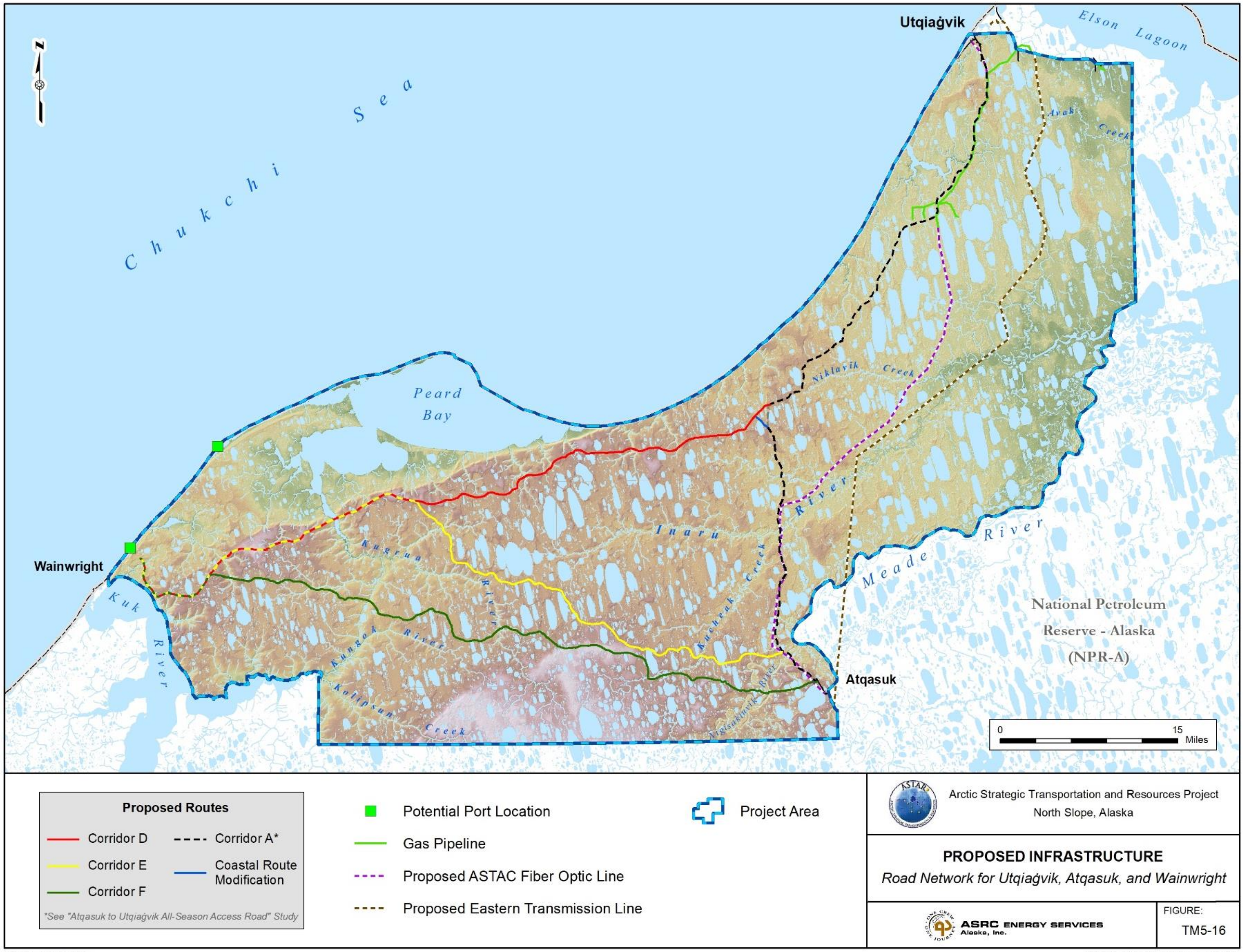
Utqiaġvik
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Kuk River
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Niklavik Creek
Avak Creek
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National Petroleum Reserve - Alaska (NPR-A)
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Miles
Proposed Routes
Corridor D
Corridor A*
Corridor E
Coastal Route Modification
Corridor F
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
Potential Port Location
Gas Pipeline
Proposed ASTAC Fiber Optic Line
Proposed Eastern Transmission Line
Project Area
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
PROPOSED INFRASTRUCTURE
Road Network for Utqiaġvik, Atqasuk, and Wainwright
ASRC ENERGY SERVICES
Alaska, Inc.
FIGURE:
TM5-16
UTM Zone 4N (NAD83)
AES-RTS: 20-001-TM5-010.mxd, 04/09/20

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Arctic Port

Wainwright was considered as a potential deep-draft port location during the Alaska Deep-Draft Arctic Port System Study (U.S. Army Corps of Engineers 2013), however, the study outcome indicated more favorable locations at Nome and Port Clarence. These locations offer limited benefit to NSB communities.

Royal Dutch Shell considered a port location northeast of Wainwright near Point Belcher that offered deep water access in relative close proximity to shore, and potential for road connection to existing infrastructure in Wainwright. However, Shell abandoned plans for offshore oil development, citing difficult conditions due to sea ice extents, regulatory environment, and poor results from its one exploratory well.

The location of these two potential port sites is shown on Figure TM5-16. A network of roads with access to a deep-water port would serve to meet the needs of providing local and regional economic development opportunities from resource extraction, tourism, research, and improved subsistence access for marine mammal harvest. It would decrease operating costs in the Arctic, provide for efficient delivery of bulk goods (fuel, building materials, dry goods, etc.), provide protected moorage to support offshore oil and gas endeavors, mineral resource extraction vessels, and cruise ships, and provide for vessel repair and maintenance support.

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Technical Memorandum 6 – Roadway Engineering Considerations

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Technical Memorandum 6 – Roadway Engineering Considerations

Prepared by: Benjamin Lane, Project Civil Engineer

Reviewed by: Paul Ramert, PE, Principal Civil Engineer

Date: April 2020

Overview

This memorandum provides a general overview of roadway engineering considerations relevant to the proposed Road Network for Utqiaġvik, Atqasuk, and Wainwright, including preliminary roadway design criteria, estimates of granular material required, criteria for drainage structures, and related information.

ASRC Energy Services Alaska (AES Alaska) completed a desktop analysis of an all-season road connection between Atqasuk and Utqiaġvik in July 2019, titled *Atqasuk to Utqiaġvik All Season Access Road, Arctic Strategic Transportation and Resources Project, North Slope, Alaska* (AES Alaska 2019). The study concluded that a coastal route appeared to be the most favorable alignment, offering greater benefits than other options (Corridor A – Coastal Route on Figure TM6-1).

The study also concluded that because the alignment of Corridor A essentially parallels the coastline, it sets the stage for a road extension to Wainwright, offering potential to link together the three communities (Wainwright, Atqasuk, and Utqiaġvik). Connecting the three communities would further enhance the benefits listed in the 2019 study, and could open opportunities for development of a regional marine port for freight and fuel deliveries. It was also pointed out that simultaneously considering all three communities could result in minor adjustments to portions of the original alignment for Corridor A.

The purpose of this memorandum is to provide information for route alternatives that extend the road network to Wainwright, while considering outcomes of the 2019 study. This effectively means retaining Corridor A from the previous study and evaluating several alignments extending to Wainwright, thereby forming a road network that links the three communities. Table TM6-1 provides general information for Corridor A and three route alternatives under consideration for the connection to Wainwright; Figure TM6-1 depicts the alignments.

Table TM6-1. Preliminary Road Alignment Alternatives

Road Alignment	Length (miles)	Western Terminus	Eastern Terminus	Elevation-min./max. (feet MSL[1])	Named River Crossings[2]
Corridor A – Coastal Route	67.5	Atqasuk Landfill Road	Emaiksoun Road	20 / 91	Nigisaktuvik River, Inaru River, Singaruak Creek
Corridor D – Coastal Route Extension	62.9	Olgoonik Corp. Road	Route A at MP-39, approximately 5 miles inland from Skull Cliff	1 / 118	Augmun Creek, Kugrua River, Kunarak Creek, Papigak Creek, Sinaruruk River, Walik Creek
Corridor E – Middle Route	68.8	Olgoonik Corp. Road	Route A north of Nigisaktuvik River	1 / 118	Augmun Creek, Kucheak Creek, Kugrua River, Sinaruruk River
Corridor F – Southern Route	68.2	Olgoonik Corp. Road	Atqasuk Landfill Road	17 / 118	Kucheak Creek, Kugrua River, Nigisaktuvik River, Sinaruruk River

1. Mean Sea Level
2. Note that each route alternative crosses other un-named streams and rivers. Please refer to Tech Memo 3 – River Hydrology for additional information on drainage crossings.

Topography

The terrain is characterized by relatively flat arctic tundra, although terraces and steep river banks are found adjacent to larger rivers and streams. The ground surface elevation within the project area varies from about 0 to 142 feet (ft) above sea level as shown on Figure TM6-1. Elevation profiles and major crossings for Corridors D, E, and F are shown on Figure TM6-2.

Figure TM6-1. Topography

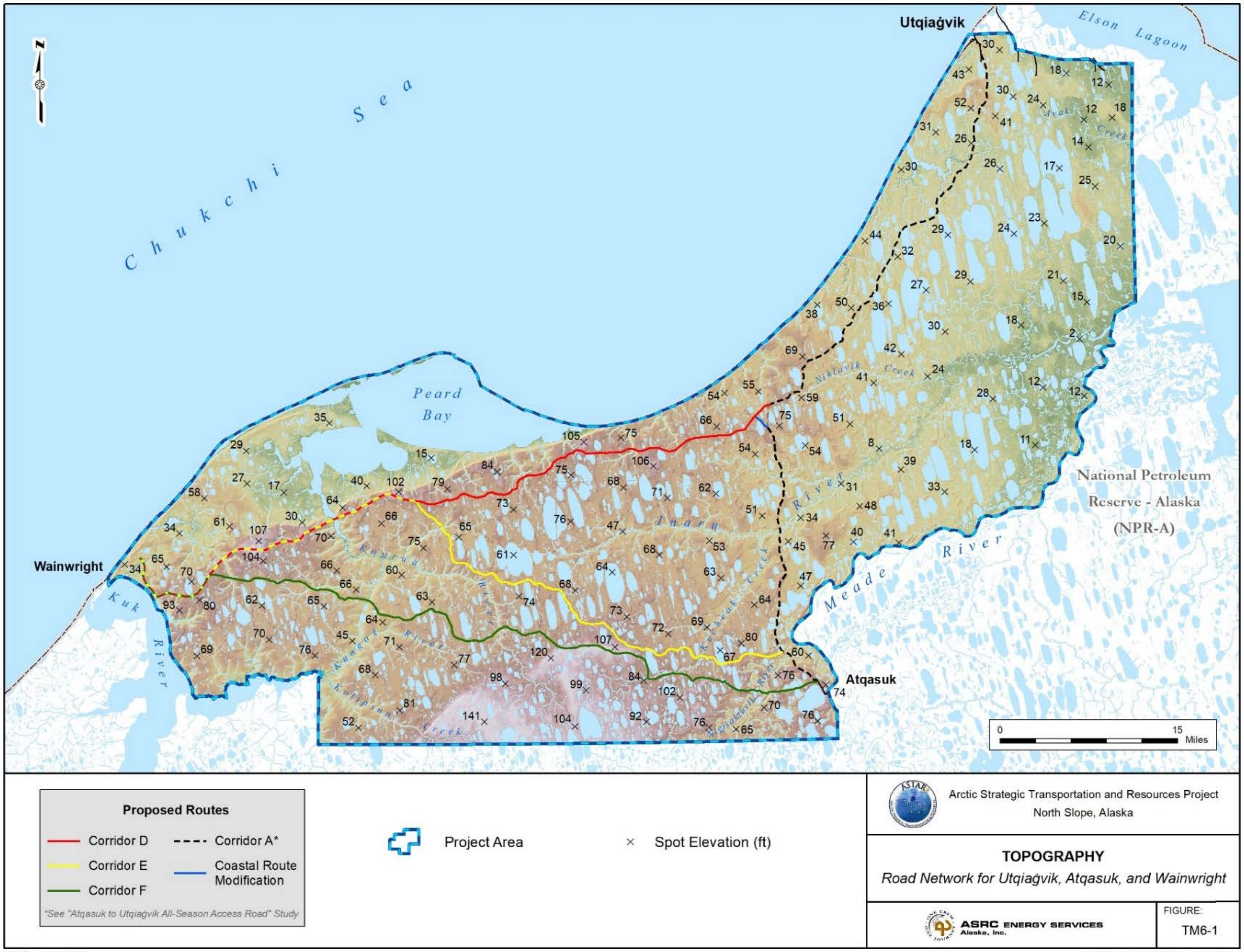

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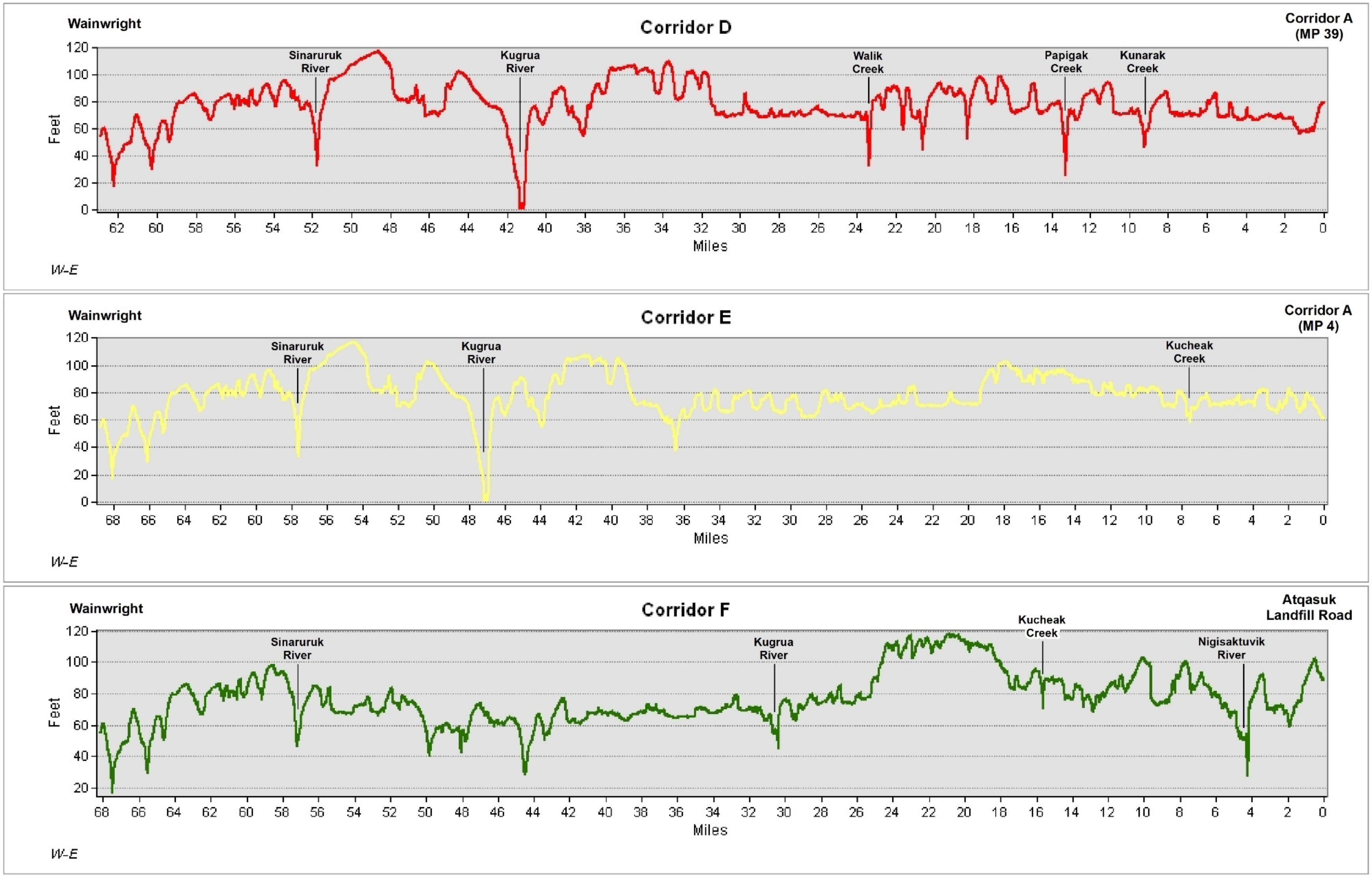
Figure TM6-2. Elevation Profiles and Major Crossings



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Design Criteria

General design criteria for the proposed road are presented in Table TM6-2 and described further in the following sections. These roadway design criteria are derived primarily from guidance published by the American Association of State Highway and Transportation Officials (AASHTO), the U.S. Forest Service (USFS), and the Alaska Department of Transportation and Public Facilities (ADOT&PF).

Table TM6-2 Preliminary Roadway Design Criteria

Element	Road Network for Utqiaġvik, Atqasuk, and Wainwright	Criteria/Guidance/Rationale
Project Type/ Area Type	New Construction/ Rural Area	AASHTO 2019, page 1-2
Functional Classification	Low-Volume Local Road	AASHTO 2019, page 1-1
Functional Subclass	Rural Industrial/Commercial Access Road	AASHTO 2019, page 2-5
Surfacing	Unpaved	AASHTO 2019, page 2-5 and 4-37
Number of Lanes	1 with Turnouts at Regular Intervals for Two-Way Single-Lane Road or 2 for Double-Lane Road	AASHTO 2019, page 4-40 AASHTO 2019, pages 4-2, 4-3
Projected AADT **Estimated % Commercial Truck**	>100 vehicles per day <10%	AASHTO 2019, page 2-8
Design Speed/Operating Speed	Two-Way Single-Lane Road: 40 mph Double-Lane Road: 45-50 mph	AASHTO 2019, page 4-39 AASHTO 2019, page 4-3
Grade Limitations	**Two-Way Single-Lane Road**: 30 mph – Level, 0-7% 20 mph – Rolling, 7-11% **Double-Lane Road**: 50 mph – Level, 0-4% 40 mph – Level, 4-7% 30 mph – Rolling, 7-10%	AASHTO 2011, page 3-119, 5-26, 5-33. (Steeper grades may necessitate lower design speeds. Grade limitations will be dictated by design vehicle.)
Design Vehicle **Maximum Axle Loadings**	22,000 lbs/standard axle 22,000 lbs/trunnion axle (winter only)	A 22,000 lb axle loading should cover a wide range of transportation needs including moving heavy equipment on multi-axle heavy haul trailers.
Design Flood	50-year return period (2% exceedance probability)	ADOT&PF 2006, page 7-30 Previous experience suggests agencies may require a larger design flood. The North Slope has unique hydrologic conditions and little data for prediction of flood magnitudes and varying water surface elevations (affected by ice jams, snow blockages, etc.), often requiring a greater of factor of safety.

Element	Road Network for Utqiaġvik, Atqasuk, and Wainwright	Criteria/Guidance/Rationale
Scour Protection	Designed for 100-year return period (1% exceedance probability). Checked at 500-year return period (0.2% exceedance probability)	ADOT&PF 2006, page 7-30
Cross-Drainage Culvert	24-inch dia. or greater for round culverts (equivalent pipe-arch culverts min. span-to-rise of 29 inches by 18 inches). 36-inch dia. or greater round culverts in icing problem areas	ADOT&PF 2019a ADOT&PF 2006, pages 9-4 and 9-6
Culverts >100 ft	36-inch dia. or greater	ADOT&PF 2006, page 9-6
Headwater to diameter ratio (Hw/D)	1.0 at design flow No greater than 1.5 allowable	ADOT&PF 2006, pages 9-4 and 9-5 Design for Hw/D of less than 1.0 due to potential for icing conditions
Minimum and Maximum Cover over Culverts	Varies	ADOT&PF 2013, Standard Drawing D-04.21
Fish Passage	Tier 1. Stream Simulation Design	ADF&G 2001, page 12, McDonald & Associates 1994, Behlke et al. 1991
Bridge Live Load	AASHTO HL-93	AASHTO (2017) LRFD Bridge Design Specifications.

AD Average annual daily traffic
AASHTO American Association of State Highway and Transportation Officials
ADF&G Alaska Department of Fish and Game
ADOT&PF Alaska Department of Transportation and Public Facilities
dia. diameter
ft feet
Hw/D headwater to diameter
lbs pounds
mph miles per hour

Functional Classification and Subclass

The proposed road is classified as a low-volume local road serving a rural area (i.e. western North Slope). By definition, a low-volume local road is a local road that has a design average daily traffic (ADT) volume of 2,000 vehicles per day or less (AASHTO 2019). The road's primary function is to allow movement of goods and services between Utqiaġvik, Atqasuk, and Wainwright.

The functional classification of low-volume roads is further subdivided into several subclasses. For this project, the applicable subclass is Rural Industrial/Commercial Access Road, taking into consideration trucks and other heavy vehicles are important in the design.

The primary design guidance for low-volume roads is provided in AASHTO's *Guidelines for Geometric Design of Low-Volume Local Roads* (2019). This guidance enables designers for projects on low-volume local roads to apply less restrictive design criteria than that generally used for higher volume roads. The guidelines discourage widening of lanes and shoulders, changes in horizontal and vertical alignment, and roadside improvements except in situations where such improvements are likely to provide substantial safety benefits. Thus, projects designed in accordance with these guidelines are less likely to negatively impact the environment, roadway and roadside aesthetics, existing development, historic and archaeological sites, and wildlife.

Surfacing

Like many rural access roads, roads on the North Slope are unpaved. Paving is generally avoided, since asphalt surfaces absorb greater solar radiation than gravel surfaces, leading to deeper thaw and degradation of permafrost in the road subgrade. Unpaved roads are intended to operate at low to moderate speeds, normally 45 miles per hours (mph) or less (AASHTO 2019).

Number of Lanes and Average Annual Daily Traffic

The following general guidelines apply when making decisions regarding the number of lanes for a low-volume local road (USFS 2011):

- Where the ADT for the design life is less than 100, a single-lane road is generally preferable.
- Where the ADT for the design life is 100 to 250, a double-lane road should be considered.
- Where the estimated ADT for the design life is over 250, a double-lane road is generally the minimum design standard.

Design widths should be established in accordance with the USFS guidelines (2011) for single-lane roads or the AASHTO guidelines (2019) for double-lane roads.

Average annual daily traffic (AADT) for Utqiaġvik and Atqasuk streets was considered in developing the design criteria for this project; AADT data for Wainwright has not been collected. Table TM6-3 presents 2016 AADT data provided by ADOT&PF (2019b) based on actual counts. As shown in the table, 2016 daily traffic counts for Utqiaġvik roads range from 373 to 4,656 vehicles per day; and for Atqasuk roads range from 15 to 20 vehicles per day. Using the average for all of the AADT data listed, and assuming 10 percent of this traffic might travel daily between the two communities, we have estimated an AADT greater than 100 vehicles per day for the proposed road network over the design life of the project. We have also assumed that about 10 percent of the AADT would be truck traffic to account for deliveries of fuel, gravel, freight, and similar goods. Based on this traffic volume, we assume that a double-lane road will be the design standard.

Table TM6-3. AADT for Utqiaġvik and Atqasuk Streets

Locale	Route Name	2016 AADT
Utqiaġvik	Stevenson Street, MP 0.245 to 4.013	1,362
Utqiaġvik	Stevenson Street, MP 0.000 to 0.512	1,363
Utqiaġvik	Cakeatter Road, MP 0.967 to 1.823	419
Utqiaġvik	Ahkovak Street, MP 0.000 to 0.771	2,832
Utqiaġvik	Ahkovak Street, MP 0.771 to 1.359	1,584
Utqiaġvik	Ahkovak Street, MP 1.359 to 1.722	1,551
Utqiaġvik	Laura Madison Street, MP 0.235 to 0.950	2,866
Utqiaġvik	Laura Madison Street, MP 0.000 to 0.235	3,403
Utqiaġvik	Eben Hopson Street, MP 0.363 to 0.510	3,819
Utqiaġvik	Eben Hopson Street, MP 0.000 to 0.363	4,656
Utqiaġvik	Karluk Street, MP 0.000 to 0.695	806
Utqiaġvik	Northstar Street, MP 0.000 to 0.385	1,981

Locale	Route Name	2016 AADT
Utqiaġvik	Yugit Street, MP 0.000 to 0.543	1,541
Utqiaġvik	A Avenue MP 0.000 to 0.418	373
Utqiaġvik	Okpik Street, MP 0.000 to 0.879	1,481
Utqiaġvik	Momegana Street, MP 0.000 to 0.294	1,276
Utqiaġvik	Agvik Street, MP 0.000 to 0.270	585
Utqiaġvik	Kiogak Street, MP 0.000 to 0.337	1,690
Utqiaġvik	Pisokak Street, MP 0.000 to 0.301	782
Utqiaġvik	Apayauk Street, MP 0.000 to 0.102	1,080
Utqiaġvik	Church Street, MP 0.000 to 0.131	1,283
Utqiaġvik	Hopson Street, MP 0.000 to 0.142	2,656
Atqasuk	Nashaknik Street, MP 0.000 to 1.025	15
Atqasuk	Noyokok Street, MP 0.000 to 0.095	20

1. 2017 AADT values are ADOT&PF estimates based on 2016 actual counts.

Double-Lane Road

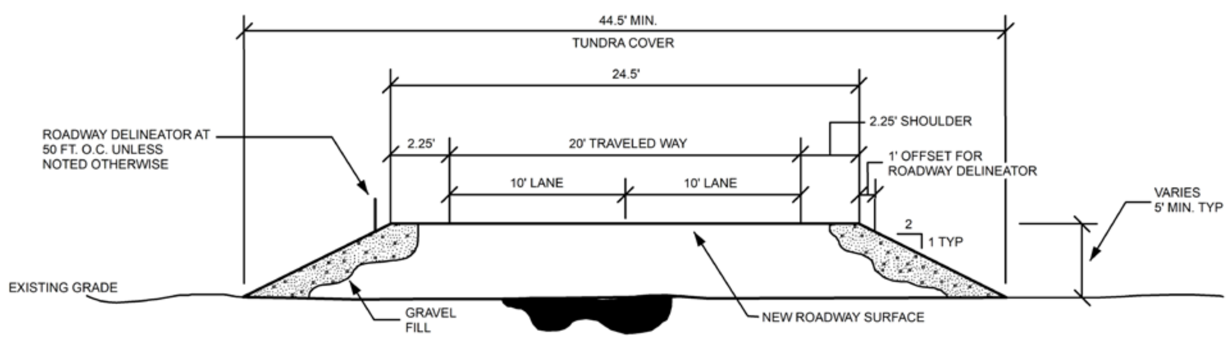
When compared with a single-lane road, a double-lane road allows higher design speeds and is much less constrained in the size and weight of loads that can be safely transported. Widths for industrial/commercial access roads consider more frequent use by trucks, wider loads, and transport of pre-fabricated construction modules for housing and other structures. These greater widths reflect the offtracking and maneuverability requirements and the greater widths of the larger vehicles using these roads. The ability of heavy vehicles in opposing directions of travel to safely pass one another is another important design consideration. Pullout areas should be incorporated into the design at selected areas to facilitate subsistence hunting, fishing, trapping, and food gathering.

Typical Section

For the industrial/commercial subclass, AASHTO guidelines (2019) list a total roadway width of 23.0 to 24.5 ft (including shoulders) for a 45 to 50 mph design speed, although designers are afforded great discretion in determining road widths based on the actual widths of vehicles expected to use the road. For this case, we recommend a total roadway width of 24.5 ft and side slopes of 2H:1V as shown on Figure TM6-3.

This width will accommodate routine truck traffic as well as oversize construction equipment commonly used in the villages, including two-way traffic for CAT D300E articulated dump trucks (approx. 10 ft wide including drivers side mirror), wheeled cranes (13- to 14-ft wide), and truckable modules (up to 20-ft wide).

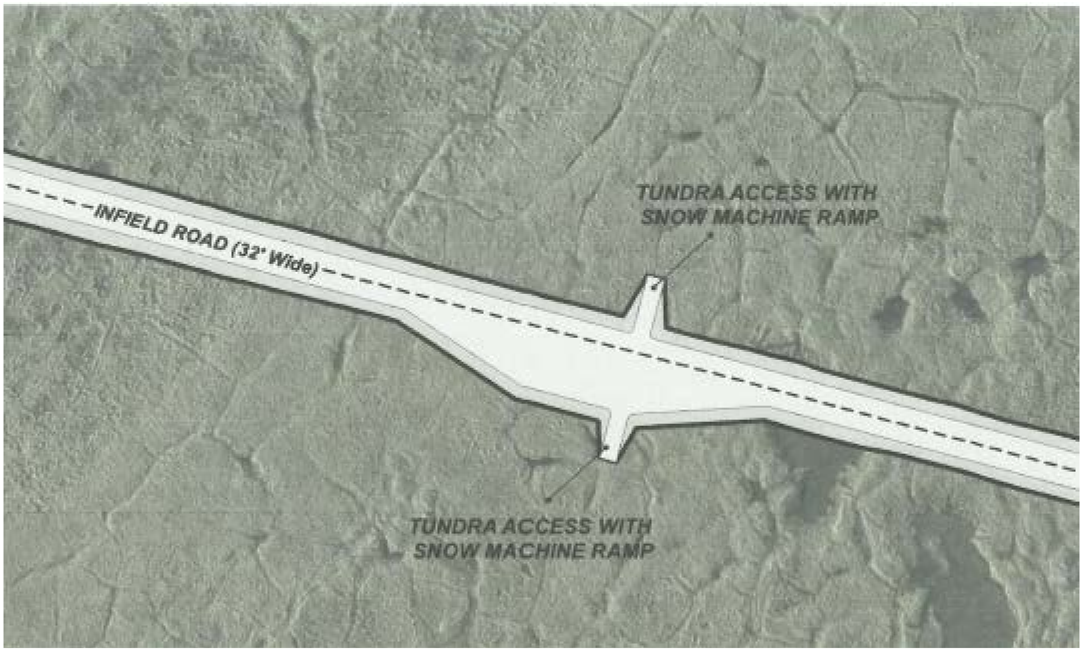
Figure TM6-3. Typical Gravel Double-Lane Road Section



Turnouts

Turnouts and all-terrain vehicle (ATV)/snowmobile ramps (Figure TM6-4) should be incorporated into the design at selected areas to facilitate subsistence hunting, fishing, trapping, food gathering, and safe passage of wide load(s) for traffic in opposing directions of travel. Ramps for ATV/snowmobile traffic would provide protection of the road embankment and safe access for its users.

Figure TM6-4. Typical Turnout with Ramps, Plan View



Design Speed and Grade Limitations

AASHTO (2019) states double-lane unpaved roads are designed to operate at low to moderate speeds. Design speeds for unpaved roads should normally be 45 mph or less, but may occasionally be as high as 50 mph in situations where the designer considers it appropriate. This design speed should be decreased in rolling terrain as outlined in Table TM6-2.

Design Vehicle and Critical Vehicle

The design vehicle is defined as the vehicle type that most frequently travels the road, travels at the road's design speed, is not subject to restrictions on use of that road, and that determines the design standards for only particular design elements for the road (e.g. turning radii and intersection geometry). Apart from standard cars and pickup trucks, the majority of anticipated traffic will be commercial delivery trucks, moderately-sized construction equipment, and occasional heavy haul vehicles. Heavy haul vehicles might include the typical "lowboys" used to haul common earth moving machines (Figure TM6-5) or articulated dump trucks for gravel hauling similar to a CAT D300 (Figure TM6-6).

Figure TM6-5. Typical Tractor Truck and Lowboy for Hauling Heavy Equipment

Figure TM6-6. CAT D300 articulated dump truck used for gravel hauling.

A critical vehicle is defined as a vehicle type, typically the largest on a road by weight, size, or unique configuration, whose limited use on the road is necessary to fulfill the road management objectives. For the road network for Utqiaġvik, Atqasuk, and Wainwright, we recommend that the critical vehicle be based on allowable loading. Establishing the loading requirements enables the road cross-section to be designed to carry this load based on the depth of section and available materials. For an industrial/commercial access road, the recommended vehicle loading is a 22,000-pound (lb) load per axle with standard axles. A 22,000-lb loading will cover a wide range of transportation needs, including moving heavy oilfield equipment using multi-axle, heavy haul trailers. The basic truck/trailer would be the standard 8-ft 6-inch width, but loads considerably wider (such as modularized equipment that can be 20 ft width) could be carried on the proposed typical section. The use of trunnion axles will accommodate significantly higher axle capacity and are also recommended, but should be prohibited from use when the ground is not frozen to minimize impacts to the structural section.

Bridges require additional loading considerations. The length of a bridge is important in determining the total weight it can carry. Shorter bridge spans may only carry part of the total load at any one time, whereas longer bridge spans will carry the entire load at once, so the gross vehicle weight must be considered. A CAT D9 dozer shipping weight is about 108,000 lbs; gross weight of the rig and load can exceed 164,000 lbs.

Structural Section

Roads in permafrost areas will ideally be built with a structural section that is both structurally adequate for the anticipated loads and thermally adequate to prevent thawing of the subgrade soil. In order to fully protect the permafrost beneath the core of a road in northern Alaska, sections on the order of 5 to 6 ft thick are typically required, or 2 to 6 inches of high strength polystyrene insulation is commonly included in the section to reduce thaw penetration and the amount of gravel needed. A 2-inch thick layer of polystyrene is roughly the equivalent of one foot thickness of gravel. During subsequent stages of design, the road alignment and structural section will be optimized considering climatic conditions in the project area as well as physical factors (e.g. design vehicle axle loads, terrain units, subsurface conditions, snow drifting, surface drainage, and soil saturation).

Material Needs and Haul Distances

For the full 5-ft thick gravel section depicted in Figure TM6-3, a minimum neat volume of 33,734 cubic yards (cy) of gravel would be needed for each mile of road across relatively flat terrain; in uneven terrain, this volume would increase. Generally, the objectives for a remote road construction project are to locate a material site every 10 miles or so and to prove up about 1 million cy of suitable material at each site to allow for construction and long term maintenance (ADOT&PF 2010). Since suitable material is scarce in the National Petroleum Reserve–Alaska (NPR-A), haul distances between material sites may have to be increased, thereby increasing the cost of construction and maintenance.

Alternative Road Configurations

As the project progresses, a number of alternatives should be considered and evaluated for the proposed road:

- If Corridor D – Coastal Route Extension is deemed the most favorable alternative, it may be worthwhile to consider a double-lane road between Utqiaġvik and Wainwright, with a single-lane spur to Atqasuk from the intersection of Corridor A with D. If more detailed analysis indicates that projected AADT will be less than 100 vehicles per day for the spur road to Atqasuk, a two-way single-lane road with inter-visible turnouts may be a more cost-effective design. The maximum recommended spacing between turnouts is 1,000 ft.
- If quality gravel is scarce or unavailable for the project, other potential design alternatives should be considered, for example sands and silts in combination with synthetic geofabrics and geomembranes, insulating materials, or chemical and mineral binders.
- Use of insulation in the road cross section may offer the potential for significant reduction in gravel required. By adding a 4-inch thick layer of insulation, the thickness of overlay needed to prevent permafrost thaw can be reduced by about two feet, and inferior material, such as frozen silty sand, can be incorporated into the lower portion of the embankment that would be kept frozen.

Roadway Bridge and Culvert Criteria

Bridges, culverts, and hydraulic calculations in support of crossing structures will be consistent with the *Alaska Highway Preconstruction Manual* (HPM) (ADOT&PF 2019a) and *Alaska Highway Drainage Manual* (HDM) (ADOT&PF 2006).

In addition, the Record of Decision (ROD) for the NPR-A Best Management Practice (BMP) E-6 (Bureau of Land Management [BLM] 2013) states that:

- 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.
- Bridges, rather than culverts, are the preferred method for crossing rivers.
- Culverts can be constructed on smaller streams, if they are large enough to avoid restricting fish passage or adversely affecting natural stream flow.

Bridges should be designed with removable or collapsible side rails to accommodate transport of over-wide loads.

Design Flood - The HPM and HDM list a 50-year return period (2 percent exceedance probability) as the design flood for bridges on all highways and culverts on primary highways and secondary highways of high importance. Culverts and bridges in designated flood hazard areas are designed for the 100-year return period (1 percent exceedance probability); however, no flood hazard areas are mapped in the project area. Scour protection will be designed for the 100-year return period and checked at the 500-year return period (0.2 percent exceedance probability) as required by HPM and HDM.

Culvert Sizes - HPM and HDM require 24-inch diameter or greater for round cross-drainage culverts or equivalent pipe-arch culverts with a minimum span-to-rise of 29 inches by 18 inches. For round culverts over 100 ft long, 36-inch diameter or greater is required. A minimum diameter of 36 inches is also recommended where icing is likely. Culverts shall be designed for a maximum headwater to diameter (Hw/D) ratio of 1.0 at the design flow, and an allowable Hw/D no greater than 1.5, although more stringent values may be needed for the North Slope to account for icing conditions, snow plugs, and other unknowns.

Bridge Design Live Load - The design live load is based on AASHTO HL-93 (2017) live load and vehicle loading previously discussed. Span lengths and total length of bridges are important parameters in evaluating capacity to support loading. Shorter bridge spans might carry only part of the load at any one time, whereas longer bridges carry the entire load at once; thus, gross vehicle weight and geometry must be considered.

Fish Passage - BMP E-14 (BLM 2013) states that:

- To ensure that crossings provide for fish passage, all proposed crossing designs shall adhere to the BMPs outlined in *Stream Crossing Design Procedure for Fish Streams on the North Slope Coastal Plain* by McDonald et al. (1994), *Fundamentals of Culvert Design for Passage of Weak-Swimming Fish* by Behlke et al. (1991), and other generally accepted best management procedures prescribed by the BLM authorized officer.
- At least three years of hydrologic and fish data shall be collected by the lessee for any proposed crossing of a stream whose structure is designed to occur, wholly or partially, below the stream's ordinary high watermark. These data shall include, but is not limited to, the range of water levels (highest and lowest) at the location of the planned crossing, and the seasonal distribution and composition of fish populations using the stream.

Based on Technical Memorandum 14, seven drainages in the project area are listed as anadromous streams in the ADF&G's Catalog of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes database. Crossings at these drainages will likely require fish passage bridges.

For the river and stream crossings along the routes where there is no documentation of fish use at the specific alignment crossings, the crossing site will require fish surveys. ADF&G will assume that every significant stream or river is fish bearing unless fish surveys show otherwise. Any culvert proposed for fish-bearing rivers and streams will be required to maintain fish passage in accordance with Alaska Statute (AS 16.05.841). Before permitting and final design are completed, three years of field studies will be required to verify and update this preliminary list of fish-bearing streams.

Technical Memorandum 3 provides a list of the crossings for each route, the approximate crossing width, and the presumed drainage structure required (bridge or culvert[s]).

BLM Stipulations and Best Management Practices for Roads in NPR-A

In addition to BMPs E-6 and E-14 pertaining to bridges and culverts, the ROD for NPR-A (BLM 2013) includes several additional performance-based stipulations and BMPs relating directly to roads. Note that these standards apply only to Federal lands, (and do not necessarily apply to Native-owned lands within the project area). Below are excerpts from the ROD that pertain directly to permanent gravel roads. Note, however, that this is not an exhaustive list of every stipulation or BMP that could apply to roads. For example, other stipulations or BMPs related to air quality, biological surveys, cultural surveys, threatened and endangered species, etc. could indirectly or directly have implications for permanent roads. In addition, some of the stipulations listed below are directed toward oil and gas leaseholders (e.g. BMP G-1), and may not apply to roads constructed by the NSB or Native Corporations for purposes not directly related to oil and gas development.

- To protect subsistence use and access to subsistence hunting and fishing areas and minimize the impact of road construction on air, land, water, fish, and wildlife resources, BMP E-1 states that 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. The BLM authorized officer will consult with appropriate Federal, State, and NSB regulatory and resources agencies prior to approving construction of roads.
- To protect fish-bearing water bodies, water quality, and aquatic habitats, BMP E-2 states that roads are prohibited upon or within 500 ft as measured from the ordinary high water mark of fish-bearing water bodies. Essential road crossings will be permitted on a case-by-case basis.
- To minimize impacts of the development footprint, BMP E-5 states that facilities shall be designed and located to minimize the development footprint. Issues and methods that are to be considered include integration of airstrips with roads and use of gravel-reduction technologies (e.g., insulated or pile-supported pads).
- To 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, BMP E-11 states that aerial surveys for spectacled and/or Steller's Eiders habitats should be conducted at least three years prior to the authorization of construction, if such construction is within the US Fish and Wildlife Service (USFWS) North Slope eider survey area and at least one year outside that area.

  If spectacled and/or Steller's Eiders are determined to be present within the proposed development area, the applicant shall work with the USFWS and BLM early in the design process to site roads and facilities in order to minimize impacts to nesting and brood-rearing eiders and their preferred habitats. Such consultation shall address timing restrictions and other temporary mitigating measures, location of permanent facilities, placement of fill, alteration of eider habitat, aircraft operations, and management of high noise levels.
- For yellow-billed loon habitats, aerial surveys shall be conducted by the lessee for at least three years before authorization of construction of facilities proposed for development which are within one mile of

a lake 25 acres or larger in size. Should Yellow-billed loons be present, the design and location of facilities must be such that disturbance is minimized. The default standard mitigation is a one mile buffer around all recorded nest sites and a minimum 1,625 ft buffer around the remainder of the shoreline. Development is generally prohibited within buffers unless no other option exists.

- To provide information to be used in monitoring and assessing wildlife movements during and after construction, BMP E-19 states that ArcGIS-compatible shapefiles of all new infrastructure shall provide to the BLM authorized officer within six months of construction completion. Shapefiles of proposed locations shall be provided during the planning and permitting phase. Roads may be represented as lines, but require ancillary data to denote width.
- To ensure long-term reclamation of land to its previous condition and use, BMP G-1 states that prior to final abandonment, infrastructure shall be reclaimed to ensure eventual restoration of ecosystem function. The leaseholder shall develop and implement an abandonment and reclamation plan approved by the BLM.
- To 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 cabin and campsites; the disruption of subsistence activities; and impacts to scenic and other resource values, BMP K-1 states that roads are prohibited in the streambed and adjacent to rivers listed in the ROD at setback distances specified. Essential road crossings perpendicular to the main channel will be permitted through setback areas. Refer to Figure 2-2 in this report or to pages 73 to 77 of the USDOI BLM ROD for specific river setbacks.
- To 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 deep water lakes; the loss of spawning, rearing or over wintering habitat for fish; the loss of cultural and paleontological resources; impacts to subsistence cabin and campsites; and the disruption of subsistence activities, BMP K-2 states that roads are prohibited on the lake or lakebed and within 0.25 mi of the ordinary high water mark of any deep lake as determined to be in Lake Zone III (i.e., depth greater than 13 ft; Mellor 1985).

  On a case-by-case basis in consultation with Federal, State, and NSB regulatory and resource agencies (as appropriate based on agency legal authority and jurisdictional responsibility), essential road crossings may be considered through the permitting process in these areas where the lessee can demonstrate on a site-specific basis that impacts will be minimal.

Operations and Maintenance

Following construction, the road will require ongoing operations and maintenance (O&M) during its operational life. Maintenance issues could include permafrost subsidence, gravel-surface wear, surface treatment, erosion, icing, and snow drifting. The maintenance crew will be responsible for maintaining the gravel road, bridges, and culverts, dust mitigation, and for snow plowing over approximately 60 to 70 mi of road, depending on the route[s] selected.

Typical heavy equipment at each maintenance facility could include a grader with sloper and boss plow; snow plow with belly blade; job truck with 3,500 lb crane, compressor, small fuel tank, and tools; D6 dozer; loader with 4 to 6 cy bucket and various other attachments (forks, snowblower, etc.); and tractor with various trailers (6,000-gallon tanker trailer, high deck trailer, lowboy trailer).

Some of the material sites developed during the construction phase must remain open for the O&M phase to provide material for maintenance and upgrades. For the Dalton Highway, ADOT&PF estimates that over a 50-

year period, 34,000 cy of material is needed to rehabilitate and maintain each mile of gravel road (Northern Region ADOT&PF Staff 2013).

Data Gaps

Following is a list of data gaps that will need to be filled to advance the project to the next phases of design.

- Confirm specific design vehicles, axel loads, and AADT.
- To facilitate geometric design and optimize alignment of the road, a detailed topographic survey data along the corridor(s) will be required. This data is typically acquired using a fixed-wing aircraft equipped with Light Detection and Ranging (LIDAR) equipment. The LIDAR data will be used to generate a digital 3-dimensional representation of the corridor.
- Field reconnaissance should be performed to view, evaluate, and refine potential locations for river crossings, as well as determine locations for cross-drainage culverts.
- Geotechnical reconnaissance and subsurface investigations should be performed to identify and prove up potential material sources.
- Geotechnical investigations should be performed along the preferred alignment to validate and refine terrain unit maps, and provide data to support road and bridge design.
- Hydrology data should be collected at all river crossings to support design of bridges and culverts.
- Fish monitoring data should be collected at proposed crossings for a period of three years.
- Aerial surveys for spectacled and/or Steller's eider habitats and yellow-billed loon habitats should be conducted at least three years prior to the authorization of construction.

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Technical Memorandum 7 – Vehicle Bridges

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Technical Memorandum 7 – Vehicle Bridges

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Reviewed by: Chip Courtright, PE, SE (PND Engineers, Inc.)

Date: April 2020

Overview

This memorandum details conceptual design, constructability/logistics review and estimated costs of potential bridge crossings associated with the Road Network for Utqiaġvik, Atqasuk, and Wainwright under evaluation for the Arctic Strategic Transportation and Resources (ASTAR) project. Three routes of transit are currently under evaluation as part of this study. These routes would connect the proposed road network located between Utqiaġvik and Atqasuk within the National Petroleum Reserve–Alaska (Figure TM7-1). This document is based on desktop evaluation of proposed vehicle bridge crossings and high-level concepts developed by PND Engineers, Inc. (PND) based on comparable North Slope bridge projects.

Bridge Crossing Locations

All regions under evaluation contain bridges crossing rivers and streams varying in size. The number, length and location of bridge crossings varies for each transit region under consideration. Table TM7-1 provides a description of the potential bridge crossings associated with each of the transit routes. For purposes of this memo, the Coastal Route Extension term is interchangeable with Corridor D, Middle Route with Corridor E, and Southern Route with Corridor F.

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Figure TM7-1. Proposed Corridors

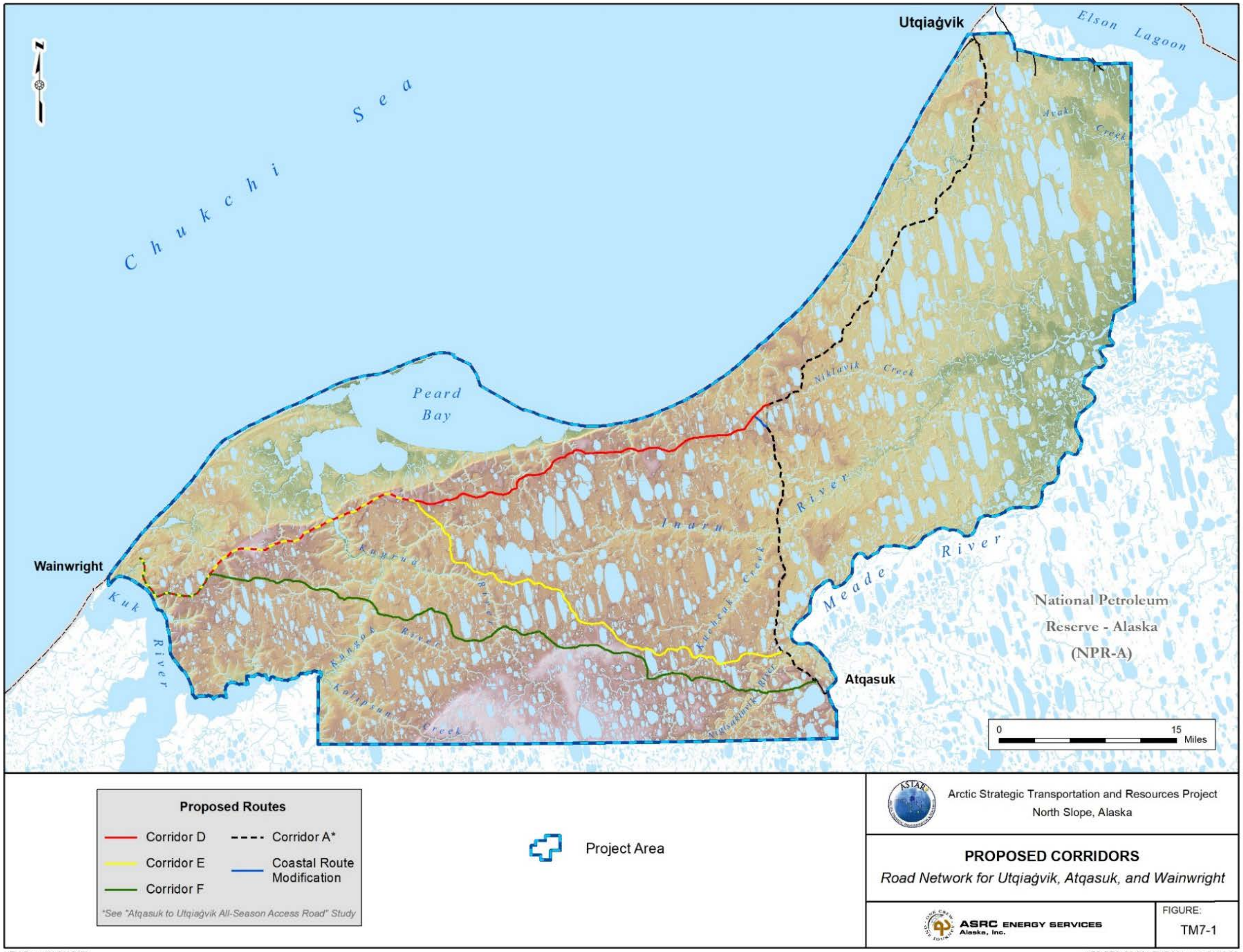

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Table TM7-1. Alternative Bridge Crossing Summary

Route	Bridge ID	Crossing Name	Est. Bridge Length (ft)	Number of Piers	Ice Breakers
Coastal – Corridor D	1.01	Kunarak Creek	40	0	No
Coastal – Corridor D	1.02	Papigak Creek	40	0	No
Coastal – Corridor D	1.03	Unnamed Crossing 1	70	0	No
Coastal – Corridor D	1.04	Unnamed Crossing 2	40	0	No
Coastal – Corridor D	1.05	Unnamed Crossing 3	60	0	No
Coastal – Corridor D	1.06	Walik Creek	60	0	No
Coastal – Corridor D	1.07	Kugrua River	1600	9	Yes
Coastal – Corridor D	1.08	Avgumun Creek	40	0	No
Coastal – Corridor D	1.09	Sinaruruk River[1]	40	0	No
Coastal – Corridor D	1.10	Unnamed Crossing 4[2]	40	0	No
Middle – Corridor E	2.01	Kucheak Creek	150	1	No
Middle – Corridor E	2.02	Unnamed Crossing 5	40	0	No
Middle – Corridor E	2.03	Unnamed Crossing 6	30	0	No
Middle – Corridor E	2.04	Unnamed Crossing 7	40	0	No
Middle – Corridor E	2.05	Unnamed Crossing 8	40	0	No
Middle – Corridor E	2.06	Kugrua River	1600	9	Yes
Middle – Corridor E	2.07	Avgumun Creek	40	0	No
Middle – Corridor E	2.08	Sinaruruk River[1]	40	0	No
Middle – Corridor E	2.09	Unnamed Crossing 9[2]	40	0	No
Southern – Corridor F	3.01	Nigisaktuvik River	400	3	No
Southern – Corridor F	3.02	Unnamed Crossing 10	40	0	No
Southern – Corridor F	3.03	Kucheak Creek	80	0	No
Southern – Corridor F	3.04	Kugrua River	80	0	No
Southern – Corridor F	3.05	Unnamed Crossing 11	60	0	No
Southern – Corridor F	3.06	Unnamed Crossing 12	300	2	No
Southern – Corridor F	3.07	Unnamed Crossing 13	40	0	No
Southern – Corridor F	3.08	Unnamed Crossing 14	45	0	No
Southern – Corridor F	3.09	Sinaruk River	60	0	No
Southern – Corridor F	3.10	Unnamed Crossing 15[2]	40	0	No

1. Crossing is shared by Corridor D (Coastal) and Corridor E (Middle) routes.
2. Crossing is shared by Corridor D (Coastal), Corridor E (Middle), and Corridor F (Southern) routes.

Design Criteria

Bridges will be designed according to the following standards:

- American Association of State Highway and Transportation Officials Load and Resistance Factor Design Bridge Design Specifications (AASHTO LFRD, Current Edition at time of design).
- Alaska Department of Transportation and Public Facilities (ADOT&PF) Preconstruction Manual.
- ADOT&PF Alaska Bridge and Structures Manual.
- ADOT&PF Highway Drainage Manual.

In addition to the requirements of the above, site-specific criteria including heavy commercial, construction and industrial live loads, and site-specific environmental loads should be considered.

Typical Section

The proposed bridge sections contain two (2) 12-foot traffic lanes with 3-foot shoulders, providing a 30-foot wide clear driving surface. Tilt-down or removable guardrails are provided on the bridges and at approaches to accommodate potential for over-width loads.

Grade and Cross Slope

Longitudinal grade is typically limited to 2 percent to ensure heavy loads can traverse the bridge under icy conditions. Bridge crown, cross slope and deck drains are provided as necessary to provide adequate drainage for site-specific rainfall intensities; however, maximum cross slope from crown is typically limited to 1 percent to accommodate heavy loads under icy conditions.

Live Loads

North Slope bridges are designed to accommodate standard AASHTO design live loads for highway bridges. In addition to these loads, a variety of standard (Strength I) and overload (Strength II) vehicles are typically accommodated in design to allow crossing by vehicles common to the North Slope. Design vehicles typically considered in design are summarized in Table TM 7-2 below.

Table TM7-2. North Slope Standard Design Vehicles

Design Vehicle	GVW (tons)	Number of Axles
HL-93 (AASHTO Standard)*	36	3
Water Truck	88	6
Euclid B-70*	115	3
Maxi Hauler*	71	5

*Design vehicles assumed for the purpose of this study

Hydrology and Hydraulics

Hydraulic characteristics of the bridges will be determined during the design process. The bridges will be designed to pass a 50-year flood, as specified in the Alaska Preconstruction Manual, for bridges not located in flood hazard areas. Scour at the bridges will be designed for the 100-year event and verified for overall stability under a 500-year event. Additionally, the bridges will be designed to ensure backwater does not exceed 6 inches under a 100-year-flood.

Additional information regarding site hydrology and hydraulics is provided in the ASTAR Road Network for Utqiaġvik, Atqasuk, and Wainwright Technical Memorandum 3 – River Hydrology.

Low Chord Clearance

Rivers designated as navigable waterways will require adequate clearance for summer and winter navigation. The U.S. Coast Guard will stipulate navigation requirements; however, it is anticipated that at least 20 feet (ft) of clearance will be required between the bridge low chord and summer water levels. Navigation channel minimum width requirements are also anticipated. Based on recent experience, a navigation channel of at least 120 ft will likely be required.

Additionally, the low chord of the bridge must be high enough to ensure that ice cannot impact the superstructure. Ice jamming characteristics, as well as ice interaction with the bridge piers, must be considered to ensure adequate low chord clearance is provided to avoid ice impact to the superstructure.

Ice Loads

Ice criteria will be established by the requirements of AASHTO and site-specific studies. Loads due to ice impact on the in-stream piers of the crossings will likely control lateral design of the structures. Ice failure through bending imparts lighter horizontal forces into bridge piers than ice crushing. Ice bending strength is also less variable than ice crushing strength and does not vary significantly with temperature. Therefore, bridge piers should be designed to fail ice floes in bending wherever possible utilizing angled ice breaking piers (see Figure TM7-2).

Smaller crossings will experience ice loads significantly lower than the major crossings. This is due to water depth limitations for formation of significant ice floes. It is assumed that piers for the smaller crossings will resist ice forces through crushing on vertically oriented pier piles due to the limited potential ice loads at these sites.

Seismic Loads

Seismic loads will be as specified by AASHTO; however, seismic loads are not anticipated to control design due to the minimal seismicity of the region.

Geotechnical Conditions

Experience on recent North Slope bridge construction provides a general idea of the potential geotechnical conditions anticipated within the rivers and flood plains. Pile embedment for bridges in these sites often exceeds 70 ft and is highly dependent on the site soil conditions. It is likely that intermittent and discontinuous layers of free water and thawed soils could be encountered, especially near the river banks, complicating pile installation methods.

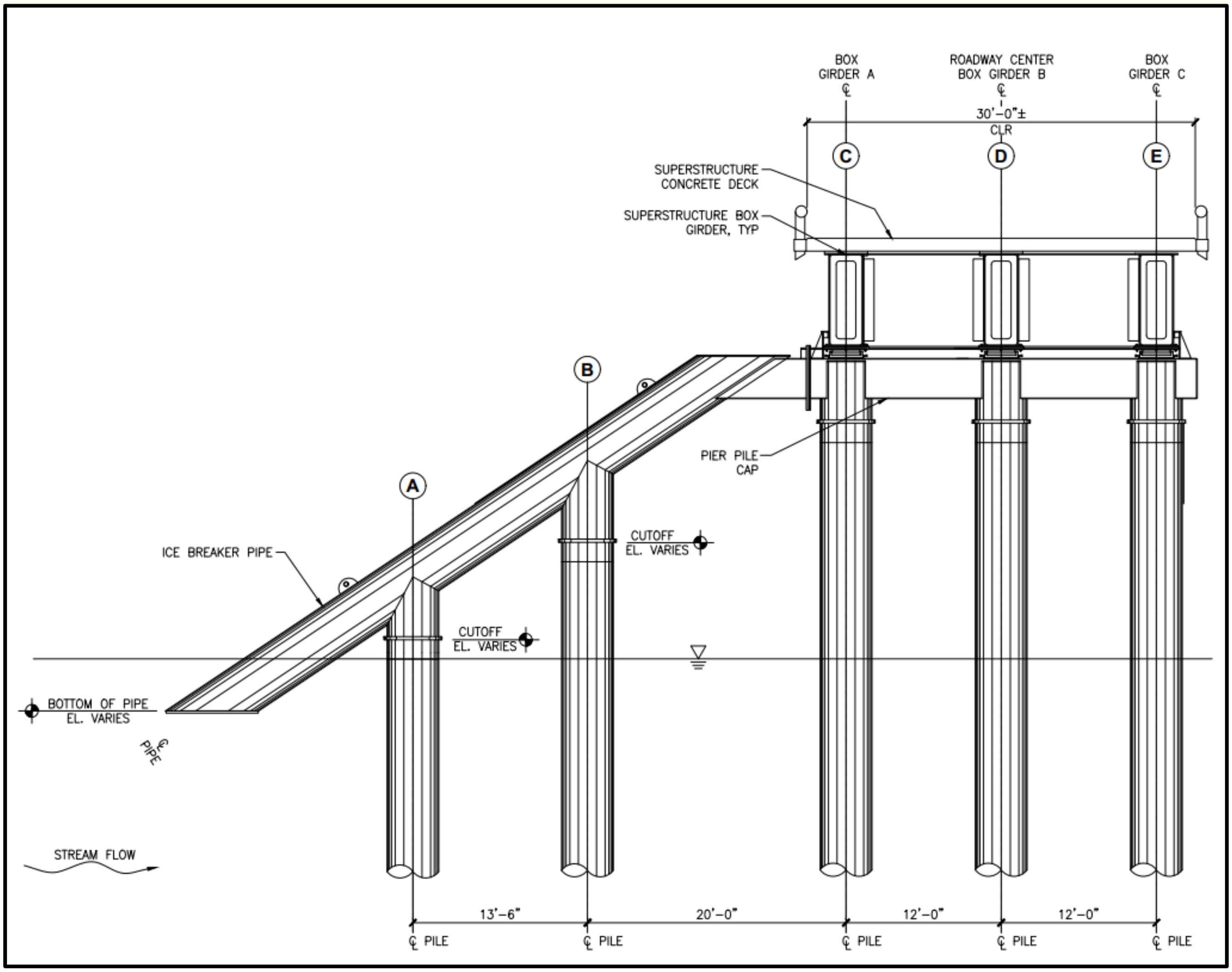
Conceptual Designs

The proposed bridge concepts consist of a steel superstructure with precast concrete deck supported by steel pipe pile foundations. Bridge abutments are constructed of steel sheet pile and include vertical support piles and concrete backwalls. Similar designs have been successfully utilized at numerous North Slope bridge crossings, including the recently constructed bridge crossing the Nigliq Channel of the Colville River. Bridge components will be prefabricated where possible in order to minimize in-field construction labor.

Large River Crossings

The superstructure of larger crossings (greater than 500 ft) consist of fabricated box girders with precast, prestressed concrete deck panels. The bridge piers are constructed with steel pipe pile and include pile-supported inclined ice breaking structures and with steel pier caps. In-stream pier piles are assumed to be predominately driven; however, near-shore piles will likely be installed with drill-and-slurry methods. Preliminary pier spacing is estimated at approximately 180 ft. See Figure TM7-2 below for a conceptual cross section of the bridge.

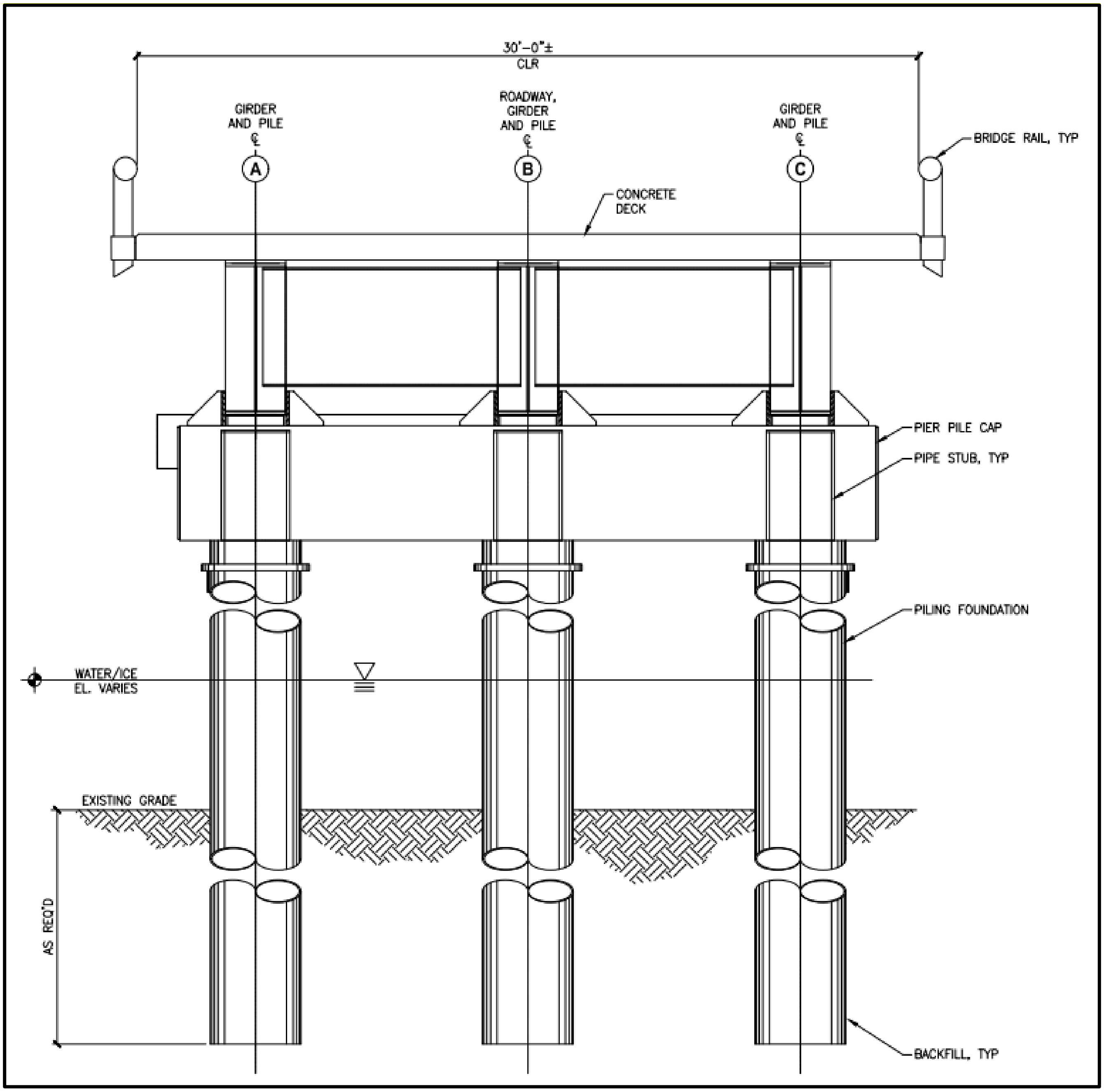
Figure TM7-2. Large Bridge Conceptual Cross Section



Intermediate and Smaller Crossings

Crossings with bridge lengths less than 500 ft consist of an I-girder superstructure with precast, prestressed concrete deck panels. Piers will likely be constructed with steel pipe installed with drill-and-slurry methods and steel pile caps. Site geotechnical conditions will dictate if pipe piles must be driven. Preliminary pier spacing is estimated at approximately 110 ft. See Figure TM7-3 below for a conceptual cross section for intermediate and smaller bridges.

Figure TM7-3. Intermediate and Small Bridge Conceptual Cross Section



Construction

Construction of the proposed bridges will occur on a seasonal basis over a multiple-year period. Construction windows are anticipated to be limited to a three-month winter period generally between mid-January and mid-April when access to the bridge locations is available using seasonal ice roads.

Construction of on-tundra ice roads required for project access will begin pending receipt of approval from the Alaska Department of Natural Resources for on-tundra access (estimated mid-January). Early season pre-packing of snow for the on-tundra ice roads will be used to allow earlier (mid-December) approval for tundra access. For the purposes of this report, ice roads are assumed to be in usable condition by January 15 and to remain usable until April 15.

Various ice pads will be required throughout the construction process. Large staging pads will be required near the bridge locations for storage of materials and equipment. Thickened ice will also be required at the areas adjacent to the bridges for equipment access.

Temporary infrastructure will be required during the construction of the river crossings. This includes remote housing for the workers, materials/equipment staging areas, site offices, sanitation facilities, fuel storage, and other infrastructure require to support construction efforts.

Pier Installation

Pier piles will be installed approximately 80 to 100 ft below grade and will be finished with a pier cap welded to the top of the piles. Where river ice does not naturally ground in the winter time, piles will be installed through holes cut in the ice. In these areas, the soils will likely be thawed and piles will be installed using a combination of vibratory and impact pile driving methods. Where river ice naturally grounds in the winter time, or where piles are installed near the edges of the river, it is likely that permafrost will be encountered. Where permafrost exists, piles will be adfreeze piles installed by means of drill and slurry methods. Holes will be drilled into the ground to the specified depth followed by setting of the pile. The pile will be secured using a sand and water slurry that is poured into the annulus between the pile and the drilled shaft. The slurry mixture will freeze due to the temperature of the surrounding permafrost and secure the pile in place.

It is likely that discontinuous permafrost will be encountered within the river channels, most likely near river banks. Where discontinuous permafrost is encountered, the drill and slurry method will be utilized to install the pile. If water is present, a casing will be installed to prevent water intrusion into the drilled shaft. If fully thawed conditions are encountered, conventional driven pile techniques would be utilized. A geotechnical investigation at the selected site is critically important to understand, design for, and anticipate construction techniques needed to address subsurface conditions.

Pier caps and the inclined ice breaking structure will be welded to the piles upon completion of pile installation. The caps and ice breakers will be supplied in prefabricated assemblies that are welded directly to the piles.

Sheet Pile Installation

Sheet pile will be used to construct the bridge abutments and retain the fill that comprises the approach to the bridge. Sheet pile will be installed by means of vibratory pile driving. Abutments will be installed on the edge of the river bank and will require steam-thawing the permafrost ground before the sheet pile can be installed.

Steel Superstructure Installation

Steel girders will be provided in prefabricated segments ranging from 50 ft to over 100 ft in length. The girder sections will be shipped to the site using conventional trucking and, in the case of long-span sections, heavy-haul trucking. Girder sections are typically ground spliced and lifted in large span segments with multi-crane picks. Alternatively, individual girder segments can be supported on temporary falsework installed on the river ice and then spliced in-air, allowing for picking and setting of the girders without multiple cranes. Launching of the preassembled bridge superstructure, including both girder sections and decking, is an alternative method of installation for large-span bridges. This method was used recently on the Nigliq Channel Bridge in order to minimize in-air splices, time spent working at heights, and equipment time on the river ice.

Concrete Deck Installation

The concrete deck panels will be set and grouted to the steel superstructure, allowing composite action between the girders and deck. The deck panels are shimmed to level during setting. Grouting operations will occur in a tented structure that is incrementally placed along the span length, allowing installation and curing to occur in a controlled environment.

Cost Estimates

Preliminary rough order of magnitude (ROM) cost estimates were prepared for this project using unit metrics compiled by PND over numerous North Slope bridge projects. The accuracy of the estimates provided is assumed to be +100 percent, -50 percent based on the current schematic level of design (Association for the Advancement of Cost Engineering 2019). The following estimates are inclusive of total-installed-cost (TIC) directly related to the bridge construction and select indirect costs. The cost categories provided are as follows:

- <u>Abutment Cost</u>: Inclusive of sheet pile abutments, precast concrete backwalls, abutment piers with deep driven pile foundations. Larger rivers include sheet pile wing walls to better protect the abutment.
- <u>Pier Cost</u>: Inclusive of driven or adfreeze deep pile foundations and steel pile caps. Larger rivers will also need ice breakers installed, which consist of two driven piles and an angled section in the direction of flow to bend and break large sheets of ice.
- <u>Superstructure Cost</u>: Inclusive of the steel girders (box section or built up I girders), concrete decking (30-foot-wide driving surface), and removable guardrails to accommodate wide vehicles.
- <u>Indirect Costs</u>: The indirect costs provided are comprised of construction administration, quality assurance/quality control (QA/QC) services, support labor and equipment, fueling and maintenance, personnel lodging, meals and airfare.

Man-day estimations have been provided for each bridge and include direct construction personnel as well as indirect support staff. Work is assumed to occur over double 12-hour shifts for the duration of the winter construction season. Costs associated with design, permitting, ice roads and pads, gravel road construction, multi-seasonal construction, fuel, equipment overwintering or stranding, contractor pre-planning, and mobilization and demobilization, are not included in the estimates. All prices are in 2020 US dollars based on conceptual level design.

The TIC ROM estimates for bridges associated with the Corridors D, E, and F are provided below in Tables TM7-3 through TM7-5.

Table TM7-3. Corridor D ROM Bridge Costs

Bridge ID	Bridge Length (ft)	Est. Man-Days	Abutment Cost	Pier Cost	Superstructure Cost	Indirect Cost	TIC Estimate
1.01	40	1280	$2,400,000	$0	$1,000,000	$2,368,000	$5,768,000
1.02	40	1280	$2,400,000	$0	$1,000,000	$2,368,000	$5,768,000
1.03	70	1580	$2,400,000	$0	$1,750,000	$2,923,000	$7,073,000
1.04	40	1280	$2,400,000	$0	$1,000,000	$2,368,000	$5,768,000
1.05	60	1480	$2,400,000	$0	$1,500,000	$2,738,000	$6,638,000
1.06	60	1480	$2,400,000	$0	$1,500,000	$2,738,000	$6,638,000
1.07	1600	11680	$5,000,000	$18,000,000	$24,000,000	$21,608,000	$68,608,000
1.08	40	1280	$2,400,000	$0	$1,000,000	$2,368,000	$5,768,000
1.09	40	1280	$2,400,000	$0	$1,000,000	$2,368,000	$5,768,000
1.10	40	1280	$2,400,000	$0	$1,000,000	$2,368,000	$5,768,000
Corridor D TIC ROM Bridge Estimate							$123,565,000

Table TM7-4. Corridor E ROM Bridge Costs

Bridge ID	Bridge Length (ft)	Est. Man-Days	Abutment Cost	Pier Cost	Superstructure Cost	Indirect Cost	TIC Estimate
2.01	150	1650	$2,400,000	$700,000	$2,250,000	$3,053,000	$8,403,000
2.02	40	1280	$2,400,000	$0	$1,000,000	$2,368,000	$5,768,000
2.03	30	1180	$2,400,000	$0	$750,000	$2,183,000	$5,333,000
2.04	40	1280	$2,400,000	$0	$1,000,000	$2,368,000	$5,768,000
2.05	40	1280	$2,400,000	$0	$1,000,000	$2,368,000	$5,768,000
2.06	1600	11680	$5,000,000	$18,000,000	$24,000,000	$21,608,000	$68,608,000
2.07	40	1280	$2,400,000	$0	$1,000,000	$2,368,000	$5,768,000
2.08	40	1280	$2,400,000	$0	$1,000,000	$2,368,000	$5,768,000
2.09	40	1280	$2,400,000	$0	$1,000,000	$2,368,000	$5,768,000
Corridor E TIC ROM Bridge Estimate							$116,952,000

Table TM7-5. Corridor F ROM Bridge Costs

Bridge ID	Bridge Length (ft)	Est. Man-Days	Abutment Cost	Pier Cost	Superstructure Cost	Indirect Cost	TIC Estimate
3.01	400	3010	$2,400,000	$2,100,000	$6,000,000	$5,569,000	$16,069,000
3.02	40	1280	$2,400,000	$0	$1,000,000	$2,368,000	$5,768,000
3.03	80	1680	$2,400,000	$0	$2,000,000	$3,108,000	$7,508,000
3.04	80	1680	$2,400,000	$0	$2,000,000	$3,108,000	$7,508,000
3.05	60	1480	$2,400,000	$0	$1,500,000	$2,738,000	$6,638,000
3.06	300	2420	$2,400,000	$1,400,000	$4,500,000	$4,477,000	$12,777,000
3.07	40	1280	$2,400,000	$0	$1,000,000	$2,368,000	$5,768,000
3.08	45	1330	$2,400,000	$0	$1,125,000	$2,461,000	$5,986,000
3.09	60	1480	$2,400,000	$0	$1,500,000	$2,738,000	$6,638,000
3.10	40	1280	$2,400,000	$0	$1,000,000	$2,368,000	$5,768,000
Corridor F TIC ROM Bridge Estimate							$80,428,000

Schedule

Based on previous North Slope bridge projects, bridges at crossings with a length less than 500 ft are likely constructible in a single winter construction season. Larger bridges with multiple in-stream piers and ice breaking structures will require construction over multiple seasons. This is primarily due to the duration required for installation of the ice breaking piers. Anticipated durations, provided in years/winter construction seasons for various bridge lengths are provided in Table TM7-6 below.

Table TM7-6. Bridge Seasonal Construction Duration by Bridge Length

Bridge Length (ft)	Years / Number of Seasons
<500	1
500 to 2,000	2

The overall duration required for installation of all bridges associated with the corridors will vary depending on the number of individual prime contractors performing the work. Based on the large potential scope of the project, it is anticipated that multiple prime contractors would be commissioned to install the bridges. Based on previous North Slope bridge projects, a reasonable assumption is that a single contractor can effectively manage and work on up to two bridges simultaneously.

Potential Challenges

The following general challenges are anticipated with the bridge crossings.

Geotechnical Conditions

Geotechnical conditions for the larger bridge crossings are anticipated to vary across the length of the crossing. Recent challenges on the bridge crossing the Nigliq Channel Bridge included areas of discontinuous permafrost, in-situ materials with high salinity, and free water that required planning and implementation of multiple methods for installation of the bridge pier piles. The methods of installation included conventionally driven/thermally modified piles, adfreeze piles, and grouted piles (Anderson 2017). A site-specific geotechnical investigation with boreholes located at each pier will be required to accurately identify in-situ geotechnical conditions and thermal state of the material.

Manpower and Equipment Availability

The availability of personnel, equipment and housing is a consistent challenge for large North Slope projects. This can be further complicated if competing oil and gas infrastructure projects occur concurrently during the duration of the planned project. Implementation of projects on the North Slope is often constrained by the availability of manpower, housing and equipment, resulting in the project schedule being delayed or tailored to fit within available resources.

Fuel

The availability, storage and logistics associated with sourcing fuel is a significant challenge for remote North Slope projects. North Slope fuel supplies are limited and will likely not be able to accommodate direct sourcing of all fuel required. Adequate planning and staging of temporary fuel storage locations and importing of fuel during the winter construction season will be required. Preliminary estimates of fuel usage for the bridge construction and associated indirect operations are listed in Table TM7-7.

Table TM7-7. Preliminary Fuel Estimates

Study Area	Consumption (Gallons)
Coastal Extension – **Corridor D**	920,000
Middle Route – **Corridor E**	910,000
Southern Route – **Corridor F**	520,000

If road construction activities occur concurrently with bridge constructions, the overall fuel demand will increase significantly. Remote areas of the project will require temporary fuel storage with associated containment in order to adequately service peak demands during construction.

Weather Delays

The unpredictable nature of weather conditions on the North Slope often lead to schedule delays. The provided cost estimates do not include contingent costs for delays due to weather or shipping complications.

Logistics and Transportation

The shipping and storage of materials and careful selection of transportation strategies and techniques can be pivotal in construction of remote North Slope projects. The remote coastal villages of Wainwright and Utqiavik are serviced by air and barge only. Barge transportation of materials is further limited by short open-water seasons and an underdeveloped marine infrastructure. There are no port facilities and barge offloading is generally by beach landing. An evaluation and feasibility study of current barge capabilities at Wainwright and Utqiaġvik should be conducted to verify they can meet anticipated barge demands of this project. Cost estimates assume there is suitable site access from either end of the route.

Storing materials at the bridge sites through the summer and fall can be achieved using multi-season ice pads that are designed to maintain the integrity of the ice through the summer season, which can extend the construction durations in subsequent seasons by avoiding the need for an access ice road directly to the site before commencing seasonal operations.

Data Gaps

The following is a list of data gaps that will need to be filled as the project progresses to the next phases:

- Site geotechnical investigations to determine in-situ conditions at the proposed crossings and to identify potential gravel mining sources.
- Evaluation of current port/offload facilities at coastal villages to determine viability of meeting anticipated project barging demands.
- Site survey and bathymetry at crossing locations.
- River and stream hydrology.
- Preliminary engineering.

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Technical Memorandum 8 – Cultural Resources

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Technical Memorandum 8 – Cultural Resources

Prepared by: Ranna Wells, Archaeologist, MA, RPA

Reviewed by: Shannon Mason, Environmental Scientist

Date: April 2020

Overview

The purpose of this memorandum is to provide an inventory and assessment of cultural resources within and near the project area that could potentially be affected by project activities. Prior to ground-disturbing activity, a permittee must assess whether there are known cultural resources present, evaluate potential impacts to cultural resources, and maintain communication with the lead federal permitting agency and the Alaska State Historic Preservation Office (SHPO).

Cultural resources of concern in this report are those that may have historical and/or traditional value. They are physical resources associated with people, a society, or multiple societies. They consist of both built and natural parts of the physical environment and have some cultural value to one or more sociocultural groups (King 1998). Cultural resources exhibiting evidence of past human activity include sites, features, or artifacts.

Historic Properties are a special subset of cultural resources. A Historic Property is a cultural resource, generally 50 years of age or older, included in or eligible for inclusion in the National Register of Historic Places (National Register). A Historic Property may be a prehistoric or historic district, site, building, structure, or object. The term includes properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization. In order to qualify as a historic property, a cultural resource must meet one or more of the National Register criteria (36 Code of Federal Regulations [CFR] 800; National Park Service [NPS] 2002). These criteria are:

- Criterion A: Association with one or more important historic events.
- Criterion B: Association with a person or people who are historically significant. The property illustrates the person's or people's importance or important achievements.
- Criterion C: Association with historically significant design, craftsmanship, or construction.
- Criterion D: Potential to provide information to answer important research questions regarding the understanding of the past (NPS 2002).

Regulatory Background

The proposed project has potential to affect Historic Properties such as historic structures, archaeological sites, historic and prehistoric districts, Traditional Cultural Properties, or traditional land use areas. Federal, state, and North Slope Borough (NSB) ordinances, laws, and policies are in place to protect Historic Properties on the North Slope (Table TM8-1).

Table TM8-1. Management of Cultural and Historic Resources

Government Level	Scope	Applicable Laws, Policies, and Ordinances
Federal	Federal Undertaking	National Historic Preservation Act, Section 106 National Environmental Policy Act Archaeological Resource Protection Act Antiquities Act of 1906 Native American Graves Protection and Repatriation Act
State, Alaska OHA, Department of Natural Resources	State Undertaking	Alaska Historic Preservation Act (AS 41.35) Alaska Administrative Code (11 AAC 16)
North Slope Borough	Borough	NSBMC § 19.50.030(F) and § 19.60.040(K)

AAC = Alaska Administrative Code
AS = Alaska Statute
NSBMC = North Slope Borough Municipal Code
OHA = Office of History and Archaeology

The primary laws/policies relevant to the proposed project include Section 106 of the National Historic Preservation Act (Section 106), the Alaska Historic Preservation Act (AHPA), and the NSB Iñupiat History, Language, and Culture Division’s (IHLC) Traditional Land Use Inventory (TLUI) clearance process. Since federally managed lands fall within the study area (National Petroleum Reserve–Alaska [NPR-A]), the Native American Graves Protection and Repatriation Act (NAGPRA) will apply. The list below is a synopsis of each applicable policy and how it relates to the proposed project:

Section 106 mandates evaluation of adverse effects to Historic Properties resulting from any activity requiring a federal permit, receiving federal funding, or conducted on federally managed lands.

The NAGPRA of 1990 establishes a process in which museums and federal agencies return certain Native American cultural items to lineal descendants, Indian tribes, and Native Hawaiian organizations. These cultural items may include human remains, funerary objects, sacred objects, and objects of cultural patrimony. NAGPRA applies to federal and tribal lands.

The AHPA protects cultural resources on state land by ensuring those resources that may be adversely affected are properly documented and that any mitigation measures (if necessary) are conducted in a timely and expeditious manner. The state’s process essentially mirrors Section 106. The AHPA is initiated by state undertakings.

The IHLC has standardized procedures for protecting traditional activities and historical, archaeological, and traditional cultural values. This includes the completion of two forms: Form 500 – Certificate of IHLC/TLUI Clearance Application and Form 600 – IHLC Resource Request Application (NSB 2017).

Due to federal permitting requirements, the proposed project will likely fall under the purview of Section 106, which states any federal undertaking must take into consideration its impacts to Historic Properties. A federal undertaking includes projects occurring on federal lands, requiring a permit from a federal agency, or obtaining funding from a federal source. Section 106 mandates evaluation of adverse effects to historic properties resulting from any activity requiring a federal permit, receiving federal funding, or conducted on federally managed lands.

The proposed project will also be permitted by NSB. The project therefore falls under the purview of Title 19 of the North Slope Borough Municipal Code (NSBMC), which states, “development must not disturb traditional subsistence activities or values at historic, archaeological and cultural sites” (NSBMC 19.50.030[F] and

19.60.040[K]). The NSB IHLC has standardized procedures for protecting traditional activities and historical, archaeological, and traditional cultural values. This includes the completion of two forms: Form 500 – Certificate of IHLC/TLUI Clearance Application and Form 600 – IHLC Resource Request Application (NSB 2017).

Cultural Resource Sites

The following is a summary of data available for cultural resource sites and surveys within and near the project area. The summary includes a description of specific databases available for review and a discussion of the types of sites and surveys found within or near the project area.

For purposes of this desktop study, AES Alaska reviewed the Alaska Heritage Resource Survey (AHRS) database, maintained by the State of Alaska, Office of History and Archaeology (OHA), and the TLUI for previous cultural resource research and relevant literature for the project area. The information below is only as complete as the data that are publicly available, as some reports in the AHRS database have been labelled as “restricted” and are therefore not available for review.

Both the State of Alaska and the NSB maintain records on cultural resources. The AHRS is a long-term database of prehistoric, historic, and modern cultural resources (archaeological sites, buildings, structures, objects or locations, etc.) and some paleontological sites (OHA 2019).

A review of the AHRS database in March 2020 revealed 101 sites within the project area, ten of which are within road corridors (Figure TM8-1 and Table TM8-2). The Coastal Route, Corridor A between Utqiaġvik and Atqasuk, has one site within its corridor (XMR-00055). The other routes, the Coastal Route Extension, the Middle Route, and the Southern Route--Corridors D, E, and F, respectively--all have the same nine sites within their road corridors (WAI-00082, WAI-00083, WAI-00084, WAI-00085, WAI-00123, WAI-00125, WAI-00126, WAI-00127, WAI-00128).

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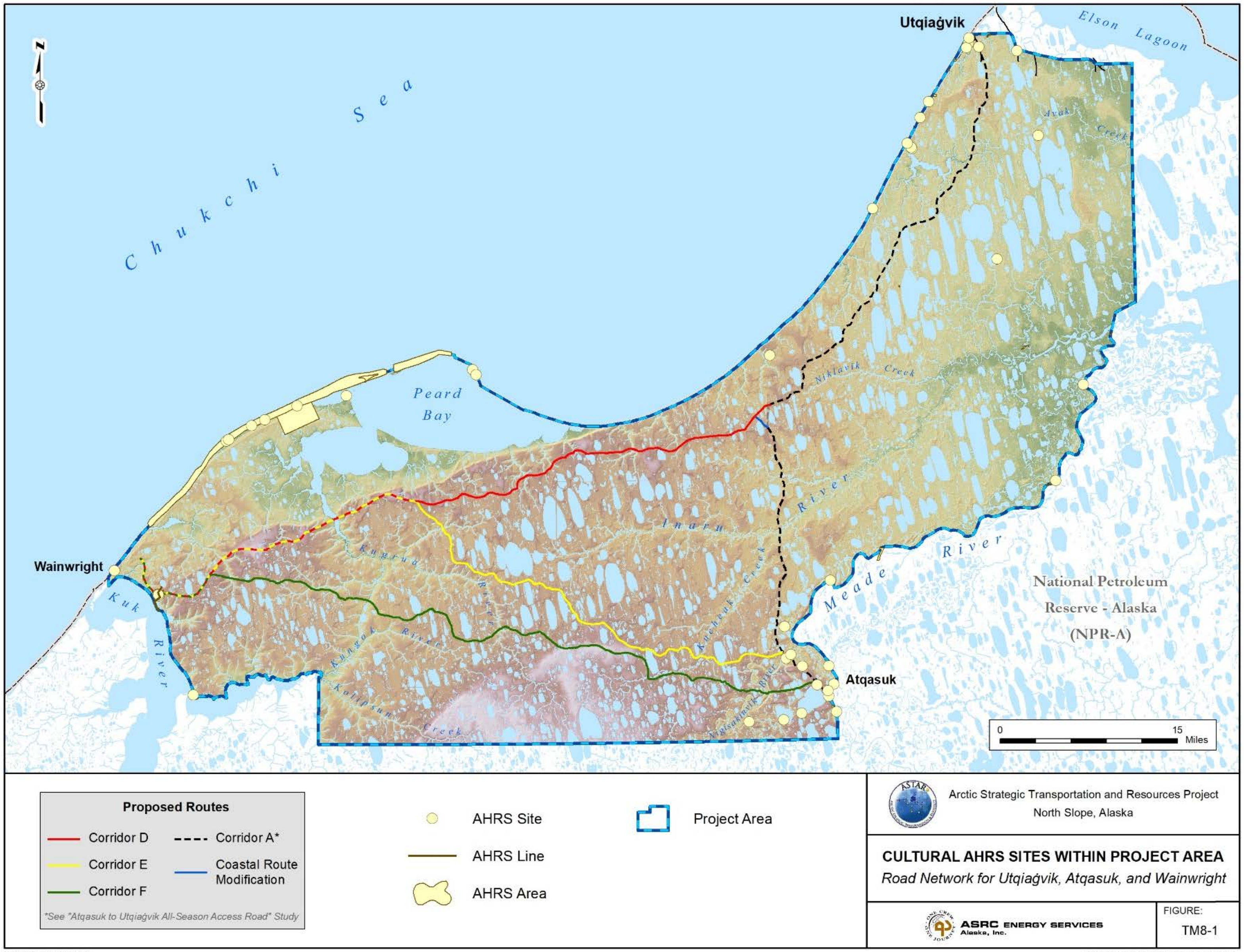
Utqiaġvik
Elson Lagoon
Chukchi Sea
Peard Bay
Wainwright
Atqasuk
Kuk River
Meade River
Inaru River
National Petroleum Reserve - Alaska (NPR-A)
0 15 Miles
Proposed Routes
Corridor D
Corridor E
Corridor F
Corridor A*
Coastal Route Modification
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
AHRS Site
AHRS Line
AHRS Area
Project Area
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
CULTURAL AHRS SITES WITHIN PROJECT AREA
Road Network for Utqiaġvik, Atqasuk, and Wainwright
ASRC ENERGY SERVICES Alaska, Inc.
FIGURE:
TM8-1
UTM Zone 4N (NAD83)
AES-RTS: 20-001-TM8-001.mxd, 03/26/20

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Table TM8-2. AHRS Sites within the Project Area

AHRS Number	Name	Site Description	Time Period	National Register Status
BAR-00003	Kugusugaruk Site	A Birnirk culture site containing burials, in six mounds, and six houses on tundra knolls.	Prehistoric	Eligible
BAR-00005	Rogers-Post Site	Two monuments where Will Rogers and Wiley Post were killed in a plane crash on 8/15/1935.	Historic	Listed
BAR-00010	Napawrax	Iñupiat summer village. Also called "Nunaktuau."	Prehistoric/ Historic	n/a
BAR-00013	Walakpa Site (Ualiqpaa)	Deeply stratified historic village site with prehistoric component.	Prehistoric/ Historic	Eligible
BAR-00014	Coffin Site	Site with assemblage representing a late Denbigh transitional into Choris.	Prehistoric	n/a
BAR-00037	North Nunavak	Ford reported briefly on a number of burials excavated here by Hopson in 1929.	Prehistoric	n/a
BAR-00038	South Nunavak	Burials excavated here by Hopson in 1929. Most of the features are on the south side of the lagoon.	Prehistoric	n/a
BAR-00039	BAR-00039	Human skeletal remains (40–50 individuals). The concentration is from a reburial in 1925.	Prehistoric/ Historic	n/a
BAR-00040	BAR-00040	Four distinct burial areas on the east shore of the lagoon.	Prehistoric/ Historic	n/a
BAR-00042	Location One, Reburial Site	No description provided in the Alaska Heritage Resource Survey (AHRS).	n/a	n/a
BAR-00043	Location Two, Reburial Site	No description provided in the AHRS.	n/a	n/a
BAR-00044	“Hollywood” Reburial Site	No description provided in the AHRS.	n/a	n/a
BAR-00087	Grave Site	Grave site	Historic	n/a
BAR-00091	Kahroak Site	Projectile points and other lithic artifacts.	Prehistoric	n/a
BAR-00097	BAR-00097	Square housepit was observed from the air.	Prehistoric	n/a
BAR-00120	BAR-00120	Camp area containing two can dumps, an old bucket, and other historic debris.	Historic	Not Eligible
BAR-00130	South Barrow Test Well 2	Well housed inside a constructed wooden box on a concrete well cellar.	n/a	Eligible
BAR-00131	South Barrow West Well 3	A well with associated scattered surface debris. The U.S. Navy drilled the well in 1949.	Historic	Eligible
WAI-00001	Nunagiak	Thirteen mounds arranged on an old beach line on the barrier beach at Point Belcher.	Prehistoric/ Historic	n/a
WAI-00004	Atanik Site	Former Iñupiat village recorded on British Admiralty Chart 593 (1827–1855) as "Attanak," by Zagoskin in 1847 as "Atinikq," and listed in the 1890 Census as having a population of 34.	Prehistoric/ Historic	Contributing property within a Listed property.
WAI-00009	Atanik District	Sixteen house outlines are visible. Two of seven are in good repair.	Prehistoric/ Historic	Listed

AHRS Number	Name	Site Description	Time Period	National Register Status
WAI-00082*	LIZ-3	Auxiliary station of the Distant Early Warning (DEW) line.	Historic	Eligible
WAI-00083*	Gravel Structures/ Wainwright Long Range Radar System (LRRS) Road System	The road system at Wainwright Short Range Radar Site (SRRS) are 12 feet (ft) and cover 23,000 ft. The roadbed is raised about 5.5 ft above the surrounding elevation.	Historic	Eligible
WAI-00084*	Gravel Structures/ Wainwright LRRS Airfield	The Wainwright airfield is built up with gravel to provide insulation.	Historic	Eligible
WAI-00085*	Gravel Structures/ Wainwright LRRS Gravel Pad System	The Wainwright SRRS gravel pad system covers approximately 782,500 square (sq.) ft and was meant to provide dry frozen ground beneath site facilities.	Historic	Eligible
WAI-00095	Siraagruk	17 dwellings and ice cellars on a stabilized dune field	Historic	n/a
WAI-00096	Pingasagruk Site	House pits, some of whale bone construction, and possible cache pits along the spit.	Prehistoric/ Historic	Eligible
WAI-000123*	Building 1, ACW/DEW Operations/ Wainwright LRRS Facilities	Building 1 was built in 1957 to provide both radar facilities and living quarters. The geodesic radar dome extends above the rectangular structure and is supported by a square platform.	Historic	Eligible
WAI-00124	Building 2, Vehicle Maintenance Shop/Wainwright LRRS Facilities	Building 2, the Vehicle Maintenance Shop, was built in 1957 to provide heated facilities for the base vehicles.	Historic	Eligible
WAI-00125*	Building 3, Supply and Equipment Warehouse/ Wainwright LRRS Facilities	Building 3 was built in 1957 as a warehouse but has since been deactivated.	Historic	Eligible
WAI-00126*	Building 3001, Supply & Equipment Shed/ Wainwright LRRS Facilities	Building 3001 was built in 1957 as a supply and equipment shed. This 96 sq ft building has a rectangular plan.	Historic	Eligible
WAI-00127*	Building 3009, Supply & Equipment Shed/ Wainwright LRRS Facilities	Building 3009, a small 384 sq ft one story building, was built in 1985 to house the site's emergency generator. It is a metal skid-mounted structure supported by one layer of timber.	Modern	Not Eligible
WAI-00128*	Building 3021, Supply & Equipment Shed/ Wainwright LRRS Facilities	Built in 1985 for storage space, Building 3021 has a total area of 1,008 sq ft and has a typical Quonset hut style. The building has a steel frame covered with galvanized siding and a roll-up door on one end.	Modern	Not Eligible

AHRS Number	Name	Site Description	Time Period	National Register Status
WAI-00130	1871 Whaling Fleet Remains	Wood and metal remains of the fleet boats of the 1871 whaling fleet	Historic	n/a
WAI-00131	John Kelly's Commercial Whaling And Trading Station	The commercial whaler John Kelly had a shore whaling and trading station at this location 1891-1892.	Historic	n/a
WAI-00132	Kugalukruak	Jerome Lopes' house.	Historic/Modern	n/a
WAI-00134	Wainwright FSRC	Two buildings (completed in 1960 and 1992), a shipping container, and a small metal boat.	Historic/ Modern	n/a
WAI-00135	Siisragruk	Site consists of four sod house ruins and other features.	Historic/ Modern	n/a
WAI-00136	Asiniak Point, Ahsiatchiak	A place where seals were hunted.	Prehistoric	n/a
XMR-00001	Attenok	Former Iñupiat village reported as "Attenokamiut" in the 11th Census of 1890.	Historic	n/a
XMR-00002	Charnrokruit	Former Iñupiat camp or settlement listed with a population of 162 in the 1890 Census.	Historic	n/a
XMR-00003	XMR-00003	At least two lithic components are present on a terrace of Meade River.	Prehistoric/ Historic	n/a
XMR-00007	XMR-00007	Five pieces of heat-fractured cobbles and one flaked nodule of chalcedony were located within a 1.5 meter x 9 meter blowout area on a high terrace 130 meters west of the present river bluff.	Prehistoric	n/a
XMR-00010	XMR-00010	Deep cache pit, with caribou bone both within and scattered about it.	Historic	n/a
XMR-00012	XMR-00012	Deep cache pit, with caribou skulls both within and outside it.	Historic	n/a
XMR-00034	XMR-00034	A rectangular house pit, a hearth, a single flake, pottery, and a possible cache.	Prehistoric	n/a
XMR-00035	XMR-00035	Deep cache pit.	Historic	n/a
XMR-00036	XMR-00036	The remains of a historic tent camp.	Historic	Not Eligible
XMR-00037	XMR-00037	A scatter of fifteen flakes.	Prehistoric	n/a
XMR-00039	XMR-00039	Two dark grey lithic flakes.	Prehistoric	n/a
XMR-00041	XMR-00041	An extensive site with 43 house pits. The site has been disturbed by vandalism.	Prehistoric/ Historic	n/a
XMR-00042	Tikigluk	The old village of Tikigluq, or Meade River Village.	Historic	n/a
XMR-00071	Qaglugruaq	House pits and cellars with evidence of recent camping, and historic debris.	Prehistoric/ Historic	n/a
XMR-00072	Aatut North	21 major archaeological features (many are old houses) and evidence of recent use.	Prehistoric/ Historic	n/a
XMR-00074	Qaviarat	Numerous house pits and ice cellars were located on high, well-drained tundra.	Prehistoric/ Historic	n/a

AHRS Number	Name	Site Description	Time Period	National Register Status
XMR-00076	Payugvik	Twenty-six house ruins, storage pits, and a modern cabin. Artifacts eroding out of the river bank.	Prehistoric/ Historic	n/a
XMR-00077	Pulayaaq	Sod house ruins, associated features, historic artifacts, and a human burial.	Prehistoric/ Historic	n/a
XMR-00079	Iviksuk	House ruins and associated features, camp	Historic	n/a
XMR-00082	Meade River Coal Mine	No AHRS Description	Historic	Eligible
XMR-00083	1871 Whaling Fleet Remains	Wood and metal remains of the fleet boats of the 1871 whaling fleet are scattered for more than 30 miles.	Historic	n/a
XMR-00084	Kilusiktok	Visible scatter of 20th century to modern camp debris, cartridges, etc. and a prehistoric component.	Prehistoric/ Historic	n/a
XMR-00089	Skull Cliff Core Test 1	The U.S. Navy drilled the core test 779 ft deep in 1947.	Historic	Eligible
XMR-00095	XMR-00095	A large stake on a sand dune shaped with an axe or hatchet. Possible grave marker.	Historic	n/a
XMR-00184	Isolated Surface Flakes	Two chert flakes on the surface of a small rise (approx. 75 ft. elevation) 680 ft west of a rectangular tundra thaw lake	Prehistoric	n/a
XMR-00185*	55-gal drums and can scatters	An approximately 1-acre area containing 11 rusted 55-gallon drums and three loci of a larger, discontinuous can scatter.	Historic	n/a
XMR-00186	Two isolated 55-gallon drums	Two isolated 55-gallon drums spaced 1,000 ft apart	Historic	n/a
XMR-00187	Can and Household Item Dump	55-gallon drums, metal generator, stove, and discontinuous can scatter	Historic	n/a

Notes: *Site is within the road corridor

The TLUI maintained by the NSB IHLC department is a database of prehistoric, historic, and traditional cultural resource locations that contribute to the understanding of the historical record of the land, people, and villages of the NSB. AES Alaska received the TLUI data from NSB in March 2020 and it is presented in the following table and figure (Figure TM8-2 and Table TM8-3). There are two TLUI sites within road corridors of this project. TLUIBAR065 is within the road corridor of the Utqiaġvik to Atqasuk Coastal route. TLUI site TLUIWAI105 is within the road corridor of the Coastal Route Extension, Middle Route, and the Southern Route.

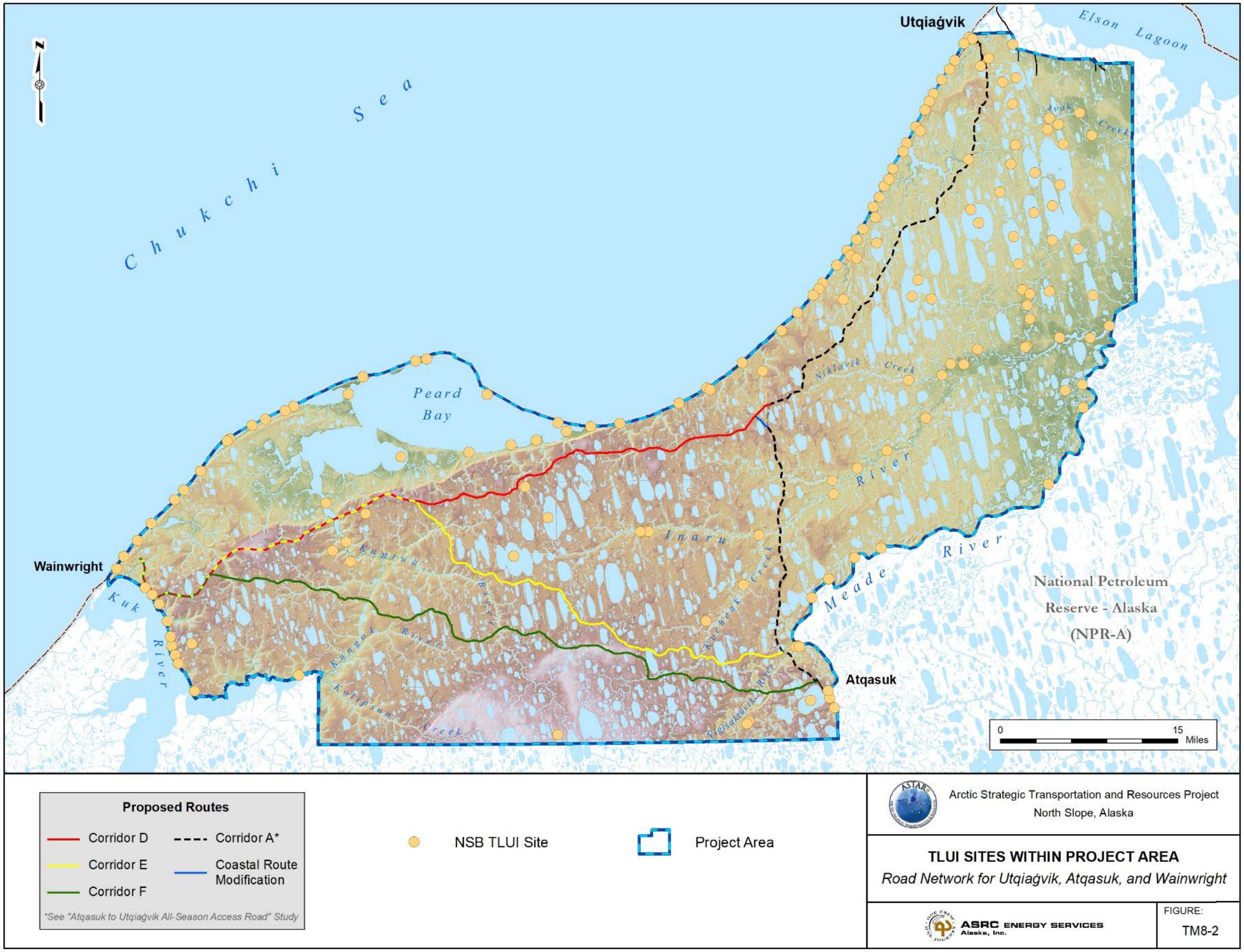
Utqiaġvik
Elson Lagoon
Chukchi Sea
Peard Bay
Wainwright
Atqasuk
Kuk River
Niklavik Creek
Inaru River
Meade River
Avak Creek
National Petroleum Reserve - Alaska (NPR-A)
0 15 Miles
Proposed Routes
Corridor D
Corridor A*
Corridor E
Coastal Route Modification
Corridor F
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
NSB TLUI Site
Project Area
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
TLUI SITES WITHIN PROJECT AREA
Road Network for Utqiaġvik, Atqasuk, and Wainwright
ASRC ENERGY SERVICES Alaska, Inc.
FIGURE:
TM8-2
UTM Zone 4N (NAD83)
AES-RTS: 20-001-TM8-002.mxd, 03/26/20

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Table TM8-3. TLUI Sites within the Project Area

TLUI Key	Site Name	Description
TLUIWAI130	Pifusugruk	Sod house ruins. The following families used to live there: Kutchiataq, Tiguluk, Argialak, Uyaguagruk, Angasak, all of Wainwright. "Old" Whaling site, In 1916, a man named Pinusugruk used to live alone there.
TLUIWAI129	Asiatchiaq	"Old" graves are just on top of the ground. This is the route through the inlet to Kugrua River,
TLUIWAI128	Atanik	Shelter cabins (frame houses) belong to Ben Ahmaogak and Weir Negovanna of Wainwright. Graves include those of Mark Ahsoak's mother, Florence Ahmaogak's grandparents, Ekak's grandparents, Ahlak, (Sovalik father).
TLUIWAI127	Ikkuabmiut	Before people lived in Atanik, this was the place considered an "old" site.
TLUIWAI126	Kugalukruak	Jerome (Jerome and Kelly) old sodhouse ruin.
TLUIWAI125	Sirraabruich	Old ruins where Papigluk used to live.
TLUIWAI124	Nungiatchiak	Jerome and Kelly had the first "houses" here. Old whaling settlement from where white whaling began.
TLUIWAI123	Nunagiak	Pt. Belcher: Two shelter cabins used to belong to Anigialuk - Nayakik father. Old sod house ruins and old whaling site in the Peard Bay area.
TLUIWAI121	Kuugmiu	Place name means "of the Kuk River". Old sod house ruins of J Angialuk. These people went up the Kuk River for fishing. Old village site of people who used to stay at Ahaliraq before Wainwright.
TLUIWAI119	Abvaat	Old ruins from a year-round camping site.
TLUIWAI118	Ikpijguk	Seal hunting area.
TLUIWAI117	Sifibarak	Four old sod house ruins - not known whose.
TLUIWAI116	Akulakitchuk	Place name means "a group of creeks close together". Seal hunting area
TLUIWAI114	Ugrukvik Creek	The first cemetery of the people of Wainwright.
TLUIWAI113	Ulbunik	The present village of Wainwright; established in 1906. The people of Atanik, Pinusugruk, Kuk River, Kayaasiuvik (Icy Cape), Sisrakruk were first to move to Wainwright. First cemetery was at Ugrugvik Creek is now adjacent to the airport, about 700 feet.
TLUIWAI106	Qavviksiun	Place name means "what you used for red dye". Old trapping grounds.
TLUIWAI105*	Siksrigaq	Place name means "a rock". There is a story here where an old woman turned to stone. Squirrels and weasels present. Distant Early Warning (DEW) Line Site.
TLUIWAI104	Tuttulivik	First location of Wainwright. Old sod houses have since eroded. Caribou hunting area.
TLUIWAI100	Amabualik	Fishing and camping area during the summer.
TLUIWAI102	Pabualuk	Place name means "this is the grave of Pagualuk".
TLUIWAI101	Iglabparak #1	Coal reserve that was used until 1965.
TLUIWAI099	Abthabakviitch	The place name references many racks that have fallen over. There is a story about a woman rolling over and she turned into a smelt. This place is known to have abundance of smelt.
TLUIWAI098	Nujlagiak	Place name means "where you camp before you go into the Kungok River".

TLUI Key	Site Name	Description
TLUIWAI097	Siisragruk	Place name means “flat or sandspit area”. Summer camping area with year-round fishing on Kuk River.
TLUIWAI096	Kuunguq	Ikkaun. Meaning place to cross. Sandspit area leading way to inland.
TLUIWAI134	Kabmak	This place was named after a man, one of the leaders in this area.
TLUIWAI133	Kabmak	This place is named after an old man named Kagmak, one of the leaders in this area.
TLUIWAI131	Kuugruaq	Fishing especially at Umilguuk. Camping especially at Niglaivik area. Site features coal area, old sod house ruins, and reindeer herding camps.
TLUIWAI132	Umijguk	Kangi Kugaruk, Used as portage for the boats.
TLUIXMR012	Mifukturuk	Camping ground, located on a ridge
TLUIXMR013	Uallia Kuubuuram	Ualliq Creek. Ualliq means toward the west. Hunting and trapping area. A stopover place for hunters.
TLUIXMR014	Tuvaq	No description in the Traditional Land Use Inventory (TLUI) database.
TLUIXMR015	Kuugaabruk	Fishing along the river for broad whitefish, grayling, Arctic cisco, humpback whitefish, least cisco, and burbot.
TLUIXMR016	Itiniq	Itiniq Lake. Itiniq means “an area with deep water”. Fishing and hunting area.
TLUIXMR017	Sikutubnaixaq	Sikutugnailaq Lake. Place name means “it is forbidden to use the ice”.
TLUIBAR120	Ipiqsuaq	Spring geese and seal hunting area. Summer hunting of walrus, ringed seal, and bearded seal off the coast.
TLUIBAR037	Amafnaat/Atuutibrua q	Place name derived from a Portugese man, Antone Betts, whose Inupiaq name was Atuutigruaq. His white fenced-in grave is located here. The area is used by Utqiagvik residents as a gravel pit. Summer and fall hunting.
TLUIBAR038	Maliqpik	Place name derived from Mliqpik, a shaman who is buried here. Maliqpik was a blind girl who dipped her face in the water so she could see the people living in Utqiagvik. After she dipped her face in the water, her sight returned. A grave marker stands.
TLUIBAR039	Qiku	Qiku means a clay substance, used in making pottery. Spring and summer hunting area for walrus, ringed seal, and bearded seal.
TLUIBAR040	Natibnaq	"Natignaq" means "flat land". Trapping area for fox. Hunting area for caribou. Nesting area for all types of birds.
TLUIBAR044	Nunavaaq	A well-known summer camping area. Popular place for summer seal, bearded seal, and walrus hunting off the coast. An active whaling settlement in the past.
TLUIBAR045	Kumaktuyuniq	*Kumaktuyuk* means "one who eats bugs". Traditional trail used by the people of Nuvuk, Barrow, and Pigniq during the summer when traveling inland through the lakes for fishing and hunting. Caribou hunting area during hot summer days.
TLUIBAR047	Imaiqsaun	Fresh water lake used by the people of Utqiagvik for fresh water in the summer and ice during the winter. Popularly referred to as fresh water lake. A scenic gravel road leads from Barrow to the lake.
TLUIBAR048	Nunavaat Ualliat	South end of Nunavaaq. Well known spring and summer camping area. Hunting area for walrus, ringed seal, bearded seal, and ducks. An active whaling settlement.

TLUI Key	Site Name	Description
TLUIBAR049	Siqjukaq	This place is popularly known as Hollywood. Walt Disney productions filmed *The Track of the Giant Snow Bear* at this site in 1969. The film featured many local residents, including Stephen Kaleak, Laura Itta George, Amy Taalak, and Rossman Peetok.
TLUIBAR051	Avvam Kuufata Kafia	Placename means “end of the Avvaq River”. Summer and fall caribou hunting area.
TLUIBAR052	Iksrubabvik	Iksrugagvik Lake. Fresh water source used by the people of Utqiagvik. Part of the Kumaktuyuniq traditional qayaq trail when traveling inland for summer hunting or fishing.
TLUIBAR053	Nappauraq	Place name means “a pole standing upright”. A meat rack is located here (Ikiggaq). Area used for spring camping and geese hunting. Summer hunting of walrus, ringed seal, and bearded seal. Place used by Ugiagnaq for camping.
TLUIBAR054	Kuubusugruk	Place name means “ravine”. Area used for spring camping and geese hunting, and summer hunting of walrus, ringed seal, and bearded seal.
TLUIBAR055	Naqixbuq	Place name means “the lower part of the land”. Camping area for spring duck and geese hunting and whaling off the coast and summer hunting of walrus, ringed seal, and bearded seal. Area claimed by Nasuayaaq and Numnik as their hunting area.
TLUIBAR056	Pifuatchiaq	Pinguatchiaq Lake. Part of the Kumaktuyuniq traditional qayaq trail. A stopover place when traveling inland for summer hunting and fishing.
TLUIBAR057	Sikulik	Sikulik Lake. Sikulik means “it has ice”. A stopover place for hunters who are traveling inland.
TLUIBAR058	Iksrubabvium Kuubuurafa	Iksrugagvik Creek. Hunting and trapping area.
TLUIBAR059	Itivliq	*Itivliq* means “to cross overland”. Part of the Kumaktuyuniq traditional qayaq trail when traveling inland for summer hunting and fishing.
TLUIBAR060	Itivliq	Part of the other Itivliq site to the east; a place on a qayaq trail where people carry overland and camp as they are going inland.
TLUIBAR061	Avvaum Kuufa	Avvaq River. Summer gillnet fishing for broad whitefish and least cisco. Summer and fall caribou hunting area.
TLUIBAR062	Nauyalik	Nauyalik Lake. Part of the Kumaktuyuniq traditional qayaq trail when traveling inland for summer fishing and hunting.
TLUIBAR063	Sirruqqaq	*Sirruqqaq* means a new opening of water for passage through a lake. Fishing and caribou hunting area. Winter fox trapping area. A cabin here is owned by the Eben Hopson family.
TLUIBAR065*	Ualiqpaam Kuubuurafa	Ualiqpaa Creek. Hunting and trapping area.
TLUIBAR066	Nauyalaaq	Nauyalaaq Lake. Part of the Kumaktuyuniq traditional qayaq trail when travelling inland for summer fishing and hunting.
TLUIBAR067	Qimuksiq	Qimuksiq Lake, located at Sungugruaq. Part of the Kumaktuyuniq traditional qayaq trail when traveling inland for summer hunting and fishing.
TLUIBAR068	Uqatubaq	Uqatugaq Island, located inside Sungugruaq lake. Fishing and caribou hunting area. Fox trapping area.
TLUIBAR069	Sukalaaq	Sukalaaq Lake. Part of the Kumaktuyuniq traditional qayaq trail when traveling inland for summer fishing and hunting.

TLUI Key	Site Name	Description
TLUIBAR071	Ikpitchiam Nuvua	Ikpitchiaq Point. Point of land located on Ikpitchiaq Lake. Hunting and fishing area.
TLUIBAR072	Sungubruaq	Sungugruaq Lake. Part of the Kumaktuyuinq traditional qayaq trail when traveling inland for summer fishing and hunting. Summer and winter gillnet fishing for least cisco and grayling. Winter fox trapping area. Summer and fall caribou hunting area.
TLUIBAR073	Ivrulivik	Ivrulivik Lake. Part of the Kumaktuyuniq traditional qayaq trail when traveling inland for summer fishing and hunting. A stopover place for hunters traveling inland.
TLUIBAR074	Ikpitchiaq	Ikpitchiaq Lake. Part of the Kumaktuyuniq traditional qayaq trail when traveling inland for summer fishing and hunting. A stopover place for hunters traveling inland.
TLUIBAR076	Sukaq	Sukaq Lake. Part of the Kumaktuyuniq traditional qayaq trail when traveling inland for summer fishing and hunting. A stopover place for hunters traveling inland.
TLUIBAR077	Ikkalbuayaaq	Ikkalguayaaq Lake. Part of the Kumaktuyuniq traditional qayaq trail when travelling inland for summer fishing and hunting. Fishing area for many types of fish.
TLUIXMR001	Qaviarat	*Qaviarat* means “fine sand”. A fishing and hunting area located on both sides of the Kuulugruaq, about two miles below the confluence of the Uqpiksuu. On the west side of the river there are several ice cellars and house pits.
TLUIBAR121	Natibnaq	Place name means “flat land”, or “flat terrain”. Area used for spring camping and geese hunting. Summer hunting area for walrus, ringed seal, and bearded seal off the coast.
TLUIBAR122	Ualiqpaa	*Ualliq* means "west side". It is an historic and archaeological site which qualifies as a landmark on the national register of historic places. Old graves and sod houses remain.
TLUIBAR123	Igluluk	Place name means “old sod house ruins”. Graves and ruins are found in this area. Spring camping area. Hunting for walrus, ringed seal, and bearded seal off the coast during the summer months.
TLUIBAR124	Ibeivik	Place name means “breeding area”. Summer camping area. Hunting area for walrus, ringed seal, and bearded seal. Winter fox trapping area.
TLUIBAR125	Kuububruk	Place name means “a small ravine”. Summer camping and abundant hunting of walrus, ringed seal, and bearded seal off the coast.
TLUIBAR126	Saatkunnak	Spring camping and hunting area for ducks and seals. Summer and fall hunting area for walrus, ringed seal, bearded seal, and caribou.
TLUIBAR127	Sieibabruaq	Old sod house ruins, one of which belonged to Tabbaq. Good summer camping and hunting area for walrus, ringed seal, and bearded seal off the coast. Active whaling offshore. Cellars in this area have eroded. The river was a historic route used to travel.
TLUIBAR128	Sieibabruam Kuubuurafa	Sinigagruaq Creek. Summer camping and hunting area.
TLUIBAR129	Qabliik	*Qagliik* means “men's snow pants”, or trousers with fur inside. Summer camping and hunting area for caribou. Summer hunting for walrus, ringed seal, and bearded seal off the coast.
TLUIBAR130	Tasibruaq	Tasigruaq Lake. Place once frequented by reindeer herders. Fishing, trapping, and hunting area.

TLUI Key	Site Name	Description
TLUIBAR131	Umiaqtubvik	Umiaqtugvik Lake. Place name means "a place to go boating". Fishing, trapping, and caribou hunting area.
TLUIBAR132	Nullabvik	*Nullagvik* means "a camping or stopover place". Well known summer camping and hunting area for walrus, ringed seal, and bearded seal. Spring whaling offshore. Duck and brant hunting area. Coastline bluffs on the east side. Cabin used for fishing.
TLUIBAR133	Nullabvium Kuubuurafa	Nullagvik Creek. Spring duck and brant hunting area. Summer camping area.
TLUIBAR134	Sieibat Ualliit	Place name means "the western side of the coastline bluffs". Summer camping and hunting area with abundant walrus, ringed seal, and bearded seal. Good hunting area for brant and duck. Spring whaling off the coast.
TLUIXMR024	Imaabvik	Place name means "a place where one has fallen into the water". Winter fishing area for broad whitefish, grayling, least cisco, humpback whitefish, and burbot. Winter fox trapping area. Caribou hunting area with an abundance of salmonberries.
TLUIXMR025	Kuutchiam Paafa	Entry or mouth of the Kuutchiaq River. Fishing and hunting area.
TLUIXMR027	Aiviq	Winter trapping area. A popular fish camp with fishing for grayling, humpback whitefish, least cisco, broad whitefish, and burbot. Nesting area. Caribou hunting area.
TLUIXMR029	Kuutchiaq	Kuutchiaq River. *Kuutchiaq* means "a newly formed river". Fishing and hunting area. Whyborn Nungasak has a cabin here.
TLUIXMR030	Qablubruaq	This site is located on a *qaglu*, which means "deep water area". Its original name was *qalugruaq*. A good fishing and hunting site located on the west bank of the Kuulugruaq, approximately seven miles downstream from the confluence of the Nigisaqtugvik River.
TLUIXMR032	Nasiqsrubvik	Entry or mouth of the Nigisaqtugvik River. Place name means a high vantage point to go scout out game. Caribou hunting area.
TLUIXMR033	Nibisaqtubvium Paafa	Entry or mouth of the Nigisaqtugvik River. Fishing, trapping, caribou and geese hunting area. Old cellars remain in this area. Old cellars remain in this area.
TLUIXMR034	Nibisaqtubvik	Place name means "where you go eat hearty". Located at the north of the river are old sod house ruins that used to belong to the families of Uniiyaq Nasukpauraq, and Okpeaha's parents fishing area. Trapping area. Some old cellars are located at the mouth of the river.
TLUIXMR036	Alliq	Alliq River. *Alliq* means at the bottom or other side of (in reference to the Nigisaqtugvik River). Fishing area for grayling, broad whitefish, least cisco, and humpback whitefish. Camping and hunting area.
TLUIXMR042	Atqasuk	The modern village site of Atqasuk was re-establilshed on the Meade River in 1972 by the Alaska Native Claims Settlement Act. The original name of the site was Qingagnaak because the bend in the river at this site looks like a nose. Fishing area.
TLUIXMR043	Imabruaq	Imagruaq Lake. Place name means "big water". Located close to Atqasuk, this lake is surrounded by salmonberries.
TLUIXMR045	Tikibxuk	An important historic site, located at the mouth of a small stream that enters the Kuulugruaq River from the west, approximately one mile upstream from modern Atqasuk. Deep water at this site has made it an important fishing site for many generations.

TLUI Key	Site Name	Description
TLUIXMR047	Kuukkak Kivallium Paafa	Entry or mouth of the East Kuukkak Creek. Fishing, camping, trapping, and caribou hunting area.
TLUIXMR048	Kuukkak Ualliq Paafa	Entry or mouth of the West Kuukkak Creek. This area is used as a fish camp. Trapping and caribou hunting area.
TLUIXMR145	n/a	n/a
TLUIXMR147	n/a	n/a
TLUIXMR071	Miefuqturuq	An old camping ground of the people of Wainwright, located on a ridge.
TLUIXMR075	Pakirgibvik	*Pakirgigvik* describes a stretch of land.
TLUIXMR076	Tatchim isua	Tatchim Isua means the end of the lagoon (Peard Bay). It is popularly known as Liz C. Good summer camping area and hunting area off the coast for walrus, ringed seal, and bearded seal. Spring duck and brant hunting area. Year round caribou hunting area.
TLUIXMR077	Papigaaq	Summer camping area. Hunting area off the coast for walrus, ringed seal, and bearded seal.
TLUIXMR078	Nullabvik	Hunting and camping area. Ahvakana, Taaqpak, and Panigeo took shelter here while herding reindeer.
TLUIXMR079	Igluqpauraqablik	Hunting and trapping area. This is a stopover place for hunters. Bert Panigeo once owned a big house here, but it is now destroyed.
TLUIXMR080	Uallia kuubuuram	Uallia Creek. *Uallia* means toward the west. Hunting and trapping area. A stopover place for hunters.
TLUIXMR081	Kuugruam puviafa	Kuugruaq Bay. Place name means “mouth or pocket of Kuugruaq”. Hunting and fishing area. Spotted seals are hunted here by Ataniq residents.
TLUIXMR082	Qunfixaat	Place name means “many reindeer herders”. A camp used by reindeer herders. Winter hunting and trapping area. Summer brant and duck hunting area.
TLUIBAR135	Sieibat	Place name means “coastline bluff”. Summer camping and hunting area for walrus and ringed and bearded seals. Spring whaling off the coast.
TLUIBAR136	Sikulium Nuvua	Sikulik Point. Fishing, trapping, and hunting area.
TLUIXMR084	Napaqsraq	Napaqsraq means “an upright pole or tower”. A tower is still standing, used by hunters as a landmark. Summer hunting area off the coast for walrus and ringed and bearded seals.
TLUIXMR085	Usuabruk	An old site with sod house ruins belonging to Kisisaq and Alagiaq. Summer camping area and hunting area off the coast for walrus and ringed and bearded seals.
TLUIXMR086	Nullabvium kuubuurafa	Nullagvik Creek. Spring duck and brant hunting area. Summer camping area.
TLUIXMR087	Sikulik	Sikulik Lake. Fishing, trapping, and hunting area.
TLUIXMR088	Uluuraq	Place name means “an ulu”, or woman's knife. Summer camping area and hunting area off the coast for walrus, ringed seal, and bearded seal.
TLUIXMR089	Abnaatchiabruaq	Place name derived from Agnaatchiagruaq, a shaman who is buried here. Caribou hunting area.
TLUIXMR091	Qikuligaabruk	Place name means “a place with many seal holes”. Summer hunting area off the coast for walrus and ringed and bearded seals. Caribou hunting area.

TLUI Key	Site Name	Description
TLUIXMR092	Tuapaktusuum kuubuurafa	Tuapaktusuk Creek. A historic site. Summer camping and caribou hunting area. A reindeer herding and grazing area.
TLUIXMR094	Killi	*Killi* means “on the border or edge of something”. *Uyagalik* means “a place where there are many rocks”. A story is told about an old woman who played Eskimo ball and used this site for a field goal. Summer camping area. Hunting area off the coast for walrus.
TLUIXMR095	Niblaivik	The Niglaivik River is a tributary of the Kuugaagruk, known as a geese nesting area and hunting area. Winter fishing area for *sulukpaugaq*.
TLUIXMR096	Uyabatuuq	Summer camping area. Hunting area off the coast for walrus, ringed seal, and bearded seal. Caribou hunting area.
TLUIXMR097	Naullat	Land feature is shaped like a spear in camping area. Fishing area with an abundance of grayling. Spring geese hunting area.
TLUIXMR098	Nimibiaq	Place name means “shaped like a snake”, in reference to the river.
TLUIXMR099	Kuugaabruk	Fishing along the river for broad whitefish, grayling, Arctic cisco, humpback whitefish, least cisco, and burbot. Trapping area for fox. Caribou and spring geese hunting area.
TLUIXMR100	Sukam kuubuurafa	Sukaq Creek. Trapping and hunting area.
TLUIXMR101	Maniqtuut	Fishing area. Hunting area for caribou and spring geese.
TLUIXMR102	Iviksulugruaq	Iviksulugruaq Lake. Well known fishing area for broad whitefish, grayling, humpback whitefish, Arctic cisco, and burbot. Geese hunting area. Trapping and hunting area. Part of the Kumaktuyuniq traditional qayaq trail when traveling inland for summer fish.
TLUIXMR103	Ikkalbubruaq	Ikkalgugruaq Lake. Fishing area for many types of fish. Part of the Kumaktuyuniq traditional qayaq trail when traveling inland for summer fishing and hunting.
TLUIXMR104	Afmalubruum kuubuurafa	Angmalugruk Creek. Fishing for grayling, least cisco, and broad whitefish. Trapping area for fox. Geese and caribou hunting area.
TLUIXMR106	Iqixaaluk	Iqilaaluk Creek. Fishing, trapping, and hunting area.
TLUIXMR112	Uyabaabvik	Place name means “an area where there are rocks or stones”. Fishing area for many types of fish. Geese hunting area. Trapping and hunting area.
TLUIXMR115	Kuugaabruk	Fishing along the river for broad whitefish, grayling, Arctic cisco, humpback whitefish, least cisco, and burbot. Trapping area for fox. Caribou and spring geese hunting area.
TLUIXMR116	Iviksuk	This area qualifies as a historic site. There are old sod house ruins of Keerik, Okpeaha, Uniiya, and Nasukpaurak. A cabin belongs to Ina Kalayauk of Utqiagvik. An old cellar is located on the mouth of the river. At times there are many cabins pitched here.
TLUIXMR117	Pifubrugaabruich	Place name given to these high bluffs. Fishing area for grayling, least cisco, humpback whitefish, burbot, and broad whitefish. Trapping area for fox. Caribou and spring geese hunting area. Cabin owned by Joseph Nashaknik.
TLUIXMR118	Pifubrugaabruk	Place name given to the bluffs here. Fishing area for many types of fish. Trapping area for fox. Caribou and spring geese hunting area. Cabins located here.

TLUI Key	Site Name	Description
TLUIXMR119	Niblaivigum paafa	Mouth of the Niglaivik River, a tributary of the Kuugaagruk. Place name means “a place where geese raise their young”, and a place to hunt geese. Good fishing area for grayling, Arctic cisco, humpback whitefish, broad whitefish, and burbot.
TLUIXMR120	Payugvik	This site is an important historical and modern day hunting and fishing site with modern fish camps, caches of fishing equipment and camping gear, and a plywood shelter cabin. Close to the Utqiagvik-Atqasuk trail, travelers ofter often stop here.
TLUIXMR121	Akiqti	Akiqti River. The Akiqti River flows into the Payugvik River. Fishing area for broad whitefish, grayling, and least cisco. This is a place where one should not sleep overnight.
TLUIXMR127	Miefuqturuq Qikiqtaq	Not listed, named, or described in the TLUI report for the area. Immediately to the south of Minguqturuq Island.
TLUIXMR139		
TLUIBAR142	Uluuraq	Trapping area. *Ugruq* and seal summer camp.
TLUIBAR143	Igniviq	Trapping Area. *Ugruq* and seal summer camp.
TLUIBAR144	Sunnugruak	Nate Neakok's Family camps here every summer for fishing by gillnets. Ikalusaak and Sulukpaugak fish. Nesting area. The old Ikkigaks serves as landmarkers in following the trail. Fox trapping area,
TLUIBAR147	Kagliik	Place name means “with two forks”, like trousers. Camping and seal hunting area.
TLUIWAI145	Niglaivik	Camping site with old reindeer camp and sod house ruins.
TLUIXMR148	Uyagalik	Camping and seal hunting area.
TLUIXMR149	Agmalugruk	Good fishing area for Ikalusaak, Anaagluk, and Sulukpaugak in the fall. Camping and hunting site. There are two cellars belonging to Mark Ahsoak and Nate Olemaun
TLUIXMR150	Kaleak	Good fishing area near the mouth. Trapping area. A popular geese hunting and camping in the spring
TLUIXMR153	Nimigiak	Hunting/camping area
TLUIXMR154	Olemaun Camp	Fish camp. Sulukpaugak is a place name which means “where you go to hunt geese.”
TLUIWAI103	Umifmak	Place name
n/a	Qifabnaak	Added June 1, 2017
n/a	Aatut	Site C of Aatut described as the third area of Aatut in the Land use values through time Atqasuk to Utqiagvik.
n/a	Iviksuk	Description included in the other Iviksuk placename adjacent to this site.

Data Gaps

Until a detailed survey is conducted within the project area, much of the land remains unresearched and unsurveyed for cultural resources. Archaeologists should conduct a visual reconnaissance overflight of the potential road corridor, followed by complete field surveys and testing of high-potential areas along the preferred corridor.

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Technical Memorandum 9 – Paleontological Resources

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Technical Memorandum 9 – Paleontological Resources

Prepared by: Ranna Wells, Archaeologist, MA, RPA

Reviewed by: Shannon Mason, Environmental Scientist

Date: April 2020

Overview

Paleontology is the study of fossils and ancient life forms. A paleontological resource is any “fossilized remains, traces, or imprints of organisms, preserved in or on the earth’s crust, that are of paleontological interest and provide information about the history of life on earth,” but that does not include archaeological items or other cultural items (Paleontological Resources Protection Act of 2009 [PRPA]) (PRPA, 16 US Code 470aaa-470aaa-11). Examples of paleontological resources found in Alaska include fossils of dinosaurs, clams, trilobites, microorganisms, or mammals, such as mammoths.

Regulatory Background

Like cultural resource sites, paleontological sites are protected by federal, state, and local laws and policies – see Table TM9-1.

Table TM9-1. Management of Paleontological Resources

Government Level	Scope	Applicable Laws, Policies, and Ordinances
Federal	Federal lands	PRPA 2009
State, Alaska OHA, Department of Natural Resources	State undertaking	Alaska Historic Preservation Act (AS 41.35) Alaska Administrative Code (11 AAC 16)
North Slope Borough	Borough	NSBMC § 19.50.030(F) and § 19.60.040(K)

Notes:
AS = Alaska Statute
NSBMC = North Slope Borough Municipal Code
OHA = Office of History and Archaeology
PRPA = Paleontological Resources Protection Act

Federal Laws and Policies

Paleontological resources on federal lands are owned by the United States (Federal Land Policy and Management Act of 1976, Board of Regents of the University of Oklahoma 2005). The PRPA affirms that it is the responsibility of federal land-managing authorities to manage and protect paleontological resources on federal lands. This act provides guidelines for collection of paleontological resources and collection permits; curation of the resources; and civil and criminal penalties for unauthorized removal, transport, or damage to the resources. The act also requires that federal agencies develop regulations, establish public awareness and education programs, and inventory and monitor federal lands. At this point, the Bureau of Land Management (BLM) has not implemented regulations to manage paleontological resources on BLM-managed lands. Impacts to paleontological resources are included in the National Environmental Policy Act process. On BLM lands, such as the National Petroleum Reserve–Alaska (NPR-A), it is BLM policy to consider potential impacts to paleontological resources from federal actions (BLM 2008). A desktop study analysis may suffice for an impact analysis, and is often accepted in Alaska. However, in an area known to be sensitive or known to have paleontological resources, BLM may require a field study.

State Laws and Policies

In Alaska, paleontological sites are managed together with cultural resources (Alaska Preservation Plan). Therefore, paleontological resources are protected under the Alaska Historic Preservation Act (AHPA). The AHPA (Alaska Statutes [AS] 41.35) protects paleontological resources on state land by ensuring those resources that may be adversely affected are properly documented and that any mitigation measures (if necessary) are conducted in a timely and expeditious manner.

North Slope Borough

While paleontological remains are not explicitly mentioned in the North Slope Borough (NSB) Comprehensive Plan (2005), NSB Municipal Code (NSBMC) Title 19, or through the NSB Iñupiat Heritage, Language, and Culture Division (IHLC 2020), it may be assumed that paleontological resources are treated along with cultural resources. For example, the NSB development permit renewal for the Toolik Field Station stipulated, "Should any cultural, archeological or paleontological resource materials (including, but not limited to artifacts, house mounds, grave sites, ice cellars, and fossilized animal remains) be discovered in the course of activities conducted under this permit, the site shall not be disturbed and the NSB IHLC shall be promptly notified at (907) 852-0422. NSBMC 19.70.050(E) through (G), NSBCMP 2.4.3(e) through (g) (NSB 1999)."

Paleontological Resource Sites

The following is a summary of data available for paleontological sites and surveys within and near the project area. The summary includes a description of specific databases available for review and a discussion of the types of sites and surveys found within or near the project area.

For purposes of this desktop study, AES Alaska reviewed the Alaska Heritage Resource Survey (AHRS) database, maintained by the State of Alaska, Office of History and Archaeology (OHA), for previous cultural resource research and relevant literature for the project area. The information below is only as complete as the data that are publicly available, as some reports in the AHRS database have been labelled as "proprietary" and are therefore not available for review.

The Alaska OHA records paleontological sites within Alaska in the AHRS database. However, the AHRS is a database used by cultural resource professionals for the documentation and recording of cultural resources (i.e., resources attributed to humans and human use) and not necessarily for paleontological resources. Therefore, paleontological data collected and reported to the OHA are not consistent and not always complete.

Typically, concentrations of paleontological sites are recorded along rivers and ridgelines that have significant cut-banks and land cuts revealing deep stratigraphic levels. The highest concentration of recorded paleontological sites is associated with areas immediately adjacent to the Colville River drainage system within NPR-A. The absence of paleontological sites in other areas may be more a result of sites not found and/or reported in those areas rather than the lack of resources there. A search of the AHRS database in March 2020 revealed one paleontological site within a 2,000 foot corridor of the routes (Figure TM9-1, Table TM9-2). XMR-00055 is the only paleontological site that falls within the road corridor and it falls within the Utqiaġvik to Atqasuk Coastal Route, Corridor A.

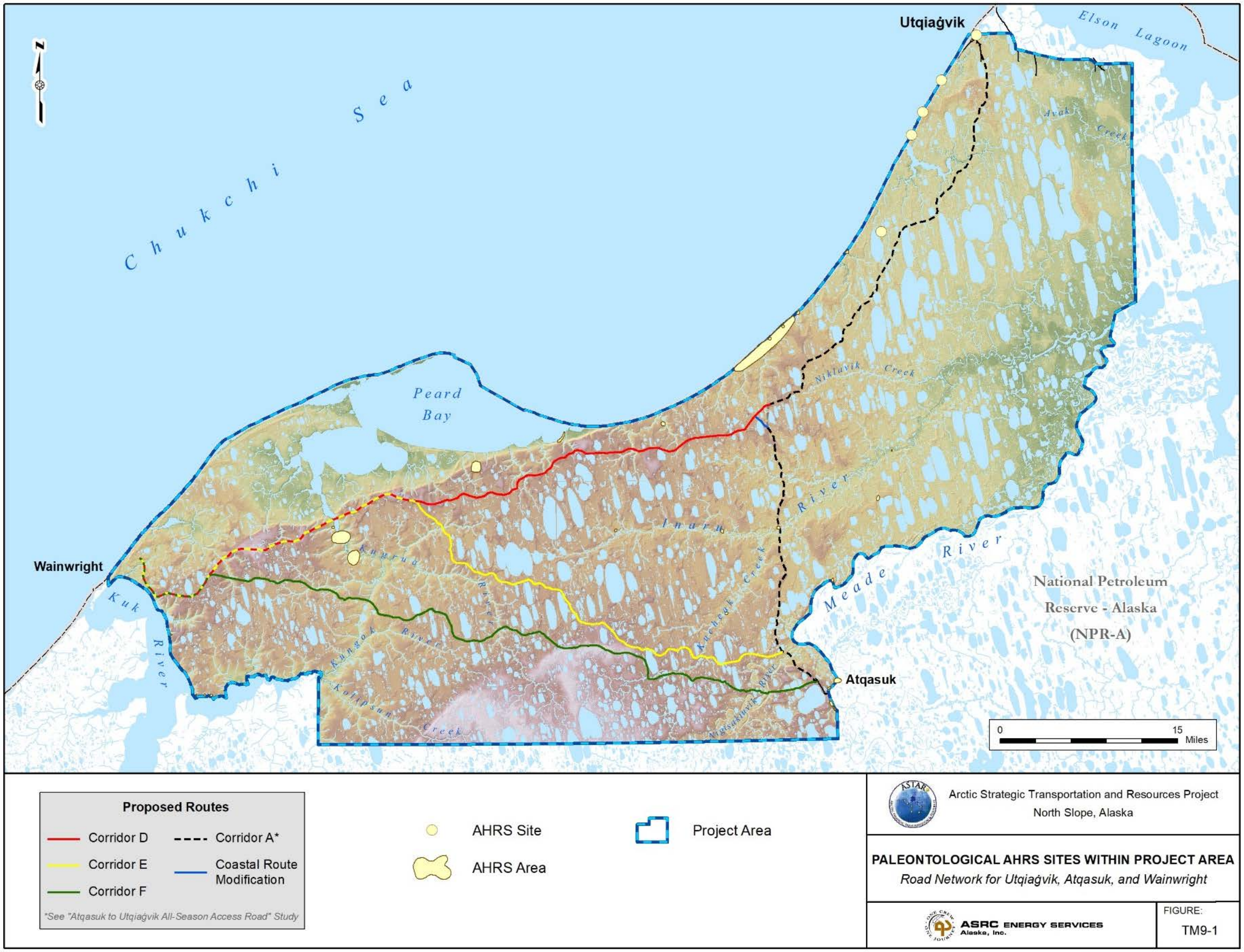
Utqiaġvik
Elson Lagoon
Chukchi Sea
Avak Creek
Peard Bay
Nikluvik Creek
Wainwright
Kuk River
Inaru River
Meade River
National Petroleum Reserve - Alaska (NPR-A)
Atqasuk
Kuugruaq River
Kungok River
Kaolaksuk Creek
0
15
Miles
Proposed Routes
Corridor D
Corridor A*
Corridor E
Coastal Route Modification
Corridor F
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
AHRS Site
AHRS Area
Project Area
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
PALEONTOLOGICAL AHRS SITES WITHIN PROJECT AREA
Road Network for Utqiaġvik, Atqasuk, and Wainwright
ASRC ENERGY SERVICES
Alaska, Inc.
FIGURE:
TM9-1
UTM Zone 4N (NAD83)
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Table TM9-2. Paleontological Sites

Number	Name	Site Description
BAR-00025	PA, M7163	Paleontological site reported by Lindsey consisting of bivalves.
BAR-00027	PA, *7228/7229	Paleontological site reported by Lindsey consisting of pelecypods.
BAR-00029	PA, M7429	Paleontological site reported by Lindsey consisting of bivalves, gastropods.
BAR-00030	PA, M7431	Paleontological site reported by Lindsey consisting of bivalves, gastropods.
BAR-00031	PA, *7228	Paleontological site reported by Lindsey.
BAR-00035	PA, V-7	Consists of mammoth remains in an unnamed Pleistocene formation consisting of unconsolidated sands and silts without marine fauna.
WAI-00064	PA, 65	Paleontological site reported by Lindsey.
WAI-00065	PA, 66	Paleontological site reported by Lindsey.
WAI-00066	PA, 67	Paleontological site reported by Lindsey.
WAI-00069	PA, 7165	Paleontological site reported by Lindsey.
WAI-00070	PA, 7860	Paleontological site reported by Lindsey.
WAI-00071	PA, 7859	Paleontological site reported by Lindsey consisting of ginkgo.
WAI-00072	PA, M1831	Paleontological site reported by Lindsey.
WAI-00081	PA, 73	Paleontological site reported by Lindsey consisting of ginkgophyte, cycadophyte, conifers.
XMR-00050	PA, L-3-53	Paleontological site reported by Lindsey consisting of ginkgo, conifers, Taxodiaceous cones.
XMR-00052	PA, M865	Paleontological site reported by Lindsey consisting of all gastropods.
XMR-00053	PA, M864/M7172	Paleontological site reported by Lindsey consisting of all gastropods.
XMR-00054	PA, M7176	Paleontological site reported by Lindsey consisting of gastropods, pelecypods.
XMR-00055*	PA, M7175	Paleontological site reported by Lindsey consisting of gastropods, pelecypods.
XMR-00056	PA, M7173	Paleontological site reported by Lindsey consisting of pelecypods.
XMR-00057	PA, L-1-53	Paleontological site reported by Lindsey consisting of ferns, cycad, conifers, angiosperm.
XMR-00058	PA, M7311	Paleontological site reported by Lindsey consisting of gastropod, pelecypods.
XMR-00059	PA, 15929	Paleontological site reported by Lindsey consisting of pelecypods, gastropods.
XMR-00060	PA, M7177	Paleontological site reported by Lindsey consisting of pelecypods, barnacle.
XMR-00061	PA, M7174	Paleontological site reported by Lindsey consisting of gastropods, pelecypods.
XMR-00062	PA, M7314/M7315	Paleontological site reported by Lindsey consisting of pelecypods.
XMR-00063	PA, M7170/A	Paleontological site reported by Lindsey consisting of gastropods, pelecypods.
XMR-00064	PA, M7313	Paleontological site reported by Lindsey consisting of gastropods, pelecypods.
XMR-00065	PA, M7169	Paleontological site reported by Lindsey consisting of gastropods, pelecypod.
XMR-00066	PA, M7312	Paleontological site reported by Lindsey consisting of a pelecypod.
XMR-00067	PA, 3627/M3524/4	Paleontological site reported by Lindsey consisting of gastropods, type locality, pelecypods.

Number	Name	Site Description
XMR-00068	PA, M7168	Paleontological site reported by Lindsey consisting of gastropods, pelecypods.
XMR-00069	PA, 1/1087	Paleontological site reported by Lindsey consisting of gastropods, pelecypods.
XMR-00070	PA, 3	Paleontological site reported by Lindsey.

Notes: * Site located within the road corridor

Data Gaps

Much of the project area remains unresearched and unsurveyed for paleontological resources. Concurrent with cultural resources studies, a survey for paleontological resources should be conducted along the preferred route, particularly along river banks and ridgelines.

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Technical Memorandum 10 – Subsistence Patterns

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Technical Memorandum 10 – Subsistence

Prepared by: Shannon Mason, Environmental Scientist

Reviewed by: Inuuteq Stotts, MA

Date: April 2020

Overview

Subsistence is an essential component of Iñupiat culture – it is a means of sustaining and maintaining cultural values and Traditional Knowledge (TK). For the Iñupiat of northern Alaska, subsistence is a way of life that has developed over generations and adapting to the unique conditions of arctic Alaska. The North Slope Borough (NSB) zoning and land use code (Title 19) defines subsistence as "an activity performed in support of the basic beliefs and nutritional needs of North Slope Borough residents and includes hunting, whaling, fishing, trapping, camping, food gathering, and other traditional and cultural activities" (NSB 2018).

Subsistence is based on cooperation and sharing at a familial and community level, serving to strengthen and continue those bonds. Harvest sharing is an integral aspect of the subsistence way of life for many North Slope residents. The subsistence harvest is often shared among communities that do not have access to the same resources. Hunters also share their harvest with elders and other members of the community (Bacon et al. 2011).

Regulatory Drivers

The use, access, and trading of subsistence resources are regulated by federal and state laws (Table TM10-1). At a local level, protection of these resources may be addressed through ordinances, land use stipulations, subsistence user co-management organizations, and the National Petroleum Reserve – Alaska (NPR-A) Subsistence Advisory Panel.

Table TM10-1. Management of Subsistence Resources

Government Level	Scope	Applicable Laws, Policies, and Ordinances
Federal, ANILCA, US Department of the Interior	Federal land	Subsistence use (§ 810(a))
North Slope Borough	Borough land	NSBMC § 19.50.030(F) and § 19.60.040(K)

Notes:
ANILCA Alaska National Interest Lands Conservation Act
NSBMC North Slope Borough Municipal Code

Bureau of Land Management National Petroleum Reserve — Alaska Integrated Activity Plan

The Bureau of Land Management (BLM) NPR-A Integrated Activity Plan (IAP) determines the required operating procedures, best management practices, and appropriate stipulations for all BLM-managed lands in the project area.

Under the 2013 Record of Decision, a Subsistence Advisory Panel is responsible for reviewing resource-related development plans within the planning area and issuing recommendations to the BLM regarding whether the plans adequately consider subsistence (BLM 2012). Projects are required to submit documentation of consultation efforts to the BLM and develop a subsistence plan to show how the activity would be scheduled and located to prevent conflicts. Monitoring is mandated to assess the range of potential effects by the project on resources and subsistence.

In 2017, BLM transferred the responsibilities of the Subsistence Advisory Panel to the NPR-A Working Group, which has convened twice since.

A new IAP is in the process of being developed (BLM 2019). Alternative A of the Draft Environmental Impact Statement would preserve the guidelines of the last IAP.

Alternatives B through D would require that projects which occur within 50 miles of a community or fewer than 15 miles from heavily used subsistence rivers consult with affected communities. Rivers within the study area are classified as heavily used by the following communities:

- Wainwright: Kuk and tributaries (Kaolak, Ketik, Avalik, Ivisaruk, Kungok), and Kugrua Rivers
- Atqasuk: Meade, Niġisaktugvik, and Isiqtuq Rivers
- Utqiaġvik: Inaru, Topagaruk, Chipp, Ikpikpuk, Miguakiak, and Piasuk Rivers.

Aircraft use is restricted over these rivers during spring goose hunting and summer and fall caribou hunting under Alternatives B through D. A subsistence plan describing strategies for conflict prevention and documentation of project effects on subsistence activities would be submitted to the BLM and appropriate North Slope entities.

In both cases, permittees that propose barging equipment or supplies to the NPR-A need to notify and coordinate with the Alaska Eskimo Whaling Commission and the relevant local community whaling captains' associations.

Neither Alternative A or Alternatives B through D is designated as preferred.

North Slope Borough

The project falls under the purview of Title 19 of the NSB Municipal Code (NSBMC), which states, "development must not disturb traditional subsistence activities or values at historic, archaeological and cultural sites" (NSBMC 19.50.030[F] and 19.60.040[K]). Through the NSB Comprehensive Plan and land management regulations, potential impacts from certain exploration and development activities require NSB approvals (NSB 2019). Sample stipulations the NSB may require include the implementation of a Subsistence Mitigation Program, which will assist in the mitigation of adverse impacts to subsistence activities and hiring of local subsistence representatives to work as guides and monitors.

Subsistence Resources

Data available about subsistence resources are often not consistent or thorough. Data gaps, inconsistent surveys and survey methods, and misidentification of resources are just some of the problems associated with many studies that involve subsistence. Therefore, the discussion below should not be viewed as an exhaustive report of all the subsistence resources used. The types and quantities of subsistence harvests will vary depending on several outside factors, including resource availability, weather, and the availability of subsistence participants (Bacon et al. 2011).

Utqiaġvik

The community of Utqiaġvik is the largest NSB city, with approximately 5,256 residents as of 2015 (NSB 2019). Utqiaġvik is located on the Chukchi and Beaufort Sea coasts, in the Arctic Ocean. Utqiaġvik residents reported on over sixty different resources for Bacon et. al.'s 2009 study (2011), indicating that a large portion of the available subsistence resources is in use (Bacon et al. 2011). The subsistence use areas for Utqiaġvik residents are depicted in Figure TM10-1.

Marine Mammals: Hunting for bowhead whale is a critical cultural tradition and subsistence activity in Utqiaġvik. Whaling takes place in the spring and fall, with much of the harvest distributed to other communities and shared at the Nalukataq celebration in June. Walrus, bearded, ringed, and spotted seal are hunted, as are polar bears (Bacon et al. 2011).

Land Mammals: Caribou is one of the most consistently eaten subsistence foods (Brown et. al 2016). More residents participate in caribou hunting than any other hunting activity. Animals are predominantly harvested from the Teshekpuk Herd. Brown bear, arctic and cross fox, ground squirrel, weasels, wolves, and wolverines are also taken for subsistence purposes (Bacon et al. 2011).

Fish: Fishing is one of the most popular subsistence activities among Utqiaġvik residents (Brown et al 2016), given their access to both inland water sources and the ocean. Broad whitefish are the most commonly caught, mostly during the fall. The Arctic grayling is second most important in subsistence fishing. Char, flounders, northern pike, lake trout, burbot, smelt, halibut, least cisco, and chum, Chinook, pink, coho, and sockeye salmon are also available for subsistence harvest (Bacon et al. 2011).

Birds: A variety of waterfowl are harvested, frequently in the late spring and early summer following whaling (Brown et. al 2016). King and common eiders, and greater white-fronted geese are the most common, while other species of waterfowl including brant, pintail and long-tailed ducks, eiders, and snow goose are harvested in lesser amounts. Ptarmigan species and snowy owls are also harvested. (Bacon et al. 2011).

Plants: Plants are gathered to a lesser extent. Blueberries and salmonberries are the most commonly collected, but crowberries and cranberries are harvested in smaller amounts. Other plants gathered by Utqiaġvik residents are wild rhubarb and spinach, willow leaves, and assorted roots (Bacon et al. 2011).

Invertebrates: Clams are also harvested as a subsistence resource (Bacon et al. 2011).

Atqasuk

The community of Atqasuk is located approximately 58 miles southwest of Utqiaġvik and 61 miles east of Wainwright. It is inland from the Arctic Ocean, on the Meade River, and therefore relies on caribou and fish. Atqasuk was established in 1976 by families from Utqiaġvik and currently has about 261 residents (NSB 2016). Subsistence use areas for Atqasuk are shown on Figure TM10-1.

Marine Mammals: Atqasuk residents travel to Utqiaġvik to participate in bowhead whaling. Other marine resources are obtained through barter or gift-giving between NSB communities. Polar bears are also found in the vicinity (NSB 2017).

Land Mammals: Caribou are the principle terrestrial subsistence resource for Atqasuk. They are harvested year-round but hunting peaks in September (NSB 2016). Other land mammals available to Atqasuk residents are moose, brown bear, lynx, and porcupine.

Furbearers including ground squirrel, weasel, wolverine, fox, and wolf are harvested for their warm skins, sometimes incorporated into locally made clothing and crafts (Bacon et al. 2011, NSB 2017).

Fish: Residents rely heavily on the fish of the Meade River drainage, particularly several species of whitefish, Arctic grayling, and burbot. Gillnets are used at summer fish camps to harvest humpback and broad whitefish and grayling. Gillnets are also set beneath the ice in fall and winter. Ice fishing for burbot is done with jigs in spring and fall. Smaller amounts of Arctic char, chum, Chinook salmon, least cisco, and rainbow smelt are also caught for subsistence purposes (Bacon et al. 2011, NSB 2017).

Birds: Bird hunting is mainly a spring activity. Both rock and willow ptarmigan are harvested, but waterfowl is the dominant avian resource. Of the various ducks, geese, and swans that are subsistence hunted, the main species is a white-fronted goose (Bacon et al. 2011, NSB 2017).

Plants: The main plant resources harvested by Atqasuk residents are blueberries and salmonberries (cloudberries). Cranberries, blackberries, wild spinach, and Labrador tea are also gathered by community members (Bacon et al. 2011, NSB 2017).

Wainwright

Located approximately 61 miles west of Atqasuk and 86 miles southwest of Utqiaġvik, the community of Wainwright is situated between the Chukchi Sea and the Kuk River estuary. The river and coastal waters are used heavily for travel by the village's 555 residents, who rely more heavily on subsistence foods than much of the NSB (NSB 2016, Bacon et. al 2011). Nearly 73 percent of Wainwright households receive half or more of their diet from subsistence foods, compared to 57 percent of Atqasuk households and 65 percent of Utqiaġvik (NSB 2016). Subsistence use areas for Wainwright are shown on Figure TM10-1.

Marine Mammals: Traditionally, marine resources have been the most important for the people of Wainwright and surrounding settlements. Residents harvest six species of whales, seals, and walrus (NSB 2017a). Over ninety percent of the 95 walrus, 84 bearded seals, and 28 beluga whales harvested during a 2002–2003 survey period were taken in the months of July and August (Bacon et. al 2011).

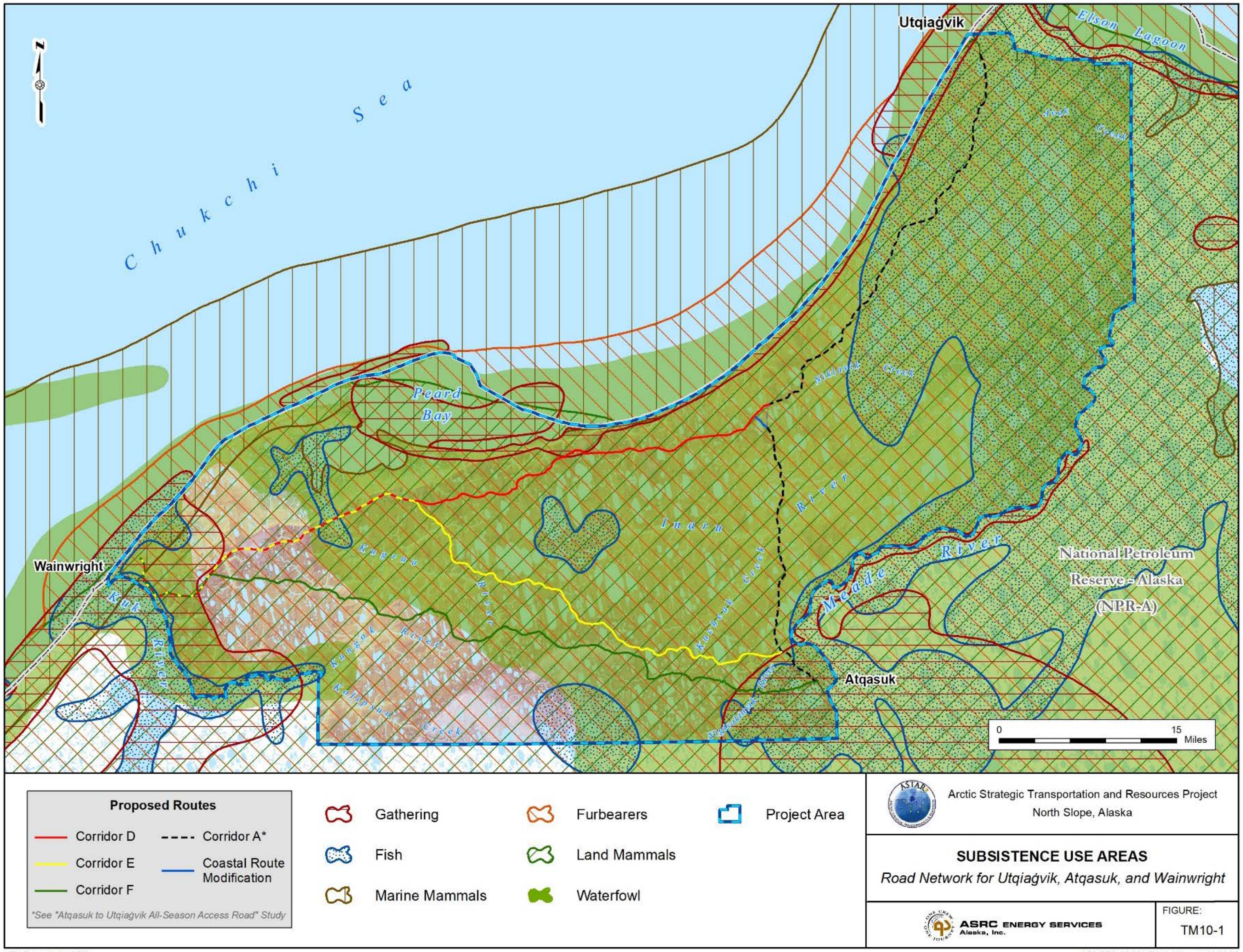
Land Mammals: Caribou are the principle terrestrial subsistence resource for Wainwright, as evidenced by the 866 animals harvested 2002 to 2003. Caribou hunting peaks in August and September. The primary furbearers harvested were red fox and polar bear (Bacon et al. 2011, NSB 2017).

Fish: Up to fourteen species of fish are harvested annually. The species with the highest number of individuals harvested were rainbow smelt, and the second-highest was Arctic grayling (Bacon et al. 2011).

Birds: Traditionally, waterfowl have been a prized resource for inhabitants of the Wainwright area (Nelson 1981). White-fronted geese, brant, and eiders were the chief bird resources for Wainwright (Bacon et al. 2011).

Plants: Residents gather salmonberries (Bacon et al. 2011).

Existing data on subsistence resources for the project area are available publicly through the Alaska Department of Fish and Game (ADF&G) Community Subsistence Information System, the repository of Alaska community harvest information gathered by ADF&G Division of Subsistence, the NSB website, and the Alaska Resources Library and Information Services.


Utqiaġvik
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Native Use Areas (Camps and Cabins)

NSB maintains information on reported camps and “fixed” campsites within its boundaries. A “fixed campsite” is defined as a site with a long history of camping, or where a cabin has been constructed. Temporary campsites are not included in the database. Some campsites are now abandoned, while others have more recent structures built on top of or nearby the original site. The location of a camp or campsite indicates an area of successful hunting and/or fishing, both currently and historically/traditionally. Subsistence users often travel long distances to use these cabins and camps and can travel over 100 miles from them in a day to use other subsistence locations (Stephen R. Braund & Associates [SRB&A] 1993).

Camp and cabin locations (Figure TM10-2) obtained from NSB are focused on current sites and completed structures. The data indicates that one cabin is within 2,500 ft of the intersection of Corridor A and Corridor E, and another is situated 1.17 miles from Corridor E. The database is unlikely to account for all existing camp and cabin structures that are in current use for subsistence activities. This information should be primarily used to identify the density of subsistence use.

Most subsistence cabins and campsites are adjacent to water, such as productive streams, rivers, and lakes. Proposed routes cross and run parallel to portions of major streams in the project area. Subsistence cabins and camps can also be found along the coast or in the interior, away from water bodies.

The highest density of NSB documented camps or cabins in the project area are concentrated in the following locations:

- Approximately 1 mile northeast of Atqasuk, along the Meade River
- Approximately 3 miles southwest of Utqiaġvik
- Approximately 5 miles northwest of Atquasuk, along the Niġisaktugvik River
- Approximately 28 miles south of Utqiaġvik on the Inaru River
- Approximately 31 miles northwest of Atqasuk on the eastern edge of Peard Bay

Limitations on Industrial Activities Associated with Camps and Cabins

Within the proposed project area, there are limitations on activities in the proximity of subsistence camps and cabins. BLM (2012) determined that the Best Management Practice for these properties in NPR-A is avoidance. An officer of the appropriate Native Tribal government will make the determination, depending on the type of industry proposed and density of subsistence activities in the area. BLM also requires that there be a minimum of aircraft disturbance in areas where there are known subsistence camps and cabins.

Historic and Contemporary Subsistence Use Areas

North Slope residents subsistence hunt close to villages, but sometimes will travel great distances to procure their subsistence resources. For example, Utqiaġvik residents travel northeast and southwest along the coast for caribou, and also travel inland for caribou and fur-bearing mammals. Some residents have reported traveling more than 150 miles to the headwaters of the Meade and Ikpikpuk rivers and the Colville River (SRB&A 1993, Tremont 1987).

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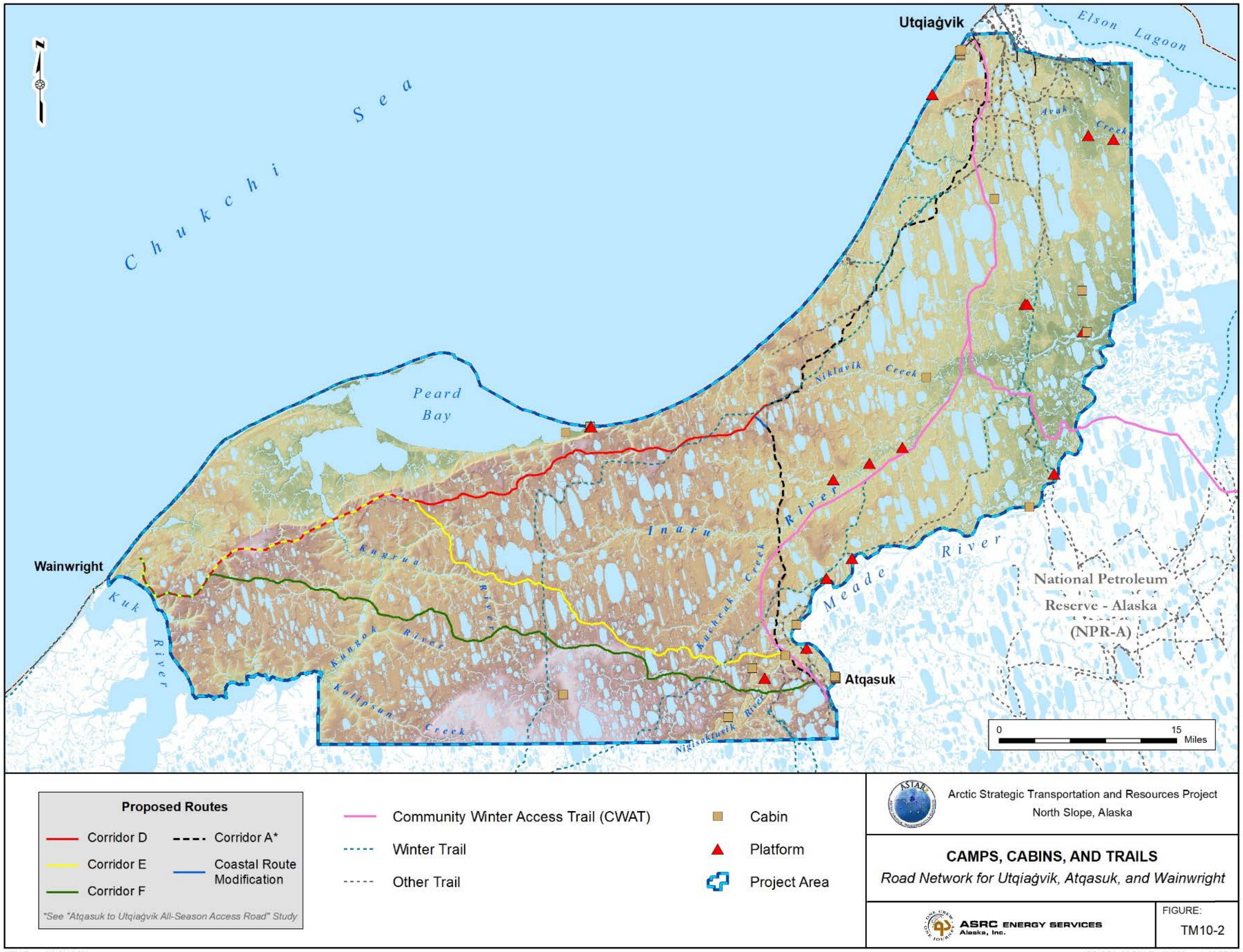
Utqiaġvik
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Inaru River
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Avak Creek
Kugrua River
Kungok River
Kaolak Creek
Kolipsun Creek
Nigisaktuvik River
National Petroleum Reserve - Alaska (NPR-A)
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Proposed Routes
Corridor D
Corridor A*
Corridor E
Coastal Route Modification
Corridor F
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
Community Winter Access Trail (CWAT)
Winter Trail
Other Trail
Cabin
Platform
Project Area
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
CAMPS, CABINS, AND TRAILS
Road Network for Utqiaġvik, Atqasuk, and Wainwright
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Historic Trails

Many rural trails, including ones for mail, mining routes, and other historic transportation routes, have been designated as Revised Statute (RS) 2477 trails. An RS 2477 trail may include historic or prolonged use of the area. A search of Alaska Mapper (ADNR 2019) yielded no RS 2477 trails in the project area.

There are trails in the project area that have been labeled as potential and historic transportation routes but have not been assigned AHRS numbers or RS2477 status (ADNR 1993, 2019). The first inventory of the routes compiled in a State of Alaska, ADNR map was performed by the Alaska Department of Transportation and Public Facilities (ADOT&PF) in 1973. A historic transportation route between Atqasuk and Utqiaġvik is included, as well as another potential route (ADNR 1993).

The proposed coastal route proposed between Utqiaġvik and Wainwright, and the potential southern route between Atqasuk and Wainwright, roughly mirror historic routes mapped by Tremont (1987).

Over time, some of the historically-used subsistence trails have fallen out of use, although some may still receive sporadic usage. Regardless of their level of use, the "Iñupiat consider all of these routes as part of their cultural heritage and realm of activities" (Tremont 1987).

Summer Trails

Tundra becomes marsh-like and wet once the snow has melted, making travel on the North Slope in summertime difficult. Subsistence users travel overland less frequently or for shorter distances during this time than they do in the winter months, using watercraft and, to some extent aircraft, to access subsistence areas. The generalized access routes in Tremont (1987) appear to follow rivers closely.

Winter Trails

The locations of winter subsistence trails are dependent upon local travel patterns, subsistence harvest ranges, and social, physical, and climatic factors that guide their development (Tremont 1987). The north-south winter trail that generally follows the Meade and Inaru Rivers between Atqasuk and Utqiaġvik is one of several Tremont (1987) details in the general project area. The proposed central route east of Wainwright parallels the historic winter industrial trail to Utqiaġvik and Nuiqsut.

Many of these trails appear to parallel the historic transportation routes labeled by ADNR (Figure TM8-2; ADNR 1993). The winter trails not only provide access routes among communities, but they also provide greater ease of access for subsistence users to cabins and campsites. They allow for easier access to subsistence resources in winter, such as caribou, fish, and fur-bearing mammals. These winter trails are actively used by North Slope residents, who travel them via snowmachine and sled (ADOT&PF 2004).

GPS Trails

More recently, selected hunters have carried GPS units to track their movements while performing subsistence activities throughout the NSB. Both summer and winter routes were tracked- aquatic, inland, and sea ice. The areas between Utqiaġvik and Atqasuk, and between Utqiaġvik and Wainwright, are well marked with GPS trails. Less traffic is exhibited between Wainwright and Atqasuk (Harcharek 2015).

Communities

The travel patterns of each village are characterized by the geographic or climatic condition of the arctic region in which the village is located. The following is a brief discussion of the principal subsistence-use areas within each community of the NSB.

Utqiaġvik: Utqiaġvik residents' subsistence-use travel extends from Nuiqsut in the east to Wainwright in the west and the Colville River in the south to the Beaufort Sea in the north. The area is the largest subsistence-harvest zone of the NSB. One of the most frequently used travel routes is the route from Admiralty Bay via the Inaru River (Tremont 1987).

Atqasuk: The main Atqasuk subsistence route was originally a trail that led inland to the now abandoned community of Tigaluk. Atqasuk residents focus their subsistence travel patterns on the Meade River, which is used intensively throughout its length. Atqasuk residents occasionally travel as far upstream as the headwaters. Other rivers comprising an essential component of the community's subsistence zone include the Usuktuk, Shaningarok, Niġisaktugvik, and Inaru river drainages (Tremont 1987).

Wainwright: The Kuk River estuary and its tributaries are the centers for both summer and winter movement for Wainwright residents. After freeze-up, they range along the coast and far into the interior (Tremont 1987).

Data Gaps

BLM guidelines for the management of NPR-A will be finalized in the 2020 IAP Record of Decision.

This document should be updated as new data are made available. Also, the data gap analysis will need to be revised if the project area is changed and/or expanded. Data gaps for subsistence resources will be identified by the land managing or permitting agency/ies, in conjunction with consultation with the local villages, tribal entities, and NSB. Early and frequent consultation with these entities will identify data gaps and will facilitate a smooth process.

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Technical Memorandum 11 – Wetlands

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Technical Memorandum 11 – Wetlands

Prepared by: Joe Christopher, PWS
Reviewed by: Samantha Simpson, PWS, Senior Fisheries Biologist
Date: April 2020

Overview

The project area is located in Alaska's Arctic Coastal Plain physiographic province within the northwest National Petroleum Reserve–Alaska (NPR-A), between Utqiaġvik, Atqasuk and Wainwright (Figure TM11-1). The landscape in the project area is dominated by palustrine patterned ground wetlands underlain by permafrost. The annual thaw cycle in the permafrost active layer drives wetland development in the region. The active layer forms a varied landscape of both high- and low-centered polygons and numerous tundra ponds and lakes. Wetlands vegetation is dominated by low and dwarf facultative shrubs in drier areas, and obligate sedge grasses in areas with a longer duration of standing water. Soil in this area is typical of the Arctic Coastal Plain physiographic province and is composed of thick layers of low permeability organics underlain by ice-rich organic and low chroma (dark) mineral soils.

The southwest coastal portion of the project area contains marine and intertidal waters of the United States associated with Peard Bay. Peard Bay is located in the Chukchi Sea and has been designated by the Bureau of Land Management (BLM) as a Special Area within the NPR-A (BLM 2013). Peard Bay is sheltered by barrier islands and contains high densities of polar bears, seals, and migratory waterfowl. In addition, a small portion of the Teshekpuk Lake Special Area is located in the northeast project area. Teshekpuk Lake is one of the largest lakes in Alaska and provides important habitat for migratory bird populations and caribou insect relief. Technical Memorandum 2–Land Status provides additional information on Peard Bay and Teshekpuk Lake Special Areas.

Fill placed in jurisdictional wetlands and waters of the United States would require a U.S. Army Corps of Engineers (USACE) permit under Section 404 of the Clean Water Act (CWA). Any fill or work in, over, or under a traditional navigable water, including the territorial sea, would also require authorization under Section 10 of the Rivers and Harbors Act.

The extent of wetlands and waters of the U.S. within the project area and the corridors analyzed were based on the U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) Mapping (USFWS 2019). Small portions of the project area where no NWI mapping exists were inferred based on aerial photography and best professional judgment.

The project area was evaluated using the USACE Alaska District Compensatory Mitigation Thought Process (Thought Process) (USACE 2018) to assess the most beneficial corridor locations in the project area with respect to CWA Section 404 permitting. Impacts requiring only a Section 10 authorization do not typically require compensatory mitigation. The USACE utilizes the Thought Process as an objective and defensible method to determine if compensatory mitigation may be necessary. By evaluating the wetland habitats in the project area against the requirements of the Thought Process, it is possible to estimate portions of the project area that would be more favorable, and less costly to permit with respect to compensatory mitigation. The results of this analysis are presented in the following sections.

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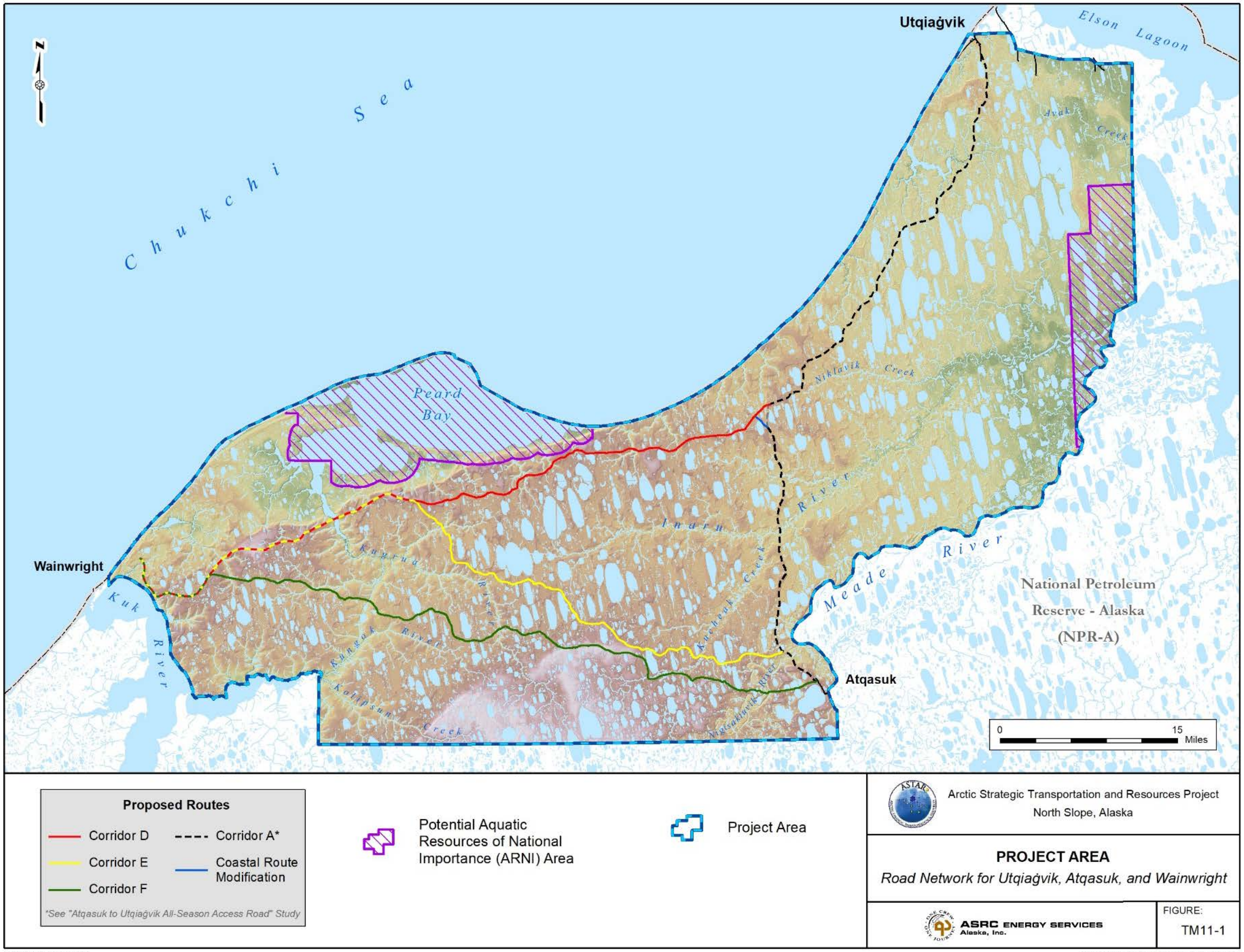
Utqiaġvik
Elson Lagoon
Chukchi Sea
Peard Bay
Wainwright
Atqasuk
Kuk River
Meade River
Inaru River
Avak Creek
Niklavik Creek
Kugrua River
Kungok River
Kaolak River
Kuchiak Creek
Nigisaktuvik River
National Petroleum Reserve - Alaska (NPR-A)
0 15 Miles
Proposed Routes
Corridor D
Corridor A*
Corridor E
Coastal Route Modification
Corridor F
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
Potential Aquatic Resources of National Importance (ARNI) Area
Project Area
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
PROJECT AREA
Road Network for Utqiaġvik, Atqasuk, and Wainwright
ASRC ENERGY SERVICES Alaska, Inc.
FIGURE:
TM11-1
UTM Zone 4N (NAD83)
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Total Wetlands/Uplands Acres within the Project Area per 10-Digit HUC

The first step in the Thought Process is to identify the watershed and watershed scale that is most appropriate for the project with respect to existing development and overall project impacts. United States Geological Survey (USGS) 10-Digit Hydrologic Unit Code (HUC) was selected because the project area overall does not represent an area of elevated development activities, which conforms to USACE Thought Process evaluation criteria. The acres of wetlands and uplands within each USGS 10 Digit HUC were calculated using NWI mapping and aerial image interpretation. Table TM11-1, below, shows the total wetlands and uplands mapped within the fifteen 10-digit HUC watersheds potentially impacted by the project area. Some of the project area is not currently mapped by NWI. The unmapped acres are listed in Table TM11-1 to identify data gaps where future wetlands information would be required to complete this analysis; therefore, they are not included in the watershed totals or the watershed disturbance calculation. Please note that natural uplands and disturbed uplands are separated out in order to identify which HUCs have anthropogenic disturbance. Existing anthropogenic disturbance is an important feature to identify when determining if a watershed is disturbed, and is a required parameter in the Thought Process. The wetlands mapping within the project area is shown on Figure TM11-2.

Table TM11-1. Total Wetlands/Uplands (acres) per 10 Digit HUC

USGS 10 Digit HUC Name	Palustrine Emergent/Shrub Wetlands	Other WOUS (Streams/Lakes/ Ponds/Marine)	Uplands Natural	Uplands Disturbed	Unmapped **	Totals
Kungok River	189,100	44,257	268	0.0	0.0	233,625
Kuk River	175,945	55,469	1,160	0.0	0.0	232,575
Wainwright Inlet	18,394	12,978	819.9	89.8	0.0	32,281
1906020311	90,102	25,243	143	0.0	7,480	115,487
Headwaters Inaru RIver	218,037	64,743	2.6	0.0	0.0	282,783
Kusheak Creek	71,770	20,972	193	0.0	0.0	92,936
Middle Meade River	73,633	31,067	3,423	64.3	130,920	108,188
Outlet Inaru River	140,045	61,486	32.8	5.4	0.0	201,569
Outlet Meade River	206,065	94,392	6,158	28.0	0.0	306,643
Outlet Nigisaktuvik River	152,793	42,290	4,170	83.7	4,230	199,337
Avak Creek-Frontal Harrison Bay	130,853	197,233	378	263	0.0	328,727
Isatkoak Lagoon-Frontal Chukchi Sea	150,894	148,266	677	1,245	0.0	301,082
Kugrua River	156,902	28,154	19.5	19.1	0.0	185,094
Peard Bay-Frontal Chukchi Sea	85,575	85,061	10.7	0.0	0.0	170,646
Point Belcher-Frontal Chukchi Sea	57,638	160,115	603	155	0.0	218,511

Note: Totals may not add up due to rounding

** Unmapped portions of the watershed are not included in totals. These would need to be mapped to obtain accurate watershed disturbance levels.

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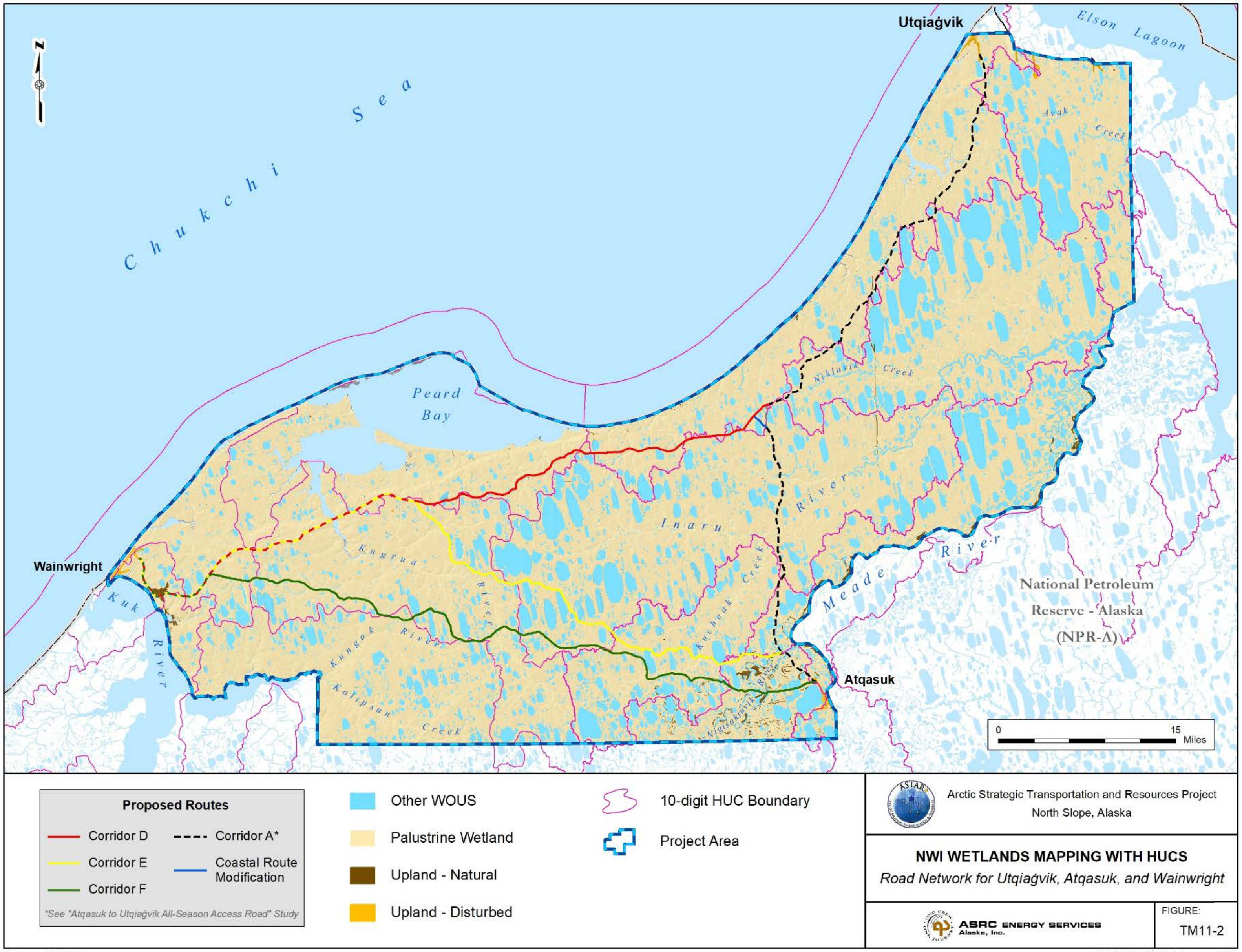
Utqiaġvik
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Peard Bay
Wainwright
Kuk River
Atqasuk
Meade River
Inaru River
Kugrua River
Kungok River
Kolipsun Creek
Kucheak Creek
Niklavik Creek
Avak Creek
National Petroleum Reserve - Alaska (NPR-A)
0 15 Miles
Proposed Routes
Corridor D
Corridor A*
Corridor E
Coastal Route Modification
Corridor F
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
Other WOUS
Palustrine Wetland
Upland - Natural
Upland - Disturbed
10-digit HUC Boundary
Project Area
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
NWI WETLANDS MAPPING WITH HUCS
Road Network for Utqiaġvik, Atqasuk, and Wainwright
ASRC ENERGY SERVICES Alaska, Inc.
FIGURE:
TM11-2
UTM Zone 4N (NAD83)
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The Thought Process provides a crosswalk from the implementing regulations provided in 33 Code of Federal Regulations (CFR) Part 320.4(r)(2) to Alaska District internal guidance regarding the need for compensatory mitigation.

Alaska District internal guidance provides six instances where compensatory mitigation may be required. They are as follows:

1. Project occurs in a rare, difficult to replace or threatened wetlands, or areas of designated critical habitat;
2. Project places fill material in more than a $1/10^{th}$ acre of wetlands or other waters of the United States and/or 300 linear feet (ft) of stream, AND the watershed condition is such that compensatory mitigation is necessary;
3. Fill is placed within intertidal waters associated with special aquatic sites;
4. Fill is placed in fish bearing waters, or wetlands within 500 ft of such waters when impacts are determined to be more than minimal;
5. The project is federally funded;
6. Project is large scale with adverse aquatic resource impacts.

AES Alaska's analysis of using the above Alaska District crosswalk guidance is provided below.

Rare, Difficult to Replace, or Threatened Wetlands and Wetlands located in Designated Critical Habitat

The *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Alaska Region (Version 2.0)* (USACE 2007) identifies that wetlands occupy as much as 83 percent of the land area of the Arctic Coastal Plain; therefore, wetlands in the overall project area are not rare or threatened; however, the wetlands in the Peard Bay Special Area and Teshekpuk Lake Special area could be considered an Aquatic Resource of National Importance (ARNI); thus wetlands and waters of the U.S in these areas are likely to be considered unique and may require special status consideration.

AES Alaska reviewed USFWS Polar Bear Critical Habitat (PBCH) mapping to estimate the area of PBCH within each HUC. Based on this analysis, 48,350 acres of the project area are designated as PBCH. However, none of the route alternatives are located in PBCH.

AES Alaska used North Slope Science Initiative (NSSI 2013) data and wetland Cowardin classifications to estimate the existence and concentration of *Arctophila fulva* (pendant grass) in each HUC. The USFWS considers pendant grass a high value vascular plant important to spectacled and Stellar's eider nesting and foraging habitat, and as difficult to replace. Additionally, the USACE recently issued a special public notice where they intend to authorize minor fill activities (less than 10 acres) under a Regional General Permit. Conditions in that permit restrict fill placement in certain wetland types or within a 100 ft buffer of those wetlands because they are considered high quality wetlands that are difficult to replace. These wetlands and their buffers include: One hundred feet of other riverine waters, lacustrine waters, or palustrine wetlands with an unconsolidated bottom (PUB), subclass 2 (PEM2, indicating they are associated with *Arctophila*), or a water regime modifier of F, G, H, L, or N (PEMF/G/H/L/N, including beaded streams).

The BLM, in their 2013 Integrated Activity Plan (IAP), has identified Best Management Practices (BMPs) for in the NPR-A that are considered special protection areas important to the ecosystem (BLM 2013). The IAP is directed toward oil and gas development projects; however, it is reasonable to include the BMPs in our analysis, as these areas may include wetlands with administrative conditions that are considered difficult to replace. The BMPs include minimizing impacts to spectacled and Steller's eiders, and setbacks from yellow-billed loon nests.

Based on our analysis, the project area contains approximately 1.1 million acres of cumulative wetlands and other waters of the United States that may be considered difficult to replace (Table TM11-2).

Table TM11-2, below, provides a summary of each 10-digit HUC with respect to rare, difficult to replace wetlands (Biological and Administrative), and/or wetlands located in areas of critical habitat. Please note, the wetlands acreages presented below may be included in multiple analysis categories; therefore, the acreages in the table may represent cumulative acreages.

Table TM11-2. Project Area Wetlands within Special Habitat Areas

USGS 10-Digit HUC Name	Rare (ARNI) Wetlands (Acres)	Polar Bear Critical Habitat (Acres)	Biologically Difficult to Replace Wetlands (Acres)	Difficult to Replace Wetlands with Administrative Conditions (K1/K2 Areas) (Acres)	Intertidal Waters (Acres)
Kungok River	0	0	49,702	37,415	254
Kuk River	0	0	2,207	0	295
Wainwright Inlet	0	0	2,296	0	242
1906020311	0	0	669	0	0
Headwaters Inaru River	2	0	171,070	76,899	0
Kusheak Creek	0	0	62,487	32,503	0
Middle Meade River	0	0	3,277	30	0
Outlet Inaru River	19,904	5,415	136,663	38,620	0
Outlet Meade River	22,085	8,662	88,868	34,655	0
Outlet Nigisaktuvik River	0	0	24,684	24,465	0
Avak Creek-Frontal Harrison Bay	3,948	31,655	57,668	22	0
Isatkoak Lagoon-Frontal Chukchi Sea	266	2,618	56,995	2,890	2,535
Kugrua River	289	0	72,685	27,804	3,271
Peard Bay-Frontal Chukchi Sea	103,964	0	95,677	10	79,152
Point Belcher-Frontal Chukchi Sea	2,612	0	13,680	0	4,373
Totals	153,070	48,350	838,628	275,313	90,122

* Administratively Difficult to Replace Wetlands are BMPs identified in the BLM 2013 IAP and include select streams (K1) and deepwater lakes (K2) with potential setback distance requirements (BLM 2013).

Current Watershed Condition

The project area includes portions of fifteen 10-digit HUC watersheds that have experienced a maximum of 0.5% disturbance from previous anthropogenic activities; therefore, they are not currently considered disturbed or degraded. The 10-digit HUC identification of these watersheds and the existing percent disturbance are shown in Table TM11-3.

Table TM11-3. Existing Fill Placement

USGS 10-Digit HUC Name	Total Watershed Acres*	Existing Fill (Acres)	Existing Fill (%)
Kungok River	233,625	0.0	<0.1
Kuk River	232,575	0.0	<0.1
Wainwright Inlet	32,281	89.8	0.5
1906020311	115,487	0.0	<0.1
Headwaters Inaru RIver	282,783	0.0	<0.1
Kusheak Creek	92,936	0.0	<0.1
Middle Meade River	108,188	64.3	0.1
Outlet Inaru River	201,569	5.4	<0.1
Outlet Meade River	306,643	28.0	<0.1
Outlet Nigisaktuvik River	199,337	83.7	<0.1
Avak Creek-Frontal Harrison Bay	328,727	263	<0.1
Isatkoak Lagoon-Frontal Chukchi Sea	303,515	1,245	0.4
Kugrua River	185,094	19.1	<0.1
Peard Bay-Frontal Chukchi Sea	170,646	0.0	<0.1
Point Belcher-Frontal Chukchi Sea	218,511	155	<0.1

*Note- Totals do not include unmapped acres

Intertidal Waters

Table TM11-2 shows the project area acreage in each 10-digit HUC associated with intertidal waters. These deepwater and adjacent tidal wetlands are classified as Estuarine under the Cowardin Classification System (Cowardin et al. 1979). They encompass the coastal wetland habitats subject to tidal flux by having open, partly obstructed, or sporadic access to the open ocean. Based on our analysis, the project area contains approximately 90,122 acres of wetlands and other waters of the United States may be considered Intertidal Waters.

Fill Placed in Fish Bearing Streams and their Adjacent Wetlands

Table TM11-4 shows the project area acreage in each 10-digit HUC associated with resident and anadromous fish bearing waters, or jurisdictional wetlands within 500 ft of those bearing waters. The location of fish bearing waters were determined based on the Alaska Department of Fish and Game (ADF&G) Anadromous Waters Catalog (AWC) (ADF&G 2019). In addition, lakes over 20 acres in size that were not in the ADF&G AWC were assumed to have resident fish.

Table TM11-4. Project Area Resident Fish Bearing and Anadromous Waters and Wetlands within 500 ft of those Waters

USGS 10-Digit HUC Name	Resident Fish Bearing Waters (Acres)	Anadromous Waters (Acres)
Kungok River	24,119	3,659
Kuk River	1,183	455
Wainwright Inlet	1,526	345
1906020311	539	0
Headwaters Inaru River	94,510	5,215
Kusheak Creek	31,621	13
Middle Meade River	3,078	168
Outlet Inaru River	83,971	5,007
Outlet Meade River	52,968	4,619
Outlet Nigisaktuvik River	16,268	3,625
Avak Creek-Frontal Harrison Bay	32,794	4,417
Isatkoak Lagoon-Frontal Chukchi Sea	25,708	18
Kugrua River	33,702	7,616
Peard Bay-Frontal Chukchi Sea	8,874	193
Point Belcher-Frontal Chukchi Sea	8,230	0

Federal Funding

At this point it is uncertain where funding for construction of the project would originate. According to Executive Order 11990, compensatory mitigation would be necessary for portions of a project that receive federal funding in order to meet the national policy goal of no net loss of wetlands. This should be reevaluated once the funding sources are known.

Project Scale and Impact Severity

A road corridor of this scale would likely be considered a large project, and would most likely require an Environmental Impact Statement prior to receiving a CWA Permit from the USACE and a federal Right-of Way authorization from BLM. The severity of impacts would be project specific and dependent on the avoidance and minimization procedures incorporated into the project design.

Corridor Analysis

AES Alaska analyzed the three preliminary corridors and one modified coastal route corridor in the project area against the Thought Process and total wetlands impacts. Table TM11-5, below, and Figure TM11-3 provide the findings of our application of the Thought Process to each route. The wetlands acreages presented below may be included in multiple analysis categories; therefore, the acreages in the table may represent cumulative acreages.

Table TM11-5. Thought Process Corridor Analysis

	Rare (ARNI) Wetlands (Acres)	Polar Bear Critical Habitat (Acres)	Biologically Difficult to Replace Wetlands (Acres)	Difficult to Replace Wetlands with Administrative Conditions (K1/K2 Areas)	Resident Fish Bearing Waters (Acres)	Anadromous Waters (Acres)	Intertidal Waters (Acres)	Total Cumulative Category Impacts
Corridor D	0	0	1,955	252	756	118	12	3,093
Corridor E	0	0	5,832	2,030	1,500	118	12	9,492
Corridor F	0	0	5,560	2,943	1,921	41	0	10,465
Modification to Coastal Route	0	0	84	0	109	0	0	193
Totals	0	0	13,431	5,225	4,286	277	24	23,243

* Administratively Difficult to Replace Wetlands are BMPs identified in the BLM 2013 IAP and include select streams (K1) and deepwater lakes (K2) with potential setback distance requirements (BLM 2013).

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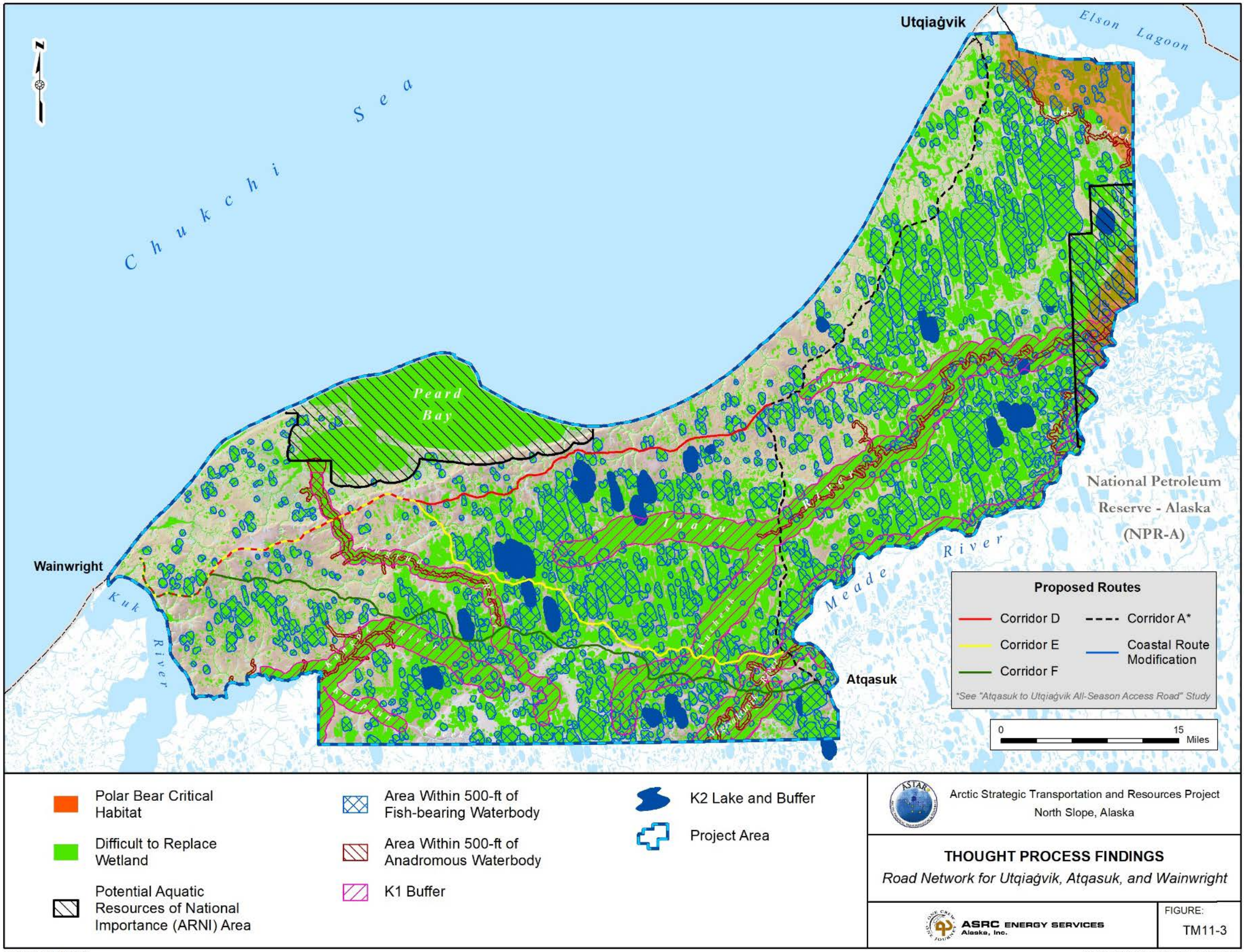
Utqiaġvik
Elson Lagoon
Chukchi Sea
Peard Bay
Wainwright
Kuk River
Meade River
Atqasuk
National Petroleum Reserve - Alaska (NPR-A)
Proposed Routes
Corridor D
Corridor A*
Corridor E
Coastal Route Modification
Corridor F
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
0
15
Miles
Polar Bear Critical Habitat
Difficult to Replace Wetland
Potential Aquatic Resources of National Importance (ARNI) Area
Area Within 500-ft of Fish-bearing Waterbody
Area Within 500-ft of Anadromous Waterbody
K1 Buffer
K2 Lake and Buffer
Project Area
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
THOUGHT PROCESS FINDINGS
Road Network for Utqiaġvik, Atqasuk, and Wainwright
ASRC ENERGY SERVICES
Alaska, Inc.
FIGURE:
TM11-3
UTM Zone 4N (NAD83)
AES-RTS: 20-001-TM11-003.mxd, 04/06/20

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Our analyses of the Corridors using the USACE Thought Process has determined the following:

- Corridor D would require the least amount of wetland fill that in areas that may require compensatory mitigation.
- None of the corridors would require fill in an ARNI.
- None of the corridors would result in fill placed in critical habitats.
- Each of the corridors would result in placement of fill in wetlands considered difficult to replace, as well as wetlands within 500 ft of resident and anadromous fish bearing waters. Corridor D would have the least fill within resident fish bearing streams and Corridor F has the least fill within 500 ft of anadromous streams.
- Based on current NWI mapping and available imagery, none of the project area contains a significant amount of existing fill. Therefore, none of the corridor options would be in a watershed that is considered degraded.
- Route refinement should be completed during final design to determine if avoidance measures can be incorporated to reduce fill volumes in intertidal areas.

Data Gaps

Data gaps for wetlands and wetlands impacts:

- A desktop wetland delineation should be completed for those portions of the project area where no NWI mapping exists.
- A formal wetland delineation following USACE procedures should be competed with a 1,000 ft buffer of the proposed center line of each route.
- Fish surveys should be completed at waterbodies within 500 ft of the route that do not have documented resident or anadromous fish presence.
- A pendant grass survey should be completed along with the wetlands delineation.
- Determine if federal funding would be part of the project construction.

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Technical Memorandum 12 – Threatened & Endangered Species

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Technical Memorandum 12 – Threatened and Endangered Species

Prepared by: Shannon Mason, Environmental Scientist

Reviewed by: Stewart Seaberg, Principal Biologist

Date: April 2020

Overview

The Endangered Species Act (ESA) of 1973 provides a process by which animal or plant populations that are in jeopardy of extinction throughout all or a significant portion of their range can be listed as threatened or endangered to protect the species and its critical habitat. A threatened species is an animal or plant species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. An endangered species is a species that is in danger of extinction throughout all or a significant portion of its range. Critical habitat consists of designated areas that are essential to the conservation and continued existence of the species.

Regulatory Drivers

Under the ESA, the taking of a listed species is prohibited without an authorization such as a Letter of Authorization or Incidental Harassment Authorization, issued by the agency that has jurisdiction over that species. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. This may include significant habitat modification or degradation if it kills or injures wildlife by significantly impairing essential behavioral patterns including breeding, feeding, or sheltering. Table TM12-1 lists the species, listing agency, and status of species that could potentially occur in the proposed project area.

Table TM14-1. Species, Listing Agency, and Status of Species Found In the Proposed Project Area

Species	Listing Agency	Status
Polar Bear (*Ursus maritimus*)	USFWS	Threatened
Spectacled Eider (*Somateria fischeri*)	USFWS	Threatened
Steller's Eider (*Polysticta stelleri*)	USFWS	Threatened

As sea ice comprises the principal habitat of polar bears, the species is protected under the Marine Mammal Protection Act. Requirements of this act generally prohibit the take or import of marine mammals and their parts or products.

The U.S. Army Corps of Engineers (USACE) and the Bureau of Land Management (BLM) will not permit ground disturbing activity from June 1 through July 31 for North Slope projects that expand gravel infrastructure in the habitat of listed species in wetlands or BLM lands (USFWS 2020).

Polar Bears

Polar bears have a circumpolar range in the Northern Hemisphere that is determined primarily by seasonal ice. Polar bears generally live on the pack ice, following the advancing and retreating ice edge, as this is the most productive area for hunting seals. A map showing the range of polar bears along Alaska's northern coast is presented as Figure TM12-1. Only pregnant females den to bear their young. Dens are generally located on the mainland near cliffs or riverbanks where the snow accumulates to sufficient depths, or in areas of stable pack ice with snow depths adequate for denning sites. Females enter dens during October through November, exiting in March through April.

Declining sea ice in the arctic marine environment may lead to changes in polar bear use of their terrestrial environment. Sea ice must be stable for ice denning to be successful. Therefore, if the quality of sea ice decreases, more females may den on land (Durner et al. 2006). An estimate of greater than 60 percent of females from the Southern Beaufort Sea population currently den on land, while the remaining females den on drifting pack ice (Fischbach et al. 2007). Climate change may also affect the quality of denning habitat on coastal or island bluffs due to rapid erosion and slope failure caused by melting permafrost (Durner et al. 2006).

The polar bear was listed by the US Fish and Wildlife Service (USFWS) as a threatened species under the ESA on May 15, 2008 (USFWS 2008).

The USFWS published a final rule on December 7, 2010, designating critical habitat for the polar bear, effective January 6, 2011 (USFWS 2010a). The rule designated critical habitat encompassing three units: Unit 1–sea ice, Unit 2–terrestrial denning habitat, and Unit 3–barrier island habitat. The total area designated covers 187,157 square miles (mi^2) of which about 96 percent is sea ice habitat.

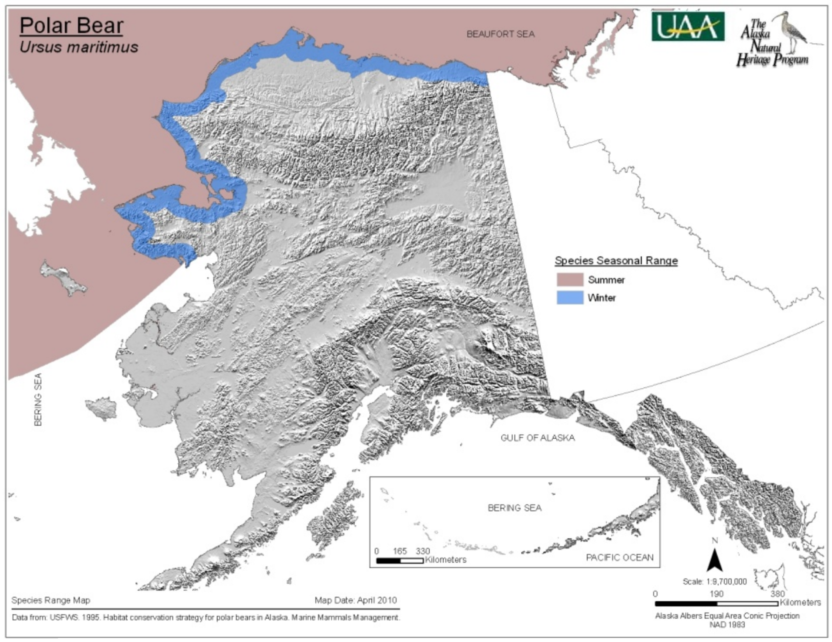
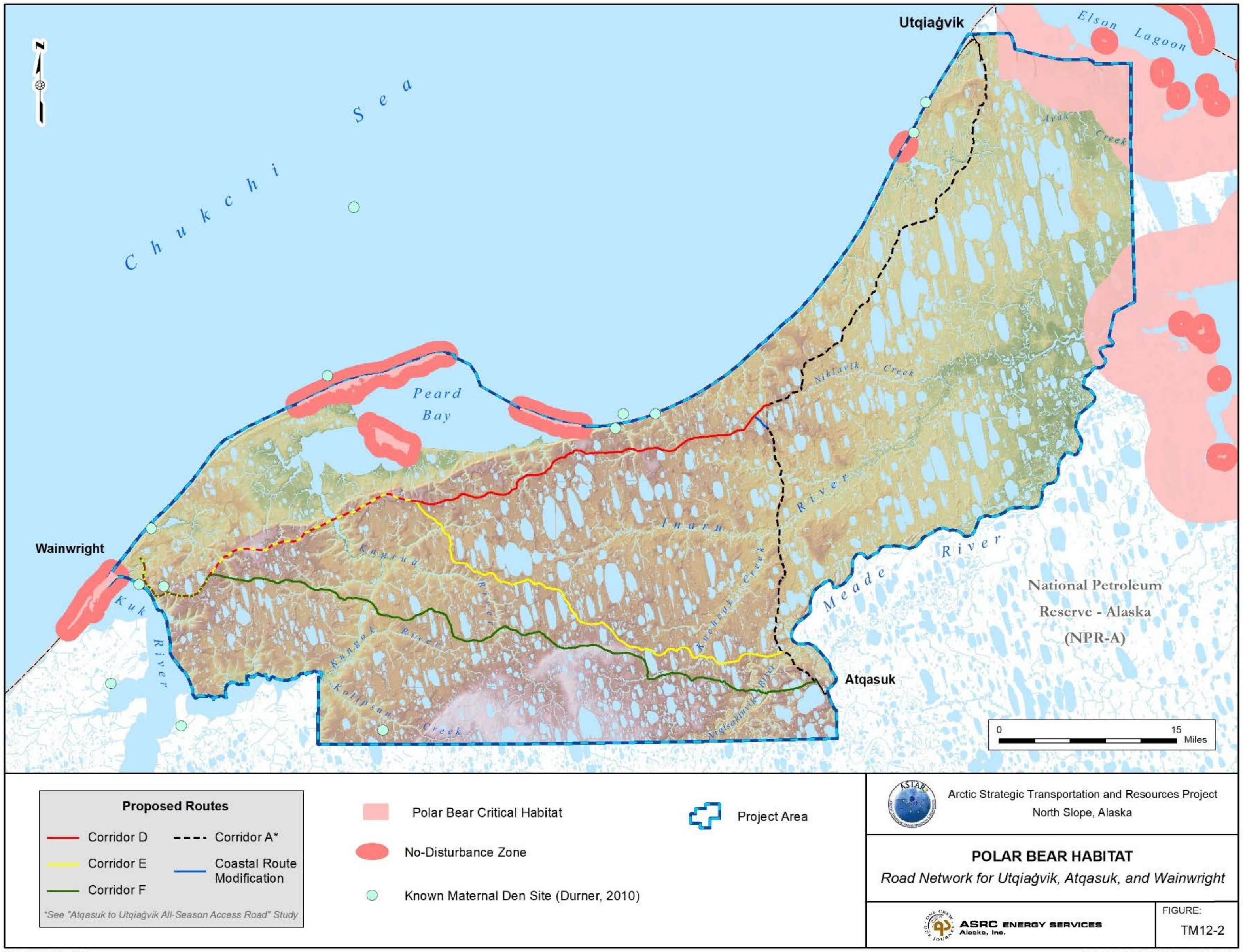


Figure TM12- 1. Map showing the range of polar bears along Alaska's north and northwest coasts (Alaska National Heritage Program 2010).

The sea ice critical habitat is located over the continental shelf, and includes ice over water up to 984 feet (ft) in depth extending to the outer limits of the US Exclusive Economic Zone, 200 miles (mi) from shore. Terrestrial denning habitat includes lands within 20 mi of the northern coast of Alaska between the Canadian border and the Kavik River and within 5 mi between the Kavik River and Utqiaġvik. The barrier island critical habitat includes coastal barrier islands and spits along Alaska's northern coast, and water, sea ice, and land within one mile of the barrier islands.

Barrier islands and associated spits within the study area contain habitat designated as critical to polar bears (Figure TM12-2), but these areas do not overlap with the proposed project corridors. Within the study area, maternal dens have primarily been found near the coast, although they have also been inland in the drainages between Wainwright and Atqasuk. Any active polar dens found within the Bureau of Land Management (BLM) land in the project area would be subject to the prohibition of any activities that could potentially disturb dens within one mile of active polar bear dens (BLM 2013).


Utqiaġvik
Elson Lagoon
Chukchi Sea
Peard Bay
Wainwright
Atqasuk
Kuk River
Meade River
Inaru River
Niklavik Creek
Ivak Creek
Kaolak River
Kungok River
Kolipsun Creek
Kuchiak Creek
National Petroleum Reserve - Alaska (NPR-A)
0
15
Miles
Proposed Routes
Corridor D
Corridor E
Corridor F
Corridor A*
Coastal Route Modification
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
Polar Bear Critical Habitat
No-Disturbance Zone
Known Maternal Den Site (Durner, 2010)
Project Area
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
POLAR BEAR HABITAT
Road Network for Utqiaġvik, Atqasuk, and Wainwright
ASRC ENERGY SERVICES
Alaska, Inc.
FIGURE:
TM12-2
UTM Zone 4N (NAD83)
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Steller's Eiders

The Steller's eider is a small sea duck with a Holarctic distribution in Russia and Alaska. Three distinct breeding populations are recognized: the Alaska breeding population, the Russian Atlantic breeding population, and the Russian-Pacific breeding population. These breeding populations mix in wintering areas such as the Bering Sea.

The Alaska breeding population of the Steller's eider was listed as a threatened species under the ESA on June 11, 1997 based on the observed contraction in the breeding range in Alaska and the resulting increased vulnerability of the remaining breeding population (USFWS 1997). Potential causes to the decline in population include hunting, ingestion of lead shot, predation, and changes in the marine environment that may be affecting eider food resources.

Approximately 2,830 square miles of land and coastal waters in five units were designated as critical habitat for the Alaskan breeding population of Steller's eiders in 2001 (USFWS 2001b). These areas include the Yukon-Kuskokwim Delta, staging areas in the Kuskokwim Shoals, and molting areas near the Seal Islands, Nelson Lagoon, and Izembek Lagoon on the Alaska Peninsula. Only Steller's eiders that nest in Alaska are listed as threatened, and no critical habitat has been designated within the study area.

A comprehensive analysis of Steller's eiders on the Arctic Coastal Plain estimated an average population of 576 Steller's eiders (90% CI = 292–859) from 1993 to 2008 (Stehn and Platte 2009). The Utqiaġvik area is the birds' primary breeding area in North America (Quakenbush et al. 2004). In early June to July as nesting begins, Steller's eiders commonly use shallow *Carex* and *Arctophila* ponds for nesting habitat (Safine 2011, Graff 2018). Hatching generally occurs in mid to late July and Steller's eiders and their broods forage on insect larvae and beetle species in emergent vegetation in shallow ponds. Steller's eiders move to coastal marine water as broods fledge in mid-August to early September (Rojek 2008).

The mapping of geographic distribution is limited by the data publically available. Figure TM12-3 illustrates Steller's eider nests and observations in the project area. Outside Utqiaġvik, low densities of Steller's eiders are found within the proposed corridors (Figure TM12-4). Active Steller's eiders nests are currently subject to a 656 ft buffer from June 1 through August 15 within the NPR-A (BLM 2013).

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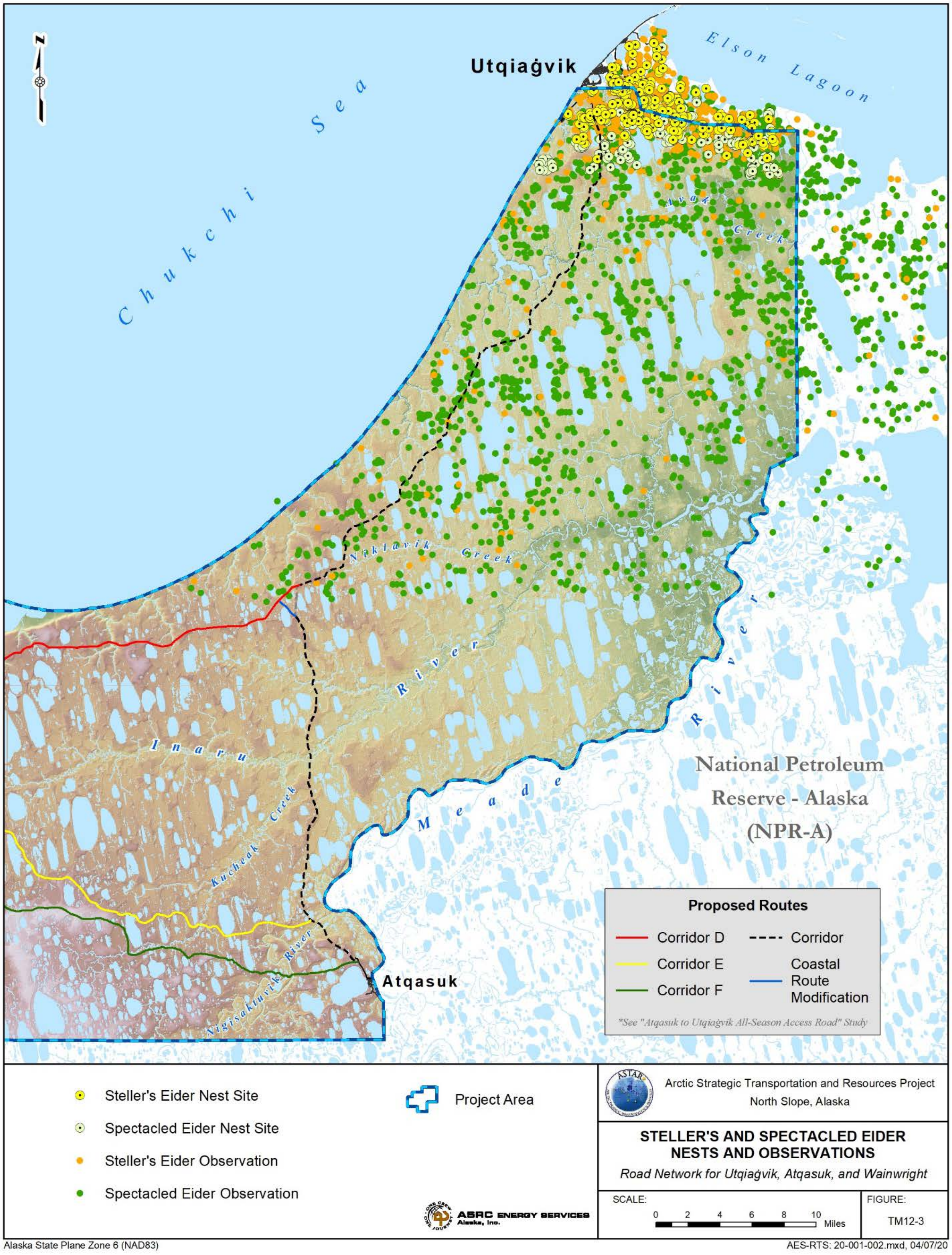
Utqiaġvik
Elson Lagoon
Chukchi Sea
Avak Creek
Nikiavik Creek
River
Inaru
Kucheak Creek
Meade River
Nigisaktuvik River
Atqasuk
National Petroleum Reserve - Alaska (NPR-A)
Proposed Routes
Corridor D
Corridor E
Corridor F
Corridor
Coastal Route Modification
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
Steller's Eider Nest Site
Spectacled Eider Nest Site
Steller's Eider Observation
Spectacled Eider Observation
Project Area
ASRC Energy Services Alaska, Inc.
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
STELLER'S AND SPECTACLED EIDER NESTS AND OBSERVATIONS
Road Network for Utqiaġvik, Atqasuk, and Wainwright
SCALE:
0 2 4 6 8 10 Miles
FIGURE:
TM12-3
Alaska State Plane Zone 6 (NAD83)
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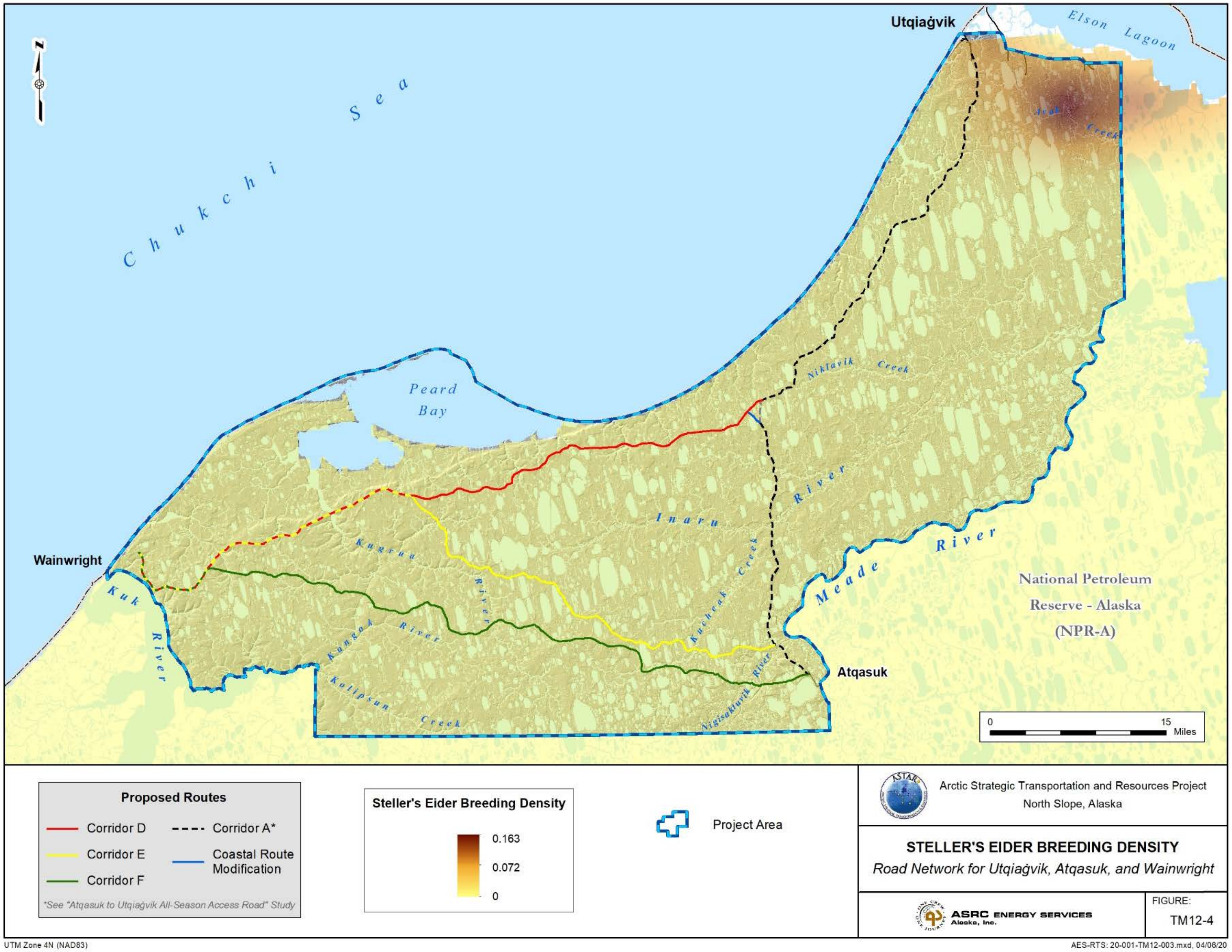
Utqiaġvik
Elson Lagoon
Chukchi Sea
Peard Bay
Wainwright
Atqasuk
Kuk River
Kugrua River
Kungok River
Kolipsun Creek
Nigisaktuvik River
Kucheak Creek
Inaru River
Niklavik Creek
Meade River
Avak Creek
National Petroleum Reserve - Alaska (NPR-A)
0
15
Miles
Proposed Routes
Corridor D
Corridor A*
Corridor E
Coastal Route Modification
Corridor F
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
Steller's Eider Breeding Density
0.163
0.072
0
Project Area
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
STELLER'S EIDER BREEDING DENSITY
Road Network for Utqiaġvik, Atqasuk, and Wainwright
ASRC ENERGY SERVICES
Alaska, Inc.
FIGURE:
TM12-4
UTM Zone 4N (NAD83)
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Spectacled Eiders

The spectacled eider is a sea duck that inhabits the northern extent of the Pacific Ocean in the Chukchi and Bering Seas. Three primary breeding populations have been identified; the Russian arctic population, the Arctic Coastal Plain of Alaska population, and the Yukon-Kuskokwim Delta population in western Alaska. A map showing the range of spectacled eiders is presented as Figure TM12-4.

The spectacled eider was listed as threatened throughout its range under the ESA May 10, 1993 (USFWS 1993). Possible causes for the declines in the populations were due to exposure to lead shot, increased predation, and changes in forage quality in wintering areas of the Bering Sea (USFWS 2002). Critical habitat for spectacled eiders was designated by the USFWS in 2001 (USFWS 2001a) and is composed of nesting habitat in the Delta, molting areas in Norton Sound and Ledyard Bay, and wintering habitat south of St. Lawrence Island. Ledyard Bay, located between Point Hope and Wainwright, is the only area on the North Slope listed as critical habitat for the spectacled eider, as it is a principal molting area. Other important molting and staging areas in the Chukchi Sea include Peard Bay and Kasegaluk Lagoon (Petersen et al. 1999).

The highest densities of spectacled eiders on the Arctic Coastal Plain of Alaska have been found northeast of Teshekpuk Lake, the Prudhoe/Kuparuk area, and around Utqiaġvik (Larned et al. 2010, 2011). Spectacled eider breeding populations arrive in the area in late May or early June and nest in coastal wetlands near relatively shallow lakes and ponded areas dominated by emergent vegetation. Males depart the nesting grounds once females begin to incubate their clutch of eggs from mid- to late June. Depending upon breeding success, females will leave nesting areas between late June and early September.

While there is no critical habitat designation within the project area, there is a known breeding spectacled eider population by Utqiaġvik. This breeding population has fluctuated from 24 to 221 spectacled eiders in a breeding season, since surveys began in 1999 (Graff 2018). Observed numbers have been relatively high in recent surveys, with a record high of 221 in 2017.

Figure TM12-3 illustrates spectacled eider nests and observations in the project area. Low densities of spectacled eiders are found along the proposed corridors (Figure TM12-5). Active spectacled eiders are subject to a 656 ft buffer from June 1 through August 15 within the NPR-A (BLM 2013).

Existing Data

U.S. Geological Survey and USFWS has maintained a database of polar bear denning locations dataing back to 1910 throughout the Arctic Coastal Plain (ACP). In recent years, Forward-looking Infrared has been used to detect yearly polar bear denning locations for winter projects.

Aerial surveys of birds of the Arctic Coastal Plain have been conducted annually by the USFWS since 1986 (Amundsen et al 2019). Since 1991, foot surveys of Steller’s eiders breeding biology around the Utqiaġvik area have been conducted by the USFWS Ecological Services Fairbanks Field office and the North Slope Borough Wildlife Department. Yearly breeding pair ground surveys in the Utqiaġvik area and aerial studies known as the Barrow Triangle Surveys done by ABR, Inc. began in 1999. The project area is also included in the waterfowl breeding population survey area, conducted regularly by USFWS. These studies have allowed for the documentation of the abundance and distribution of both Steller’s and spectacled eiders and avian predators in the Utqiaġvik area.

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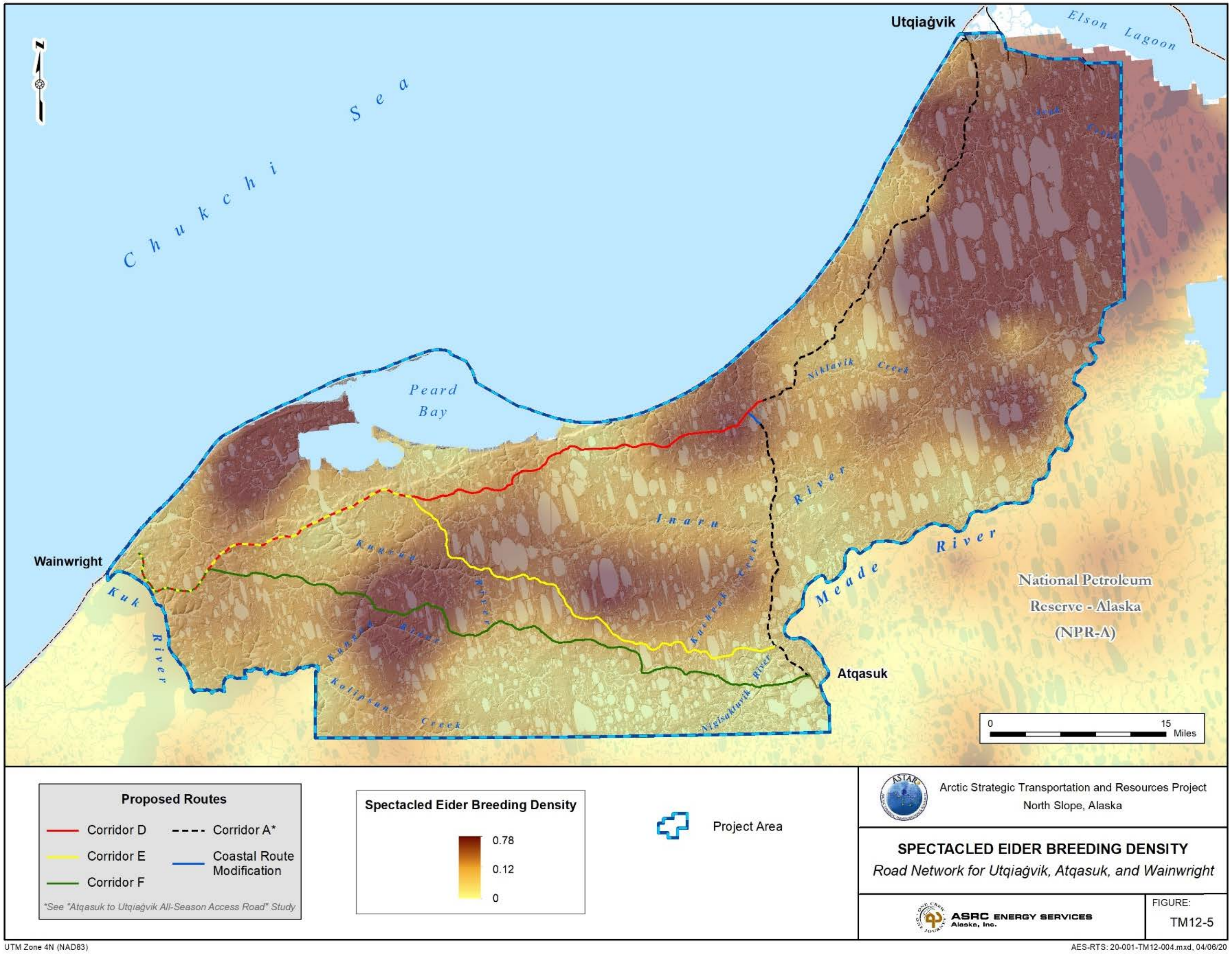
Utqiaġvik
Elson Lagoon
Chukchi Sea
Peard Bay
Wainwright
Kuk River
Nikilavik Creek
Inaru River
Meade River
Atqasuk
Kolipsun Creek
Nigisaktuvik River
National Petroleum Reserve - Alaska (NPR-A)
0
15
Miles
Proposed Routes
Corridor D
Corridor E
Corridor F
Corridor A*
Coastal Route Modification
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
Spectacled Eider Breeding Density
0.78
0.12
0
Project Area
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
SPECTACLED EIDER BREEDING DENSITY
Road Network for Utqiaġvik, Atqasuk, and Wainwright
ASRC ENERGY SERVICES
Alaska, Inc.
FIGURE:
TM12-5
UTM Zone 4N (NAD83)
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Data Gaps

While yearly survey data exists, denning and nesting locations are dynamic and historical data may not reflect denning and nesting found during project construction. Most existing data sources will only provide general distribution or broad scale information for ESA listed species. Survey lines are spaced wide apart in the USFWS aerial surveys and the eiders appear to have a clumped nesting distribution (NSB nd.).

A large portion of the proposed project is on BLM lands, whose guidelines may be revised in the 2020 Final IAP EIS. The 2013 IAP EIS establishes that development in the NPR-A would require:

- Surveys conducted for potential polar bear dens before initiating activities around coastal habitat between October 30 and April 15.
- Three years of pre-disturbance aerial surveys for Steller's and spectacled eiders. Results of these surveys may require additional ground nest surveys.
- USFWS-approved Steller's and spectacled eiders ground nest surveys would be conducted prior to development during mid-June.

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Technical Memorandum 13 – Terrestrial Mammals

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Technical Memorandum 13 – Terrestrial Mammals

Prepared by: Shannon Mason, Environmental Scientist

Reviewed by: Stewart Seaberg, Principal Biologist

Date: April 2020

Overview

Nineteen terrestrial mammal species are known to occur in or near study area. Table 13-1 provides information on many of the species present. Of these animals, caribou (*Rangifer tarandus*) are an essential subsistence resource for the communities of Utqiaġvik, Atqasuk, and Wainwright. The study area is within the range of both the Teshekpuk Caribou Herd (TCH) and the Western Arctic Herd (WAH) (Bureau of Land Management [BLM] 2012).

In 2017, scientists estimated the Teshekpuk Caribou Herd population of 56,255 animals (Klimstra 2018). The herd typically calves near Teshekpuk Lake, although after 2010 significant calving occurred west of the lake, including in areas west of Atqasuk (Prichard et al. in press). Telemetry data indicates that between 1990 and 2018, seventy-five percent of all female caribou during calving season were located in an area extending from south of Nuiqsut to northwest of Atqasuk (Prichard et al. 2019, Figure TM13-1). The herd uses the study area more heavily between September 16 and April 15, during fall migration and winter.

The WAH is the largest herd in Alaska and ranges over the northwest part of the state. In the most recent population estimate, the Alaska Department of Fish and Game (ADF&G) considers the WAH is comprised of approximately 259,000 animals (Hansen 2018). Only 0.03 percent of the herd is collared, but the available data suggests the WAH generally occurs in low densities in the study area, between Wainwright and Atqasuk (Dau 2015, Alaska Center for Conservation Science 2019; Figure TM13-2).

In addition to caribou, the study area supports limited numbers of moose and muskox. The ADF&G does not typically conduct aerial moose surveys within the study area due to the small numbers of moose and the limited available habitat. Local residents frequently travel outside the study area to hunt moose (Carroll 2014). Transitory muskox range irregularly and widely in the study area and within the National Petroleum Reserve–Alaska (NPR-A).

In addition to large mammals, the project area supports many small mammal species, listed in Table 13-1.

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Figure TM13-1. Teshekpuk Caribou Herd Seasonal Ranges (Prichard et al. 2019)

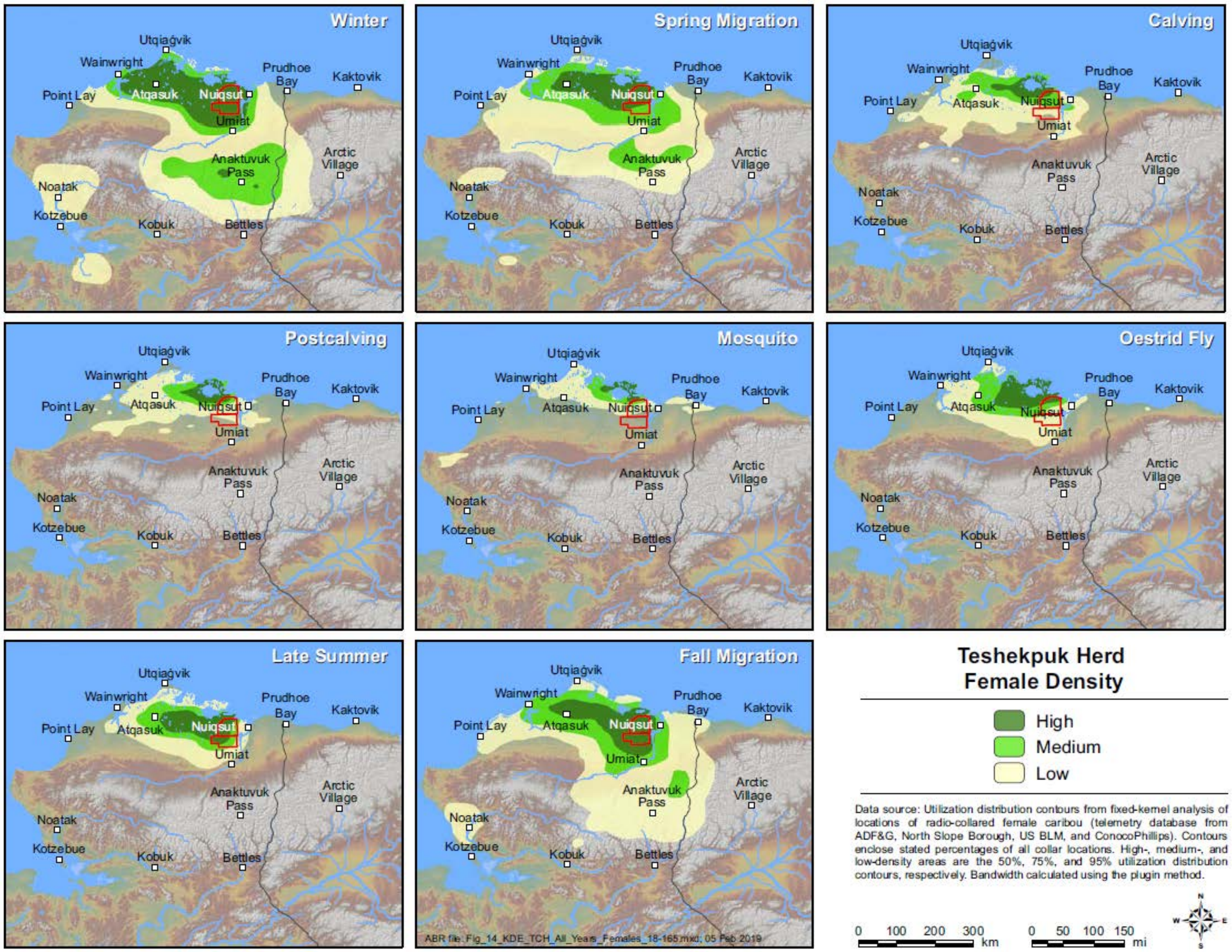

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Figure TM13-2. Western Arctic Caribou Herd Seasonal Range

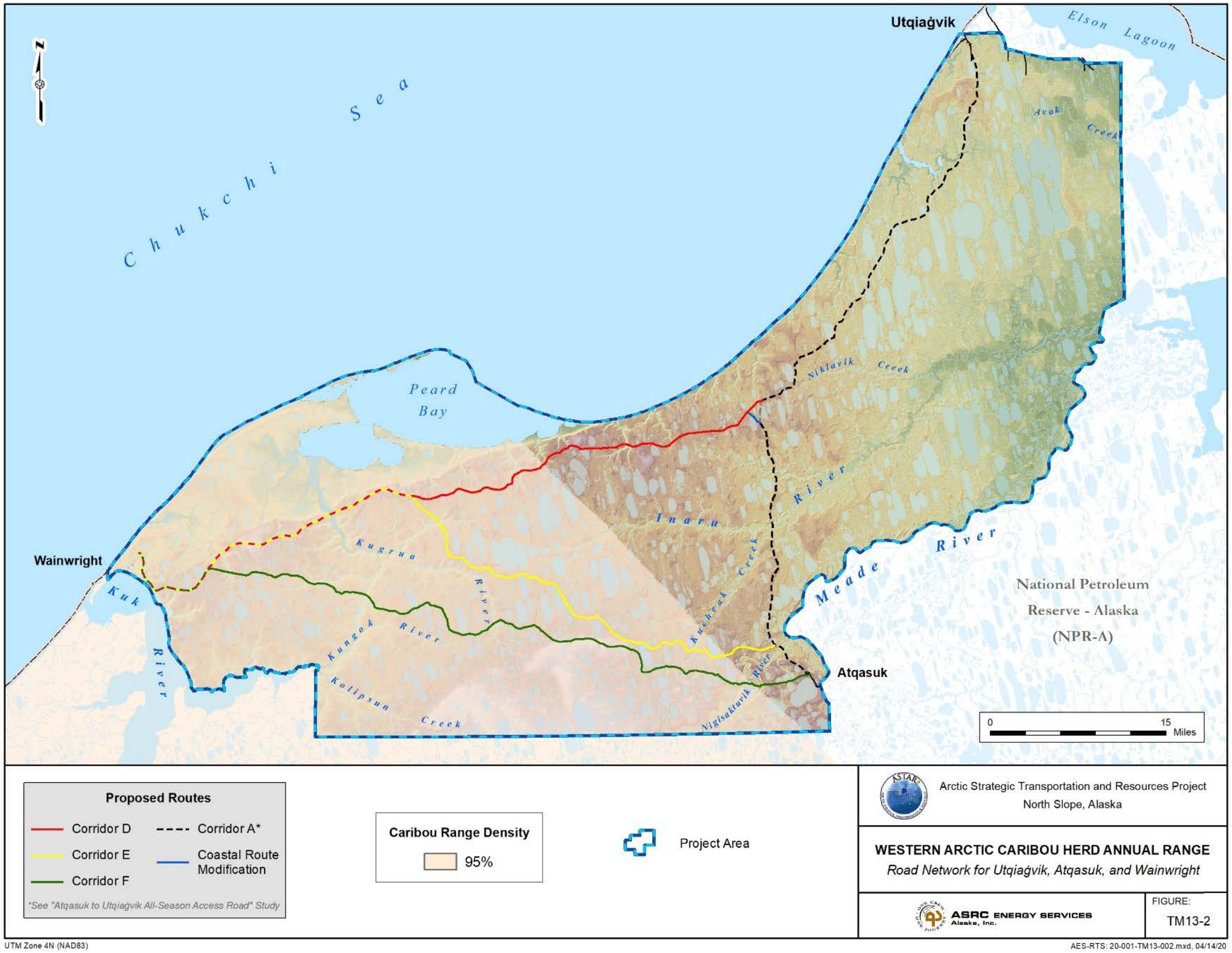

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Table TM13-1. Mammal Species Known to Occur in or Near the Project[1]

Managed By	Scientific Name	Occurrence in Study Area
Large Mammals		
Caribou	*Rangifer tarandus*	The Teshekpuk Caribou Herd calves in medium densities west of Atqasuk and winters in high density north and west of Atqasuk. The Western Arctic Herd winters in low density between Wainwright and Atqasuk (BLM 2019).
Muskox	*Ovibos moschatus*	A Wainwright resident reported a large herd (>30) between Wainwright and the Kugrua River in November 2010.
Moose	*Alces alces*	A lack of quality habitat severely limits the population size in the Arctic Coastal Plain (North Slope Subsistence Regional Advisory Council 2019), and the area lacks the extensive riparian corridors preferred by moose.
Grizzly bear	*Ursus arctos*	Grizzly bears may be present, though in low densities compared to the foothills of the Brooks Range.
Arctic fox	*Vulpes lagopus*	Arctic foxes are the most common furbearers in the Arctic Coastal Plain.
Red fox	*Vulpes vulpes*	Red foxes are present.
Gray wolf	*Canis lupus*	Wolves are uncommon in the area.
Small Mammals		
• Arctic ground squirrel (*Urocitellus parryii*) • Barren ground shrew (*Sorex ugyunak*) • Brown lemming (*Lemmus trimucronatus*) • Collared lemming (*Dicrostonyx groenlandicus*) • Ermine (*Mustela ermine*) • Least weasel (*Mustela nivalis*)		• Lynx (*Lynx canadensis*) • Northern red-backed vole (*Evotomys rutilus*) • Singing vole (*Microtus miurus*) • Snowshoe hare (*Lepus americanus*) • Tundra shrew (*Sorex tundrensis*) • Tundra vole (*Microtus oeconomus*)

[1]BLM 2012

Regulatory Drivers

The majority of the study area is within the NPR-A and under BLM jurisdiction. The BLM Record of Decision for the Integrated Activity Plan (IAP) establishes best management practices and monitoring requirements for many land use activities within NPR-A (BLM 2012). The Draft IAP and Environmental Impact Statement (EIS) was released in November 2019 (BLM 2019). If the newly revised Habitat Area is adopted, it would border the study area, reflecting recent shifts in habitat use by the TCH (Figure 13-1).

The ADF&G monitors population trends and manages big game species and other mammal populations in the state. To facilitate caribou management decisions, the ADF&G compiles annual caribou herd reports summarizing abundance surveys and monitoring results. Land Use Permits from the State of Alaska will not likely require extensive monitoring of caribou or other terrestrial mammals.

NSB permits and/or authorizations may include mitigation measures and monitoring requirements for caribou and other mammals which are important subsistence resources for the communities of Utqiaġvik, Atqasuk, and Wainwright.

Data Gaps

The current Draft EIS alternatives do not mandate caribou studies for land use activities within the study area. BLM may adopt additional requirements in the future if habitat use shifts and agency guidelines change.

Agencies have extensive caribou baseline information, given longtime study of the TCH and the WAH by the ADF&G, BLM, and the NSB. Should caribou monitoring surveys be required as a condition of approval for development, the project may consider coordinating monitoring activities for cost savings and data consistency.

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Technical Memorandum 14 – Fisheries and Fish Habitat

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Technical Memorandum 14 – Fisheries & Fish Habitat

Prepared by: Shannon Mason, Environmental Scientist
Reviewed by: Sam Simpson, Senior Fisheries Biologist
Date: April 2020

Overview

Fishery resources have not been systematically documented in much of the proposed project area, whose surface is covered by many small lakes and streams.

The project area includes many waters that have either been classified as anadromous or that are likely to possess anadromous fish presence. Information on the area affected by Corridor A–Coastal Route is available in the study of the *Atqasuk to Utqiaġvik All Season Access Road* (ASRC Energy Services 2019). Corridor D–Coastal Route Extension, Corridor E–Middle Route, and Corridor F–Southern Route cross the Kugrua River, an anadromous stream. Corridors E and F intersect the Niġisaktugvik River, an unsampled tributary of the anadromous Meade River, just south of the rivers' confluence.

Arctic grayling (*Thymallus arcticus*) and ninespine stickleback (*Pungitius pungitius*) have been widely documented in streams of all sizes throughout the area (ADF&G 2019), and are expected to be present in lakes. Since fish are presumed to be distributed throughout the project area during the summer, all project-related activities should be conducted in a manner that protects these important fish resources and their habitats.

The project area and proposed routes are shown on Figure TM14-1.

Regulatory Drivers

Within State of Alaska North Slope Areawide Oil and Gas Leases, fish-related mitigation measures have established stream buffers prohibiting the siting of oil and gas facilities within 500 feet of all fish-bearing waterbodies. Facilities may be sited within these buffers if it can be demonstrated site locations outside these buffers are not practicable, or a location inside the buffer is environmentally preferred. Although this project is not considered an oil and gas infrastructure project, the Alaska Department of Natural Resources (ADNR) may recommend similar setbacks be maintained for this project.

Fish Habitat Regulations

The Alaska Department of Fish and Game (ADF&G) has statutory responsibility for protecting anadromous fish habitat under the Anadromous Fish Act, Alaska Statute (AS) 16.05.871-.901. A Fish Habitat Permit from ADF&G is required for any activity using or changing the natural flow of a lake or stream that ADF&G has specified as supporting anadromous fish (Figure TM14-1). This includes water withdrawals, discharges, diversions, construction, and operation of equipment within and on the frozen surfaces of specified anadromous fish streams.

ADF&G also has authority to ensure free passage of resident and anadromous fish is maintained in accordance with the Fish Passage Act (AS 16.05.841). This means any activity that could impede free and efficient passage of fish could require a Fish Habitat Permit from ADF&G. Drainage structures, such as culverts and bridges, are required to provide fish passage and meet ADF&G fish passage criteria.

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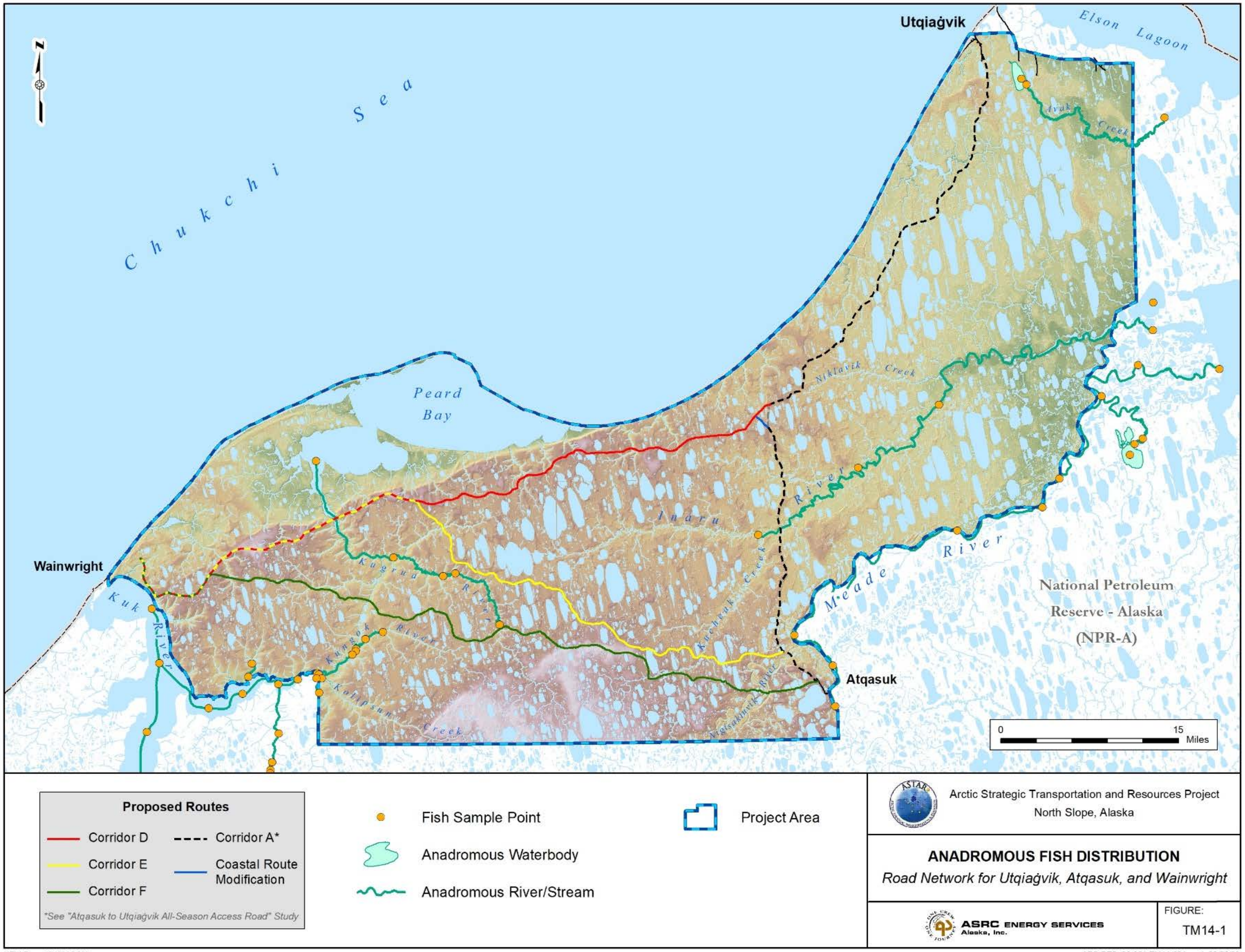
Utqiaġvik
Elson Lagoon
Chukchi Sea
Peard Bay
Avak Creek
Niklavik Creek
Inaru River
Meade River
Kugrua River
Kuk River
Kungok River
Kaolipsum Creek
Kucheak Creek
Nigisaktuvik River
Wainwright
Atqasuk
National Petroleum Reserve - Alaska (NPR-A)
0
15
Miles
Proposed Routes
Corridor D
Corridor A*
Corridor E
Coastal Route Modification
Corridor F
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
Fish Sample Point
Anadromous Waterbody
Anadromous River/Stream
Project Area
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
ANADROMOUS FISH DISTRIBUTION
Road Network for Utqiaġvik, Atqasuk, and Wainwright
ASRC ENERGY SERVICES
Alaska, Inc.
FIGURE:
TM14-1
UTM Zone 4N (NAD83)
AES-RTS: 20-001-TM14-001.mxd, 03/26/20

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Potential concerns over road construction and the effects on fish include the following:

- Surface water withdrawal during construction and operations
- Fish passage (bridges, culverts, and stream diversion)
- Habitat impacts (stream crossings and streambank or streambed disturbance)
- Water quality impacts (in-water equipment operation, stream flow diversions, and erosion control)

Temporary Water Use Authorizations

ADNR requires a Temporary Water Use Authorization (TWUA) in accordance with 11 Alaska Administrative Code 93.220 for withdrawal of greater than 5,000 gallons of water from any single water source in a calendar year. Surface water withdrawals are generally permitted from North Slope rivers, streams, and lakes during the ice-free months. Winter water withdrawals are generally limited to lakes and are not typically permitted from surface-flowing rivers and streams in order to protect important overwintering fish habitat.

Winter water withdrawal from freshwater lakes to facilitate construction of ice roads and pads is a common North Slope practice. Because of this, ADNR and ADF&G have developed winter water withdrawal guidelines for North Slope lakes as summarized in Table TM14-1.

Table TM14-1. North Slope Water Withdrawal Guidelines

If	Then
No fish present	20% of lake volume available for withdrawal
Non-sensitive fish present*	30% of lake volume deeper than 5 feet available for withdrawal
Sensitive fish present	15% of lake volume deeper than 7 feet available for withdrawal

*Non-sensitive fish are Alaska blackfish and ninespine stickleback, all other fish species are considered sensitive

Essential Fish Habitat

One federal law applies directly to fish and fish habitat. The Magnuson-Stevens Fishery Conservation and Management Act requires consultation with the National Marine Fisheries Service (NMFS) for all Federal activities that may adversely impact Essential Fish Habitat (EFH). Activities that require a federal authorization or use federal funding require EFH consultation in accordance with EFH regulations.

EFH is defined as the waters and substrate necessary to support fish spawning, breeding, feeding, or growth to maturity. This includes waters used by certain fish species and may include areas historically used by fish (North Pacific Fishery Management Council 2009). In Alaska, EFH in the project area only applies to the five species of Pacific salmon.

NMFS has adopted ADF&G's *Catalog of Waters Important for Spawning, Rearing, or Migration of Anadromous Fishes* (Johnson and Blossom 2019) as the specified anadromous fish streams under EFH jurisdiction. Only rivers, lakes, and streams specified in ADF&G's Anadromous Waters Catalog (AWC) are considered EFH for Alaska's freshwaters.

Existing Data

Fish populations in this region of the North Slope have been assessed since the mid-1970s. Although some sampling was conducted on streams in the proposed project area (ADF&G 2019), effort was focused upon larger drainages and lakes to the east of the project area (Netsch 1977).

Much of the data on fish within the project area is concerned with the resources located between Utqiaġvik and Atqasuk, and is discussed within the 2019 study of a route between the two communities (ASRC Energy Services 2019). Within the area affected by Corridors D, E, and F, ADF&G performed fish and aquatic resources studies from 2010 to 2014 in drainages discharging into Wainwright Inlet and Peard Bay (Bradley et al. 2016). In 2017, ADF&G electrofished a number of small streams within the proposed project area (ADF&G 2019). In general, fisheries survey data has been assembled in two datasets maintained by ADF&G. Statewide, anadromous fish data is compiled in the AWC, while resident fish data are compiled in the Alaska Freshwater Fish Inventory (ADF&G 2019). Within the project area, seven streams and one lake have been cataloged by the AWC as the specified anadromous fish streams under EFH jurisdiction (Table TM14-2).

Table TM14-2. Anadromous Fish Streams and Lakes in Project Area[1]

Name	AWC	Fish
Avak Creek	333-00-10931	Sp, BCp, LCp
Ikroagvik Lake	333-00-10931-0050	Sp, BCp, LCp
Inaru River	330-00-10930	Wsr
Kolipsun Creek	330-00-10980-3019	LCp
Kugrua River	330-00-10940	CHs, Ps
Kungok River	330-00-10980-2004	Ps, CHs, LCp, BWp, OMp
Maguriak Creek	330-00-10980-3017	LCp
Unnamed stream	330-00-10980-3006	LCp

1. Johnson and Blossom 2019

Notes:
BW = Bering cisco
CH = chum salmon
LC = least cisco
OM = rainbow smelt
P = pink salmon
p = present
r = rearing
S = sockeye salmon
s = spawning
W = whitefish, undifferentiated

The sustainable management of the subsistence fishery is a key concern of the North Slope Borough and ADF&G. Moreover, EFH seems to be increasing as climactic conditions become more conducive to salmon populations in the area (Milman 2018). For example, sockeye salmon appear to have only recently occurred in Ikroagvik Lake and Avak Creek (Carroll 2012).

Data Gaps

Data on fish presence, distribution, or abundance has not been systematically collected on most reaches and lakes in the project area.

The Niġisaktugvik River, a tributary of the Meade River, has not been surveyed, although the distribution of camps by its banks would indicate that it may host some of the same anadromous species as the Meade River. Only Corridors D and E cross a reach of the Kugrua River designated as anadromous, but Corridor F spans the stream just upstream of the last point sampled.

Following is a list of data gaps that will need to be filled to advance the project to the next phases of design.

- Regulatory agencies are likely to require fish distribution surveys and stream habitat assessments at road crossing locations. These surveys are typically required to support the National Environmental Policy Act alternatives analysis and to establish stream setbacks from fish-bearing waters.
- Fish surveys may also be required to document the presence of anadromous fish to potentially establish regulatory authority for ADF&G Fish Habitat Permits and NMFS EFH consultation. Agencies may require fish surveys to document anadromous fish habitat in currently unspecified streams for the placement of permanent facilities such as drainage structures (bridges and culverts). Fish studies likely required are summarized in Table TM14-2.

Table TM14-2. Fish Study Recommendations

Regulatory Driver	Requirement	Timing (Years)	Topic
TWUA Permitting	Fisheries and bathymetric sampling	1	Water Quality and Fisheries
ADF&G Title 16 Permitting	Fisheries sampling to document fish species	1	Water Quality and Fisheries

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Technical Memorandum 15 – Avian Resources and Habitat

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Technical Memorandum 15 – Avian Resources and Habitat

Prepared by: Samantha Simpson, Senior Biologist

Reviewed by: Stewart Seaberg, Principal Biologist

Date: April 2020

Overview

Avian resources are an important biological and subsistence resource in the proposed project area. The North Slope supports a large seasonal abundance of avian resources including important breeding populations of over 90 species of migratory and resident birds. Coastal areas in the National Petroleum Reserve Alaska (NPR-A) provide molting and fall staging areas for large quantities of waterfowl, seabirds, and shorebirds. The migrant birds come primarily from the Trans-Beringian and Pacific flyways, although some species travel much farther (e.g. bar-tailed godwits [*Limosa lapponica*] from New Zealand). As these are seasonal summer inhabitants that use the area as nesting habitat, impacts to bird resources in the area can affect bird abundance in other parts of the world. In general, areas of concentrated bird use include lagoons, river deltas, lakes, coastal salt marshes, and the wetlands associated with these habitats.

Regulatory Drivers

Birds, nests, and avian habitats are protected from disturbance through a variety of federal regulations. Almost all bird species inhabiting the North Slope are protected from impacts by the Migratory Bird Treaty Act (MBTA). The MBTA protects actively nesting birds from disturbance on both federal and state lands. Regulatory agencies can restrict ground disturbance during nesting periods, typically between June 1 and July 31 (USFWS 2017). A list of migratory birds protected under the MBTA that have the potential to occur in the project area generated from the United States Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPaC) tool is listed in Table TM15-1.

Several agencies and groups maintain lists of birds with special conservation status. Birds of Conservation Concern (BCC), maintained by USFWS, are birds that have noted population declines or overabundance, restricted populations, and dependence on vulnerable habitats. Birds that warrant special attention are birds that are not listed as BCC in the proposed project area, but warrant special attention because of the Bald & Golden Eagle Protection Act, or for potential susceptibilities in offshore areas from certain types of development or activities. The U.S. Bureau of Land Management (BLM) maintains the Sensitive Animals in Alaska list, of which six bird species known to breed in the project area are included (Table TM15-1).

On October 1, 2014, the USFWS published their 12-month finding on the petition to list the yellow-billed loon under the Endangered Species Act (ESA). The USFWS concluded that listing the yellow-billed loon as threatened or endangered was not warranted at this time. While the yellow-billed loon is not protected under the ESA, the Final BLM NPR-A Integrated Activity Plan (IAP) / Environmental Impact Statement (EIS) set guidelines that require all recorded nesting sites to have a 1-mile buffer and an additional 1,625 foot buffer around the remaining shoreline (BLM 2013).

The USFWS listed both the spectacled eider and Steller's eider as threatened species under the ESA. Active eider nests have activity restrictions within 656 feet from June 1 through August 15 (BLM 2013).

Table TM15-1. Species, Status of Species, and Breeding Season in the Project Area

Species	Bird of Conservation Concern (BCC)	Warrants Special Attention	BLM Sensitive Species	Breeding Season
American Golden-plover (*Pluvialis dominica*)	X			Breeds May 20 to Aug 15
Arctic Tern (*Sterna paradisaea*)		X		Breeds May 20 to Aug 15
Bald Eagle (*Haliaeetus leucocephalus*)		X		Breeds Feb 1 to Sep 30
Bar-tailed Godwit (*Limosa lapponica*)	X		X	Breeds May 15 to Aug 15
Black Guillemot (*Cepphus grille*)		X		Breeds May 15 to Sep 10
Black Scoter (*Melanitta nigra*)		X		Breeds elsewhere
Black-legged Kittiwake (*Rissa tridactyla*)		X		Breeds elsewhere
Buff-breasted Sandpiper (*Calidris subruficollis*)	X		X	Breeds June 10 to Aug 20
Common Eider (*Somateria mollissima*)		X		Breeds June 1 to Sep 30
Common Loon (*Gavia immer*)		X		Breeds Apr 15 to Oct 31
Common Murre (*Uria aalge*)		X		Breeds Apr 15 to Aug 15
Dunlin (*Calidris alpina arcticola*)	X		X	Breeds May 20 to Jul 20
Great Black-backed Gull (*Larus marinus*)		X		Breeds Apr 15 to Aug 20
Herring Gull (*Larus argentatus*)		X		Breeds Apr 20 to Aug 31
Ivory Gull (*Pagophila eburnean*)	X			Breeds elsewhere
Long-tailed Duck (*Clangula hyemalis*)		X		Breeds elsewhere
Parasitic Jaeger (*Stercorarius parasiticus*)		X		Breeds elsewhere
Pomarine Jaeger (*Stercorarius pomarinus*)		X		Breeds elsewhere
Red Phalarope (*Phalaropus fulicarius*)		X		Breeds elsewhere
Red-breasted Merganser (*Mergus serrator*)		X		Breeds elsewhere
Red-necked Phalarope (*Phalaropus lobatus*)		X		Breeds elsewhere
Red-throated Loon (*Gavia stellate*)	X		X	Breeds May 1 to Sep 30
Ross's Gull (*Rhodostethia rosea*)	X			Breeds elsewhere
Semipalmated Sandpiper (*Calidris pusilla*)	X			Breeds June 10 to Aug 20
Snowy Owl (*Bubo scandiacus*)	X			Breeds May 15 to Sep 30
Surf Scoter (*Melanitta perspicillata*)		X		Breeds elsewhere
Thick-billed Murre (*Uria lomvia*)		X		Breeds Apr 15 to Aug 15
Whimbrel (*Numenius phaeopus*)	X		X	Breeds May 10 to Aug 20
White-winged Scoter (*Melanitta fusca*)		X		Breeds elsewhere
Yellow-billed Loon (*Gavia adamsii*)	X		X	Breeds June 1 to Sep 20

Existing Data

The project area is included in the Arctic Coastal Plain waterfowl breeding population survey area, conducted regularly by USFWS. The survey provides an indication of species of waterfowl present in the area and a measure of relative abundance of waterfowl nesting. The survey suggests waterfowl are common in the project area, and occur in the highest concentrations near Utqiaġvik and Peard Bay.

Since 1991, foot surveys of Steller's eiders breeding biology around the Utqiaġvik area have been conducted by the USFWS Ecological Services Fairbanks Field Office and the North Slope Borough Department of Wildlife Management. Annual breeding pair ground surveys in the Utqiaġvik area and aerial studies known as the Barrow Triangle Surveys conducted by ABR, Inc. began in 1999. The project area is also included in the Arctic Coastal Plain waterfowl breeding population survey area, conducted regularly by USFWS. These studies have allowed for documenting the abundance and distribution of both Steller's and spectacled eiders, and avian predators in the Utqiaġvik area.

The Final BLM NPR-A IAP/EIS produced several maps of bird densities (BLM 2013). These bird density maps could be useful for discussions during project development. Graphics are available at the project website (BLM 2012).

While currently in Draft form, the bird density maps were amended to include new data for incorporation into the 2019 Draft BLM IAP/EIS and are available for viewing at the project website (BLM 2019).

Data Gaps

While annual survey data exists, nesting locations are dynamic and historic nesting data may not reflect nesting found during construction. Most existing data sources will only provide general distribution or broad scale information. Furthermore, many studies occur near existing infrastructure and resources, such as Utqiaġvik, so study efforts have not been consistent across the project area.

The following is a list of data gaps that will need to be filled to advance the project to the next phases of design. Due to the project being on BLM lands, there are established guidelines for bird surveys. The BLM NPR-A IAP/ EIS Record of Decision (ROD) establishes that development in the NPR-A would require (BLM 2013):

- Three years of pre-disturbance aerial surveys for Steller's and spectacled eiders. Results of these surveys may require additional ground nest surveys.
- USFWS-approved Steller's and spectacled eiders ground nest surveys would be conducted prior to development during mid-June.
- Three years of pre-disturbance aerial surveys for proposed development within 1 mile of lakes 25 acres or larger for yellow-billed loons. These surveys include shorelines of lakes 25 acres or larger during nesting and brood rearing of yellow-billed loons during late June and August following accepted BLM protocol.

Development Considerations

Permitting issues associated with infrastructure development focus on avoidance of disturbing all nesting migratory birds. To avoid disturbing nesting birds, the USFWS recommends vegetation clearing or ground disturbing activities not occur during the period from June 1 through July 31 on the North Slope (USFWS 2017). If limited clearing/ground disturbance is necessary, it is recommended a nest clearing survey take place immediately prior to ground disturbance to ensure no take of migratory bird nests occurs. It is typical of North Slope operations to conduct these activities in the winter.

The BLM NPR-A IAP/ EIS ROD established a 107,000-acre area surrounding Peard Bay as a Special Area to protect high-use staging and migration habitat for shorebirds and waterbirds (BLM 2013). Its designation as a Special Area does not impose specific restrictions on activities, with the exception of making oil and gas leasing and exploratory drilling unavailable. Rather, the designation highlights areas and resources for which BLM will extend "maximum protection" consistent with the exploration of NPR-A. In implementing management of the Peard Bay Special Area, among others, BLM may consult with local residents and expertise from other federal, state, and local agencies and tribes.

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Technical Memorandum 16 – Environmental Compliance and Permitting

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Technical Memorandum 16 – Environmental Compliance and Permitting

Prepared by: Mandy Tuttle, Associate Environmental Scientist

Reviewed by: Amanda Henry, Senior Project Manager

Date: April 2020

Overview

The purpose of this memorandum is to provide a broad analysis of environmental compliance and permitting for the Arctic Strategic Transportation and Resources Project (ASTAR), Road Network for Utqiaġvik, Atqasuk, and Wainwright. The project will be subject to different regulatory jurisdictions based on the fact that potential routes pass through varied land ownership and management, such as Bureau of Land Management (BLM) lands; Native Village land; lands owned by the regional and local native corporations Arctic Slope Regional Corporation (ASRC), Ukpeaġvik Iñupiat Corporation (UIC), Atqasuk Corporation, and Olgoonik Corporation; National Petroleum Reserve–Alaska (NPR-A) federal lands; and Alaska Department of Transportation and Public Facilities. A brief description of the potentially applicable regulatory authorities is below with further details of the regulatory and permitting requirements shown in Table TM16-1. Note that regulatory and permitting requirements are preliminary and will be updated when the project route and description is finalized.

National Environmental Policy Act

The National Environmental Policy Act (NEPA) process would apply to the construction of the Road Network for Utqiaġvik, Atqasuk, and Wainwright due to federal permitting for potential impacts to wetlands and subsistence resources. The project proponent will publish a Notice of Intent in the Federal Register, which will inform the public of upcoming environmental analysis and describe how the public can become involved in the NEPA process. The Notice of Intent starts the scoping process, which is the period in which the federal agency, project proponent, and the public collaborate to define the range of issues and possible alternatives to be addressed during the NEPA process. A draft NEPA document is published for public review and comment for a minimum of 45 days. Upon close of the comment period, agencies consider all substantive comments and, if necessary, conduct further analyses. A final NEPA document is published, which provides responses to substantive comments and begins the minimum 30-day "waiting period," in which agencies are generally required to wait 30 days before publishing a final decision on a proposed action. The lead federal agency will publish a Notice of Availability in the Federal Register, announcing the availability of both the draft and final NEPA documents to the public. The NEPA process ends with the issuance of the Record of Decision (ROD). The ROD explains the agency's decision, describes the alternatives the agency considered, and discusses the agency's plans for mitigation and monitoring, if necessary. Once the ROD is signed, construction may begin.

U.S. Army Corps of Engineers Section 10 Permit (Rivers and Harbors Act)

Building a bridge to cross rivers may affect the navigable capacity of the waters of the United States, thus it may require a U.S. Army Corps of Engineers (USACE) Section 10 permit.

U.S. Army Corps of Engineers Section 404 Permit

Construction of gravel roads and bridges will require discharge of fill into Waters of the U.S., thus a USACE Section 404 permit will be required. The 1987 Corps of Engineers Wetlands Delineation Manual will be used for the identification and delineation of wetlands. A USACE Section 404 permit will require a Public Notice and is the most likely trigger for NEPA. Processing time for the 404 usually takes 90 to 120 days, unless a public hearing is required or an environmental impact statement must be prepared.

In accordance with 33 Code of Federal Regulations (CFR) Part 325.1(d)(7), "For activities involving discharges of dredged or fill material into waters of the U.S., the 404 permit application must include a statement describing how impacts to waters of the United States are to be avoided and minimized." Mitigation is a sequential process of avoidance, minimization, and compensation. Compensatory mitigation is not considered until after all appropriate and practicable steps have been taken to first avoid and then minimize adverse impacts to the aquatic ecosystem. An Applicant Proposed Mitigation Statement will most likely be required for this project.

Bureau of Land Management Land Use Permit (Right-of-Way)

The proposed project will require a BLM Land Use Permit (Right-of-Way Authorization) if the gravel road corridor is constructed on federal lands. The authorization is required to cross BLM lands to perform a survey of the corridor centerline for the proposed gravel road and to construct the road. Right-of-Way Authorizations have an agency review period of 30 to 60 days from the date of submittal.

Gravel Mine Site

Gravel for this project will be purchased from the landowner where the gravel is located. This would require a Material Sale Contract and a Land Management Regulations (LMR) Permit if on North Slope Borough (NSB) or village corporation land, or a Material Sale Contract if on State of Alaska land, or a Gravel Mine Site Negotiated Sale if on BLM land. The NSB and ASRC maintain rights to gravel resources near the project area and may be potential sources for gravel.

Section 7 Endangered Species Act Consultation

Section 7 of the Endangered Species Act (ESA) requires federal agencies to ensure that actions they authorize do not jeopardize the existence of any species listed under the ESA, or destroy or adversely modify designated critical habitat of any listed species. Thus, Section 7 requires consultation by the federal "action agency" (the agency authorizing the action) with the appropriate regulatory agency, either the National Oceanic Atmosphere Administration (NOAA) / National Marine Fisheries Service (NMFS) for marine mammals and fisheries and the U.S. Fish & Wildlife Service (USFWS) for polar bear and eiders.

Biological Assessment for Endangered Species Act-Listed Species

A Biological Assessment (BA) for ESA-listed species will be developed as part of the USFWS and NOAA/NMFS consultation process to determine whether the approved project actions may affect listed or proposed species, designated areas, and proposed critical habitat.

Special Area Permit

A Special Area Permit from the State of Alaska Department of Fish and Game (ADF&G) Habitat Division, will be required if the route crosses into the following Special Areas:

- Teshekpuk Lake Special Area
- Utukok River Uplands Special Area
- Peard Bay Special Area

A Special Area permit review period is approximately 30 days.

Essential Fish Habitat Assessment Report

Section 305(b)(2) of the Magnuson-Stevens Act requires federal action agencies to consult with NOAA/NMFS on all actions that may adversely affect Essential Fish Habitat.

Federal Land Policy Management Act Permit

For any portion of the route that crosses Federal lands, a BLM Federal Land Policy Management Act permit is required for infrastructure development such as a gravel road, and field studies and surveys.

Marine Mammal Protection Act Letter of Authorization for Directed and Incidental Take of Polar Bears

The Marine Mammal Protection Act (MMPA) Letter of Authorization (LOA) for intentional and incidental take of polar bears is required for construction and operational use of the proposed gravel road route. A polar bear denning survey will be required prior to construction activities. The LOA review and approval period is 90 days.

- Incidental Take: The LOA will allow for incidental "take" (as defined under the MMPA) of polar bears during authorized activities. Prior to issuance of an LOA, the USFWS requests submittal of a plan of cooperation. LOAs include measures to minimize impacts.
- Directed Take: Directed Take is also referred to as intentional harassment or deterrence. A LOA is requested when bears may need to be deterred from human-use areas for safety reasons.

LOAs for incidental and directed take activities require monitoring and reporting requirements. Monitoring and reporting results provide a basis for evaluating current and future impacts of activities on bears.

Alaska Department of Fish and Game Fish Habitat Permit

The Fish Passage Act (Alaska Statute 16.05.841) requires notification and authorization from the ADF&G Division of Habitat for activities in fish-bearing waters if it is determined that such uses or activities could represent an impediment to the efficient passage of resident or anadromous fish. Based on these requirements, Fish Habitat permits will be required for the proposed project. Construction seasonal constraints may be implemented for work within anadromous streams. Review period for Fish Habitat Permits are 30 days.

River Set-Backs

River set-backs in the proposed route areas are identified in the NPR-A Record of Decision under the lease stipulation/Best Management Practice K-1 (BLM 2013). River set-back waivers will be required for river crossings and development of a gravel road along the following rivers:

- Meade River
- Inaru River
- Niklavik Creek
- Kucheak Creek
- Nigisaktuvik River
- Kugrua River
- Kungok River
- Kolipsun Creek

Alaska Department of Natural Resources, Division of Mining, Land and Water Temporary Water Use Authorization

The proposed study area will require Temporary Water Use Authorizations (TWUAs) for water withdrawal from lakes to build ice roads and for gravel road dust control during summer months. A TWUA can take up to 60 days for review and approval.

Alaska Department of Natural Resources/Division of Mining, Land and Water Land Use Permit and Supplemental Questionnaire for Use of Non Marine Waters

The Division of Mining, Land and Water Northern Regional land office is responsible for managing state land and resources on the North Slope. A Land Use Permit will be required for temporary use of State of Alaska non-marine waters. A Land Use Permit can be issued for up to five years.

Alaska Department of Environmental Conservation Clean Water Act Section 401 Water Quality Certificate of Reasonable Assurance

Section 401 of the Clean Water Act provides states with the legal authority to review an application or project that requires a federal license or permit (in this case a 404 permit) that might result in a discharge into a water of the U.S. The project must apply for and obtain a Certificate of Reasonable Assurance from Alaska Department of Environmental Conservation.

Alaska Department of Environmental Conservation Excavation Dewatering General Permit (AKG002000)

An Alaska Pollutant Discharge Elimination System (APDES) Excavation General Permit AKG-33-2000 will be required for excavation dewatering.

Alaska Department of Environmental Conservation Stormwater Construction General Permit

Construction of the gravel road will require a Construction General Permit for Storm Water Discharges for Large and Small Construction Activities (AKR100000). The proposed project will require a Stormwater Pollution Prevention Plan to ensure minimization of erosion and reduction or elimination of the discharge of pollutants, such as sediment carried in storm water runoff from the construction site by using the appropriate control measures as described in the permit.

Alaska Department of Environmental Conservation Air Emissions

Determination of compliance with National Ambient Air Quality Standards for particulate generation and emissions from construction equipment and vehicles is needed. An operating permit may be needed.

Alaska Department of Environmental Conservation Incinerator Permit

If solid waste is not trucked to an approved disposal facility, it may be burned in an Incinerator Unit, which will require an Incinerator Permit.

North Slope Borough Rezoning and Master Plan

Title 19 of the North Slope Borough Municipal Code (NSBMC) governs zoning. A Master Plan and rezoning is required because the vast majority of NSB lands are zoned within the Conservation District and the project will include uses and developments that are generally not allowed in the existing Conservation District. Since the proposed project is a linear transportation project, the project area will need to be rezoned as either a Transportation Corridor or potentially a Resource Development District depending on whether additional industrial activities are proposed within the project area. NSBMC § 19.40.070 more fully describes the rezoning and master plan approval process conducted by the North Slope Borough (NSB) Planning Commission and the NSB Assembly.

North Slope Borough Land Management Regulations Permit

A Land Management Regulations (LMR) Permit (also known as a Development Permit) is required to conduct industrial activities within the NSB. Title 19 of the NSBMC requires land use permits for development and land uses within the NSB boundaries. The proposed project will require a LMR Permit because building a gravel road is considered development within the NSB. A LMR Permit has a 60-day review period.

North Slope Borough Study Permit

A scientific or archeological study and any associated activities that may affect land within NSB boundaries are considered uses or developments that require a permit. The proposed project will require studies and surveys to collect pertinent data to construct the gravel road.

North Slope Borough Property/Land Owner Consent Form

It is NSB procedure that before issuing a NSB Land Use Permit, the NSB will require the project to provide a signed Property/Land Owner consent form with its application for all owners or co-owners within the project area. The consent form approval ensures that the Property/Land Owner is aware of the permit application, has reviewed the application, and agrees with the content.

Surface and Subsurface Interest Holders

A surface land access agreement will need to be obtained from UIC; Atqasuk Corporation; Olgoonik Corporation; ASRC; the Native Villages of Utqiaġvik, Atqasuk, and Olgoonik; and any Native Allotment owners within the proposed project footprint. A Letter of Non-Objection may need to be obtained from ASRC for the portion of the project that crosses land where ASRC holds subsurface rights.

Table TM16-1. Preliminary Summary of Agency Responsibilities and Permitting Requirements

Agency	Permit/Approval/Required Studies	Estimated Permitting/Approval Durations	Regulation/Requirement Description
Federal			
BLM	Federal land ownership review	N/A	Federal land ownership. Review of potential cumulative impacts and indirect impacts on federal land.
BLM	Notice of Intent to prepare EIS	N/A	NEPA
BLM	Development of the EIS (Preliminary Draft EIS, Draft EIS, Final EIS, Record of Decision)	17 months	NEPA
BLM	Land Use Permit (Right-of-Way Authorization)	30 – 60 day applications and review period	Authorization to cross BLM lands to perform a land survey and construct the route.
BLM	Gravel Mine Site Negotiated Sale	12 months	43 CFR 3610 and 3620, Form 3600-9
BLM	Section 7 Consultation	N/A	ESA Section 7 Consultation with USFWS and NMFS
BLM	Biological Assessment	N/A	Biological Assessment for ESA-listed species (as part of the USFWS and NMFS consultation process)
BLM	EFH Assessment Report	N/A	EFH Assessment Report (as part of the EFH coordination process). Coordination with NMFS under the MSFCMA for EFH
BLM	Cultural Resources Summary Report (as part of the NHPA Section 106 process)	N/A	Section 106, Compliance with NHPA.
BLM	Archaeological Resource Protection Act Permit for Archaeological Investigations	30-day application review period	Authorization to conduct archaeological field investigations and surveys on federal lands.
BLM	Federal Land Policy Management Act Permit	Approximately 30 days	Authorization for infrastructure development and field studies/surveys. Laying gravel for roads, infrastructure that supports development, cultural resource surveys, biological surveys, and geotechnical studies.

Agency	Permit/Approval/Required Studies	Estimated Permitting/Approval Durations	Regulation/Requirement Description
BLM	ANILCA 810 Evaluation (combined with EIS process)	17 months	ANILCA 810 Evaluation. Public Law 96-487, ANILCA, Title VIII, Section 810, subtitled Subsistence and Land Use Decisions.
BLM	Executive Order 13175 Tribal Consultation	N/A	Executive Order 13175 Tribal Consultation
EPA	RCRA and EPA Identification for waste	N/A	Review for potential hazardous waste sites due to historical exploration wells, and storage of wastes during construction. EPA form 8700-12
EPA	Review of USACE Section 404 Permit	6–9 months	USACE Section 404 (b)
NOAA/NMFS	NEPA cooperating agency	17 months	ESA. Review and approve NEPA outcome and place conditions on federal permits. If there is a potential impact to species protected under ESA or Migratory Bird Act, a biological assessment may be required.
NOAA/NMFS	Coordination with Lead Federal Agency	N/A	Coordination with Lead Federal Agency under the MSFCMA for EFH
NOAA/NMFS	Section 7 (ESA) Consultation	N/A	Section 7 (ESA) Consultation with USFWS and Lead Federal Agency
USACE	EIS	17 months	Section 309 of the CWA (NEPA review).
USACE	Section 10 Permit	6–9 months	Section 10 of the Rivers and Harbors Act. Permit for work in navigable waters.
USACE	Section 404 Permit	6–9 months	Section 404 of the CWA. Permit for discharge of fill material in wetlands and excavation of wetlands.
USCG	Bridge Permit	5 months	A bridge permit will be needed if building across navigable waters of the U.S.
USCG	Update navigation charts, if needed.	5 months	Review and determine if project would impair navigation.
USFWS	ESA Section 7 Consultation	17 months	Endangered Species Act, Section 7 Consultation. Consultation on the planned project and field studies and their potential effects on endangered and threatened species, and critical habitats. The outcome of the biological assessment determines whether a Section 7 consultation is required.
USFWS	NEPA cooperating agency	17 months	Endangered Species Act. Review and approve NEPA outcome and place conditions on federal permits. If there is a potential impact to species protected under ESA or Migratory Bird Treaty Act, a biological assessment may be required.

Agency	Permit/Approval/Required Studies	Estimated Permitting/Approval Durations	Regulation/Requirement Description
USFWS	LOA- incidental take during specified activities	90 days	MMPA LOA for incidental take of polar bears (construction and operations). Authorization for impacts to polar bear due to project activities. Polar bear denning survey is required.
USFWS	LOA- intentional take during specified activities	90 days	Intentional Take (Polar Bear) by Hazing
State			
ADEC/Air	Determination of compliance	N/A	Clean Air Act. Determination of compliance with National Ambient Air Quality Standards for particulate generation and emissions from construction equipment and vehicles. An operating permit may be needed.
ADEC/Air	Incinerator for Solid Waste Permit	12 months if a Title IV Operating Permit is required	40 CFR 60 Subpart CCCC or DDDD. May need a Title IV Operating Permit.
ADEC/Water	CWA Section 401 Water Quality Certificate of Reasonable Assurance (tied to USACE Permit)	6-9 months	Review and approval is during the 404 Permit process.
ADEC/Water	APDES General Permit AKG-33-2000	60 days	Permit for discharges of Greywater, Gravel Pit Dewatering, Excavation Dewatering, Stormwater, Mobile Spill Response, and Secondary Containment.
ADEC/Water	Mine Site Dewatering APDES	3 months	Withdrawing water from a mine site.
ADEC/Water	Excavation Dewatering General Permit (AKG002000)	30 days before discharging	Notice of Intent submission deadline
ADEC/Water	Stormwater Construction General Permit and SWPPP	45 days before discharging	Must submit information required by the ADEC at least thirty calendar days prior to filing the Notice of Intent and must receive DEC's written reply prior to the commencement of construction.
ADF&G	Fish Habitat Permit	30 days	Alaska Statute, Title 16. Required for all activities within or across an anadromous water body and all in-stream activities affecting an anadromous water body. Seasonal constraints to construction of bridge or culverts in any anadromous stream.
ADF&G	Special Area permit	30 days	Required for crossing Special Areas.
ADNR/DMLW	Temporary water use permits	60 days	Required for water withdrawal.
ADNR/DMLW	Land Use Permit and Supplemental Questionnaire for Use of Non Marine Waters	60 days	Land use permits are authorizations issued to use state land, on a temporary basis. The permits range in duration from one to five years.

Agency	Permit/Approval/Required Studies	Estimated Permitting/Approval Durations	Regulation/Requirement Description
OHA/SHPO	State Cultural Resource Investigation Permit (SCRIP)	unknown	Must be obtained to perform a cultural survey even if the survey is remote sensing over land or water.
OHA/SHPO	SHPO Concurrence: Cultural Resource Desktop and Field Surveys.	30 days	Under Section 106 of the NHPA, SHPO is one of the consulting parties. The lead agency will ask SHPO to concur with findings of archaeological study results of No Historic Properties Affected or Adverse Effect to Historic Properties, and measures mitigating adverse effects to historic properties, if needed.
University of Alaska/Museum of the North	Provisional Curation Request	30 days	Request to house and maintain cultural artifacts that may be collected in the field during cultural resource fieldwork. The ARPA permit application requires proof of a curatorial facility that will maintain collected artifacts.
Local			
NSB	Title 19 Rezoning and Master Plan (Form 300)	6 – 12 months	Planning & Community Services/Land Management Regulations Division
NSB	TLUI Data Request (Form 600)	60 days	Data request on archaeological, historic, paleontological, and traditional resources within the project area.
NSB	Certificate of TLUI Clearance (Form 500). Cultural resource survey is required.	60 days	Certificate ensures that TLUI sites are protected from projects involving earth-moving activity. Form 500 is applicable when any entity seeks a land use permit from the NSB for industrial/commercial development in a Resource Development, Conservation, Scientific Research, or Transportation Corridor/District and whose planned activities include an earth-moving activity or activities.
NSB	Land Management Regulations Permit/ Title 19 Development Permit (Form 100)	60 days	Approval to conduct industrial activities within the NSB.
NSB	Study Permit (Form 400)	10-90 days (10 days for regular review/approval) (90 days if Planning Commission reviews/approves)	Required for biological research, archeological, geological, geotechnical, meteorological, hydrological, surveys
NSB	Statement of Contractual Terms for Infrastructure Sharing (Form 1100)	N/A	Needed if using ConocoPhillips ice roads, gravel roads, pads, etc.
NSB	Property/Land Owner Consent Form (Form 1300)	N/A	Send to all landowners where the road will cross.

Agency	Permit/Approval/Required Studies	Estimated Permitting/Approval Durations	Regulation/Requirement Description
Private			
ASRC	Land access agreement	30 days	Surface interest holder
ASRC	Letter of Non-Objection	15 days	Subsurface interest holder
Atqasuk Corporation	Land access agreement	30 days	Surface interest holder
Native Allotments	Land access agreement	60 days	Surface interest holder
Olgoonik Corporation	Land access agreement	30 days	Surface interest holder
UIC	Land access agreement	30 days	Surface interest holder

ADEC = Alaska Department of Environmental Conservation
ADF&G = Alaska Department of Fish and Game
ADNR = Alaska Department of Natural Resources
ANILCA = Alaska National Interest Lands Conservation Act
APDES = Alaska Pollutant Discharge Elimination System
ASRC = Arctic Slope Regional Corporation
BLM = Bureau of Land Management
CFR = Code of Federal Regulations
CWA = Clean Water Act
DMLW = Division of Mining, Land and Water
EFH = Essential Fish Habitat
EIS = Environmental Impact Statement
EPA = Environmental Protection Agency
ESA = Endangered Species Act
LOA = Letter of Authorization
MMPA = Marine Mammal Protection Act
MSFCMA = Magnuson-Stevens Fishery Conservation and Management Act
N/A = Not Applicable
NEPA = National Environmental Policy Act
NHPA = National Historic Preservation Act
NMFS = National Marine Fisheries Service
NOAA = National Oceanic and Atmospheric Administration
NSB = North Slope Borough
OHA = Office of History and Archaeology
RCRA = Resources Conservation and Recovery Act
SHPO = State Historic Preservation Office
SWPPP = Stormwater Pollution Prevention Plan
TLUI = Traditional Land Use Inventory
UIC = Ukpeagvik Inupiat Corporation
USACE = United States Army Corps of Engineers
USCG = United States Coast Guard
USFWS = United States Fish and Wildlife Service

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Technical Memorandum 17 – Construction Cost

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Technical Memorandum 17 – Construction Cost

Prepared by: Michael Beglin, PE (PND Engineers, Inc.)

Reviewed by: Chip Courtright, PE, SE (PND Engineers, Inc.)

Date: April 2020

Overview

This memorandum details estimated rough order-of-magnitude (ROM) costs of potential roadway corridors associated with the Road Network for Utqiaġvik, Atqasuk, and Wainwright Study under evaluation for the Arctic Strategic Transportation and Resources project. Three main routes for transit are currently under evaluation as part of this study. These routes would connect to the proposed road network located between Utqiaġvik and Atqasuk within the National Petroleum Reserve–Alaska (Figure TM17-1). This document establishes the basis of estimate detailing the procedures, assumptions, and methodology used in development of ROM estimates as presented. Note, a modified leg of the coastal route as shown in Figure TM17-1 (Modification to Coastal Route per legend) will be generally disregarded in this memo as its construction costs are assumed negligible compared to the main routes.

Accuracy

The accuracy of the estimates provided is assumed to be +100 percent, -50 percent based on the current schematic level of design (Association for the Advancement of Cost Engineering 2019). Contingency costs have been excluded from the estimates but would typically be applied at a rate of 20 percent to 40 percent of the total estimated construction cost. All costs presented should be considered conceptual in nature, and materials, fabrication, and transportation costs will vary over time based on inflation, procurement procedures and project implementation.

Estimate Methodology

Publicly available cost data from previous North Slope projects is highly limited. As such, estimates were developed using crew and resource loaded, bottom-up estimating techniques using historical and anticipated production rates of “assemblies” comprised of personnel, equipment and materials. These assemblies were then combined to make up tasks associated with cost category items within the Cost Breakdown Structure in the estimating program InEight® Estimate V19.2.0 (formerly HardDollar®).

Basis of Estimate

Estimated Scope

The cost estimates developed here encompass the civil infrastructure associated with the ASTAR Road Network for Utqiaġvik, Atqasuk, and Wainwright. Costs include: haul and placement of gravel roads, drainage culverts and batteries, gravel-haul ice roads, gravel mine development and mining royalties, and summer gravel rework. Bridge costs are also presented as a single lump sum line item in these estimates; cost estimate information for the bridges is provided in Technical Memorandum 7 –Vehicle Bridges.

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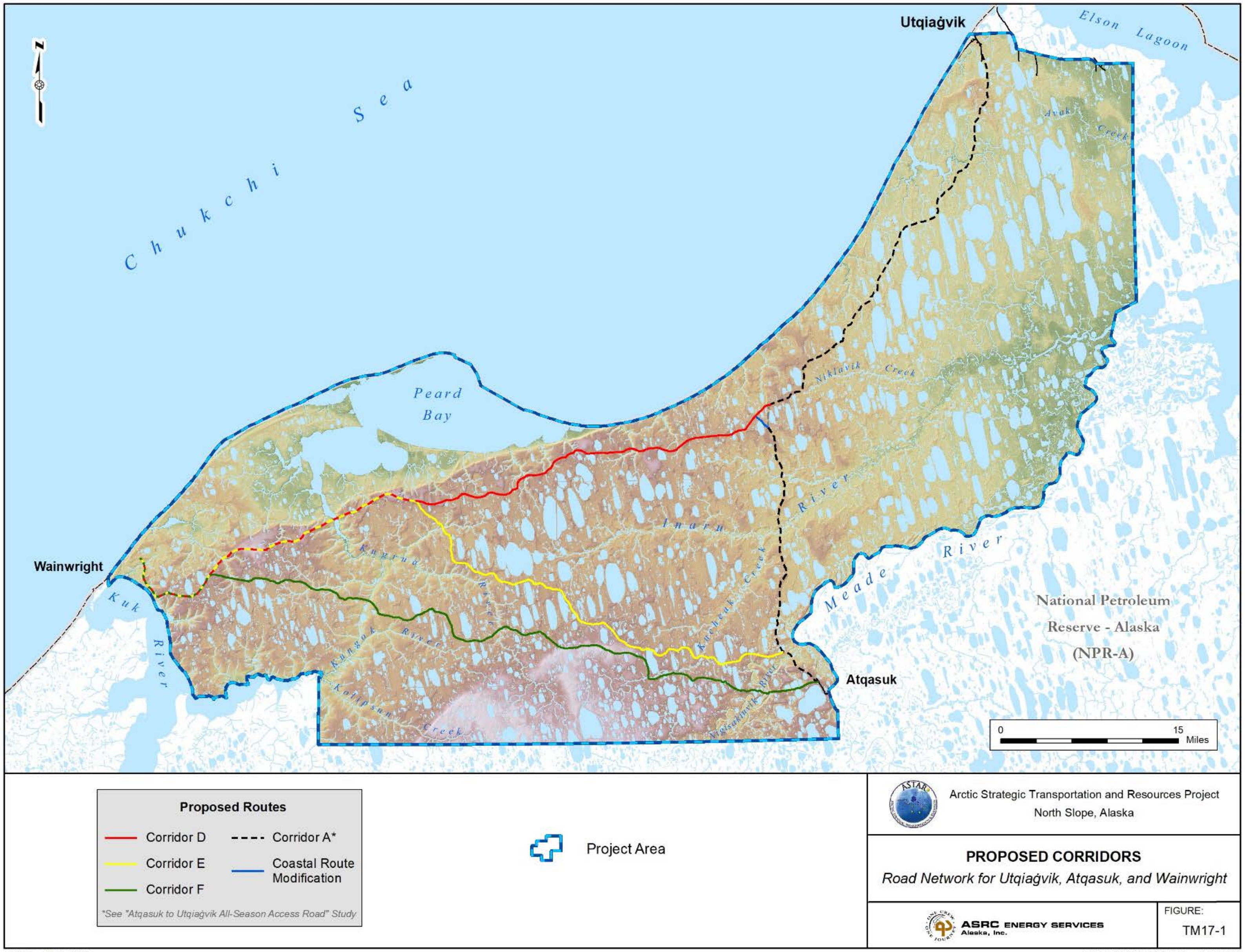
Utqiaġvik
Elson Lagoon
Chukchi Sea
Peard Bay
Wainwright
Kuk River
Atqasuk
Meade River
Inaru River
Kugrua River
Kungok River
Kolipsun Creek
Avak Creek
Niklavik Creek
Kucheak Creek
National Petroleum Reserve - Alaska (NPR-A)
0
15
Miles
Proposed Routes
Corridor D
Corridor E
Corridor F
Corridor A*
Coastal Route Modification
*See "Atqasuk to Utqiaġvik All-Season Access Road" Study
Project Area
Arctic Strategic Transportation and Resources Project
North Slope, Alaska
PROPOSED CORRIDORS
Road Network for Utqiaġvik, Atqasuk, and Wainwright
ASRC ENERGY SERVICES
Alaska, Inc.
FIGURE:
TM17-1
UTM Zone 4N (NAD83)
AES-RTS: 20-001-TM17-001.mxd, 04/13/20

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A separate estimate was prepared for each of the three main proposed routes. There is a modified segment of the coastal route that is not considered in the cost estimate as the alternate leg of roadway is assumed negligible compared to the main route (see Modifications to Coastal Route in Figure TM17-1). Estimates include all applicable direct construction costs as well as all contractor-incurred indirect costs, including but not limited to: construction camp rental, support and maintenance staff, contractor quality assurance/quality control (QA/QC), construction surveying, weather contingency days and fuel costs. For purposes of this memo, the Coastal Route Extension term is interchangeable with Corridor D, Middle Route with Corridor E, and Southern Route with Corridor F. A summary of the civil infrastructure associated with the proposed corridors is provided in Table TM17-1.

Table TM17-1. Route Alternative Summary

Route	Total Length (mi)	Number of Bridges	Number of Culvert Batteries	Proposed Road Width (ft)	Minimum Road Prism Thickness (ft)
Coastal Extension– Corridor D	62.9	10	13	32	5
Middle Route– Corridor E	68.8	9	8	32	5
Southern Route– Corridor F	68.2	10	20	32	5

Logistics and Transportation

The remote coastal villages of Wainwright and Utqiaġvik are serviced by air and barge only. Barge transportation of materials is further limited by short open-water seasons and an underdeveloped marine infrastructure. There are no port facilities existing, and barge offloading is generally by beach landing. An evaluation and feasibility study of current barge capabilities at Wainwright and Utqiaġvik should be conducted to verify that they can meet anticipated barge demands of this project. The construction costs associated with the proposed Corridors D, E, and F from Wainwright to Atqasuk assume there is suitable site access from either end of the route.

Cost Breakdown Structure

The estimate presented has been separated in to primary components that comprise the work to be performed, and is further broken down into subcomponents, with the basis being assemblies created using the personnel, equipment and materials used to complete the work. A brief description of the cost breakdown structure (CBS) structure can be seen in Table TM17-2.

Table TM17-2. Cost Breakdown Structure Definitions

CBS Position Code	Category	Description
1.1	Mobilization and Demobilization	Encompasses all costs associated with mobilizing and demobilizing all personnel, equipment, camps and materials to complete the scope.
1.2	Ice Roads and Pads	Cost of constructing and maintaining the seasonal ice roads and pads. Pads are used for temporary storage and/or staging of materials and equipment.
1.3	Gravel Mine	Cost of developing gravel sources for roads and pads. Includes access road development, overburden strip and stockpile, drill and blasting, royalties, and reclamation work.
1.4	Gravel Fill	The cubic yardage depicted under this line item represents a neat line quantity of gravel. The costs presented are inclusive of hauling, placing and compacting the material, as well as installing drainage culverts and culvert batteries.
1.5	Summer Work	Summer work includes the rework of the winter-placed gravel and installing all delineators.
1.6	Bridges	Bridge estimate definitions can be found in Technical Memorandum 7 – Vehicle Bridges. The estimate provided in this memo is a lump sum installed cost of all bridges including their indirect costs. Ice pads associated with the bridges are included with CBS line item 1.3.
1.7	Indirect Costs	All applicable contractor indirect costs including contractor planning and training, salaried indirect staff, camp rental, construction surveying, weather contingency, small tools/consumables and fuel.

Equipment and Materials Pricing

Equipment rates are based on historically compiled rates from North Slope heavy civil contractors and are presented in current (2020) prices with no allowance for inflation. Material prices are based on historically compiled rates from material suppliers and fabricators and are presented in current (2020) prices with no allowance for inflation.

Labor Rates and Factors

Labor rates for this estimate are based on the September 2019 *Pamphlet 600 – Laborers' and Mechanics' Minimum Rates of Pay* (Alaska Department of Labor and Workforce Development 2019). Labor rates include a standard markup for contractor's payroll tax, overhead, general and administrative expenses, and a contingency markup. The assumed work schedule is 12 hours per day, 7 days per week for the duration of the project, and the wages include a markup of 1.5x for overtime hours.

Estimate Assumptions

General

To provide a reliable basis for developing the cost estimates for the proposed corridors, assumptions were made to define critical work elements and factors that will influence the total estimated cost. The following section details the assumptions made during the development of this estimate.

Project Contract Structure

It is assumed that the civil infrastructure and bridges will be issued as lump sum fixed fee contracts and bid on as separate jobs and awarded separately. It is assumed that for the purposes of this project there will be no owner provided materials and services. This estimate omits owner-provided QA, engineering support, and contract management/oversight.

Cost Estimate Assumptions

Table TM17-3. Cost Estimate Assumptions

CBS Position Code	Category	Description
1.1	Mobilization and Demobilization	All routes are assumed to require multiple seasonal mob/demobs. All construction materials and equipment shall be barged to either Wainwright or Utqiaġvik. Infrastructure capable of supporting heavy-haul items is assumed to be in place at either end of the proposed routes.
1.2	Ice Roads and Pads	Ice roads lengths are derived from an assumed 5-mile water source access road distance plus approximately 1.5x the total length of constructed gravel roads. Material and storage ice pads are estimated at one 5-acre pad per 10 miles of road and one 3-acre pad per 300 linear feet (ft) of bridge.
1.3	Gravel Mine	Existing gravel mines in the project area are not anticipated to be able to provide the magnitude and quality of material needed for the project scope and therefore new gravel sources are anticipated to be developed. A gravel source is anticipated every 20 miles of constructed road to minimize haul distances. Costs are approximated based on similar remote Alaska Development projects. Mine development and mining costs are estimated with 1.5-2.0 million cubic yards (CY) of gravel mined per material source and includes a $3/CY royalty, the cost of overburden removal and storage, drilling, blasting, stockpiling and loading, and short-term (seasonal) mine site remediation.
1.4	Gravel Fill	Gravel fill is assumed to be sourced from the newly developed mine sites; therefore, gravel material costs are not included in this line item. Average hauling distances were assumed to be approximately 10 miles with the assumption a new mine will be developed every 20 miles. Gravel hauling quantities are assumed to be 30% over neat line quantities to account for thaw consolidation and compaction during embankment construction. The average road prism is assumed to be 7.5 ft tall with a 32 ft shoulder-to-shoulder width and 2:1 side slopes. This includes an estimated 1.5 ft of settlement due to thawing after the first season. The hauling crews are back-calculated using an average haul distance with an average speed and loading time for the optimum number of trucks. Drainage culverts and culvert batteries are included in this line item. Drainage culverts are assumed to be an average of 36 inches in diameter and placed at intervals of 500 ft. Site specific culvert batteries are assumed to have (2) 48 inch and (1) 60 inch diameter pipe with 15CY of rip rap at each end.
1.5	Summer Work	Delineators are assumed to be placed at an average interval of 45 ft in pairs.
1.6	Bridges	Bridge Estimates can be found in Technical Memorandum 7 – Vehicle Bridges.
1.7	Indirect Costs	Camp rental costs are assumed to be $500,000 per month for a 250-man camp. 10 days of weather contingency are assumed per year of construction. Fuel is assumed to cost $6.00/gal.

Inclusions

- Contractor profit and risk for equipment is included in the hourly labor and equipment rates, and is estimated at 15 percent.
- Contractor profit and risk for materials is assumed to be 10 percent.
- Contractor consumables for each task are included where applicable. There is also an indirect cost for small tools and consumables associated with seasonal equipment maintenance.
- Construction survey support is included in the indirect costs.
- Contractor indirect staff is assumed to include the following in-field positions: QA/QC Specialist, Health, Safety, and Environment Specialist, Project Engineer, and Project Manager.

Exclusions

- Erosion control for the road prism within the flood plain (rip rap and/or gravel bags; further route and site studies must be completed to quantify)
- Geotechnical exploration as needed for bridge foundations and identifying gravel sources.
- Owner engineering support and QA/QC positions
- Field-wide indirect costs
- Unit operator costs
- Escalation
- Legal costs
- Equipment standby or overwintering costs
- Engineering, permitting, and contract management
- Long-term mine site remediation
- Contingency

Schedule

Please reference Technical Memorandum 7 – Vehicle Bridges for bridge construction scheduling discussion.

Based on previous North Slope projects, an average road length of approximately 10 miles is constructible in a single season by a single contractor. See Table TM17-4 for project duration estimates for projects over 10 miles in length.

Table TM17-4. Seasonal Construction Duration by Road Length per Contractor

Project Length (mi)	Number of Seasons / Contractors
<10	1
10-20	2
20-30	3
40-50	4
50-60	5
>60	6+

The overall duration required for installation of all civil scope of work associated with the corridors will vary depending on the number of individual prime contractors performing the work. For the purposes of this estimate, it was assumed that the project will be split in to multiple zones and work performed by multiple contractors to complete the project in a compressed time frame. Each route is assumed to be employed by two contractors and completed in three to four seasons. Additional contractors or further phasing of the project will be required for bridge construction (see Technical Memorandum 7).

The construction window for winter gravel placement and compaction is generally over a three-month period after the construction of the on-tundra ice roads and pads, generally in the middle of January. Construction of on-tundra ice roads required for project access will begin pending receipt of approval from the Alaska Department of Natural Resources for on-tundra access (estimated mid-January). Early season pre-packing of snow for the on-tundra ice roads will be used to allow earlier (mid-December) approval for tundra access. For the purposes of this report, ice roads are assumed to be in usable condition by January 15, with construction continuing to a completed stage by February 15 and to remain usable with constant maintenance until April 15.

Cost Estimates

ROM estimates for Corridors D, E, and F are contained below in Tables TM17-5 through TM17-7, respectively.

Table TM17-5. Corridor D ROM Costs

CBS Position Code	Description	Material Quantity	Unit of Measure	Total Unit Cost	Total Cost
1.1	Mobilization and Demobilization	1	LS	$15,000,000	$15,000,000
1.2	Ice Roads and Pads	1	LS	$11,818,000	$11,818,000
1.2.1	On Tundra Ice Roads	126	Mile	$73,000	$9,198,000
1.2.2	On Tundra Ice Pads	56	Acre	$27,500	$1,540,000
1.2.3	Ice Road Maintenance	60	Day	$18,000	$1,080,000
1.3	Gravel Mine	3	EA	$30,000,000	$90,000,000
1.4	Gravel Fill (Neat Line Qty)	4,350,000	CY	$13.65	$59,360,500
1.4.1	Haul and Place Gravel (Avg. 10-mi haul)	5,655,000	CY	$7.50	$42,412,500
1.4.2	Drainage Culverts	664	EA	$22,000	$14,608,000
1.4.2.1	Provide 24" x 1" Pipe	46,496	LF	$260	$12,088,960
1.4.2.2	Install Culverts	664	EA	$3,900	$2,589,600
1.4.3	Culvert Batteries	13	EA	$180,000	$2,340,000
1.4.3.1	Provide (2) 48" x 1" Pipe	1,820	LF	$550	$1,001,000
1.4.3.2	Provide (1) 60" x 1.25" Pipe	910	LF	$860	$782,600
1.4.3.3	Install Culvert Battery	13	EA	$31,000	$403,000
1.4.3.4	Install Inlet/Outlet Protection	390	CY	$450	$175,500
1.5	Summer Work	1	LS	$13,009,500	$13,009,500
1.5.1	Summer Gravel Rework	180	Day	$69,500	$12,510,000
1.5.2	Purchase and Install Delineators	14,800	EA	$33.75	$499,500

CBS Position Code	Description	Material Quantity	Unit of Measure	Total Unit Cost	Total Cost
1.6	Bridge Costs	1	LS	$123,565,000	$123,565,000
1.7	Indirect Costs	1	LS	$72,574,000	$72,574,000
1.7.1	Construction Camp	1	LS	$24,000,000	$24,000,000
1.7.1.1	Camp Rental	4	Year	$6,000,000	$24,000,000
1.7.2	Contractor Pre-Planning and Training	1	LS	$290,000	$290,000
1.7.2.1	Pre-Planning	30	Day	$5,800	$174,000
1.7.2.2	Employee Training	1	LS	$116,500	$116,500
1.7.3	Winter Construction Indirects	4	Year	$1,888,500	$7,554,000
1.7.3.1	Salaried Indirect Staff	360	Day	$6,200	$2,232,000
1.7.3.2	Support Labor and Equipment	360	Day	$4,700	$1,692,000
1.7.3.3	Fuel, Servicing and Repair	360	Day	$6,400	$2,304,000
1.7.3.4	Field Sanitation and Servicing	360	Day	$1,100	$396,000
1.7.3.5	Contractor Quality Control - 3rd Party Services	360	Day	$2,800	$1,008,000
1.7.4	Summer Construction Indirects	4	Year	$1,259,000	$5,036,000
1.7.4.1	Salaried Indirect Staff	240	Day	$6,200	$1,488,000
1.7.4.2	Support Labor and Equipment	240	Day	$4,700	$1,128,000
1.7.4.3	Fuel, Servicing and Repair	240	Day	$6,400	$1,536,000
1.7.4.4	Field Sanitation and Servicing	240	Day	$1,100	$264,000
1.7.4.5	Contractor Quality Control - 3rd Party Services	240	Day	$2,800	$672,000
1.7.5	Construction Survey	600	Day	$8,600	$5,160,000
1.7.6	Weather Contingency	40	Day	$8,600	$344,000
1.7.7	Small Tools and Consumables	4	LS	$400,000	$1,600,000
1.7.8	Fuel	4,765,000	Gallon	$6.00	$28,590,000
				Corridor D Total Concept Level Cost:	**$385,327,000**

Table TM17-6. Corridor E ROM Costs

CBS Position Code	Description	Material Quantity	Unit of Measure	Total Unit Cost	Total Cost
2.1	Mobilization and Demobilization	1	LS	$15,000,000	$15,000,000
2.2	Ice Roads and Pads	1	LS	$12,694,000	$12,694,000
2.2.1	On Tundra Ice Roads	138	Mile	$73,000	$10,074,000
2.2.2	On Tundra Ice Pads	56	Acre	$27,500	$1,540,000

CBS Position Code	Description	Material Quantity	Unit of Measure	Total Unit Cost	Total Cost
2.2.3	Ice Road Maintenance	60	Day	$18,000	$1,080,000
2.3	Gravel Mine	3	EA	$30,000,000	$90,000,000
2.4	Gravel Fill (Neat Line Qty)	4,753,000	CY	$13.42	$63,775,750
2.4.1	Haul and Place Gravel (Avg. 10 mi haul)	6,178,900	CY	$7.50	$46,341,750
2.4.2	Drainage Culverts	727	EA	$22,000	$15,994,000
2.4.2.1	Provide 24" x 1" Pipe	50,857	LF	$260	$13,222,820
2.4.2.2	Install Culverts	727	EA	$3,900	$2,835,300
2.4.3	Culvert Batteries	8	EA	$180,000	$1,440,000
2.4.3.1	Provide (2) 48" x 1" Pipe	1,120	LF	$550	$616,000
2.4.3.2	Provide (1) 60" x1.25" Pipe	560	LF	$860	$481,600
2.4.3.3	Install Culvert Battery	8	EA	$31,000	$248,000
2.4.3.4	Install Inlet/Outlet Protection	240	CY	$450	$108,000
2.5	Summer Work	1	LS	$15,141,000	$15,141,000
2.5.1	Summer Gravel Rework	210	Day	$69,500	$14,595,000
2.5.2	Purchase and Install Delineators	16,200	EA	$33.75	$546,750
2.6	Bridge Costs	1	LS	$116,952,000	$116,952,000
2.7	Indirect Costs	1	LS	$74,426,000	$74,426,000
2.7.1	Construction Camp	1	LS	$24,000,000	$24,000,000
2.7.1.1	Camp Rental	4	Year	$6,000,000	$24,000,000
2.7.2	Contractor Pre-Planning and Training	1	LS	$290,000	$290,000
2.7.2.1	Pre-Planning	30	Day	$5,800	$174,000
2.7.2.2	Employee Training	1	LS	$116,500	$116,500
2.7.3	Winter Construction Indirects	4	Year	$1,888,500	$7,554,000
2.7.3.1	Salaried Indirect Staff	360	Day	$6,200	$2,232,000
2.7.3.2	Support Labor and Equipment	360	Day	$4,700	$1,692,000
2.7.3.3	Fuel, Servicing and Repair	360	Day	$6,400	$2,304,000
2.7.3.4	Field Sanitation and Servicing	360	Day	$1,100	$396,000
2.7.3.5	Contractor Quality Control - 3rd Party Services	360	Day	$2,800	$1,008,000
2.7.4	Summer Construction Indirects	4	Year	$1,259,000	$5,036,000
2.7.4.1	Salaried Indirect Staff	240	Day	$6,200	$1,488,000
2.7.4.2	Support Labor and Equipment	240	Day	$4,700	$1,128,000
2.7.4.3	Fuel, Servicing and Repair	240	Day	$6,400	$1,536,000
2.7.4.4	Field Sanitation and Servicing	240	Day	$1,100	$264,000

CBS Position Code	Description	Material Quantity	Unit of Measure	Total Unit Cost	Total Cost
2.7.4.5	Contractor Quality Control - 3rd Party Services	240	Day	$2,800	$672,000
2.7.5	Construction Survey	600	Day	$8,600	$5,160,000
2.7.6	Weather Contingency	40	Day	$8,600	$344,000
2.7.7	Small Tools and Consumables	4	LS	$400,000	$1,600,000
2.7.8	Fuel	5,122,000	Gallon	$6.00	$30,732,000
				Corridor E Total Concept Level Cost:	**$387,989,500**

Table TM17-7. Corridor F ROM Costs

CBS Position Code	Description	Material Quantity	Unit of Measure	Total Unit Cost	Total Cost
3.1	Mobilization and Demobilization	1	LS	$15,000,000	$15,000,000
3.2	Ice Roads and Pads	1	LS	$12,373,500	$12,373,500
3.2.1	On Tundra Ice Roads	137	Mile	$73,000	$10,001,000
3.2.2	On Tundra Ice Pads	47	Acre	$27,500	$1,292,500
3.2.3	Ice Road Maintenance	60	Day	$18,000	$1,080,000
3.3	Gravel Mine	3	EA	$30,000,000	$90,000,000
3.4	Gravel Fill (Neat Line Qty)	4,727,000	CY	$13.86	$65,528,250
3.4.1	Haul and Place Gravel (Avg. 10 mi haul)	6,145,100	CY	$7.50	$46,088,250
3.4.2	Drainage Culverts	720	EA	$22,000	$15,840,000
3.4.2.1	Provide 24" x 1" Pipe	50,413	LF	$260	$13,107,380
3.4.2.2	Install Culverts	720	EA	$3,900	$2,808,000
3.4.3	Culvert Batteries	20	EA	$180,000	$3,600,000
3.4.3.1	Provide (2) 48" x 1" Pipe	2,800	LF	$550	$1,540,000
3.4.3.2	Provide (1) 60" x1.25" Pipe	1,400	LF	$860	$1,204,000
3.4.3.3	Install Culvert Battery	20	EA	$31,000	$620,000
3.4.3.4	Install Inlet/Outlet Protection	600	CY	$450	$270,000
3.5	Summer Work	1	LS	$15,135,000	$15,135,000
3.5.1	Summer Gravel Rework	210	Day	$69,500	$14,595,000
3.5.2	Purchase and Install Delineators	16,000	EA	$33.75	$540,000
3.6	Bridge Costs	1	LS	$80,428,000	$80,428,000
3.7	Indirect Costs	1	LS	$72,196,000	$72,196,000
3.7.1	Construction Camp	1	LS	$24,000,000	$24,000,000
3.7.1.1	Camp Rental	4	Year	$6,000,000	$24,000,000

CBS Position Code	Description	Material Quantity	Unit of Measure	Total Unit Cost	Total Cost
3.7.2	Contractor Pre-Planning and Training	1	LS	$290,000	$290,000
3.7.2.1	Pre-Planning	30	Day	$5,800	$174,000
3.7.2.2	Employee Training	1	LS	$116,500	$116,500
3.7.3	Winter Construction Indirects	4	Year	$1,888,500	$7,554,000
3.7.3.1	Salaried Indirect Staff	360	Day	$6,200	$2,232,000
3.7.3.2	Support Labor and Equipment	360	Day	$4,700	$1,692,000
3.7.3.3	Fuel, Servicing and Repair	360	Day	$6,400	$2,304,000
3.7.3.4	Field Sanitation and Servicing	360	Day	$1,100	$396,000
3.7.3.5	Contractor Quality Control - 3rd Party Services	360	Day	$2,800	$1,008,000
3.7.4	Summer Construction Indirects	4	Year	$1,259,000	$5,036,000
3.7.4.1	Salaried Indirect Staff	240	Day	$6,200	$1,488,000
3.7.4.2	Support Labor and Equipment	240	Day	$4,700	$1,128,000
3.7.4.3	Fuel, Servicing and Repair	240	Day	$6,400	$1,536,000
3.7.4.4	Field Sanitation and Servicing	240	Day	$1,100	$264,000
3.7.4.5	Contractor Quality Control - 3rd Party Services	240	Day	$2,800	$672,000
3.7.5	Construction Survey	600	Day	$8,600	$5,160,000
3.7.6	Weather Contingency	40	Day	$8,600	$344,000
3.7.7	Small Tools and Consumables	4	LS	$400,000	$1,600,000
3.7.8	Fuel	4,702,000	Gallon	$6.00	$28,212,000
				Corridor F Total Concept Level Cost:	**$350,660,750**

Data Gaps

The following is a list of data gaps that will need to be filled as the project progresses to the next phases:

- Site geotechnical investigations to determine in-situ conditions at the proposed crossings and to identify potential gravel mining sources.
- Evaluation of current port/offload facilities at coastal villages to determine viability of meeting anticipated project barging demands.
- Evaluating the possible use of insulation in the road prism.
- Site survey and bathymetry at crossing locations and flood plain determination for road prism erosion protection.
- Preliminary engineering.

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