3.20 AIR QUALITY

This section describes the current air quality and climate for the Environmental Impact Statement (EIS) analysis area. The EIS analysis area (hereafter, analysis area) for air quality and climate analysis encompasses the mine site, port, the transportation corridor, and the natural gas pipeline corridor for each alternative and variants, as well as the larger geographical area that would experience indirect impacts. The air quality and climate analyses presented are applicable for all alternatives, because they are generally located in the same area.

3.20.1 Regional Air Quality

Air quality is defined by the concentration of criteria pollutants and their interactions in the atmosphere, Hazardous Air Pollutants (HAPs), and the magnitude of haze and acidic deposition generally referred to as Air Quality Related Values (AQRVs). An understanding of current conditions and trends of these air quality metrics also provides a baseline for comparison of potential future impacts. Recent trends in air quality are important to consider when evaluating potential future changes, independent of an individual project.

Analysis area air quality is assessed through the analysis of values measured by the monitors listed in Table 3.20-1, and from the Alaska Air Monitoring Network. A map of the monitor locations is presented in Figure 3.20-1. Criteria pollutants were analyzed using data obtained from the Alaska Department of Environmental Conservation (ADEC). Existing visibility conditions were assessed using monitors from the Interagency Monitoring of Protected Environment (IMPROVE) network. The wet and dry deposition measurements are collected by the National Acid Deposition Program (NADP) and the Clean Air Status and Trends Network (CASTNeT), respectively. With the exception of Denali National Park monitors, all monitors are within 200 miles of the mine site, which is typically close enough to be considered representative of the area.

Table 3.20-1: Monitor Name and Details Used in the Analysis

Network	Monitor Name	Monitoring Period	Monitored Parameters[1]	Monitor Purpose[2]	Approximate Distance from Mine Site
ADEC[3]	Chevron Trading Bay	2008-2009	NO_2, CO	Maximum Impact	130 miles east
	Chevron Swanson River	2008-2009	NO_2, CO	Maximum Impact	160 miles east
	Agrium Nikiski	2013-2014	PM_{10}, $PM_{2.5}$, ozone	Maximum Impact	140 miles east
	Alaska LNG Nikiski	2015	NO_2, CO, PM_{10}, $PM_{2.5}$, SO_2, ozone	Background	140 miles east
	Chugach International Station	2011-2012	NO_2, ozone	Maximum Impact	200 miles east-southeast
Alaska Air Monitoring Network[4]	Select Anchorage monitors	2000-2014	$PM_{2.5}$, PM_{10}, ozone, CO	Background	180 miles east
IMPROVE[5]	Tuxedni	2008-2014	Visibility	Background	80 miles southeast
	Denali National Park	2008-2016	Visibility	Background	330 miles northeast

Table 3.20-1: Monitor Name and Details Used in the Analysis

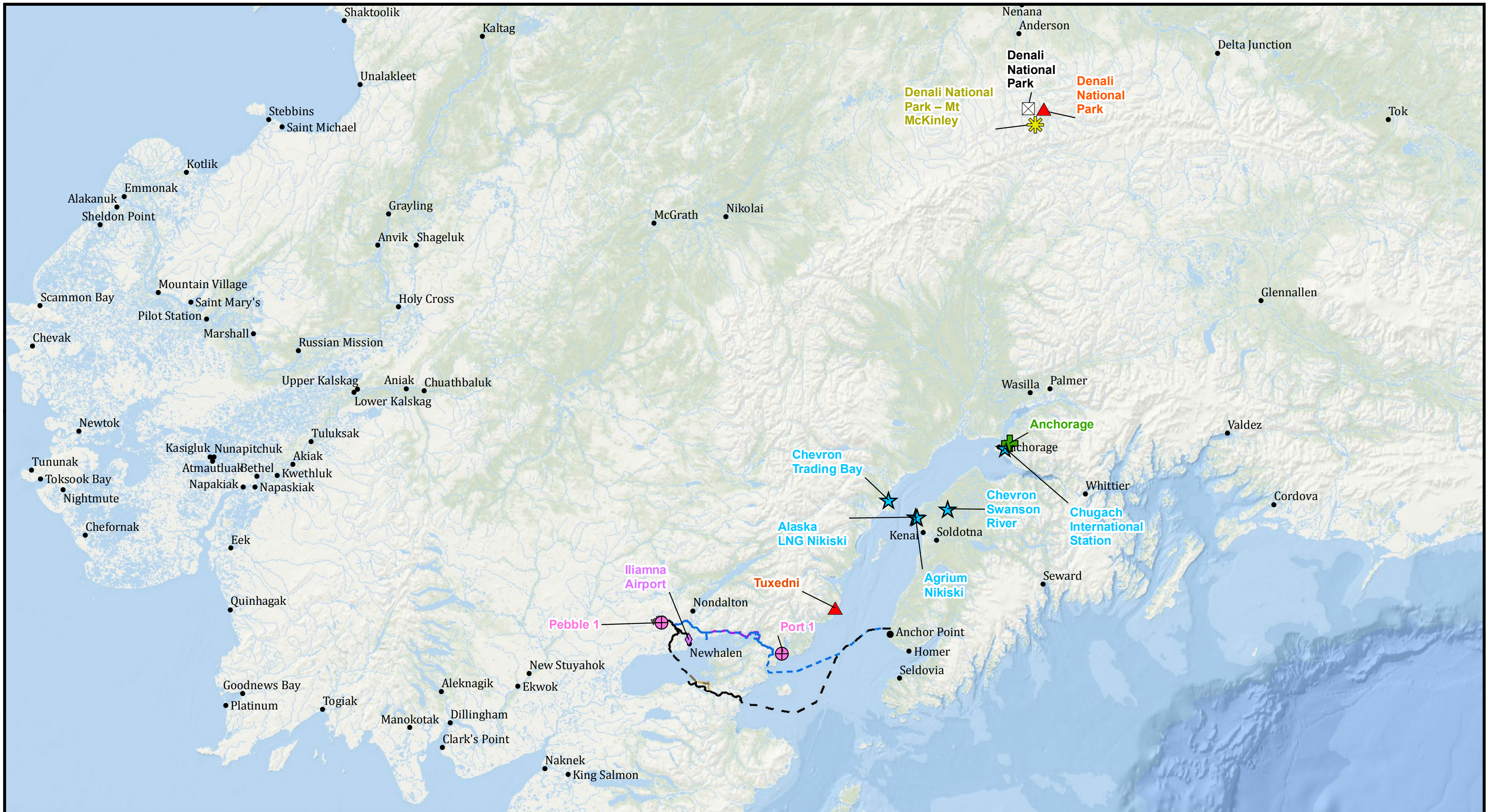
Network	Monitor Name	Monitoring Period	Monitored Parameters[1]	Monitor Purpose[2]	Approximate Distance from Mine Site
CASTNeT[6]	Denali National Park	1999-2016	Dry Deposition	Background	330 miles northeast
NADP[7]	Denali National Park – Mt McKinley	1999-2015	Wet Deposition	Background	330 miles northeast

[1]NO_2 = nitrogen dioxide, CO = carbon dioxide, PM_{10} = PM particulate matter with an aerodynamic diameter less than or equal to 10 microns, $PM_{2.5}$ = PM particulate matter with an aerodynamic diameter less than or equal to 2.5 microns, and SO_2 = sulfur dioxide.
[2]For the purpose of monitors presented, the data are collected either to provide background data or to capture maximum impacts from emission sources near the monitor location.
[3]ADEC 2018c
[4]ADEC 2016a
[5]IMPROVE 2018a, 2018b
[6]US Environmental Protection Agency 2018b
[7]NADP 2018

3.20.1.1 Criteria Pollutants

The relative importance of criteria pollutant concentrations can be determined by comparison with the Alaska Ambient Air Quality Standards (AAAQS) which are equivalent to, or more stringent than, the National Ambient Air Quality Standards (NAAQS). Air pollutant concentrations that are lower than the AAAQS provide public health protection, including protecting the health of sensitive populations such as asthmatics, children, and the elderly. All pollutants in the region containing the analysis area are below the AAAQS. With the exception of locations near airfields, where lead emissions from aircraft exhaust has the potential to occur, regional sources of lead are minimal. Given the project is far from any airfields where lead emissions could occur and potential project lead emissions are extremely low, ambient lead concentrations and comparisons to the lead AAAQS are not addressed further in this analysis.

The Alaska Air Monitoring Network measures certain criteria pollutants of interest throughout Alaska, and can be used to assess the general air quality trends of the region. The nearest of these monitors are in relatively urbanized areas in and around Anchorage, and are distant from the analysis area (ADEC 2016a). Due to the increased anthropogenic activity, measurements at these monitors are expected to be elevated compared to what should be observed in the analysis area; however, the long-term measurement record available from this network can provide a valuable understanding of regional trends. The Alaska Air Monitoring Network only measures particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM_{10}), particulate matter with an aerodynamic diameter less than or equal to 2.5 microns ($PM_{2.5}$), ozone, and carbon monoxide (CO) close enough to the analysis area to be relevant. For the remaining criteria pollutants, long-term trends are not available for analysis. For $PM_{2.5}$ and PM_{10}, the frequency of AAAQS exceedances has increased since 2000 (ADEC 2016a). ADEC documents that this increase is due to an increase in the frequency of wildfires near the monitors. For the more rural monitors that are more representative of the analysis area, the measured concentrations have remained relatively constant, with average annual $PM_{2.5}$ values near 6.5 micrograms per cubic meter ($\mu g/m^3$), and well below the AAAQS. The measured CO concentrations at the Anchorage monitor have decreased to values consistently below 6 parts per million (ppm) from 2000 to 2014 (ADEC 2016a). An assessment of 4 years of ozone measurements at monitoring sites near Anchorage indicates that hourly ozone concentrations peak in the late spring, and are lowest in winter (ADEC 2016a). This is consistent with global trends for this latitude.



Sources: PLP 2018d; Esri et al. 2018; ADEC, Alaska Air; IMPROVE; CASTNeT; NADP; Hoefler 2010a; WRCC

US Army Corps of Engineers®

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Miles

Station Network

- ADEC
- Alaska Air Monitoring Network
- CASTNeT
- Hoefler
- IMPROVE
- NADP
- WRCC

Alternative 1

- Mine Site
- Transportation Corridor
- Natural Gas Pipeline

Kokhanok East Ferry Terminal Variant

- Transportation Corridor

Alternative 2

- Transportation Corridor
- Natural Gas Pipeline

Alternative 3

- Transportation Corridor

RELEVANT AIR QUALITY MONITORING STATIONS

PEBBLE PROJECT EIS

FIGURE 3.20-1

Table 3.20-2 lists existing conditions measured at locations near the project study area; shown for all criteria pollutants except lead. Compared to the Anchorage monitors discussed previously, with the exception of the Chugach International Station, these monitors are found in more remote areas with fewer anthropogenic sources, aside from those associated with the large industrial facilities the data collection efforts were designed to support. None of the monitoring programs documented in this table represent more than 1 year of data; therefore, multi-year averages that are required for the 1-hour nitrogen dioxide (NO_2), 1-hour sulfur dioxide (SO_2), and $PM_{2.5}$ AAAQS cannot be properly calculated. For those pollutants and averaging periods, the values presented in Table 3.20-2 are not directly comparable to the AAAQS, but are still a reliable indicator of recent air quality, and show if values in the vicinity of the analysis area are near AAAQS thresholds, keeping in mind that a single year of data could represent an anomalous event.

All values listed in Table 3.20-2 are well below the AAAQS. Unlike the measurement locations themselves, the analysis area is far from large industrial emissions sources, with relatively sparse population. Therefore, measured concentrations in the analysis area are expected to be lower.

Secondary NAAQS set limits to protect public welfare, including protection against decreased visibility; endangerment to animals; and damage to crops, vegetation, and buildings. In most cases, the AAAQS are also protective of the health of plant and animal species because they are equal to or more stringent than the secondary NAAQS. However, for some species of lichens, which can be particularly sensitive to SO_2, ADEC (2016b) recommends supplementing these standards with an annual SO_2 threshold of 13 $\mu g/m^3$, which is more stringent than the annual SO_2 AAAQS. Annual SO_2 concentrations at the Alaska Liquefied Natural Gas (LNG) Nikiski monitor are reported as zero (Table 3.20-2), indicating that concentrations are less than 0.0005 ppm (1.4 $\mu g/m^3$), and well below the annual SO_2 threshold of 13 $\mu g/m^3$. Given that the project study area has limited sources of anthropogenic SO_2, it is expected that the SO_2 concentrations in the project study area would be similar to those measured at the LNG Nikiski monitor.

Table 3.20-2:Criteria Pollutant Data Complied by ADEC

Pollutant	Averaging Period	Form of the Standard	AAAQS	Monitor Name				
				Chevron Trading Bay	Chevron Swanson River	Agrium Nikiski	Alaska LNG Nikiski	Chugach International Station
NO_2	1-hour	98th Percentile of Daily Max	100 ppb	n/a	n/a	n/a	16.0 ppb	80.7 ppb
	Annual	Average	53 ppb	3.0 ppb	7.0 ppb	n/a	1.0 ppb	15 ppb
SO_2	1-hour	99th Percentile of Daily Max	75 ppb	n/a	n/a	n/a	1.6 ppb	n/a
	3-hour	Second High	0.5 ppm	n/a	n/a	n/a	0 ppm	n/a
	24-hour	Second High	0.14 ppm	n/a	n/a	n/a	0 ppm	n/a
	Annual	Average	0.030	n/a	n/a	n/a	0 ppm	n/a

Table 3.20-2:Criteria Pollutant Data Complied by ADEC

Pollutant	Averaging Period	Form of the Standard	AAAQS	Monitor Name				
				Chevron Trading Bay	Chevron Swanson River	Agrium Nikiski	Alaska LNG Nikiski	Chugach International Station
			ppm					
PM_{10}	24-hour	Second High	150 μg/m^3	n/a	n/a	58.5 μg/m^3	30.0 μg/m^3	n/a
$PM_{2.5}$	24-hour	98th Percentile	35 μg/m^3	n/a	n/a	8.0 μg/m^3	12 μg/m^3	n/a
	Annual	Average	12 μg/m^3	n/a	n/a	3.6 μg/m^3	3.7 μg/m^3	n/a
CO	1-hour	Second High	35 ppm	1.5 ppm	1.7 ppm	n/a	1 ppm	n/a
	8-hour	Second High	9 ppm	1 ppm	0.9 ppm	n/a	1 ppm	n/a
Ozone	8-hour	Fourth High	0.070 ppm	n/a	n/a	0.051 ppm	0.047 ppm	0.047 ppm

Notes:
AAAQS = Alaska Ambient Air Quality Standards
ADEC = Alaska Department of Environmental Conservation
CO = carbon dioxide
LNG = liquefied natural gas
μg/m^3 = micrograms per cubic meter
n/a = not available
NO_2 = nitrogen dioxide
PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 microns
$PM_{2.5}$ = particulate matter with an aerodynamic diameter less than or equal to 2.5 microns
ppb = parts per billion
ppm = parts per million
SO_2 = sulfur dioxide

3.20.1.2 Hazardous Air Pollutants

HAPs can cause serious health effects or adverse environmental or ecological effects. Concentrations of HAPs are rarely measured, and there are no monitors measuring HAPs in the region; therefore, no data are available to assess the current concentrations or trends. HAPs are not generally measured, except in the vicinity of very specific large sources, such as refineries. The HAPs of major concern are reactive and short-lived in the atmosphere. Therefore, absent large regional anthropogenic sources, there is no reason to expect measureable concentrations in the analysis area, except for what is biogenic in nature. For the same reasons, increasing or decreasing trends over time of HAPs in the analysis area are not expected.

3.20.1.3 Air Quality Related Values

Thresholds for AQRVs have been set to protect resources sensitive to acidic deposition and visibility degradation. These resources include vegetation, soils, water, fish wildlife, and recreation. Visibility and deposition are reviewed in more detail below for the purpose of establishing baseline conditions pertinent to vegetation, soils, water, fish, and recreation.

Visibility

Visibility impairment primarily impacts the recreational value of a location, and is not a concern for vegetation, soil, water, and fish. Regional haze is a visibility impairment caused by the cumulative air pollutant emissions from numerous sources over a wide geographic area. Visibility impairment is caused by particles and gases in the atmosphere that scatter or absorb light. The primary cause of regional haze in many parts of the country is light scattering, resulting from fine particles (e.g., $PM_{2.5}$) in the atmosphere. Additionally, coarse particles between 2.5 and 10 microns in diameter can contribute to both light absorption and scattering, increasing regional haze. Coarse particles and $PM_{2.5}$ can be naturally occurring, or the result of human activity. The natural levels of coarse particles result in some level of visibility impairment in the absence of any human influences, and vary with season, daily meteorology, and geography (Malm 1999).

The US Environmental Protection Agency (EPA) and other agencies have been monitoring visibility in national parks and wilderness areas since 1988. Observations have shown that visibility at national parks and wilderness areas throughout the United States was not as good as estimated natural background conditions (i.e., visibility is impaired relative to natural background conditions). The Regional Haze Rule was promulgated by the EPA in 1999 to establish Reasonable Progress Goals for improving visibility (EPA 2018c).

ADEC (2011) has determined that a primary source of visibility degradation for Alaska is short- and long-range transport of dust, and transport of combustion emissions from anthropogenic sources in Asia and Northern Europe. The long-range transport of dust across the Pacific Ocean typically influences visibility in Alaska in spring and summer, while anthropogenic emissions from Northern Europe and Russia reach Alaska during the winter and early spring. Additionally, particulate and gaseous emissions from wildfires influence visibility throughout Alaska. Wildfire season typically starts once snow melt occurs in late spring, and ends early fall (ADEC 2011).

Visibility impacts are expressed in deciviews (dv), which is a measure for describing perceived changes in visibility. Deciview values are calculated from either measured or estimated light extinction values in units of inverse megameters (Mm^{-1}). The smaller the dv value, the more pristine the atmosphere, and farther distances can be seen without visibility obstruction increasing, resulting in large visual range values. For Tuxedni (approximately 50 miles east-northeast of the mine site), the estimated annual average natural visibility condition for the haziest days is 11.3 dv; and for the clearest days, 3.1 dv. An estimate of 11 dv typically results in a visual range of 80 miles, while an estimate of 3 dv results in a visual range of 180 miles.

The natural visibility condition represents the long-term degree of visibility that is estimated to exist in a Federal Class I area in the absence of human-caused impairment, and gives a sense of the magnitude of the dv metric. Visibility in the analysis area was inferred using the two closest visibility monitoring stations operated by the IMPROVE program, as listed in Table 3.20-1. Visibility for the 20 percent best days (i.e., clearest), 20 percent worst days (i.e., haziest), and natural conditions are shown in Table 3.20-3 for these two IMPROVE stations over the period from 2011 to 2016, noting that the Tuxedni monitor does not have data after 2014.

Data in Table 3.20-3 indicate that for either Tuxedni or Denali National Park, the haziest days generally have visibility values between 7 and 13 dv, while the clearest typically have visibility values less than 5 dv. When comparing the current visibility at either monitoring station to the estimated natural visibility conditions, both the haziest and clearest days are higher than natural background conditions. Natural visibility conditions represent the visibility conditions without the effects of air pollution and diminished air quality. Overall, at the Tuxedni monitor, which is most representative of the EIS analysis area, the annual average haze index is closer to the natural visibility conditions on both the haziest and clearest days, whereas the measured visibility at Denali National Park is worse compared to the natural condition for both the haziest and clearest days. However, the values measured in 2016 are comparable to the natural conditions. Most importantly, regardless of the location, visibility has been steadily trending toward natural conditions.

Table 3.20-3: Visibility Values by Year

Monitor Name	Type	Annual Average Haze Index (deciview)						
		2011	2012	2013	2014	2015	2016	Natural Condition
Tuxedni	Haziest Days	12.3	11.6	12.4	13.2	n/a	n/a	11.3
	Clearest Days	4.3	3.9	3.6	3.8	n/a	n/a	3.1
Denali National Park	Haziest Days	9.1	8.7	9.6	8.6	12	7.3	7.3
	Clearest Days	2.7	2.7	2.2	2.3	2.2	1.9	1.8

Notes:
n/a = Not Available
Source: IMPROVE 2018a, 2018b

Deposition

Deposition can be from both wet and dry processes. Wet deposition refers to acidic rain, fog, and snow; whereas dry deposition refers to acidic gases and particles the wind blows onto buildings, cars, homes, and trees. The effects of atmospheric deposition of nitrogen and sulfur compounds on terrestrial and aquatic ecosystems are well-documented for some ecosystems, and have been shown to cause leaching of nutrients from soils, acidification of surface waters, injury to high elevation vegetation, and changes in nutrient cycling and species composition. The effects of acidification through sulfur deposition are not prevalent in Alaska due to lack of sources; and as a result, nitrogen deposition is often the main contributor of acidification in Alaska, if it occurs.

In Alaska, deposition is routinely measured at Denali National Park. However, given that both SO_2 and NO_x emissions contribute to both visibility impairment and deposition, and knowing that visibility degradation in Denali National Park is slightly worse than Tuxedni, it is expected that deposition measurements in Denali National Park are conservatively representative of Tuxedni and the analysis area. Wet deposition measurements at Denali National Park are collected by NADP in micro-equivalent per liter (µeq/l), and dry deposition is estimated from ambient measurements collected by CASTNet in kilograms per hectare (kg/ha). Deposition measurements in Denali National Park indicate that total sulfate and nitrate deposition rates have steadily decreased since the start of the record (Table 3.20-4).

Table 3.20-4: Wet and Dry Deposition at Denali National Park Monitoring Location

Year	Wet Deposition (µeq/l)[1]		Dry Deposition (kg/ha)[2]	
	Sulfur	Nitrogen	Sulfur	Nitrogen
2016	n/a	n/a	0.2	0.2
2015	1.8	1.5	0.2	0.3
2014	3.7	1.9	0.2	0.3
2013	2.5	1.5	0.2	0.3
2012	2.3	1.5	0.2	0.2

Table 3.20-4: Wet and Dry Deposition at Denali National Park Monitoring Location

Year	Wet Deposition (µeq/l)[1]		Dry Deposition (kg/ha)[2]	
	Sulfur	Nitrogen	Sulfur	Nitrogen
2011	2.4	1.0	0.2	0.2
2010	3.2	2.3	0.2	0.12
2009	6	1.7	0.3	0.4
2008	2.6	1.3	0.2	0.2
2007	3.4	1.2	0.2	0.3
2006	3.7	1.4	0.3	0.3
2005	3	2.2	0.2	0.4
2004	3.2	2	0.3	0.5
2003	3.1	2.4	0.3	0.3
2002	6.5	3.5	0.2	0.4
2001	4.6	2.9	0.3	0.3
2000	3.5	1.7	0.2	0.3
1999	2.2	2	0.3	0.3

Notes:
[1] Wet Deposition for station AK03 (NAPD 2018)
[2] Dry Deposition for station DEN417 (EPA 2018b)
kg/ha = kilograms per hectare
µeq/l = micro-equivalent per liter

As discussed for Alaska, the focus is on nitrogen deposition. Nitrogen deposition impacts will manifest before those from sulfur deposition. Currently, the National Park Service (NPS) is recommending the use of nutrient nitrogen-critical loads for the evaluation of deposition impacts in terrestrial and aquatic ecosystems. The nutrient nitrogen critical load thresholds are a tool used to assess and understand the impacts of nitrogen deposition to ecosystems. The nitrogen critical loads are determined by amount of nitrogen deposition below which no harmful effects to an ecosystem are expected. This value varies based on the type of ecosystem present in an area. Estimates of nitrogen-critical load values in Denali National Park range from 1.2 kilograms of nitrogen per hectare per year (kgN/ha/yr) for lichens and bryophytes, to 17.0 kgN/ha/yr for forests and nitrate leaching (NPS 2018e). Although additional information would be needed to convert the wet deposition rates into appropriate units for comparison to critical load values, the estimates of dry deposition at Denali National Park are well below the lowest critical load value of 1.2 kgN/ha/yr (Table 3.20-4). The same is expected for the analysis area.

3.20.2 Regional Climate

The analysis area is in a transitional climatic zone with a strong maritime influence (Hoefler 2010a). Terrain changes and proximity to large bodies of water locally influence the climate. For example, the proximity of Cook Inlet more heavily influences the climate around the project port site than the vicinity of the mine site. Portions of the analysis area that are at higher elevation are likely to experience colder temperatures and differences in precipitation patterns relative to those areas at lower elevations. Summer temperatures are moderated by the open waters of Iliamna Lake, the Bering Sea, and Cook Inlet. During winter, ice forms on these open waters, resulting in a more continental temperature pattern. Overall, the weather systems arrive from the west and southwest, bringing cool to cold air that is often saturated with moisture.

These systems result in frequent clouds, rain, and snow, with possible thunderstorm activity during the warm season.

Meteorological monitoring was conducted at the mine site and Cook Inlet by Hoefler (2010a, 2010b) and SLR (2013a, 2015a). The Cook Inlet monitor (Port Site 1) is about 30 miles northeast of the proposed Amakdedori port site. Table 3.20-5 present monthly and annual averages for mean temperature, mean wind speed, and total precipitation for the mine site (Pebble Site 1) and Cook Inlet (Port Site 1) monitors, respectively. The Port Site 1 monitor has recorded slightly warmer average monthly temperatures than the Pebble Site 1 monitor (Table 3.20-5). At the Port Site 1 monitor, wind is generally from the north and northeast due to local terrain influences (Hoefler 2010b). At the Pebble Site 1 monitor, the wind is bimodal, generally from the northwest or the southeast (Hoefler 2010a). The differences in observations are likely due the influence of Cook Inlet and elevation of the monitors.

Monthly climate averages for Iliamna Airport are listed in Table 3.20-6. These averages are from 30 years of data collection and represent long-term averages compared to the Pebble Site 1 monitor, which collected data for 7 years. The 30-year record minimizes the naturally occurring year-to-year variability that can bias a shorter-term record. Overall, the Iliamna Airport has colder temperatures during the winter, and warmer temperatures during the summer, with more precipitation, than the Pebble Site 1 and Port Site 1 monitoring sites.

Estimated predicted future temperature and precipitation values for Iliamna, Alaska are presented Table 3.20-7. These data were obtained from the Scenarios Network for Alaska and Arctic Planning (SNAP) for scenario A1B (SNAP 2018). For the period of years from 2040-2049, the annual average temperatures are projected to increase relative to Iliamna Airport (Table 3.20-6) and the Pebble Site 1 (Table 3.20-5). Relative to the Iliamna Airport, all months, except July, are projected to have an increase in precipitation. An increase in temperatures, coupled with a decrease in precipitation during the summer months, could lead to an increase in drought and wildfire frequency, as well as more fires due to a longer fire season and higher temperatures that allow for drying out of vegetation (Peterson et al. 2014). Total areas burned by fire are projected to triple by the end of the century under some climate projections (ADEC 2010). An increase in wildfires would result in an increase of particulate matter emissions relative to the background conditions. Windblown dust and particulate matter could also increase from a reduction in vegetative cover that could result from plant stress caused by higher temperatures and lower precipitation.

Table 3.20-5: Monthly Climate Summary for Pebble Site 1 and Port Site 1 Monitors

Monitor	Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Pebble Site 1 Monitor, 2005-2012[1]	Average Temperature (°F)	24.9	27.5	26.5	30.8	34.2	36.1	37.8	36.9	35.5	31.3	26.3	26.8	31.2
	Average Wind Speed (mph)	18.7	21.3	18.5	17.5	15.9	14.8	14.7	14.3	15.8	16.9	20.3	20.9	17.5
	Average Total Precipitation (inches)	2.4	3.5	2.0	1.7	1.4	3.3	5.8	4.2	5.0	3.9	2.6	4.0	39.9
Port Site 1 Monitor, 2008-2012[2]	Average Temperature	28.8	30.1	30.2	33.1	35.8	37.4	38.5	38.8	37.3	34.3	30.6	30.0	33.7
	Average Wind Speed	12.3	12.9	12.2	10.0	8.3	6.8	8.0	7.1	9.6	10.2	12.1	13.5	10.2
	Total Precipitation	4.5	4.4	1.5	4.9	3.7	4.3	9.5	5.5	6.6	6.4	3.2	4.0	58.5

Notes:
[1]Period of record January 2005 through 2012; elevation 1,560 feet above mean sea level (amsl). Source: Hoefler 2010a; SLR 2015a
[2]Period of record: August 2008 through 2012; elevation: 50 feet amsl. Source: Hoefler 2010b; SLR 2013a
°F = degrees Fahrenheit
mph = miles per hour

Table 3.20-6: Monthly Climate Summary, Iliamna Airport, 1981-2010[1]

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Maximum Temperature (°F)	24.6	26.3	30.7	39.8	51.6	59.4	62.5	61.1	53.9	40.8	29.3	26.9	42.4
Average Minimum Temperature (°F)	12.8	13.4	16.7	25.9	36.6	44.2	49.2	48.4	42.1	29.6	18.1	15.0	29.4
Average Mean Temperature (°F)	18.7	19.9	23.7	32.9	44.1	51.8	55.9	54.8	48.0	35.2	23.7	21.0	35.9
Average Total Precipitation (inches)	1.35	1.09	0.91	0.92	1.09	1.26	2.61	4.04	4.46	3.30	2.08	1.58	24.69
Average Total Snow Fall (inches)[2]	10.8	9.5	9.8	5.3	1.0	0.0	0.0	0.0	0.0	2.5	8.5	11.8	59.2
Average Snow Depth (inches)[2]	8	10	11	7	0	0	0	0	0	0	2	5	4

Notes:
[1]Period of Record 1981-2010; elevation: 19 feet above mean sea level (amsl)
[2]Snow fall and snow depth are for period of record: February 1, 1920 to June 8, 2016
°F = degrees Fahrenheit
Source: WRCC 2018

Table 3.20-7: SNAP Data for Iliamna, 2040-2049[1]

Site	Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Iliamna	Average Mean Temperature (°F)	24	25	30	38	47	53	58	58	51	39	31	24	40
	Average Total Precipitation (inches)	2	1	1	1	1	2	3	5	5	4	3	2	26

Notes:
[1]Numbers are calculated using SNAP data from A1B scenario (i.e., balance across all sources) and the 2040-2049 decade.
°F = degrees Fahrenheit
Source: SNAP 2018

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3.21 FOOD AND FIBER PRODUCTION

The Farmland Protection Policy Act of 1994 was enacted to reduce the amount of highly productive farmland being converted to non-agricultural uses as a result of various federal programs. The United States Army Corps of Engineers (USACE) is required to assess the potential impacts on farmland during the National Environmental Policy Act (NEPA) review process. Prime farmland is defined as available land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops. Unique farmland is land other than prime farmland that is used for the production of specific high value food and fiber crops. While there may be some small outdoor or indoor garden projects in individual communities, there are no designated prime or unique farmlands in the project area.

In most of the US, agriculture provides food, natural fibers, biofuels, and other products to American consumers. In southwest Alaska, however, subsistence is the most important source of non-imported food and raw materials; discussed in Section 3.9, Subsistence.

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3.22 WETLANDS AND OTHER WATERS/SPECIAL AQUATIC SITES

The affected environment for wetlands and other waters includes vegetated wetlands, ponds, lakes, streams, rivers, and marine and estuarine waters that may be directly or indirectly affected from construction or operation of all project alternatives and components.

"Wetlands" are discussed in this document per the Section 404 of the Clean Water Act (CWA) definition. Wetlands are defined as areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. "Other waters" are discussed in this document as other aquatic resources such as ponds, lakes, streams, rivers, and marine and estuarine waters.

The Environmental Impact Statement (EIS) analysis area collectively includes areas for all components (mine site, transportation corridor, ports, and natural gas pipeline). The EIS analysis area for wetlands is the same as vegetation (Section 3.26, Vegetation). The EIS analysis area for the mine site includes the direct disturbance footprint; areas of indirect disturbance due to fragmentation; a 330-foot zone around the direct disturbance footprint to account for fugitive dust impacts; and the zone of influence, which is the area in which project activities may influence the groundwater elevation. The zone of influence occurs around the open pit, tailings ponds, water management ponds, and the potable water well field.

The EIS analysis areas for the transportation corridor and ports include the direct disturbance footprints plus a 330-foot zone around the direct disturbance footprints to account for fugitive dust impacts. Extent of impacts from fugitive dust impacts would not be expected to go beyond the 330-foot zone. The EIS analysis area for the ports also includes lightering areas and areas for mooring buoys.

The EIS analysis area for the stand-alone sections of the natural gas pipeline is a 30-foot corridor through Cook Inlet and Iliamna Lake, and a 100-foot corridor through overland areas. Overland areas also include direct disturbance footprints for access roads and material sites, in addition to a 330-foot zone around the access roads and material sites to account for dust impacts. See Figure 3.26-1 in Section 3.26, Vegetation, for a general overview of the analysis area for wetlands and other waters, which is identical to that of vegetation.

Wetlands and other waters are described in terms of the extent and characteristics of predominant types found in the EIS analysis area. The descriptions are primarily based on information provided in Chapters 14 and 39 of the Environmental Baseline Document (EBD) (3PPI and HDR 2011b; HDR and 3PPI 2011b), as well as more recent information provided in the Preliminary Jurisdictional Determination (PJD) Report (HDR 2018c) and the associated Geographic Information System (GIS) database, which reflects changes in the project area since publication of the EBD.

All calculations for areas are rounded to the nearest whole acre, or nearest whole percent. Apparent minor inconsistencies in sums are the result of rounding.

3.22.1 Wetlands and Other Waters/Special Aquatic Sites Terms

Wetlands and other waters are regulated by the US Army Corps of Engineers (USACE) under Section 404 of the CWA (33 US Code [USC] 1344). Section 10 of the Rivers and Harbors Act (RHA) regulates activities in wetlands and other waters in tidal areas below mean high water, and in navigable waters and associated wetlands below ordinary high water (33 USC 403). Pebble Limited Partnership (PLP) has prepared a PJD report (HDR 2018c) for part of the project area identifying wetlands, streams and other waterbodies under the USACE's regulatory jurisdiction; the USACE-signed Department of the Army PJD is provided in Appendix J.

Special Aquatic Sites – Special aquatic sites are wetlands or other waters which are large or small areas possessing special ecological characteristics of productivity, habitat, wildlife protection, or other important and easily disrupted ecological values (40 Code of Federal Regulations [CFR] Part 230.3). Special aquatic sites present in the EIS analysis area include wetlands, mudflats, vegetated shallows, and riffle and pool complexes. Special aquatic sites not present in the EIS analysis area include sanctuaries and refuges, as well as coral reefs.

Wetlands – Wetlands are defined as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (33 CFR Part 328.3[b]). Wetlands are transitional between terrestrial and aquatic ecosystems. Unvegetated areas such as streams, ponds, and lakes are not considered "wetlands" under this definition. Wetlands in the project area occur on a variety of mineral and organic soil substrates. Information on soils is provided in Section 3.14, Soils.

Wetland determinations followed guidance from the USACE. Wetland determinations from 2004 through 2008 were based on the 1987 Wetland Delineation Manual (USACE 1987), while determinations after 2013 were based on the 1987 Manual in conjunction with the 2007 Alaska Regional Supplement (USACE 2007b). Detailed descriptions of the field indicators used for wetland determinations in the project area are provided in Chapters 14 and 39 of the EBD (3PPI and HDR 2011b; HDR and 3PPI 2011b), and in the PJD Report (HDR 2018c).

Mudflats – Mudflats occur in certain intertidal portions of Cook Inlet. They are composed of fine sediments and organic material, and are either unvegetated or vegetated only by algal mats. They have not been documented in the project area for Alternative 1, as the intertidal zone is composed mostly of sand and gravel. They have been identified in upper Iliamna Bay near the project area for Alternatives 2 and 3. The extent of mudflats in this area was determined to include tidal waters below high tide line and above mean lower low water.

Vegetated Shallows – Vegetated shallows are permanently inundated areas that support rooted aquatic vegetation. They include some of the aquatic bed types defined by the National Wetland Inventory (NWI) system (described below) occurring in freshwater ponds and lake margins. These are of very limited extent in the EIS analysis area, and are described together with aquatic bed wetlands. Eelgrass beds are a relatively common type of vegetated shallows that do occur in parts of the nearshore environment of Cook Inlet. Eelgrass is known to occur in patchy beds in Iliamna and Cottonwood bays, as well as south of the EIS analysis area around reefs associated with Nordyke Island and Chenik Head, but outside of the EIS analysis area for any of the alternatives.

Riffle and Pool Complexes – Riffle and pool complexes occur in steep to moderate gradient sections of streams in the EIS analysis area. Riffles are defined by rapid flow over a coarse substrate that produces high levels of dissolved oxygen in the water. Pools are deeper, slower sections of water with a finer substrate. Baseline mapping of streams did not specifically identify riffle and pool complexes in the EIS analysis area, with the exception of the North Fork Koktuli (NFK) and South Fork Koktuli (SFK) rivers, and Upper Talarik Creek (UTC) near the mine site (R2 Resource Consultants et al. 2011). Habitat typing, as listed in Table 3.24-1, Fish Values, shows that the mainstem NFK below the mine site is dominated by riffle habitat with few mainstem pools. Upstream of the mine site, the NFK contains equal proportions of riffle and run/glide habitats, with increasing frequency of beaver-formed pools. The upper 10 miles of the NFK flow through a region with small (i.e., less than 3 acres), shallow lakes, dominated by Big Wiggly Lake. The upper SFK, just below the mine site, is also dominated by riffle habitat with few pools. UTC below the mine site is equally dominated by riffle habitat and run/glide habitat, with few pools.

All streams were characterized by flow regime (lower perennial, upper perennial, and intermittent). Riffle and pool complexes would be expected to occur most frequently in the upper perennial and intermittent zones where stream beds are predominantly gravel or coarser substrates. Stream morphology and associated fish habitat in the EIS analysis area is addressed in Section 3.24, Fish Values; surface water quality is addressed in Section 3.18, Water and Sediment Quality.

Other Waters – Other waters, as used in this section, include all non-wetland waters. Most of these areas are deepwater habitats characterized by permanent water and non-soil substrates. In the EIS analysis area, these include marine waters, both subtidal (continuously submerged) and intertidal (exposed during low tides), lakes, ponds, and streams. Streams may be characterized as perennial, intermittent, or ephemeral. No ephemeral streams were identified in the EBD; all non-perennial streams were classified as intermittent. Perennial streams are further subdivided as either upper perennial or lower perennial. Upper perennial streams tend to have higher gradients, faster flows, coarser substrates, and little floodplain development, as compared to lower perennial streams (Cowardin et al. 1979).

Intermittent streams are differentiated from ephemeral streams based on duration, timing, and sources of flow, which may vary year-to-year. Ephemeral streams flow for brief periods (i.e., hours to a few days) during and immediately after rainfall events, and do not receive groundwater inputs. Intermittent streams flow seasonally (i.e., several weeks or more), with inputs from groundwater, snow melt, and rainfall. According to the baseline stream mapping, all non-perennial streams have been classified as intermittent (3PPI and HDR 2011b). Intermittent streams are present in headwater positions in the EIS analysis area, and typically have flow during the spring snowmelt period (May to June), then may go dry or subsurface during July and August until sufficient rainfall begins again in September. Flow again gradually declines during winter as snow accumulates. These streams are typically dry during February to early April (Knight Piésold et al. 2011). The duration of flow in these streams is related to catchment area and characteristics, and to the relative contribution of groundwater to base flows.

Navigable Waters – Navigable waters of the US (NWUS) are regulated by the USACE under Section 10 of the RHA (33 USC 403). The USACE maintains a list of non-tidal navigable waters in Alaska that have been determined to be NWUS by the district engineer (USACE 2018b). All waters that are subject to the ebb and flow of the tide are also considered NWUS. Navigable waters in the EIS analysis area that are regulated under Section 10 of the RHA include Iliamna Lake and Cook Inlet. Navigable waters of the state are addressed in Section 3.12, Transportation and Navigation. The Newhalen River is also considered navigable by the US Coast Guard (USCG) under the Bridge Act. See Section 3.12, Transportation and Navigation, for further discussion of navigable waters.

3.22.2 Wetland Mapping and Classification

A GIS database was constructed for the project's environmental baseline study program that incorporated existing NWI data, USGS topographic data, land use and land cover data, existing vegetation data, soil survey data from the Natural Resources Conservation Service (NRCS), and several sources of aerial and Light Detection and Ranging (LIDAR) imagery.

Field surveys were conducted over several growing seasons (2004 to 2008, 2013, and 2017). A total of 684 wetland determination field plots were surveyed in the EIS analysis area. Detailed information on vegetation, soils, and hydrology was collected at each plot. Additional photo and data points were collected at waterbodies and stream crossings. Mapping was digitized on aerial photography at a scale between 1:1,200 and 1:1,500 for wetlands, and 1:400 for open water. Additional data was collected in the mine site area in 2018 as part of PLP's summer field 2018 program and provided in an RFI response (PLP 2018-RFI 082; PLP 2018-085).

Wetland mapping included interpretation of "photographic signatures" associated with vegetation types (see Appendix C in HDR 2018c) and interpretation of topography. Topographic depressions, toe slopes, and flat areas were often associated with wetlands, while convex slopes were indicative of potential uplands. Topography was also used to assess potential hydrologic connections between wetlands and surface waters, and to determine potential locations of groundwater seeps.

Many of the wetland polygons mapped for the project contain inclusions of uplands. These "mosaics" occur in landscapes with often complex microtopography where wetland and upland components are too closely associated to be easily mapped separately (USACE 2007b). Wetland scientists estimated the proportion of wetland versus upland in each mosaic polygon, ranging from 10 to 90 percent wetland. Approximately half of the wetland polygon area in the EIS analysis area was mapped as mosaics. Scrub-shrub and forested wetlands were more often mapped as mosaics compared to emergent wetlands. For this analysis, all mosaics have been calculated as 100 percent wetland, while the proportional wetland estimates of the mosaic map polygons are undergoing review.

Each mapped wetland and waterbody polygon was further characterized using vegetation and wetland classification systems. All polygons were first assigned a vegetation type based on the Alaska Vegetation Classification (Viereck et al. 1992), supplemented by Wibbenmeyer et al. (1982); see Section 3.26, Vegetation, for detailed vegetation classification information. Wetland and waterbody polygons were then classified by NWI class (Cowardin et al. 1979) and assigned a hydrogeomorphic (HGM) class (Brinson 1993). A wetlands mapbook of field-verified wetlands mapping (along with impact areas, discussed in Section 4.22, Wetlands) is included in Appendix K4.22.

Wetland Data Gaps – For Alternative 1, field-verified wetland mapping through 2018 covers the entire project footprint except for the pipeline crossing of Cook Inlet, and the 0.5-mile pipeline corridor and compressor station near Anchor Point on the Kenai Peninsula. For these areas, the Cook Inlet Lowlands wetland project prepared by the Kenai Watershed Forum (Gracz 2013) was applied. Wetland and waterbody data, not including the Kenai Peninsula, was confirmed in the PJD (see Appendix J).

The analysis area for the Kokhanok East Ferry Terminal Variant of Alternative 1 also lacks field-verified mapping, and NWI data is not available for this area; this area is approximately 1,300 acres. Wetland mapping for this area was obtained from publicly available synthetic aperture radar satellite data (the Advanced Land Observing Satellite Phased Array type L-band Synthetic Aperture Radar, also referred to as ALOS PALSAR) (Clewley et al. 2015). Wetlands were mapped at 100-meter resolution. This data provides a coarse estimate of wetland boundaries compared to either field-verified mapping or NWI mapping.

The EIS analysis areas for Alternatives 2 and 3 include areas that lack complete field-verified wetland mapping. These include:

- Alternative 2 natural gas pipeline overland corridor lacks field-verified mapping for 579 acres (35 percent) of the analysis area of 1674 acres.
- Alternative 3 natural gas pipeline overland corridor lacks field-verified mapping for 285 acres (95 percent) of the analysis area of 299 acres, mostly from Ursus Bay to Diamond Point.

- Alternatives 2 and 3 Diamond Point port lack field-verified mapping for 299 acres (90 percent) of the analysis area of 333 acres.
- Alternative 2 transportation corridor lacks field-verified mapping for 1,287 acres (21 percent) of the analysis area, mostly for the Pile Bay ferry terminal and access road, and Eagle Bay ferry terminal and access road.
- Alternative 3 transportation corridor lacks field-verified mapping for 676 acres (8 percent) of the analysis area of 9,010 acres.

For portions of the EIS analysis areas lacking field-verified mapping, NWI data was analyzed (NWI 2018). The NWI maps provide a reconnaissance-level depiction of the location, type, and size of wetlands; NWI data do not provide the level of detail of field-verified mapping. For purposes of this analysis, NWI wetland types have been grouped to match the project units used for the environmental baseline study program. Remaining wetland data gaps would be addressed during the 2019 field season for reporting in the Final EIS (FEIS). See Section 3.1, Introduction to Affected Environment, for discussion on data gaps analysis for the Draft EIS (DEIS).

3.22.2.1 National Wetland Inventory Classification

The NWI classification system has been used by the US Fish and Wildlife Service (USFWS) since 1979 to classify and map wetlands and deepwater habitats throughout the US. Under this classification scheme, wetlands and deepwater habitats are grouped into systems based on shared hydrologic conditions. NWI systems occurring in the EIS analysis area are palustrine, lacustrine, riverine, and marine.

Most vegetated wetlands in the analysis area classify as palustrine, which is further subdivided by dominant vegetation growth forms (trees, shrubs, emergent herbaceous, aquatic herbaceous, or moss/lichen) or bed type (for non-vegetated ponds less than 20 acres). Palustrine forested wetlands occur in a very small portion of the analysis area. These are represented primarily by broad leaved deciduous forests (PFO1) confined to valley bottoms. Primary tree species include alders (*Alnus incana, A. viridis*), various willows (*Salix sp.*), and balsam poplar (*Populus balsamifera*).

Palustrine scrub-shrub wetlands are the dominant NWI class in the analysis area. These include wetlands dominated by broad leaved deciduous shrubs (PSS1) such as birches *(Betula glandulosa, B. nana*), and willows; broad leaved evergreen shrubs (PSS3) such as sweetgale (*Myrica gale*), Labrador-tea (*Rhododendron tomentosum, R. groenlandicum*), bog-rosemary (*Andromeda polifolia*), black crowberry (*Empetrum nigrum*), and northern mountain-cranberry (*Vaccinium vitis-idaea*); and needle leaved evergreen shrubs (PSS4) represented by stunted black spruce (*Picea mariana*).

Palustrine emergent wetlands (PEM1) make up the second-most dominant NWI class in the analysis area. These include wetlands dominated by a large number of persistent, herbaceous species adapted to a wide range of saturation or non-permanent flooding. Common plants in the analysis area include bluejoint (*Calamagrostis canadanesis*), numerous sedges, rushes (*Juncus sp.*), horsetails (*Equisetum sp.*), cottongrasses (*Eriophorum sp.*), and numerous other grasses and forbs.

Palustrine aquatic bed wetlands (PAB3) occur in small ponds and other semi-permanently to permanently flooded areas. They are dominated by rooted, aquatic herbaceous species, such as yellow pond-lily (*Nuphar luteum*) and pondweeds (*Potamogeton sp.*).

Waterbodies larger than 20 acres situated in depressions (e.g., lakes) are classified as lacustrine, which are generally unvegetated but may include aquatic herbaceous species.

Waterbodies contained within a channel (e.g., rivers and streams) are classified as riverine. Riverine classes are subdivided by flow regime (lower perennial, upper perennial and intermittent) and are mostly unvegetated in the analysis area. The marine system is mapped on shorelines of Cook Inlet, and is subdivided based on tidal regime (subtidal or intertidal).

NWI classification for the project also used water regime modifiers for each polygon. Water regimes included temporarily flooded, saturated, seasonally flooded, semi-permanently flooded, and permanently flooded. Water regimes are often difficult to determine based on a single field observation during one time of the year. Interpreting water regimes from aerial photography is also particularly difficult unless photography from multiple years and seasons is available. For these reasons, NWI water regime modifiers are not used in the analysis for this EIS.

3.22.2.2 Hydrogeomorphic Classification

The HGM classification groups wetlands into categories based on the geomorphic and hydrologic characteristics that control many wetland functions. HGM classes observed in the analysis area include slope, riverine, depressional, flats, and lacustrine fringe wetlands. Two additional HGM types were described for waterbodies in the EIS analysis area: lacustrine waters and riverine channel waters. Estuarine/coastal fringe wetlands (e.g., salt marshes) occur along some of the tidally influenced shorelines of Cook Inlet and its estuaries, but have not been described in the analysis area (HDR and 3PPI 2011b). Marine waters are described as either subtidal or intertidal, depending on whether they are normally flooded or exposed during periods of low tide. HGM classes are described below.

Slope Wetlands are the most common wetlands in the analysis area, occurring on hill or valley slopes where groundwater "daylights" and begins running along the surface, or immediately below the soil surface. While groundwater discharge is the primary water source, surface flow and precipitation also contribute water. Water in these wetlands flows in one direction only (i.e., down the slope), and the gradient is steep enough that the water is not impounded. The "downhill" side of the wetland is always the point of lowest elevation in the wetland. Water is lost through subsurface and surface outflow and evapotranspiration. Slope wetlands in the analysis area commonly occur as seeps on footslopes and toeslopes, and as headwaters and drainages in steep to rolling terrain where stream channels have not yet formed. Slope wetlands also occur as fens and string bogs.

Riverine Wetlands are the second-most common wetlands in the analysis area, occurring in valleys associated with stream or river channels. They lie in active floodplains and riparian corridors and have important hydrologic links to the water dynamics of the river or stream. The distinguishing characteristic of riverine wetlands is that they are flooded by overbank flow from the stream or river at least every other year. Subsurface hyporheic flow, groundwater discharge, overland flow, and precipitation can also provide important seasonal inputs. Water loss is through flow returning to the channel, subsurface discharge to the channel, seepage to groundwater, and evapotranspiration. Riverine wetlands range from broad floodplains along large meandering rivers to narrow zones along higher gradient rivers and streams. Riverine wetlands are often modified by beaver activity. The term "riparian" is used of plant communities situated near a river or stream, which may or may not meet the definition of a riverine wetland.

Riverine Channel includes wetlands and waters contained in the active channel of intermittent or perennial streams or rivers. Both bare and vegetated sand and gravel bars, and flowing waters with or without aquatic vegetation are included. The outer extent of the channels is defined by the ordinary high water mark.

Depressional Wetlands occur in depressions where elevations within the wetland are lower than in the surrounding landscape. The shapes of depressional wetlands vary, but in all cases, the movement of surface water and shallow subsurface water is toward the lowest point in the depression. The depression may have an outlet, but the lowest point in the wetland is somewhere in the boundary, not at the outlet. Water sources include precipitation, groundwater discharge, and surface flow often with seasonal vertical fluctuations. Water loss is through intermittent or perennial outflow, evapotranspiration, or seepage to groundwater. In the analysis area, depressional wetlands occur as abandoned river features on terraces (i.e., oxbows) above active floodplains or as kettles on moraine landforms. Depressional wetlands are often embedded within other HGM wetland classes.

Flats Wetlands occur in topographically flat or very gently sloping areas that are hydrologically isolated from surrounding ground or surface water. Precipitation provides the dominant source of water, with water loss from evapotranspiration, overland flow, and seepage to groundwater. In the analysis area, flats wetlands may occur on either mineral soil or accreted organic matter similar to extensive peatlands. They are present on broad ridgetops, glacial outwash terraces, and remnant glacial lake beds. They may transition to slope wetlands at topographic breaks associated with groundwater discharge.

Lacustrine Fringe Wetlands occur next to lakes that maintain the water table in these wetlands; surface flow is bi-directional. Additional water sources are precipitation and groundwater discharge. Water loss is through flow returning to the lake and by evapotranspiration. These wetlands are of limited extent in the analysis area.

Lacustrine Waters include the unvegetated water in lakes greater than 20 acres or at least 6.6 feet deep at low water. The upper extent of this type is defined by the ordinary high water mark on the shore. Open water depressions that do not meet the size requirements of lakes are classified as ponds for this analysis.

3.22.3 Wetlands Functions and Values

Wetlands provide a variety of ecosystem functions that are valuable to society. This section provides a qualitative overview of wetland functions in the EIS analysis area based on the NWI and HGM classifications, as well as a description of some regionally important wetlands. Most of the wetlands and their basins in the EIS analysis area have very little to no anthropogenic disturbance to reduce function or quality. Therefore, wetlands in the EIS analysis area are considered to be functioning at an optimal level. However, not all wetland types provide the same functions and values. Wetland function also varies based on position in the watershed and linkages to other habitats, so a particular wetland polygon of a given class may not provide the same level of functions as others in the same class.

3.22.3.1 NWI Classes

Primary wetland functions generally associated with each NWI wetland class are described below.

Forested Wetlands – depending on their position in the landscape and water regime, forested wetlands provide modification of flood flows, flood storage and attenuation, shoreline stabilization, water quality improvement, organic matter production and export, wildlife cover and browse, and fish habitat through cover and shade. Forests are mostly confined to well-drained lowland areas, and are relatively scarce in the mine site analysis area.

Scrub-Shrub Wetlands – tall shrubs provide water quality, flood storage and attenuation, and shoreline stabilization functions similar to forested wetlands, and high quality wildlife browse (willows [*Salix* spp.]) for moose (*Alces alces*) and beavers (*Castor canadensis*). Small and dwarf shrub wetlands provide fewer habitat functions, but are relatively abundant in the EIS analysis area. Some culturally important plants occur in these wetlands, which are valued for subsistence use. Most scrub-shrub wetlands in the EIS analysis area are on slopes, and water is present in saturated soils near the surface. Seasonally flooded tall shrub wetlands occur in floodplains and depressions.

Emergent and Aquatic Bed Wetlands – persistent herbaceous vegetation provides removal of sediments and nutrients, production and export of organic matter, and habitat for aquatic invertebrates, fish, waterfowl and wetland-associated mammals (e.g., beavers and river otters [*Lontra canadensis*]). Bird species of conservation concern (ABR 2011a) associated with these wetlands include tundra swan (*Cygnus columbianus*), long-tailed duck (*Clangula hyemalis*), harlequin duck (*Histrionicus histrionicus),* common loon (*Gavia immer*), and others (ABR 2011a). These are species that have recognized threats to their long-term existence in the region, including loss of wetland habitat. Many of these wetlands are seasonally to semi-permanently flooded or ponded and provide flood storage and attenuation. Aquatic bed wetlands are relatively scarce in the EIS analysis area.

3.22.3.2 HGM Classes

Primary wetland functions generally associated with each HGM class (Brinson 1993) are described below.

Slope Wetlands – provide modification of groundwater discharge, mediation of surface and subsurface flows to other wetlands, and support of stream base flows, which indirectly supports seasonal fish habitat. Many of these are associated with groundwater seeps.

Riverine Wetlands – provide floodwater storage, modification of stream flows, water quality improvement, and general fish habitat, including spawning and rearing habitat for salmon. Woody vegetation along channels provides bank protection; shading/thermo-regulation of water; woody debris for fish habitat structure and sediment dynamics; and organic inputs to support aquatic food chains. These are dynamic systems modified by floods and beaver activity. They provide important functions relative to their proportion of the landscape.

Depressional Wetlands – provide groundwater recharge, floodwater storage, and water quality improvement. Depressional wetlands vary widely in functional capacity depending on depth, hydrologic regime, character of the inlet/outlet, and vegetation. These wetlands generally provide the most water storage and purification functions relative to their size.

Flats Wetlands – provide surface water storage, mediation of surface and subsurface flow to other wetlands and streams, production and export of organic matter, and maintenance of characteristic plant communities such as bogs and fens (these also occur on gradual slope wetlands).

Lacustrine Fringe Wetlands – provide floodwater storage, water quality improvement, shoreline stabilization, and habitat for aquatic invertebrates, fish, and waterfowl. Lacustrine fringe wetlands are relatively scarce in the analysis area.

3.22.3.3 Regionally Important Wetlands

Certain wetland types in the project area were identified as having regional importance based on EIS scoping comments and their perceived value for species, communities, and ecosystems. Regionally important wetlands are considered to be associated with the following characteristics:

- Providing habitat for sensitive or regionally important fish, wildlife, birds, or plant species. For example, many riparian or riverine wetlands provide critical habitat functions for ecologically, economically and culturally important anadromous and resident fish species in the EIS analysis area. Most of these functions are related to the contribution of the woody riparian canopy, through inputs of coarse woody debris and nitrogen (from alders [*Alnus* spp.]); sediment and streambank stabilization; provision of shading and cover; and food chain support. Therefore, riverine wetlands with forest or shrub vegetation classes are considered regionally important wetlands for purposes of analyzing environmental consequences of the project in Chapter 4, Environmental Consequences. Riverine herbaceous wetlands are also considered regionally important due to their relatively high species richness (ABR 2011a).

- Regional scarcity, or rare and high quality, within a given region. For example, forested wetlands cover a very small portion of the EIS analysis area (less than 1 percent), but provide important food and cover for wildlife (such as beavers and moose), and woody inputs, important for fish habitat and stream dynamics. Aquatic bed wetlands also cover a very small portion of the EIS analysis area (less than 0.1 percent), but provide important habitat for wildlife such as wood frogs (*Lithobates sylvaticus*).
- Undisturbed and difficult or impossible to replace, such as bogs or fens. Some bog types have relatively high species richness for bird and mammals species of conservation concern (ABR 2011a). Bogs have also been shown to contribute substantially to stream base flows (Gracz 2017), and are sensitive to disturbance. Project vegetation types identified as bogs and fens include: ericaceous shrub bog, open dwarf birch – ericaceous shrub bog, open sweetgale – graminoid bog, and open willow – low shrub fen. These vegetation types make up approximately 2 percent of the combined EIS analysis area.
- In addition to the ecosystem functions provided by wetlands, certain wetland types and locations are valued by Alaska Natives for their subsistence value (Hall et al. 1994; Jernigan no date). Some culturally important plants found mainly in wetlands include blueberries (*Vaccinium* spp.), cranberries (*Vaccinium* or *Oxycoccus* spp.), Labrador tea (*Ledum* spp.), and willows.

3.22.4 Other Waters Functions and Values

Other waters in the EIS analysis area provide numerous ecosystem functions, including support for a wide array of anadromous and resident fish, aquatic invertebrates, birds, and mammals. Habitat characterizations are provided in the baseline reports (ABR 2011a; R2 Resource Consultants et al. 2011); Section 3.23, Wildlife Values; Section 3.24, Fish Values; and Section 3.25, Threatened and Endangered Species. Marine and freshwater waterbodies also provide values associated with recreation, hunting, fishing, and navigation. Streams and lakes provide drinking water, and retention or drainage of flood flows.

Marine/Estuarine Waters – Cook Inlet provides habitat for many marine mammals, including Steller's sea lion (*Eumetopias jubatus*), harbor seal (*Phoca vitulina*), northern sea otter (*Enhydra lutris kenyoni*), beluga whale (*Delphinapterus leucas*), and gray whale (*Eschrichtius robustus*); and various bird species (see Section 3.23, Wildlife Values and Section 3.25, Threatened and Endangered Species, for details on marine mammals and birds in the EIS analysis area). Nearshore and estuarine habitats have been investigated in Iliamna Bay and Cottonwood Bay in the EIS analysis area for Alternatives 2 and 3 (Pentec Environmental/Hart Crowser 2011a, 2011b). Several habitat types including mudflats were identified, which provide resources for varying life stages of numerous fish and invertebrates including chum, pink, and coho salmon (*Oncorhynchus keta, O. gorbuscha, O. kisutch*), Pacific herring, and clams. Nearshore habitats are used as rearing areas, migration corridors, spawning areas, and places of refuge from deepwater predators. Essential services of estuaries include provision of food, habitat complexity, buffering from extreme forces of open waters, filtration, sediment trapping, and refuge from predation, which make them prime rearing or "nursery" habitats for numerous species of juvenile fish and invertebrates (Hughes et al. 2014). These habitat functions support values represented by subsistence, commercial and sport harvests. Intertidal waters represent approximately 9 percent of marine waters in the EIS analysis area.

Lakes/Ponds – Freshwater open waterbodies in the EIS analysis area range from very small ponds to large lakes (approximately 150 acres) and Iliamna Lake (1,000 square miles). The majority of waterbodies of this type in the EIS analysis area are less than 2.5 acres in size (ABR 2011a). There is a great variety in depth and hydrologic regime, shoreline complexity, and connectivity to drainages, all of which influence functions and values.

In general, these habitats have been identified as having relatively high species richness for bird and mammal species, including bird species of conservation concern (ABR 2011a), which is a characteristic of regionally important wetlands. Some species associated with these habitats include tundra swan, long-tailed duck, common loon, arctic tern (*Sterna paradisaea*), river otter, and moose. Iliamna Lake also provides habitat for harbor seals. The wood frog is the only amphibian that occurs in the EIS analysis area, and is highly associated with deeper lakes and ponds (deeper than 5 feet). Some of the larger lakes provide spawning habitat for sockeye salmon. Water impounded by lakes and ponds is also important for maintaining summer flows and downstream aquatic habitat (R2 Resource Consultants et al. 2011).

Rivers/Streams – Functions and values of these habitats vary greatly in the EIS analysis area depending on hydrologic regimes, bed and bank structure, floodplain interactions, and other fluvial processes. The relatively undisturbed nature of the watersheds means that floodplain processes, sediment and woody debris dynamics, and surface and groundwater exchanges are unencumbered, which has resulted in a large diversity of aquatic and riparian habitats in the EIS analysis area. This habitat diversity is responsible for the corresponding large population and genetic diversity of salmonids in the wider Bristol Bay basin (Rinella et al. 2018). This in turn has been recognized as contributing to the high productivity and stability of these systems for salmonids (Schindler et al. 2010).f

Streams in the EIS analysis area support five species of anadromous Pacific salmon, at least four species of non-anadromous salmonids, and numerous non-salmonid fishes (R2 Resource Consultants et al. 2011). Streams provide migration, spawning, rearing, and overwintering habitats for fish and invertebrate species. These habitat functions support values represented by subsistence, commercial, and sport fisheries. Streams maintain characteristic riparian plant communities and export organic matter to support aquatic food chains. Riparian trees and shrubs provide shade to regulate stream temperatures, and contribute large woody debris which is important for channel forming processes and creation of fish habitat. Aquatic and riparian habitats also have high value for bird and mammal species including harlequin duck, bald eagle (*Haliaeetus leucocephalus*), arctic tern, river otter, brown bear (*Ursus arctos)*, and beaver. Streams also facilitate enrichment of riparian and terrestrial ecosystems with marine-derived nitrogen and other nutrients through the return of spawning salmon. Stream systems in the EIS analysis area also convey and attenuate flood waters, maintain and purify surface waters, moderate groundwater flows, and recharge groundwater systems.

3.22.5 Alternative 1 – Applicant's Proposed Alternative

Wetlands and other waters comprise 6,305 acres (31 percent) of the Alternative 1 EIS analysis area, including 5,312 acres (26 percent) wetlands and 994 acres (5 percent) other waters. A description by major project components is provided below.

3.22.5.1 Mine Site

The Alternative 1 analysis area for the mine site occurs in the upper watersheds of both the NFK and SFK rivers, which flow into Bristol Bay via the Mulchatna and Nushagak rivers; it also includes a small portion of the UTC watershed. The Alternative 1 analysis area for the mine site is approximately 11,800 acres and composed of glaciated, volcanic-ash influenced, hills and valleys free of permafrost. Given the complexity of the mine site area, a figure depicting field-verified mapping is provided for reference (Figure 3.22-1).

Over half (59 percent) of the Alternative 1 EIS analysis area for the mine site is composed of uplands and the remaining area (41 percent) is composed of wetlands and other waters (Figure 3.22-2a). Wetlands represent 4,576 acres (39 percent) of the analysis area. The dominant NWI wetland type is Palustrine broad-leaved deciduous scrub-shrub (PSS1) occurring within 30 percent of the mine site analysis area. These occur predominantly on slopes with both mineral and organic soils. Water is present in saturated soils near the surface, but also includes shallow flooding or ponding on very gradual slopes and in small swales and depressions located on the slopes. Shrub wetlands also occur along the NFK and SFK rivers and their floodplains, as well as several smaller streams. Although dominated by a deciduous shrub layer (willows, birches [*Betula* spp.], blueberries), they can also include small evergreen shrubs, with or without herbaceous wetland species.

Bogs and fens co-dominated by shrubs of the heather (*Ericaceae*) family represent a regionally important subset of shrub wetlands occurring on slopes and topographically flat areas with organic soils. Based on project vegetation mapping, these shrub wetlands comprise approximately 5 percent of the Alternative 1 mine site analysis area.

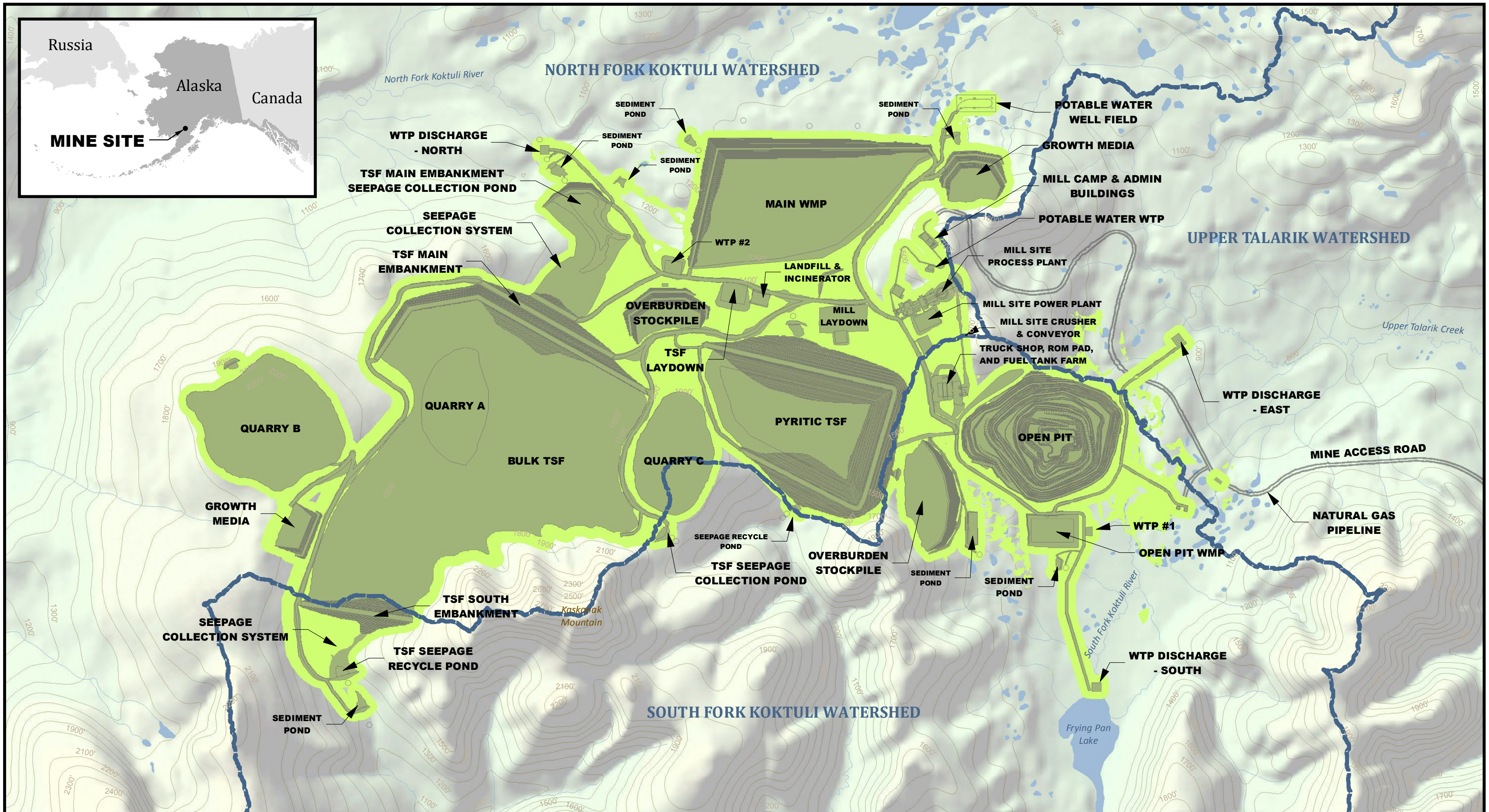
Herbaceous wetlands (classified as Palustrine Emergent with persistent vegetation [PEM1]) make up approximately 9 percent of the Alternative 1 mine site analysis area. These occur in seasonally to semi-permanently flooded depressions and shorelines, and on wetter positions of slopes and flats. Some 30 species of wetland sedges were observed in the mine site area and provide the dominant cover. Some of these sedges, along with cottongrasses (*Eriophorum sp.*), form pronounced tussocks communities. Bluejoint reedgrass (*Calamagrostis canadensis*) and horsetails (*Equisetum sp.*) are other locally common herbaceous wetland species (3PPI and HDR 2011b).

Aquatic bed wetlands occurred in depressions and ponded areas of slopes, accounting for less than 0.1 percent of the Alternative 1 mine site analysis area. Forested wetlands are absent at the mine site.

Other waters make up 2 percent of the Alternative 1 mine site analysis area. Other waters include both perennial and intermittent stream channels, lakes, and ponds. Streams and rivers make up 61 acres (1 percent) of the Alternative 1 mine site analysis area in 93 miles of channels. Most streams at the mine site are perennial. Lakes and ponds combined make up 174 acres (1 percent) of the Alternative 1 mine site analysis area (Figure 3.22-2a).

Wetlands and other waters at the mine site were also classified using the HGM system (Figure 3.22-2b). Slope wetlands comprise 34 percent of the analysis area and 86 percent of all wetlands. Riverine wetlands comprise 3 percent of the analysis area and 7 percent of all wetlands. Flats and depressional wetlands make up most of the remaining wetlands.

Human-caused vegetation disturbance in the Alternative 1 mine site analysis area was minimal and appears to be limited to all-terrain vehicle (ATV) trails or campsites (3PPI and HDR 2011b). Drill pads and other temporary disturbance from project exploration were not observed to alter wetland status or characteristics.



Sources: PLP 2018; USGS

US Army Corps of Engineers®

0.5 0 0.5 1
Miles

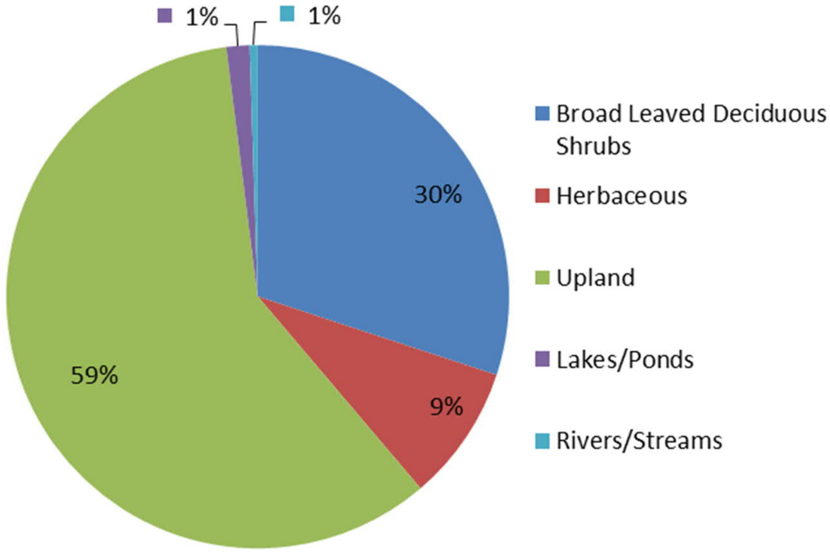
Wetlands Analysis Area
Mine Site Footprint
River/Stream
Lake/Pond
Watershed

MINE SITE WETLANDS ANALYSIS AREA

PEBBLE PROJECT EIS

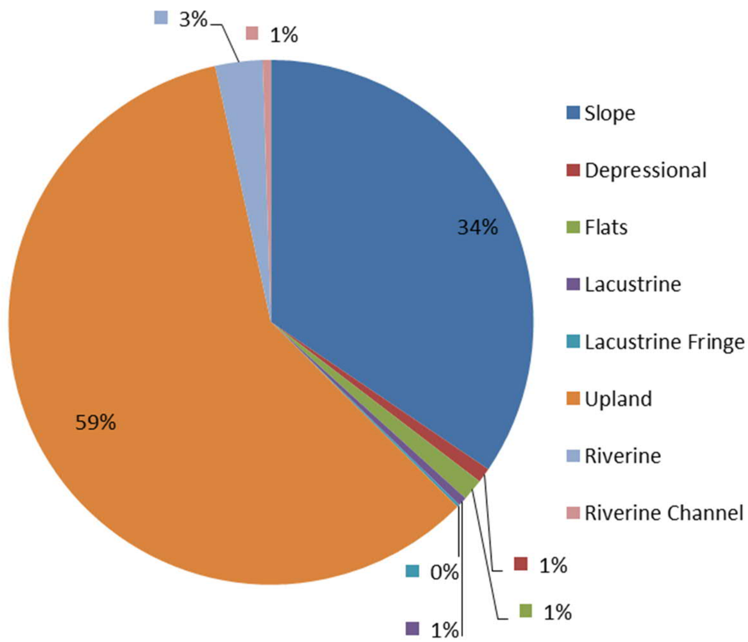
FIGURE 3.22-1

Figure 3.22-2a: NWI Wetlands, Other Waters and Uplands in the Mine Site Analysis Area



Note: Numbers are rounded to nearest whole percent. Aquatic bed wetlands represent <0.1 percent.

Figure 3.22-2b: HGM Wetlands, Other Waters and Uplands in the Mine Site Analysis Area



Note: Numbers are rounded to nearest whole percent. Lacustrine fringe wetlands represent <1 percent.

Summer-Only Ferry Operations Variant

This variant would increase the direct disturbance footprint at the mine site by approximately 39 acres for a container storage yard. This additional area contains 6 acres of deciduous shrub wetlands, and 1 acre of herbaceous wetlands. No other waters were identified in this area.

3.22.5.2 Transportation Corridor

The Alternative 1 transportation corridor analysis area includes 24 miles of the mine access road (an additional 5 miles of this road falls within the Alternative 1 mine site analysis area) from the mine site to the north ferry terminal on Iliamna Lake, an 18-mile crossing of the lake, and the port access road (37 miles) from the south ferry terminal to Amakdedori port on Cook Inlet. The Alternative 1 transportation corridor analysis area includes segments of the natural gas pipeline that fall within the transportation corridor. The Alternative 1 transportation corridor analysis area is approximately 7,660 acres, and is dominated by glaciated, volcanic ash-influenced, mountains, hills, plains, and valleys that are free of permafrost. Field-verified mapping is available for approximately 7,219 acres (94 percent) of the analysis area.

The Alternative 1 transportation corridor analysis area crosses the Bristol Bay and Cook Inlet drainage basins. The major Bristol Bay watersheds include UTC, Newhalen River on the northern side of Iliamna Lake, Gibraltar Lake on the southern side, and Iliamna Lake watershed on both sides of the lake. The Amakdedori Creek-Kamishak Bay watershed is the only major watershed in Cook Inlet drainage basin crossed by the transportation corridor.

Uplands dominate the Alternative 1 transportation corridor analysis area (87 percent), with the remaining 13 percent composed of wetlands and other waters. Wetlands comprise 725 acres (9 percent) of the Alternative 1 transportation corridor analysis area. The dominant NWI wetland type is broad leaved deciduous shrub (PSS1) (7 percent) (Figure 3.22-3). These occur predominantly on slopes with both mineral and organic soils. Water is present in saturated soils near the surface, but also includes shallow flooding or ponding on very gradual slopes and in small swales and depressions located on the slopes. Seasonally flooded shrub wetlands also occur along stream channels, primarily UTC and Newhalen River and their floodplains.

Bogs and fens co-dominated by shrubs of the heather (*Ericacea*) family represent a regionally important subset of shrub wetlands in the Alternative 1 transportation corridor analysis area. These occur on slopes and topographic flat areas with organic soils. Based on project vegetation mapping, they comprise approximately 1 percent of the analysis area.

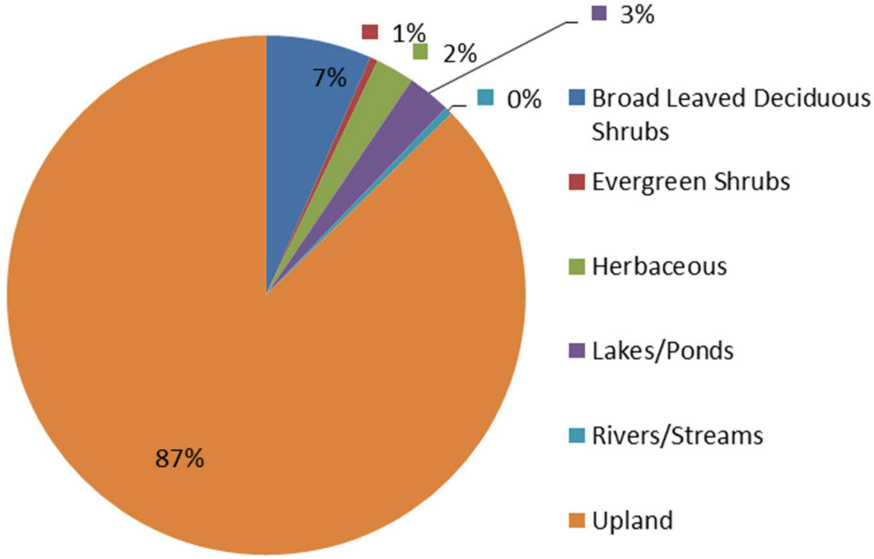
Herbaceous wetlands (PEM1) comprise 2 percent of the Alternative 1 transportation corridor analysis area. These occur in seasonally to semi-permanently flooded depressions and shorelines, and on wetter positions on slopes and flats. Some 30 species of wetland sedges were observed in the area and provide the dominant cover. Some of these sedges, along with cottongrasses, form pronounced tussocks communities. Bluejoint and horsetails are other locally common herbaceous wetland species.

Forested wetlands and aquatic bed wetlands each accounted for less than 0.1 percent of the Alternative 1 transportation corridor analysis area.

Other waters account for between 3 and 4 percent of the Alternative 1 transportation corridor analysis area. Perennial and intermittent stream channels combined account for 41 acres (less than 1 percent) of the analysis area in 63.7 miles of channels. Most of these streams are upper perennial (R3). Lakes and ponds combined, including Iliamna Lake, account for 212 acres (3 percent) of the analysis area.

Human-caused vegetation disturbance in the Alternative 1 transportation corridor analysis area was minimal and appeared to be limited to all-terrain vehicle (ATV) trails, roads and building pads near the village of Iliamna, Kokhanok Airport, and the shore of Iliamna Lake. Disturbances were not observed to alter wetland status or characteristics (3PPI and HDR 2011b).

Figure 3.22-3: NWI Wetlands, Other Waters and Uplands in the Alternative 1 Transportation Corridor Analysis Area



Note: Numbers are rounded to nearest whole percent. Rivers/streams represent approximately 0.5 percent. Aquatic bed wetlands represent <0.1 percent.

Summer-Only Ferry Operations Variant

This variant would not change the affected environment for wetlands.

Kokhanok East Ferry Terminal Variant

Field-verified wetland mapping is not available for this area, as described above. ALOS PALSAR data (Clewley et al. 2015) was used for the variant portion of the Alternative 1 transportation corridor analysis area. Wetlands and other waters comprise approximately 344 acres (26 percent) of the analysis area for the variant. The dominant NWI wetland types are herbaceous (PEM1) (17 percent of analysis area) and broad leaved deciduous shrub (PSS1) (8 percent).

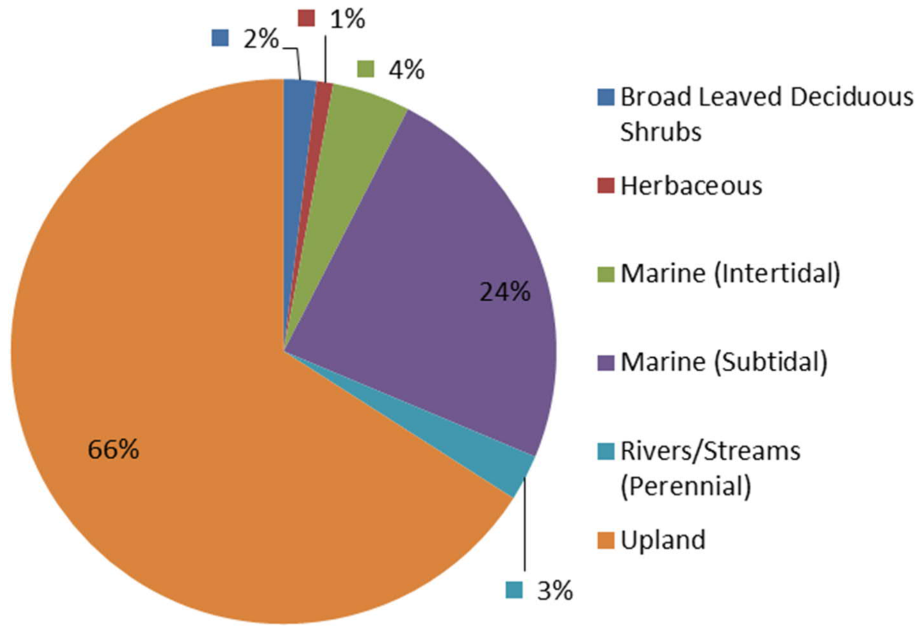
3.22.5.3 Amakdedori Port

The Alternative 1 Amakdedori port analysis area is 191 acres located on the shore of Kamishak Bay, Cook Inlet, near Amakdedori Creek. Uplands account for 66 percent of the Alternative 1 Amakdedori port analysis area with the remaining 65 acres (34 percent) composed of wetlands and other waters. Wetlands comprise 3 percent of the Alternative 1 Amakdedori port analysis area. NWI wetland types include herbaceous (PEM1) (1 percent) and broad leaved deciduous shrub (PSS1) (2 percent) (Figure 3.22-4). Both types occur almost exclusively on slopes.

Other waters comprise 31 percent of the Alternative 1 Amakdedori port analysis area. The majority of the area (24 percent) is marine subtidal waters (M1). Marine intertidal waters (M2) comprise 4 percent of the area. Most of these intertidal waters have cobble or gravel substrates that are exposed at low tide. Lower perennial streams (R2) comprise approximately 3 percent of the Alternative 1 Amakdedori port analysis area. Lakes or ponds are not present in the Alternative 1 Amakdedori port analysis area.

Coastal habitats in the Alternative 1 Amakdedori port analysis area are mixed sand and gravel beaches. Eelgrass beds are not present in the Alternative 1 Amakdedori port analysis area (see Section 3.24, Fish Values).

Figure 3.22-4: NWI Wetlands, and Other Waters, and Uplands in the Alternative 1 Port Analysis Area



Note: Numbers are rounded to nearest whole percent.

Summer-Only Ferry Operations Variant

This variant would increase the direct disturbance footprint for the container storage yard at the port by approximately 28 acres. The expanded analysis area includes an additional 3 acres of shrub wetlands and 5 acres of streams.

Pile-Supported Dock Variant

The pile-supported dock design would reduce the in-water disturbance footprint at the port by 11 acres.

3.22.5.4 Natural Gas Pipeline Corridor

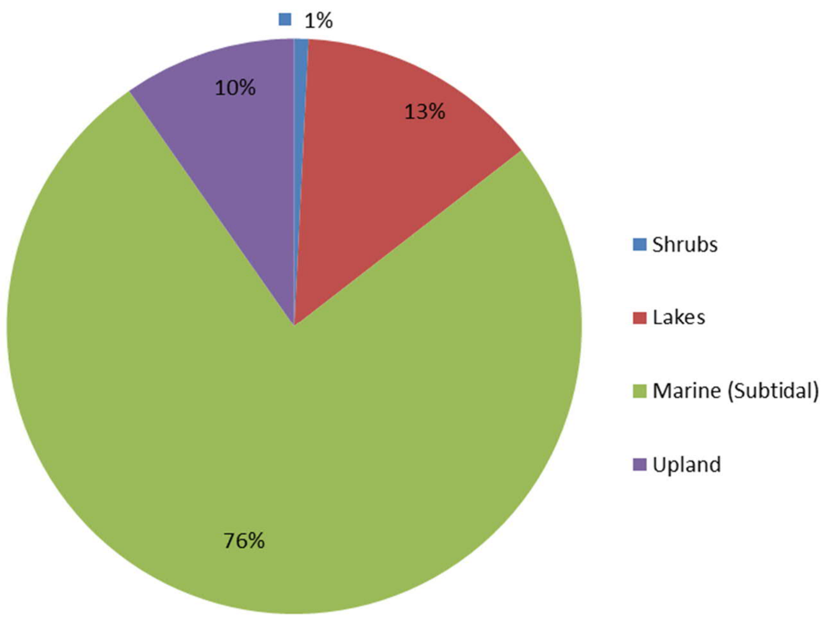
The Alternative 1 natural gas pipeline corridor analysis area includes segments of the natural gas pipeline that do not follow the transportation corridor as described above. These include the segment from the compressor station near Anchor Point on the Kenai Peninsula, across Cook Inlet to Amakdedori port, and the segment across Iliamna Lake. The Alternative 1 natural gas pipeline corridor analysis area is approximately 501 acres.

Wetlands and other waters comprise 452 acres (90 percent) of the Alternative 1 natural gas pipeline corridor analysis area, with the remaining 10 percent being composed of uplands. Wetlands account for 5 acres (1 percent) of the Alternative 1 natural gas pipeline corridor analysis area (Figure 3.22-5). NWI wetland types include deciduous shrubs (PSS1), evergreen shrubs (PSS3) and herbaceous (PEM) occurring in depressions and on slopes.

Other waters comprise 447 acres (89 percent) of the Alternative 1 natural gas pipeline corridor analysis area. The majority of the area (76 percent) is marine subtidal waters (M1) in Cook Inlet. Marine intertidal waters (M2) account for less than 1 percent of the area. The natural gas pipeline corridor across Cook Inlet is approximately 104 miles long. Cook Inlet is characterized by nearshore and deep water habitats with unconsolidated sediments on a smooth bottom and strong tidal currents. Numerous tributary basins with active glaciers contribute to high suspended sediment load in portions of Cook Inlet. The Alternative 1 natural gas pipeline corridor analysis area occurs predominantly in subtidal waters with an unconsolidated cobble-gravel bottom (M1UBL).

Iliamna Lake accounts for 14 percent of the Alternative 1 natural gas pipeline corridor analysis area. This is almost entirely deepwater habitat with an unconsolidated bottom (L1UBH). The natural gas pipeline corridor across the lake is approximately 19 miles long.

Figure 3.22-5: NWI Wetlands, Other Waters and Uplands in the Alternative 1 Natural Gas Pipeline Analysis Area



Note: Numbers are rounded to nearest whole percent. Herbaceous, evergreen shrubs, and marine (intertidal) each account for <1 percent.

Kokhanok East Ferry Terminal Variant

This variant would slightly increase (approximately 20 miles) the length of the pipeline crossing of Iliamna Lake. The increase associated with this variant would not result in any changes to wetlands affected environment.

3.22.6 Alternative 2 – North Road and Ferry with Downstream Dams

Wetlands and other waters comprise 6,442 acres (32 percent) of the Alternative 2 EIS analysis area, including 5,294 acres (26 percent) wetlands and 1,150 acres (6 percent) other waters. A description by major project components is provided below.

3.22.6.1 Mine Site

The Alternative 2 disturbance footprint for the mine site is 155 acres larger than the footprints for Alternatives 1 and 3. However, this additional area is included in the mine site analysis area, which is the same for all alternatives. See description above under Alternative 1.

3.22.6.2 Transportation Corridor

The Alternative 2 transportation corridor analysis area includes 31 miles of the mine access road (an additional 5 miles of this road falls in the mine site analysis area) from the mine site to the Eagle Bay ferry terminal, a 29-mile crossing of the lake to the Pile Bay ferry terminal, and the port access road (18 miles) between the Iliamna Lake and Diamond Point port on Cook Inlet. The Alternative 2 transportation corridor analysis area includes segments of the natural gas pipeline that fall within the transportation corridor. The analysis area is approximately 5,988 acres. Field-verified mapping is available for approximately 4,701 acres (79 percent) of the analysis area.

The Alternative 2 transportation corridor analysis area is characterized by uplands (84 percent). Approximately 982 acres (16 percent) of the Alternative 2 transportation corridor analysis area is a wetland or other water. Wetlands comprise 656 acres (11 percent) of the Alternative 2 transportation corridor analysis area. The dominant NWI wetland type is broad leaved deciduous shrub (PSS1) (7 percent) (Figure 3.22-6). These occur predominantly on slopes with both mineral and organic soils. Water is present in saturated soils near the surface, but also includes shallow flooding or ponding on very gradual slopes and in small swales and depressions located on the slopes. Seasonally flooded shrub wetlands also occur along stream channels, primarily in the Iliamna River and Newhalen River watersheds.

Bogs and fens co-dominated by shrubs of the heather (*Ericacea*) family are a regionally important subset of shrub wetlands that occur on slopes and topographic flat areas with organic soils. Bogs and fens) account for less than 1 percent of the Alternative 2 transportation corridor analysis area.

Herbaceous wetlands (PEM1) comprise 2 percent of the Alternative 2 transportation corridor analysis area. These occur primarily on wetter positions on slopes, and in seasonally to semi-permanently flooded depressions in floodplains. Numerous species of wetland sedges were observed in the project area and provide the dominant cover. Some of these sedges, along with cottongrasses, form pronounced tussocks communities. Bluejoint and horsetails are other locally common herbaceous wetland species.

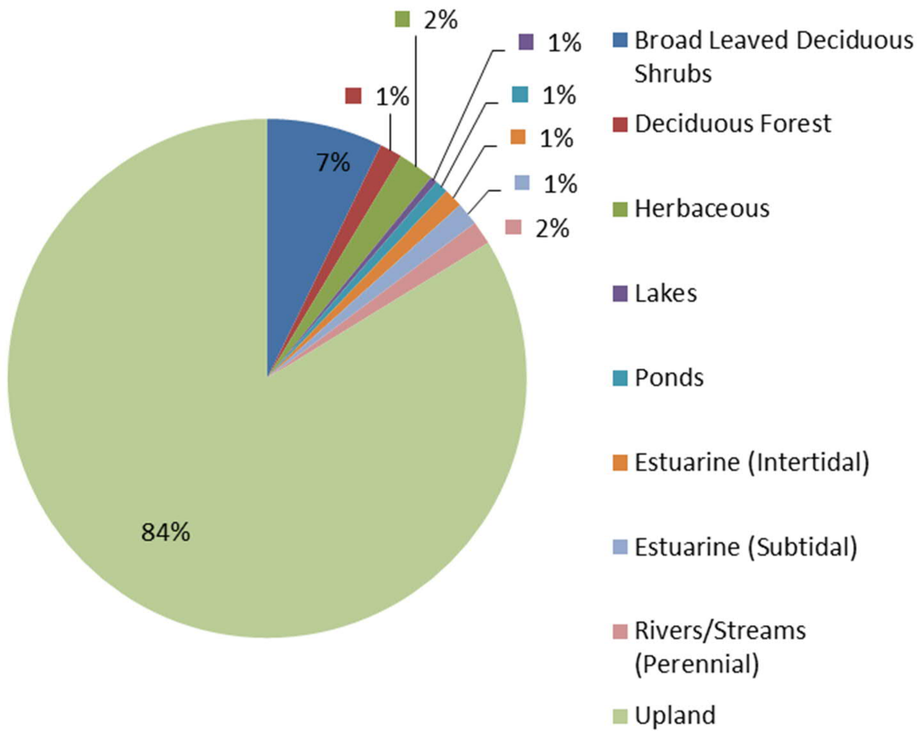
Deciduous forested wetlands (PFO1) comprise 1 percent of the Alternative 2 transportation corridor analysis area. They occur equally on seasonally saturated slopes and in seasonally flooded areas along streams and adjacent floodplains. The tree canopies are generally open, and consist of alders, birches, willows, and cottonwoods, with or without black or white spruce.

Aquatic bed wetlands account for less than 0.1 percent of the Alternative 2 transportation corridor analysis area.

Other waters account for 5 percent of the Alternative 2 transportation corridor analysis area. Lakes and ponds combined, including Iliamna Lake, account for approximately 83 acres (1 percent) of the Alternative 2 transportation corridor analysis area. Lakes are primarily deepwater habitats (L1UBH). Streams comprise approximately 88 acres (2 percent) of the Alternative 2 transportation corridor analysis area in 31 miles of channels. Streams are primarily mapped as upper perennial systems (R3).

Estuarine waters are mapped in Iliamna and Cottonwood bays (Cook Inlet), and comprise approximately 2 percent of the Alternative 2 transportation corridor analysis area. These include both subtidal (E1UBL) (1 percent) and intertidal (E2USN, E2USP) (1 percent) waters. Approximately 3 percent of the intertidal waters are vegetated wetlands (E2EM1P). These areas are dominated by mostly open stands of salt-tolerant herbs that are inundated by high tides at least a few times per month.

Figure 3.22-6: NWI Wetlands, Other Waters and Uplands in the Alternative 2 Transportation Corridor Analysis Area



Note: Numbers are rounded to nearest whole percent. Aquatic bed represents <0.1 percent; evergreen shrubs represent <1 percent.

Summer-Only Ferry Operations Variant

This variant would increase the disturbance footprint associated with a concentrate container storage area along the Williamsport-Pile Bay Road by 22 acres. The additional analysis area includes 9 acres of estuarine intertidal waters.

3.22.6.3 Diamond Point Port

The Alternative 2 Diamond Point port analysis area is located along Iliamna and Cottonwood bays in Cook Inlet. The Alternative 2 Diamond Point port analysis area is 333 acres. Field-verified wetland mapping is not available for the majority of this area, as described above. NWI mapping was used for 90 percent of the analysis area for this component (NWI 2018).

Approximately 217 acres (65 percent) of the Alternative 2 Diamond Point port analysis area is other waters. No wetlands are present in the Alternative 2 Diamond Point port analysis area. Estuarine waters comprise approximately 65 percent of the Alternative 2 Diamond Point port analysis area. Subtidal waters (E1) represent most of this area (60 percent). Perennial rivers make up less than 1 percent of the Alternative 2 Diamond Point port analysis area.

Coastal habitats in the Alternative 2 Diamond Point port analysis area include sand and pebble substrates interspersed by rocky reefs and mudflats (a special aquatic site). Mudflats are estimated to be restricted to the estuarine intertidal zone, which makes up approximately 5 percent of the Alternative 2 Diamond Point port analysis area. Eelgrass beds are not known to occur in the Alternative 2 Diamond Point port analysis area (see Section 3.24, Fish Values).

Pile-Supported Dock Variant

The pile-supported dock design would reduce the in-water disturbance footprint for the dock by 11 acres.

3.22.6.4 Natural Gas Pipeline Corridor

The Alternative 2 natural gas pipeline corridor analysis area is composed of pipeline segments that do not follow the transportation corridor: from the mine access road cut-off to Eagle Bay to the port access road cut-off to Pile Bay; from the Diamond Point port to Ursus Cove; and from Ursus Cove across the Cook Inlet (75 miles) to the compressor station near Anchor Point on the Kenai Peninsula (see Figure 3.26-1 in Section 3.26, Vegetation). The Alternative 2 natural gas pipeline corridor analysis area also encompasses construction access roads to the natural gas pipeline corridor on the north side of Iliamna Lake. Segments of the natural gas pipeline adjacent to access roads are addressed under the transportation corridor analysis area. The Alternative 2 natural gas pipeline corridor analysis area is 2,017 acres. Field-verified mapping was available for approximately 65 percent of the onshore portion of this component.

Approximately 434 acres (22 percent) of the Alternative 2 natural gas pipeline corridor analysis area is a wetland or other water. Wetlands comprise 62 acres (3 percent) of the Alternative 2 natural gas pipeline corridor analysis area. The dominant NWI wetland type is broad leaved deciduous shrub (PSS1) (2 percent) (Figure 3.22-7). These occur predominantly on slopes with both mineral and organic soils. Water is usually present in saturated soils near the surface, but also includes shallow flooding or ponding on very gradual slopes and in small swales and depressions located on the slopes. Seasonally flooded shrub wetlands also occur along stream channels and their floodplains.

Bogs and fens co-dominated by shrubs of the heather (*Ericacea*) family are a regionally important subclass of shrub wetlands occurring on slopes and topographic flat areas with organic soils. They comprise 1 acre (less than 1 percent) of the Alternative 2 natural gas pipeline corridor analysis area.

Herbaceous wetlands (PEM1) comprise 1 percent of the Alternative 2 natural gas pipeline corridor analysis area. These occur in seasonally to semi-permanently flooded depressions and shorelines, and on wetter positions on slopes and flats. Some 30 species of wetland sedges were observed in the area and provide the dominant cover. Some of these sedges, along with cottongrasses, form pronounced tussocks communities. Bluejoint and horsetails are other locally common herbaceous wetland species.

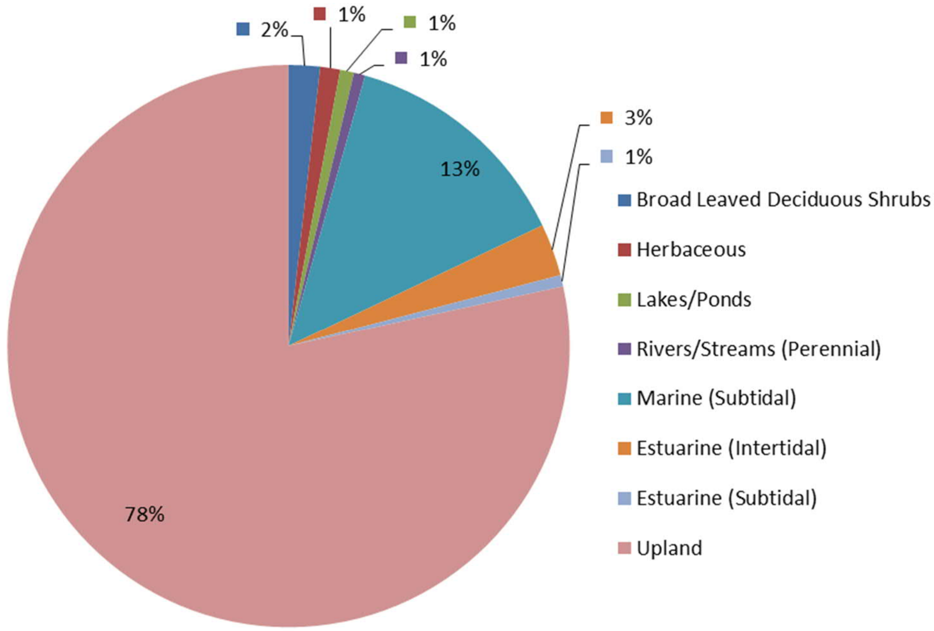
Deciduous forested wetlands account for less than 1 percent of the Alternative 2 natural gas pipeline corridor analysis area.

Other waters make up 372 acres (18 percent) of the Alternative 2 natural gas pipeline corridor analysis area. The majority of the area (14 percent) is marine subtidal waters (M1) in Cook Inlet. Marine intertidal waters (M2) make up less than 1 percent of the area. The natural gas pipeline corridor across Cook Inlet is approximately 75 miles long. Cook Inlet is characterized by nearshore and deep water habitats with unconsolidated sediments on a smooth bottom and strong tidal currents. Numerous tributary basins with active glaciers contribute to high suspended sediment load in portions of Cook Inlet. The natural gas pipeline corridor area occurs predominantly in subtidal waters with an unconsolidated cobble-gravel bottom (M1UBL).

The Alternative 2 natural gas pipeline corridor analysis area includes portions of Iliamna and Cottonwood bays which are mapped as estuarine habitats. This includes intertidal (3 percent) and subtidal (1 percent) habitats. The intertidal zone is characterized as unconsolidated shore. It is more or less equivalent to mudflats, which are a special aquatic site.

Freshwater aquatic habitats in the analysis area include 16 acres (1 percent) of lakes and ponds, and 13 acres (1 percent) of upper perennial rivers in 6.5 miles of channels.

Figure 3.22-7: NWI Wetlands, Other Waters, and Uplands, in the Alternative 2 Natural Gas Pipeline Corridor Analysis Area



Note: Numbers are rounded to nearest whole percent. Deciduous forested wetlands, evergreen shrub wetlands, and marine (intertidal) waters each represent <1 percent.

3.22.7 Alternative 3 – North Road Only

Wetlands and other waters comprise 6,541 acres (30 percent) of the Alternative 3 EIS analysis area, including 5,375 acres (25 percent) wetlands and 1,168 acres (5 percent) other waters. A description by major project components is provided below.

3.22.7.1 Mine Site

The mine site analysis area is the same for all alternatives. See description above under Alternative 1.

<u>Concentrate Pipeline Variant</u>

This variant would increase the disturbance footprint at the mine site by 1 acre for an electric pump station. No additional wetlands or waters are in the EIS analysis area.

3.22.7.2 Transportation Corridor

The Alternative 3 transportation corridor analysis area includes 77 miles of the north access road (an additional 5 miles of this road is included in the mine site analysis area), from the mine site to the Diamond Point port on Cook Inlet. The Alternative 3 transportation corridor analysis area includes segments of the natural gas pipeline that fall within the transportation corridor. The Alternative 3 transportation corridor analysis area is 9,010 acres. Field-verified mapping is available for approximately 92 percent of the Alternative 3 transportation corridor analysis area.

The transportation corridor crosses numerous streams that feed into Iliamna Lake, which is connected to Bristol Bay via the Kvichak River. The major Bristol Bay watersheds include UTC, Newhalen River, Chekok Creek, Pile River, Iliamna River, and Iliamna Lake. The major watershed draining to Cook Inlet is the Chinitna River-Frontal Cook Inlet. The Alternative 3 transportation corridor analysis area is dominated by glaciated, volcanic ash-influenced, mountains, hills, and valleys that are free of permafrost.

Uplands are common in the Alternative 3 transportation corridor analysis area, comprising 87 percent of the area. Approximately 1,159 acres (13 percent) of the Alternative 3 transportation corridor analysis area are wetlands or other waters. Wetlands comprise 790 acres (9 percent) of the Alternative 3 transportation corridor analysis area. The dominant NWI wetland type is broad leaved deciduous shrub wetlands (PSS1) (6 percent) (Figure 3.22-8), occurring predominantly on slopes, but also in river valleys and on flats.

Bogs and fens co-dominated by shrubs of the heather (*Ericacea*) family are a regionally important subset of shrub wetlands occurring on slopes and topographic flat areas with organic soils. Bogs and fens account for less than 1 percent of the Alternative 3 transportation corridor analysis area.

Herbaceous wetlands (PEM1) account for 2 percent of the Alternative 3 transportation corridor analysis area. These occur primarily on wetter positions on slopes, and in seasonally to semi-permanently flooded depressions in floodplains.

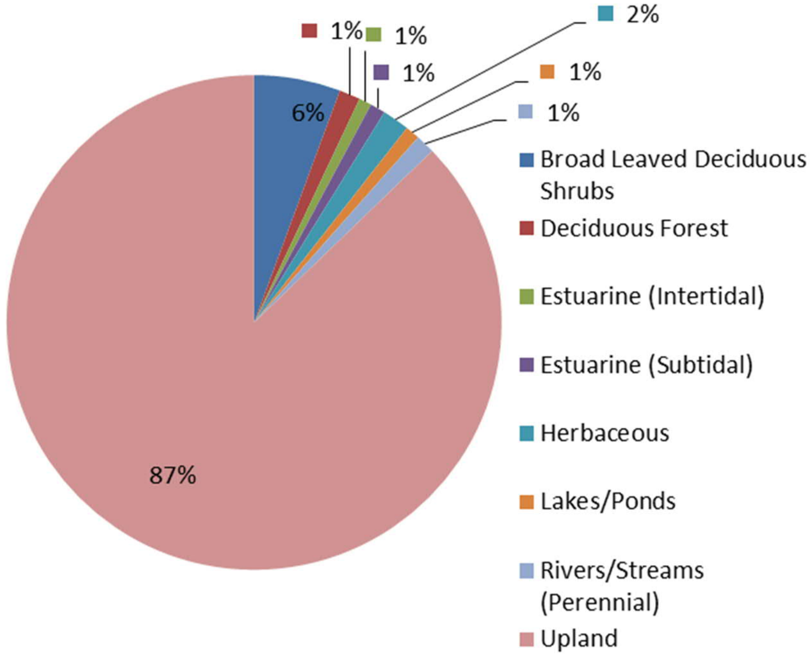
Deciduous forested wetlands (PFO1) comprise 1 percent of the Alternative 3 transportation corridor analysis area. They occur equally on slopes and along rivers in floodplains, mainly in the Iliamna and Newhalen River valleys. The tree canopies are generally open, and consist of alders, birches, willows and cottonwoods, with or without black or white spruce.

Other waters account for approximately 368 acres (4 percent) of the Alternative 3 transportation corridor analysis area. Lakes and ponds combined account for 92 acres (1 percent) of the area. Perennial streams comprise 113 acres (1 percent) of the area in 53 miles of channels. Approximately 164 acres of estuarine waters are included along Iliamna Bay. These include intertidal (1 percent) and subtidal (1 percent) waters. A very small proportion of the intertidal waters are vegetated (E2EM1P). These areas are dominated by mostly open stands of salt-tolerant herbs that are inundated by high tides at least a few times per month. Unvegetated portions of the intertidal waters are considered mudflats, a special aquatic site.

Concentrate Pipeline Variant

The concentrate pipeline would be buried in the same trench as the gas pipeline, increasing the average width of the road corridor by approximately 3 feet.

Figure 3.22-8: NWI Wetlands, Other Waters, and Uplands in the Alternative 3 Transportation Corridor Analysis Area



Note: Numbers are rounded to nearest whole percent. Evergreen shrub wetlands represent <1 percent.

3.22.7.3 Diamond Point Port

The Diamond Point port analysis area is the same for Alternatives 2 and 3. See description above under Alternative 2.

3.22.7.4 Natural Gas Pipeline Corridor

The Alternative 3 natural gas pipeline corridor analysis area comprises segments of the natural gas pipeline that do not follow the access road corridors: from the Diamond Point port to Ursus Cove; and from Ursus Cove across the Cook Inlet (75 miles) to the compressor station near Anchor Point on the Kenai Peninsula. Segments of the natural gas pipeline adjacent to access roads are addressed under the transportation corridor analysis area. Field-verified mapping was available for less than 5 percent of the onshore portion of the Alternative 3 natural gas pipeline corridor analysis area, as described above, so a pie chart is not provided. NWI mapping was used (NWI 2018).

Approximately 356 acres (56 percent) of the Alternative 3 natural gas pipeline corridor analysis area is wetland or other water. Wetlands comprise 8 acres (1 percent) of the Alternative 3 natural gas pipeline corridor analysis area. The dominant NWI wetland type is broad leaved deciduous shrub wetlands (PSS1) (1 percent). Evergreen shrub wetlands (PSS3) and herbaceous wetlands (PEM1) each account for less than 1 percent of the Alternative 3 natural gas pipeline corridor analysis area.

Other waters make up 348 acres (54 percent) of the Alternative 3 natural gas pipeline corridor analysis area, almost all of which are marine or estuarine waters. Ponds and perennial streams each account for less than 1 percent of the Alternative 3 natural gas pipeline corridor analysis area. Marine subtidal waters of Cook Inlet make up 51 percent of the Alternative 3 natural gas pipeline corridor analysis area. Marine intertidal waters account for less than 1 percent Alternative 3 natural gas pipeline corridor.

The Alternative 3 natural gas pipeline corridor analysis area includes portions of Cottonwood Bay that are mapped as estuarine waters. This includes intertidal (9 percent) and subtidal (2 percent) waters. The intertidal zone is characterized as unconsolidated shore; it is more or less equivalent to mudflats, which are a special aquatic site.

3.22.8 Climate Change

Climate change is currently affecting vegetation and wetlands in the EIS analysis area. Current and future effects on wetlands are tied to changes in physical resources and vegetation. Changes in wetland trends observed in the Bristol Bay region due to warmer and wetter conditions include rapid tree growth and expansion, new coastal wetlands, and changes in phenology (i.e., the study of cyclic and seasonal natural phenomena, especially in relation to climate and plant and animal life) (ANTHC 2018). Over the past few decades, the tundra and shrub environment in the vicinity of the project area has been replaced by alder and willow trees (ANTHC 2018). On average in the last 50 years, in the southern two-thirds of Alaska lakes have decreased in area (Klein et al. 2005; Riordan et al. 2006; Roach et al. 2011; Rover et al. 2012). This is due to a combination of permafrost thaw, greater evaporation in a warmer climate, and increased soil organic accumulation during a longer season for plant growth (Chapin and Trainor 2014). However, in some places lakes are becoming larger as a result of lateral permafrost degradation (Roach 2011). Future permafrost thaw will likely increase lake area in areas of continuous permafrost, and decrease lake area in places where the permafrost zone is more fragmented (Avis et al 2011). Both wetland drying and the increased frequency of warm, dry summers and associated thunderstorms have led to more large fires in the last 10 years than in any decade since recordkeeping began in the 1940s (Kasischke et al. 2010).

Clark (et al. 2010) evaluated the effects that a changing climate may have on key habitats in Alaska. Successional changes of wetland types is beginning to occur in some places; wetlands in northern Alaska are predicted to move toward wetland types currently existing in western Alaska, while western Alaska wetlands may tend towards interior Alaska wetland types. Increased temperatures, longer growing seasons, and warmer winters are likely to interact to create a drier warmer climate in Alaska, as it seems unlikely that the projected increased precipitation will exceed evapotranspiration (i.e., the process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces) over the longer thawed periods (Hassol 2004). Overall, Alaska is likely to have much lower overall land coverage in wetlands, and will likely see an increase in forested wetlands (Clark et al. 2010). Additional discussion on climate change trends on vegetation can be found in Section 3.26, Vegetation. Addition discussion on climate change trends on hydrology can be found in Section 3.16, Surface Water Hydrology.

3.23 WILDLIFE VALUES

The following section provides a description of the birds, and the terrestrial and marine mammals, that are known, and have a potential to occur, in the project area. Wildlife currently listed as federally threatened or endangered are discussed separately in Section 3.25, Threatened and Endangered Species. This section is divided based on the species present in or near the various components of the three alternatives (including their variants). Project components that are similar across all alternatives (such as the mine site) are only discussed once, under Alternative 1 – Applicant's Proposed Alternative.

The Environmental Impact Statement (EIS) analysis area for wildlife includes the project footprint for each alternative and the extended geographic area where disturbance to wildlife is considered for the life of the project. The EIS analysis area for terrestrial wildlife varied depending on the species and project component due to differences in species biology and potential impacts from different project components. Table 3.23-1 details the EIS analysis area per species group and project component. Generally, the lightering locations are encompassed in the transportation and natural gas pipeline corridor buffer; however, the alternate lightering location west of Augustine Island is not in the transportation and natural gas pipeline corridor, and therefore has a separate buffer. Buffers are the radial distances placed around the outermost extent of the project component footprint, and encompass both permanent and temporary impacts. It is understood that many wildlife species have a much larger range than the EIS analysis area; however, this section focuses on species that are present in the area during project construction, operations, and closure.

Table 3.23-1: EIS Analysis Area per Species/Group and Project Component

Species Group	Mine Site	Transportation and Natural Gas Pipeline Corridor	Port	Lightering Locations
Raptors	10-mile radius	3-mile radius	3-mile radius	1-mile radius
Waterbirds	10-mile radius	1-mile radius	1-mile radius	1-mile radius
Landbirds and Shorebirds	10-mile radius	1-mile radius	1-mile radius	1-mile radius
Terrestrial Mammals	10-mile radius	3-mile radius	3-mile radius	None
Marine Mammals	None	3-mile radius	3-mile radius	1-mile radius

Additionally, surveys conducted for the project often covered a much larger area than the EIS analysis area. These various survey areas were generally larger than the EIS analysis area in an attempt to understand the regional wildlife populations at the time of surveys. However, impacts from the project are only considered for species that occur in the EIS analysis area. The various survey areas for different species are detailed in their respective sections below; and for the most part, encompassed the geographic extent of the EIS analysis area.

3.23.1 Alternative 1 – Applicant's Proposed Alternative

3.23.1.1 Mine Site

Birds

The bird species present in the EIS analysis area include those that are protected under the Migratory Bird Treaty Act of 1918 (MBTA) (16 US Code [USC] 703-712) and the Bald and

Golden Eagle Protection Act (16 USC 668-668c). Additionally, multiple agencies, as well as non-profit organizations, have created Alaska-specific lists of bird species of conservation concern due to small or vulnerable population sizes in Alaska; restricted geographic ranges (including breeding and wintering); and decreased population trends, among other reasons. Bird species of conservation concern are species listed on at least one of the following three lists: the US Fish and Wildlife Service's (USFWS) Birds of Conservation Concern in Bird Conservation Regions (BCR) 2 (western Alaska) and BCR 4 (northwestern interior forest US portion only) (USFWS 2008a); the Alaska Department of Fish and Game's (ADF&G) Wildlife Action Plan (listed as a species of greatest conservation need in southwest Alaska) (ADF&G 2015a); and Audubon Alaska's WatchList 2017-Red List of Declining Populations (Warnock 2017). Bird species of conservation concern do not receive the same level of protection as those listed under the federal Endangered Species Act (ESA), but are protected by the MBTA. Bird species of conservation concern are not specifically detailed herein, but are recognized as occurring in the EIS analysis area. Lists of all bird species and their conservation status detected in the EIS analysis area and transportation and natural gas pipeline corridors are in the various Pebble Project Environmental Baseline Data Reports (ABR 2011a-e). Avian species present in the mine site are divided into groups that include raptors, waterbirds, landbirds, and shorebirds.

Historical bird surveys around the mine site include cliff-nesting raptor surveys (detailed in ABR 2011a), reconnaissance avian surveys of the mine site and surrounding areas, including waterfowl surveys on the Kvichak and Naknek rivers (Smith 1991), and landbird and shorebird studies from the Iliamna Lake region (Williamson and Peyton 1962). These historical studies cannot be directly compared to the surveys conducted for the project due to differences in survey methods, timing of surveys, habitat surveyed, geographical extent, etc. (ABR 2011a). Therefore, historical survey data are of limited use, and generally not presented herein. More recently, an examination of the wildlife resources of the Nushagak River and Kvichak River watersheds conducted by Brna and Verbrugge (2013) reviewed the mammalian and avian resources in these watersheds. These data are included where appropriate.

Avian surveys for the mine site were conducted primarily from 2004 through 2005 (with a few surveys in 2006) by ABR, Inc. The full details of the survey methods and results are provided in the Pebble Project Environmental Baseline Document 2004 through 2008, Chapter 16, Wildlife and Habitat Bristol Bay Drainages (ABR 2011a). The methods and results are summarized herein for the specific project components, where applicable.

Habitat mapping and habitat-value assessments were conducted across the mine survey area in 2004 and 2005 in an effort to better understand the biological conditions present and how they relate to avian abundance and distribution. Wildlife habitats in the mine survey area were mapped to provide a baseline inventory of the availability of wildlife habitats for use by various wildlife species (ABR 2011a). The mine survey area was defined as an area comprising 184 square miles, centered on the mine footprint. The area is primarily composed of alpine and unforested upland habitats on glacial moraine deposits, with three prominent river corridors in the area (North Fork Koktuli [NFK] River, South Fork Koktuli [SFK] River, and Upper Talarik Creek [UTC]). Field data on the vegetation, physiography, landforms, and surface forms were applied to assess the potential use of the mapped habitat by avian species, as detailed in ABR 2011a. Habitat use for each species was qualitatively categorized into one of four value classes (high, moderate, low, or negligible value) based primarily on avian survey data specific to the mine survey area, and habitat-use information from scientific literature (ABR 2011a). Twenty-five wildlife habitat types were mapped in the mine survey area, with Upland Moist Dwarf Scrub and Alpine Moist Dwarf Scrub representing over 52 percent of the mine survey area wildlife habitat types. The complete list of all avian habitat types, their plant-species composition, and their value as avian habitat are detailed in ABR 2011a. The avian habitat mapping is useful for understanding the locations where various avian species are likely to occur, and how impacts from the project are anticipated to affect the vegetation communities used by birds.

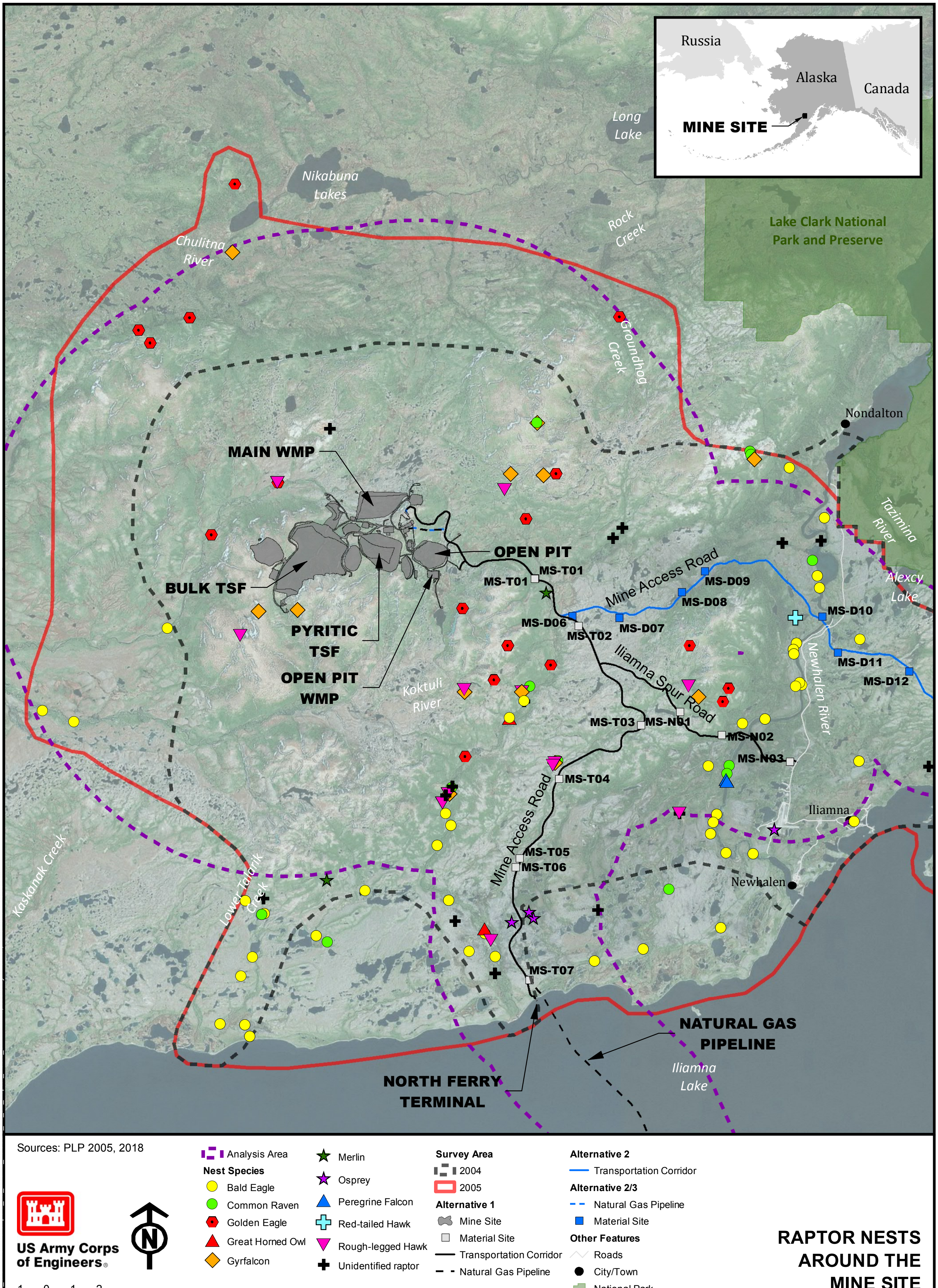
The following sections provide an overview of survey methods and results for the three categories of birds (raptors, waterbirds, and landbirds, and shorebirds) that breed, stage, winter, and migrate throughout the mine survey area.

Raptors

Methods. Historical raptor survey data were reviewed to understand the level of field effort by previous studies; however, data are not representative, because the ABR data from 2004 and 2005 are more recent and comprehensive. Aerial-based raptor studies were conducted from April to May 2004 and May to August 2005 to collect baseline data on the distribution, abundance, nesting status, and habitat use of large tree and cliff-dwelling birds of prey (and large corvids), which included bald eagles (*Haliaeetus leucocephalus*), golden eagles (*Aquila chrysaetos*), gyrfalcon (*Falco rusticolus*), peregrine falcon (*Falco peregrinus*), rough-legged hawk (*Buteo lagopus*), northern goshawk (*Accipiter gentilis*), osprey (*Pandion haliaetus*), great horned owl (*Bubo virginianus*), and common raven (*Corvus corax*). One limitation to aerial surveys is the ability to detect ground-nesting raptor species such as northern harrier (*Circus hudsonius*) and short-eared owl (*Asio flammeus*). Additional fall and winter bald eagle surveys were conducted in 2005 and 2006 to gather information on wintering bald eagles.

Surveys were conducted across the mine survey area that included all suitable cliff habitat and woodland tracts that could provide nesting platforms for large cliff and tree-nesting raptors. The area surveyed for raptors encompassed the EIS analysis area. The 2004 survey area was slightly smaller than the 2005 survey area, which is shown on Figure 3.23-1. The 2005 survey area was more encompassing, and extended from the Chulitna River to the north of the mine site; south to Iliamna Lake; west almost to the confluence of the NFK and SFK; and east to beyond the Newhalen River. Detailed survey methods are discussed in ABR 2011a, and followed the Draft Environmental Baseline Studies, Proposed 2004 and 2005 study plans (NDM 2004, 2005).

The first helicopter survey was conducted prior to leaf-out of deciduous trees to identify tree-nesting species, such as northern goshawk and bald eagle. The second survey for each year was timed to coincide with peak nesting for cliff-nesting raptors, such as golden eagle, gyrfalcon, peregrine falcon, and rough-legged hawk. Because these species nest at slightly different times, which can vary from year to year, surveys were timed to coincide with the time when most cliff-nesting raptors would have active nests. One survey was conducted in late June through early July to determine the success of early nesting species such as gyrfalcons and golden eagles. A second survey was conducted in early August to determine nesting success and productivity for some late-hatching species (such as rough-legged hawk nests) where brooding adults obscured views of the nest in the early July survey (ABR 2011a). These aerial surveys were conducted to determine nest success and productivity. A nest was considered successful if at least one live nestling was observed at approximately 80 percent of the average age of first flight for the species. Productivity was determined as the number of young per occupied nest or the total number of pairs, and the number of young per successful nest or pair (ABR 2011a). Wintering bald eagle surveys were conducted in February and November 2005 and November 2006 to determine bald eagle winter use of the mine survey area.



RAPTOR NESTS AROUND THE MINE SITE

PEBBLE PROJECT EIS

FIGURE 3.23-1

Results. No raptor nests were found directly in the mine site footprint based on ABR surveys (ABR 2011a). The mine site footprint itself lacks cliffs, large trees, and other structures that could support nesting raptors. The habitat is primarily open rocky tundra surrounded by rolling hills. Habitat for most tree-nesting raptors is limited in the EIS analysis area to trees along UTC and its tributaries, as well as the lower reaches of the Koktuli River. More extensive woodlands (spruce-dominated) occur in the area between Iliamna Lake, and Upper and Lower Talarik creeks. Habitat for cliff-nesting species is limited to isolated cliffs, and bluffs along riparian areas. This includes hills between the NFK and Upper SFK rivers, the eastern side of Koktuli Mountain, the eastern and southern slopes of Groundhog Mountain, and along UTC.

Of the 19 raptor species (12 day-active raptors and seven species of owl) that may occur in the mine survey area and surrounding areas, 10 species were recorded during aerial surveys. A complete list of the detected raptor species, along with their breeding status, nest abundance, and nest productivity, is found in ABR 2011a, and summarized herein. The most commonly detected nesting raptors were bald eagle (with the closest nest over 4 miles from the mine site footprint in the NFK), golden eagle, rough-legged hawk, and gyrfalcon (Figure 3.23-1). Not all of the nests detected were active or occupied at the time of survey, and the number of active raptor territories varied depending on prey availability. The nesting success (percentage of total nests that contained at least one live nestling at approximately 80 percent of the average age of first flight for the species during the productivity surveys) ranged from 67 percent for rough-legged hawk and golden eagle, to 71 and 80 percent for bald eagle and gyrfalcon, respectively (ABR 2011a). Merlin (*Falco columbarius*), osprey, and great horned owls were detected nesting in the mine survey area in low abundance; and no peregrine falcon or northern goshawk nests were detected during surveys. Additionally, suitable nesting habitat exists for the northern harrier and short-eared owl. However, both of these are ground-nesting species, and it is difficult to find their nests via aerial surveys, and no nests of these species were detected. Therefore, aerial surveys are limited in their ability to detect nests for all raptor species. Additionally, raptor species exhibit variation in nest timing, nesting areas, and density in relation to prey species abundance. Therefore, although the mine site footprint lacks habitat suitable for tree- and cliff-nesting raptors, there is potential habitat for ground-nesting raptors, especially around wetland and marsh areas.

Bald eagle nests were found primarily along the lower NFK and SFK rivers, Upper and Lower Talarik creeks, along the Newhalen River, and generally were not in close proximity to the mine site (Figure 3.23-1). Cliff-nesting raptors such as golden eagles, gyrfalcons, and rough-legged hawks nested on cliffs much closer to the mine site along the NFK, SFK, and UTC drainages, including Groundhog Mountain and the mountains east of Frying Pan Lake (Figure 3.23-1). The closest nests of gyrfalcons and golden eagles to any component of the mine site were approximately 0.4 mile (near the bulk tailings storage cell south embankment sediment pond), and 0.8 mile away (near Frying Pan Lake water treatment plant discharge-south), respectively. Overall, two gyrfalcon nests were less than a mile from the mine site (south of the bulk tailings storage cell), and four golden eagle nests were observed in a large area between 0.8 mile to 2.5 miles from the mine site. Several rough-legged hawk nests were also in the vicinity, and ranged from 1.7 to 2.5 miles from the mine site.

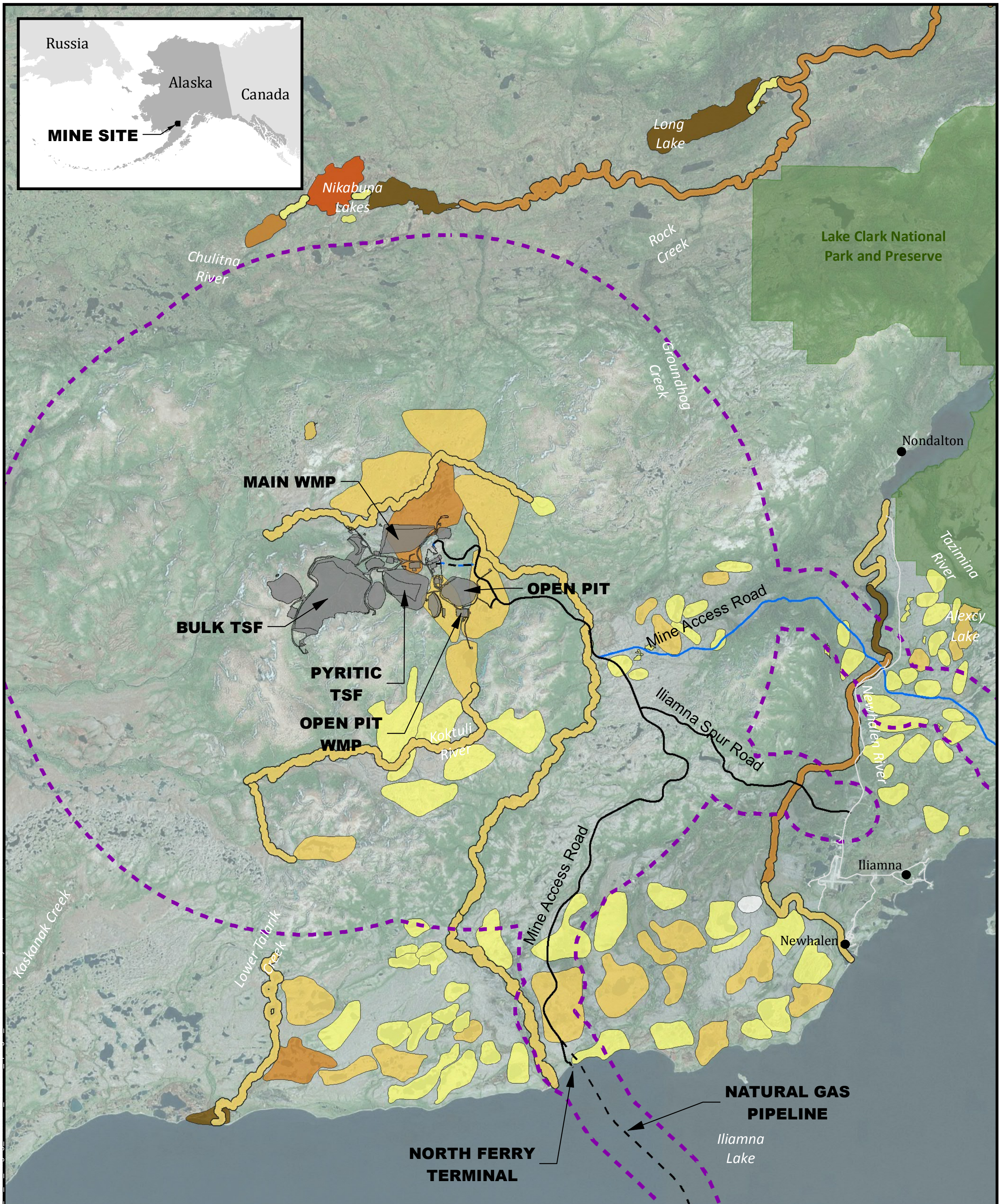
In summary, aerial raptor surveys in 2004 and 2005 documented nesting in the main river valleys and adjacent cliffs in the EIS analysis area. Although no raptors were detected nesting directly in the mine survey area (due to a lack of nesting structures, such as trees or cliffs), the habitat is suitable for foraging for a variety of raptor species that nest in the vicinity, including golden eagles, gyrfalcons, and rough-legged hawks, as well as northern harriers and short-eared owls.

Waterbirds

The Iliamna Lake region serves as a migration route for many species of waterbirds (swans, geese, ducks, loons, and gulls) moving to and from the breeding grounds in western and northern Alaska (Platte and Butler 1995). The USFWS conducts aerial-based waterbird surveys annually each spring and summer as part of the North American Waterfowl Breeding Pair Survey (USFWS 2012a). In the late 1980s, the survey effort was expanded to include additional wetlands, to improve population estimates and map the distribution of several species. This expanded breeding pair survey area included the wetlands around the mine site (labeled the Bristol Bay lowlands; Platte and Butler 1995), and aerial surveys were conducted. A series of maps (USFWS 2012d) depicting the abundance and distribution of various waterbird species was created, and generally correlate to the distribution of waterbird species found during baseline surveys. Although these data are useful for understanding historical distributions of waterbird species around the mine site, the baseline data presented below are more thorough, and include ground-based surveys to document breeding success.

Important waterbird species that use the mine survey area for breeding or staging include tundra swan (*Cygnus columbianus*), common loon (*Gavia immer*), harlequin duck (*Histrionicus histrionicus*), surf scoter (*Melanitta perspicillata*), black scoter (*Melanitta americana*), long-tailed duck (*Clangula hyemalis*), and a variety of dabbling and diving ducks (Williamson and Peyton 1962). Surveys were conducted in the mine survey area from April to October 2004, in 2005, and in September 2006 using helicopters, fixed-wing aircraft, and ground personnel to document the distribution, abundance, species composition, and habitat use of waterbird species during the breeding season (pre-nesting, nesting, molting, and brood-rearing), and during spring and fall migration. Waterbirds included species of geese, swans, ducks, loons, grebes, cormorants, cranes, gulls, terns, and jaegers. The complete details of the methods used for these various surveys are outlined in the Draft Environmental Baseline Studies, proposed 2004 and 2005 study plans (NDM 2004, 2005), and are summarized below.

Methods. The mine survey area for waterbirds in 2004 and 2005 encompassed the mine site facilities plus a large buffer encompassing adjacent wetlands (Figure 3.23-2 and Figure 3.23-3). The mine survey area included the majority of the EIS analysis area. Field work was conducted from April to October 2004, April to October 2005, and September 2006. For waterbird spring and fall migration surveys, fixed-wing aircraft flew throughout suitable habitat in the mine survey area every 7 to 10 days during spring and fall migration in 2004 and 2005. Waterfowl breeding population surveys were conducted with fixed-wing aircraft in June 2004 and May 2005. Swan nesting surveys were conducted in the mine survey area in June 2005 and May 2005, and productivity surveys were conducted in September 2006 by aircraft. Harlequin duck pre-nesting and brood-rearing surveys were conducted by helicopter in the mine survey area in May, July, and August 2004 and 2005. Species of loons were recorded incidentally as part of the spring and fall migration surveys and the waterbird brood-rearing surveys. A helicopter survey for nesting gulls was conducted in June 2005 in the mine survey area. Ground surveys for brood-rearing waterbirds were conducted in July 2004 and 2005, and included a search of wetlands, ponds, and lakes in selected locations in the mine survey area. Finally, surveys for flocks of molting waterbirds were conducted in the mine survey area in July and August 2005. The complete details of the survey data, flight paths, data recorded, and timing of surveys are detailed in ABR 2011a.



Sources: PLP 2005, 2018

Maximal Number of Birds
- 0
- 1 - 25
- 26 - 100
- 101 - 250
- 251 - 500
- 501 - 1000
- Analysis Area

Alternative 1
- Mine Site
- Transportation Corridor
- Natural Gas Pipeline

Alternative 2
- Transportation Corridor

Alternative 2/3
- Natural Gas Pipeline

Other Features
- Roads
- City/Town
- National Park

US Army Corps of Engineers®

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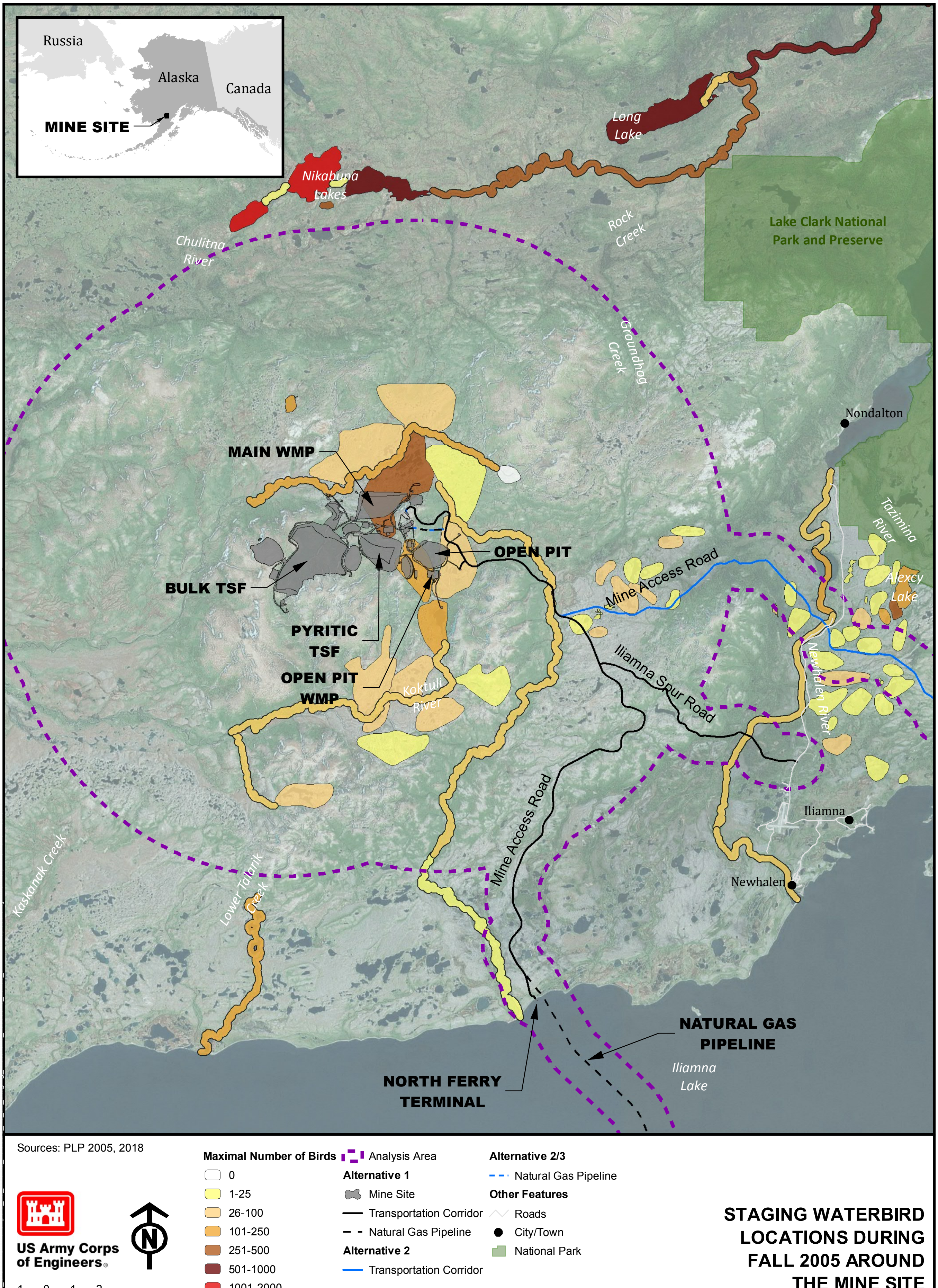
Miles

STAGING WATERBIRD LOCATIONS DURING SPRING 2005 AROUND THE MINE SITE



STAGING WATERBIRD LOCATIONS DURING FALL 2005 AROUND THE MINE SITE

PEBBLE PROJECT EIS

FIGURE 3.23-3

Results. Thirty-seven species of waterbirds were observed, with 21 confirmed to breed in the mine survey area, due to the presence of a brood. A complete list of the waterbird species detected in the mine survey area is not included here, but is detailed in ABR 2011a. Waterbirds used lakes and rivers throughout the mine survey area for staging during spring and fall migration, with swans and dabbling ducks (*Anas* species) arriving late in April to early May. Many of these birds likely nested in the area. Diving duck species arrived in mid- to late-May, and staged on rivers and lakes. Some of these birds likely nested in the area, while small flocks (approximately 60 birds) were observed resting and feeding on lakes before continuing their northern migration. During fall migration, both dabbling and diving ducks were observed in the larger lakes in the mine survey area in flocks of between 60 and 120 birds. Concentrations of birds in both spring and fall were noted in the northern half of the mine survey area from Frying Pan Lake, north to lakes in the NFK River basin. In the mine survey area, UTC was the creek most heavily used by dabbling and diving ducks.

Nikabuna and Long lakes, and the outlets of UTC and Lower Talarik Creek are important migratory stopover locations for large flocks of waterfowl. In late April, hundreds of swans, greater white-fronted (*Anser albifrons*) and Canada geese (*Branta canadensis*), and dabbling and diving ducks staged on these lakes (Figure 3.23-2). Between August and mid-October, thousands of ducks (2,000 to 5,000 birds) staged around the Nikabuna and Long lakes, with hundreds of swans starting in early October (Figure 3.23-3). The outlets of UTC and Lower Talarik Creek at Iliamna Lake are important staging locations for swans, ducks, and gulls during spring and fall migration.

Tundra swans were common breeding birds in the mine survey area in 2004 and 2005, with about half of the 14 nests (from 2004) and 15 nests (from 2005) found around the lakes in the NFK River drainage (Figure 3.23-4). Many swans returned to their same territories and nest sites in 2005 (ABR 2011a). Swan productivity surveys in late-September 2006 found one brood in the survey area, and in previous years (2004, 2005), swan broods remained in the mine survey area into mid-October (ABR 2011a).

Harlequin ducks were common breeders in the UTC, followed by the NFK and the SFK rivers. The highest numbers of broods counted by drainage were seven broods each on UTC and the NFK River, and three broods on the SFK River, totaling 71 young in 17 broods (ABR 2011a).

Common loons nested in the mine survey area in 2004 and 2005 on Big Wiggly Lake; and in 2004, on lakes east of UTC. One Pacific loon (*Gavia pacifica*) nest was found in the northern part of the NFK River drainage in 2005.

Small groups of nesting mew gulls (*Larus canus*) were found north of Frying Pan Lake (six nests) and in the NFK River drainage. A single Bonaparte’s gull (*Chroicocephalus philadelphia*) brood was seen near Big Wiggly Lake in 2004.

Eighteen species of waterbird broods were recorded in the mine survey area, with brood-rearing groups on 33 percent of the sampled lakes in 2004 (69 broods), and 26 percent in 2005 (168 broods). American wigeon, northern pintail, and scaup were the most common species seen on lakes, with red-breasted merganser (*Mergus serrator*), green-winged teal (*Anas crecca*), and mallard broods more commonly seen on rivers. Most broods were found in lowland lakes in the central part of the NFK River drainage, in Frying Pan Lake, and in lakes in the floodplain of the lower SFK River drainage.

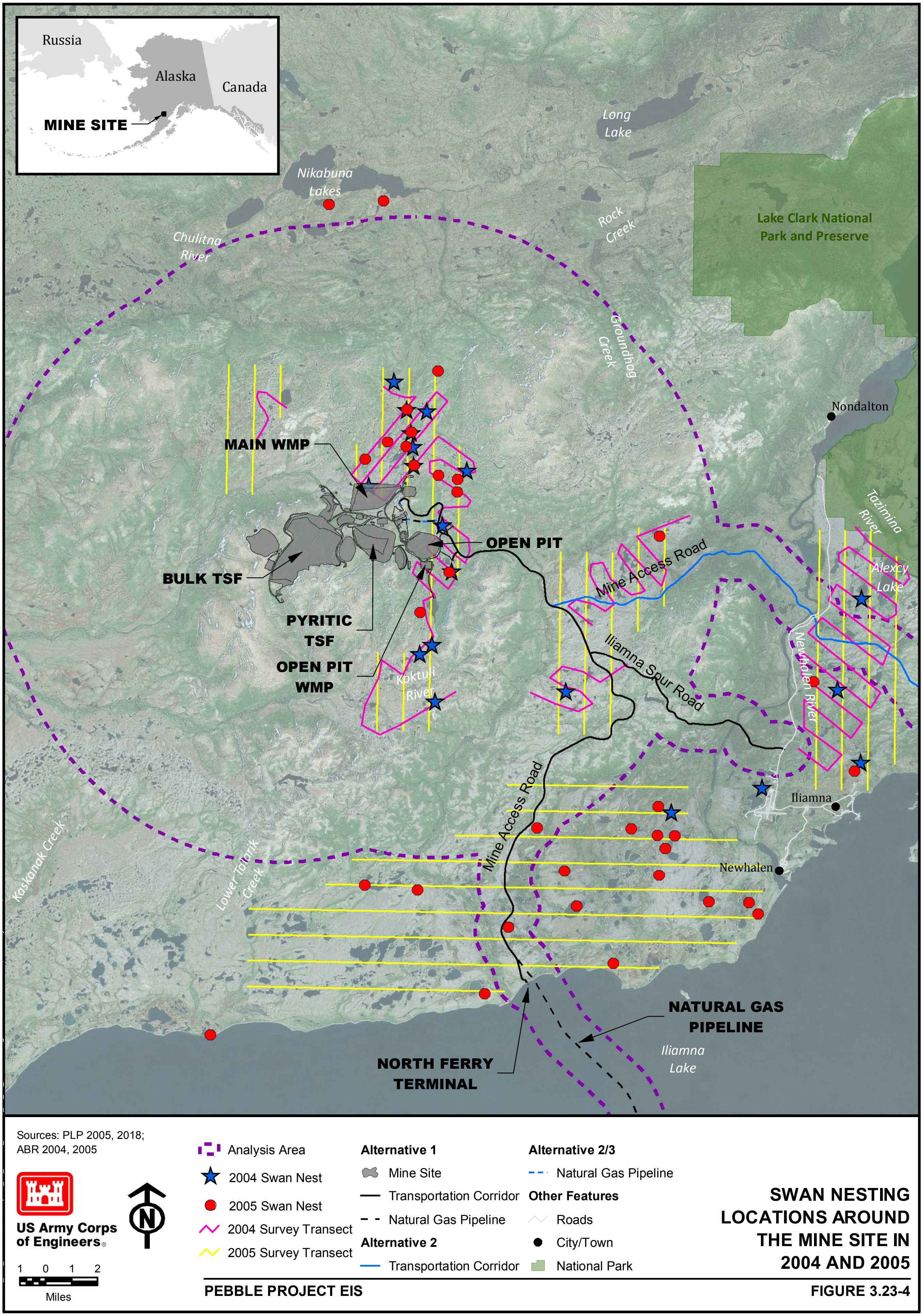


FIGURE 3.23-4

SWAN NESTING LOCATIONS AROUND THE MINE SITE IN 2004 AND 2005

During the summer waterbird molting period (late July through August), small flocks of ducks and numerous brood-rearing groups were observed in the mine survey area. Flocks of 35 to 60 birds were observed on Big Wiggly Lake, Frying Pan Lake, and other large lakes adjacent to the NFK and SFK rivers. Species of scaup were the most commonly observed duck, followed by green-winged teal and northern pintail.

In summary, the mine survey area encompasses a vast area of lowland lakes and rivers that support habitat for staging, migrating, and breeding waterbirds. The highest numbers of waterbirds pass through in late May on their northern migration, and in mid-August during fall migration. Nikabuna and Long lakes support large numbers of migrating waterbirds (primarily ducks). These lakes are over 12 miles north of the mine survey area, and occur outside of the EIS analysis area. The NFK River supported the greatest numbers of waterbird broods observed on ponds and lakes in the mine survey area. The UTC supported the greatest number of waterfowl broods observed on rivers; and scaup species were the most numerous waterbirds observed during summer molt surveys.

Landbirds and Shorebirds

Project baseline studies conducted in 2004 and 2005 are the most comprehensive source of data for landbirds and shorebirds in the mine survey area. Various avifaunal studies have been conducted in the broader region around the EIS analysis area; however, none of these studies were conducted directly in the mine site (ABR 2011a). The breeding landbird and shorebird survey area encompassed the mine site facilities plus a large surrounding buffer, including the majority of the EIS analysis area. The survey area in 2004 was 97 square miles; and in 2005, was 113 square miles. Surveys for breeding landbirds and shorebirds were conducted in June 2004, and May and June 2005, to document the landbird and shorebird species present in the mine survey area, their abundance, and the use of mapped habitats to provide data for the wildlife habitat mapping.

Landbirds were defined as passerines or songbirds (including species of ptarmigan, corvids, flycatchers, larks and pipits, swallows, kinglets, thrushes, warblers, sparrows and allies, and finches), and did not include any species of raptors, waterbirds, or waterfowl. Shorebirds consisted of species of plovers, sandpipers, and allies.

Methods. Surveys for breeding landbirds and shorebirds were conducted following the Draft Environmental Baseline Studies, proposed 2004 and 2005 study plans (NDM 2004, 2005). Surveys used variable circular-plot point-count methods (Ralph et al. 1995; Buckland et al. 2001), which are designed primarily to detect singing male passerines defending their territories, and to inventory breeding shorebirds. Prior to fieldwork, aerial photography was used to allocate point-count locations (based on prominent photo signatures), with adequate spatial representation to sample the variety of habitats in the mine survey area, and ensure point counts were at least 1,640 feet apart. Ten-minute point-count surveys were conducted between 4:30 AM and 4:00 PM (but most were conducted between 5:00 AM and 2:00 PM); point counts were accessed by helicopter and on foot. One biologist conducted each point count, and point counts were only conducted once at each location. Surveys in 2004 were conducted in June; those in 2005 were conducted at the end of May and throughout June to coincide with the peak breeding period for landbirds in southwestern Alaska. Point-count locations were chosen to adequately determine the species and average occurrence of birds using specific habitat types (vegetation communities) that could be correlated to the wildlife habitat mapping.

Results. In 2004, 166 point-count locations recorded 1,794 individual birds across the survey area. In 2005, 227 point-count locations recorded 2,636 birds across the same survey area. In 2005, eight additional point-counts were conducted in the UTC drainage to the east of the survey area. Including birds incidentally detected, 28 landbird species and 14 shorebird species were detected in 2004 and 2005, as detailed in ABR 2011a. Point-count data were used to calculate a mean of 10.2 landbirds and 1.1 shorebirds per point count when both 2004 and 2005 data are combined. The following nine landbird species were the most frequently detected species in the mine survey area: savannah sparrow (*Passerculus sandwichensis*), golden-crowned sparrow (*Zonotrichia atricapilla*), Wilson's warbler (*Cardellina pusilla*), orange-crowned warbler (*Vermivora celata*), common redpoll (*Acanthis flammea*), American tree sparrow (*Spizella arborea*), gray-cheeked thrush (*Catharus minimus*), fox sparrow (*Passerella iliaca*), and yellow warbler (*Setophaga petechia*). Of these species, the savannah sparrow, golden-crowned sparrow, and Wilson's warbler were the most common, constituting approximately 37 percent of the point-count observations in both years. Species of larks, pipits, and swallows were less common; ptarmigan, flycatchers, corvids, and kinglets were rarely recorded.

No particular shorebird species was considered an abundant breeder (ABR 2011a). Six of the 14 species were considered common breeders, and include greater yellowlegs (*Tringa melanoleuca*), Wilson's snipe (*Gallinago delicata*), least sandpiper (*Calidris minutilla*), black-bellied plover (*Pluvialis squatarola*), whimbrel (*Numenius phaeopus*), and American golden-plover (*Pluvialis dominica*).

Landbirds were recorded in 15 of the 19 wildlife-habitat types, and shorebirds were recorded in 12 wildlife-habitat types. The most productive breeding habitats in terms of bird abundance were Lowland Low and Tall Willow Scrub, Riverine Tall Alder or Willow Scrub, and Upland Moist Tall Willow Scrub. More than nine birds were observed per point count in these habitats. Most landbirds regularly used tall and low scrub habitats; most shorebirds were found in open habitats, including bogs, meadows, dwarf scrub types, and barren habitats.

Of the landbird and shorebird species that nested in the mine survey area, gray-cheeked thrush and blackpoll warbler (*Setophaga striata*) preferred to breed in dense, tall-scrub habitats, including willows and alders (along riverine alder-willow thickets), with a thick understory of low shrubs. Breeding shorebirds such as surfbird (*Aphriza virgata*) and American golden-plover used high-elevation alpine habitats for nesting, including barren and dwarf-scrub-dominated types. The other shorebird species, such as whimbrel, Hudsonian godwit (*Limosa haemastica*), lesser yellowlegs (*Tringa flavipes*), and short-billed dowitcher (*Limnodromus griseus*), used open, wet, lowland and riverine habitats such as meadows scrub-bogs and marshes.

Species of greatest conservation need (ADF&G 2015a) that were observed (and were recorded as nesting or presumed to nest) in the mine survey area include gray-cheeked thrush, blackpoll warbler, American golden-plover, whimbrel, Hudsonian godwit, surfbird, and short-billed dowitcher (ABR 2011a). Detailed information on the specific habitat types and their approximate abundance per habitat type is included in ABR 2011a. Gray-cheeked thrush (116 were documented in 2004 and 251 in 2005) were considered common in tall-scrub habitats in upland, lowland, and riverine areas of the mine survey area. Blackpoll warbler were also considered common in the mine survey area (18 were documented in 2004, and 34 in 2005) primarily in riverine tall alder or willow scrub. American golden-plovers were considered common in the mine survey area (16 were recorded in 2004, and 14 in 2005) and were documented in alpine moist dwarf scrub, upland moist dwarf scrub, upland dry dwarf shrub-lichen scrub, and lowland ericaceous scrub bog. Whimbrel were also considered common in the mine survey area (18 were recorded in 2004, and 40 in 2005) and they were found in lowland ericaceous scrub-bog and lowland wet graminoid-shrub meadow. Hudsonian godwit were considered uncommon in the mine survey area (4 were recorded in 2004, and 2 in 2005) and were found in lowland ericaceous scrub-bog and lowland wet graminoid-shrub meadow, and only in the wetlands north of Frying Pan Lake. Surfbirds were considered uncommon in the mine survey area (2 were recorded in 2004, and 8 in 2005) and were only found in alpine moist dwarf scrub. Short-billed dowitchers were considered uncommon in the mine survey area (6 were recorded in 2004, and 9 in 2005) and were only found in lowland wet graminoid-shrub meadow.

Terrestrial Mammals

Historical terrestrial mammal surveys have been conducted in the area surrounding the mine site, including population and inventory studies by the ADF&G (ADF&G 1985; Butler 2006, 2007a, 2007b, 2008; Woolington 2006, 2007a, 2007b, 2009). Smith (1991) conducted a broad reconnaissance survey to document the wildlife species present in the area around the mine site. Under an agreement with Cominco Alaska Exploration, ADF&G surveys focused on the area around the Pebble deposit in the early 1990s. Additional studies and analyses in recent years have been conducted as part of broad-scale species inventories by the National Park Service and USFWS (Cook and MacDonald 2004a, 2004b; Brna, P.J. and L.A. Verbrugge 2013).

The mine site facilities are in the far eastern corner of Game Management Unit (GMU) 17B. Terrestrial mammal surveys for the mine site were conducted from 2004 through 2010 by ABR, Inc. for a variety of species. The full details of the survey methods and results are provided in the Pebble Project Environmental Baseline Document 2004 through 2008, Chapter 16, Wildlife and Habitat Bristol Bay Drainages (ABR 2011a). The methods and results are summarized herein for the specific project components.

To quantify the suitability of vegetation communities in the mine site as wildlife habitat, habitat mapping and habitat-value assessments were conducted across the mine survey area in 2004 and 2005. Wildlife habitats were mapped in the mine survey area to provide a baseline inventory of the availability of wildlife habitats for use by wildlife; specifically, for a selected set of mammal species (ABR 2011a). The mine survey area for terrestrial mammals was defined as an area comprising 184 square miles, centered on the mine footprint, and encompassed the majority of the EIS analysis area. The mine survey area is primarily composed of alpine and unforested upland habitats on glacial moraine deposits, with three prominent river corridors in the area (NFK and SFK rivers and UTC). Field data on the vegetation, physiography, landforms, and surface forms were used to assess the use of the mapped habitat by 13 mammal species (see Section 16 in ABR 2011a). Habitat use for each species in each mapped habitat type was qualitatively categorized into one of four value classes (high, moderate, low, or negligible value), based primarily on wildlife survey data specific to the mine survey area, and habitat-use information from scientific literature (ABR 2011a). The complete list of all 25 wildlife habitat types, their plant-species composition, and their value as wildlife habitat is provided in Appendix 16.1C in ABR 2011a.

The following sections detail the specific survey methods and results for mammals that breed and migrate throughout the mine survey area. Data from these surveys were applied to wildlife habitat mapping to understand the value of the wildlife habitat in the mine survey area.

Large Mammals

Aerial strip-transect surveys were conducted from April to November 2004, March through December 2005, May through July and December 2006, June and July 2007, May 2009, and April 2010 to document the large mammal species present in the mine survey area. A general bear (*Ursus species*) survey in 2009 and moose (*Alces alces*) survey in 2010 were designed to estimate the density of those species, while additional aerial surveys were intended to gather distribution, relative abundance, and general patterns of use of the EIS analysis area. Specifically, ABR conducted the following surveys and analyses:

- Detailed analysis of ADF&G's radio telemetry data for the Mulchatna caribou (*Rangifer tarandus*) herd.
- Aerial strip-transect surveys in the mine survey area during late winter, caribou calving, caribou post-calving, caribou rut/fall migration, and early winter;
- Aerial line-transect surveys to estimate the density of bears in the Iliamna Lake region.
- Aerial surveys of brown bears (*Ursus arctos*) along salmon-spawning streams, and an examination of brown bear and gray wolf (*Canis lupus*) dens in and around the mine survey area.
- Aerial quadrant surveys to estimate the moose population in the mine and transportation corridor survey area.
- Aerial survey of beaver (*Castor canadensis*) colonies throughout the mine survey area.

Analysis of ADF&G's radio telemetry data for the Mulchatna caribou herd involved a detailed fixed-kernel analysis (a statistical method using spatial data for a defined area to estimate the relative density of use of that area by a species) of 29 years of radio transmitter and satellite collar data. The data included 12,198 locations of radio-collared caribou representing a range of age and sex classes across the years. The fixed-kernel distributions for radio-collared caribou locations were analyzed using geographic information system software, with the output mapping represented by utilization-distribution contours of different-intensity colors (Rodgers et al. 2007). The high-density contour encompassed 50 percent of all collar locations; the moderate-density contour enclosed 75 percent of all collar locations; and the low-density contour enclosed 95 percent of all locations.

A series of aerial strip-transect surveys were flown to coincide with seasonal timing to detect late-winter moose and caribou distribution, spring bear locations, caribou and moose calving, caribou post-calving, bear locations along salmon streams, caribou rut, and early winter moose and caribou distribution. Surveys involved a fixed-wing aircraft at low altitude along established transects, with two observers in the aircraft. The complete details of the methods for each survey type, including type of aircraft, count method, sampling method (e.g., quadrate or line/strip transects), and other pertinent details, are provided in ABR 2011a.

Caribou

Caribou inhabit the Arctic and alpine tundra, as well as forested habitats throughout Alaska. At the time of Smith's reconnaissance survey in 1991, during early exploration of the area, the mine area was in a calving and wintering area for the Mulchatna herd, and the valley where the deposit was located was in a known migration route. Between 1981 and 1988, the population of the Mulchatna caribou herd ranged from 20,000 to 60,000 caribou; from 1991 to 1993, the population expanded to 90,000 to 150,000 animals; and from 1994 to 1996, the population was 180,000 to 200,000 animals (Demma 2011). During this time, the Mulchatna caribou herd shifted their traditional calving grounds west and north. By 2008, that number decreased to around 30,000 animals (Woolington 2009); in 2012 and 2013, there were 22,809 and 18,308 caribou estimated, respectively (Barten 2015). The most recent survey data from July 2, 2014 yielded a population estimate of 26,275 caribou in the Mulchatna herd (Butler 2015). The downward trend in the Mulchatna caribou herd from historical high numbers in the 1990s is not fully understood. However, based on traditional knowledge of local elders in the region, one potential reason for the decline is that the population grew so large that the caribou herd had limited food, which led to an epidemic of hoof rot, and the herd shifted their range north (Van Lanen 2018).

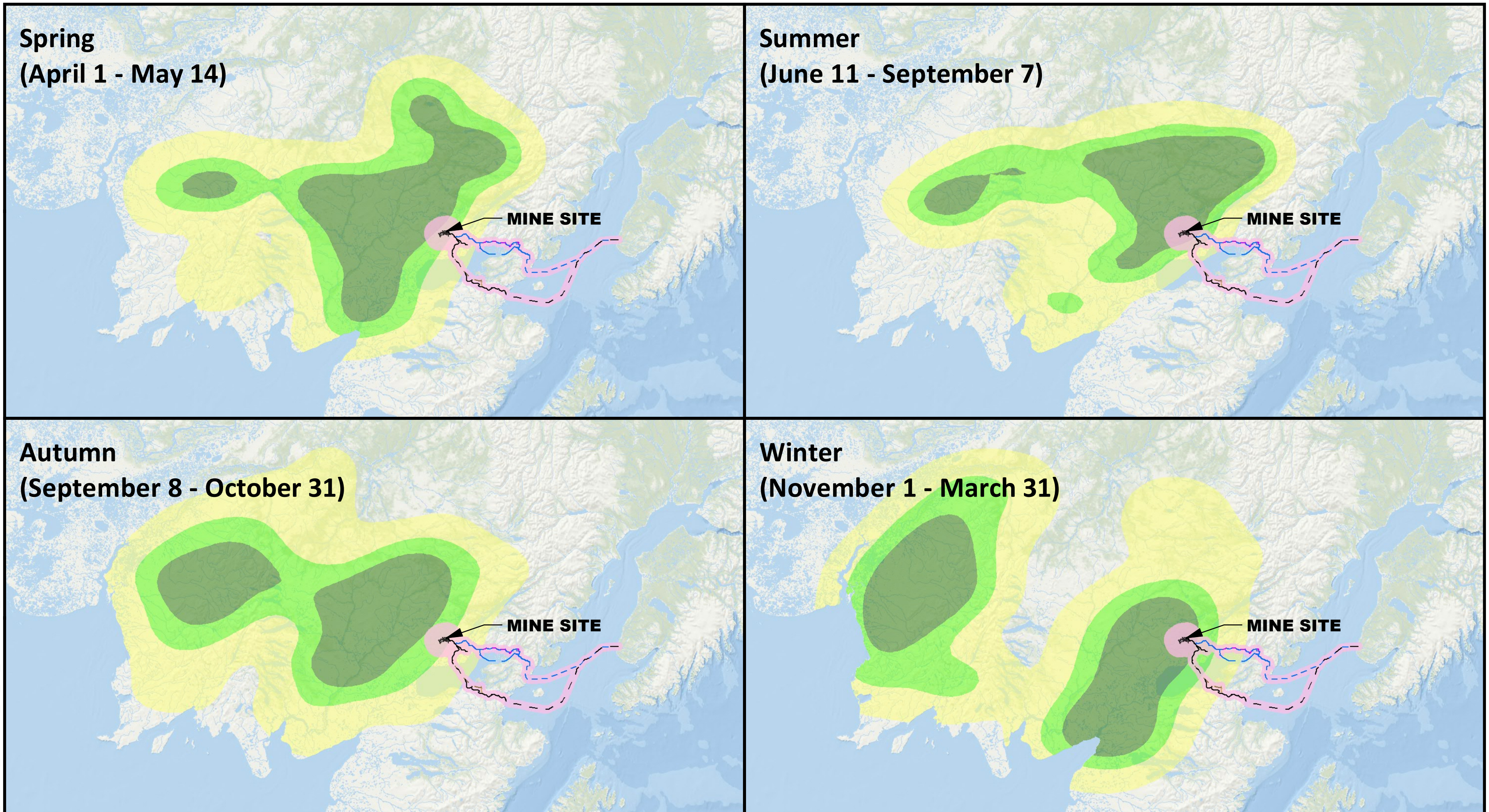
Analysis of telemetry data indicated that between 1993 and 2004, use of the mine area by the Mulchatna caribou herd occurred primarily during the post-calving aggregation period; and to a lesser extent, during the rut (Woolington 2003). Fixed-kernel analysis of the radio-collar data indicate that across 29 years of data, the Mulchatna caribou herd has occurred in moderate to high densities throughout the mine survey area during spring; low density during calving, high density during summer and winter; and moderate density during autumn (Figure 3.23-5). Despite population declines, the herd continues to use a vast area primarily west of the mine survey area. In summary, the area west and northwest of the mine site facilities (as compared to south or east) is currently used by the Mulchatna caribou herd to a greater degree than the mine site footprint itself (Figure 3.23-5). These data were derived from a subset of the Mulchatna caribou herd that was radio-collared, and they do not necessarily reflect the distribution of the entire herd, but are meant to represent the core of the herd (since radio-collaring efforts often target the core of the herd).

Aerial transect surveys of the mine survey area in 2004, 2006, and 2007 confirmed the Mulchatna caribou herd telemetry analysis, in that the greatest numbers of caribou were found in the mine survey area during the summer post-calving period (Figure 3.23-6). Incidental observations of caribou during other biological surveys for the project revealed small groups of caribou scattered throughout the mine survey area in June 2004 and 2005. During post-calving surveys in July 2004, close to 10,000 caribou were observed in the mine survey area moving southwest (ABR 2011a). Historical caribou trails are depicted on Figure 3.23-6, and occur primarily to the west of the mine site. The historical caribou trails often follow local topographical lines. Currently, the mine site does not appear to be used by the majority of the Mulchatna caribou herd for calving (Figure 3.23-7), but may be used by the herd during the post-calving summer period. Figure 3.23-7 depicts the density of calving areas from 1981 to 2010, based on radio-collar data.

Currently, the herd occurs primarily to the north and west of the mine site, with the mine site on the periphery of their annual range. Small groups of caribou that are likely associated with the Mulchatna caribou herd occur in the general vicinity of the mine site throughout the year, based on surveys in 2004 and 2005, but not in large concentrations (ABR 2011a). Observations from local residents in the eastern part of the Mulchatna caribou herd range indicate that habitat conditions are improving in formerly overgrazed areas, and the population appears to be increasing (Van Lanen 2018).

Moose

A moose population survey in April 2010 estimated 33 moose in the 455-square-mile survey area, which corresponds to an estimated density of 0.07 moose per square mile (ABR 2011a). The survey area was larger than for other species because it included a large portion of habitat along the northern shore of Iliamna Lake. The mine site appeared to have a low density of moose; however, the population of moose may be higher in the fall and early winter, when moose use higher-elevation habitats. No moose were recorded directly in the mine site facilities footprint during the April 2010 survey, or during other surveys from 2004 through 2007. This is consistent with the habitat types and vegetation communities in the mine site, which are composed primarily of low-growing tundra plant species that are not the preferred habitat for moose. Moose were sighted in UTC and the drainages surrounding the mine site facilities footprint, which contain preferred vegetative forage and cover.



Sources: PLP 2005, 2018

US Army Corps of Engineers

25 0 25 50
Miles

Areas of Concentrated Use
- High Density
- Medium Density
- Low Density
- Analysis Area

Alternative 1
- Mine Site
- Transportation Corridor
- Natural Gas Pipeline

Alternative 2
- Transportation Corridor
- Ferry Route

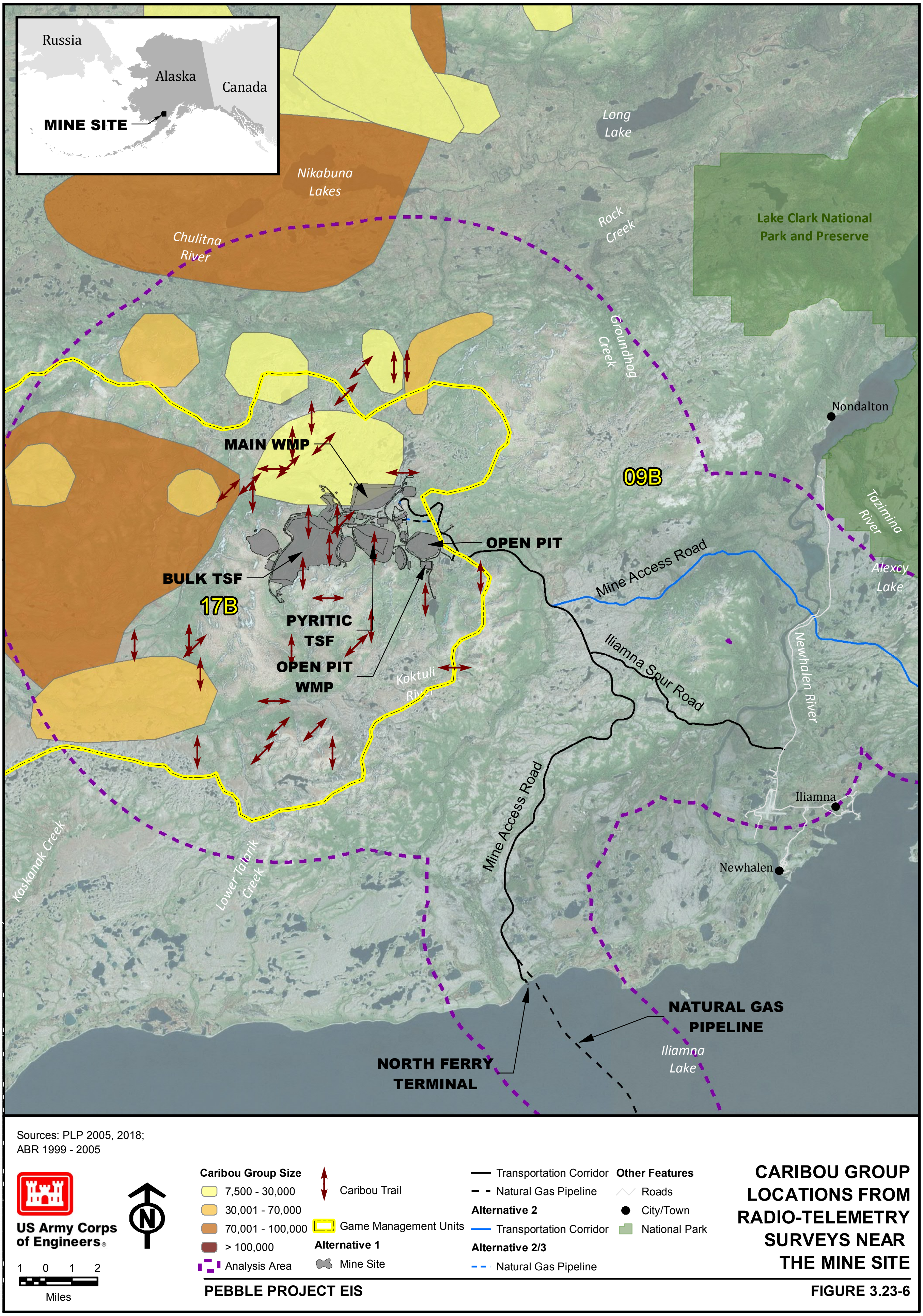
Alternative 2/3
- Natural Gas Pipeline

Alternative 3
- Transportation Corridor

MULCHATNA CARIBOU HERD SEASONAL RANGE USE SUMMARY OF YEARS 1981 - 2010

PEBBLE PROJECT EIS

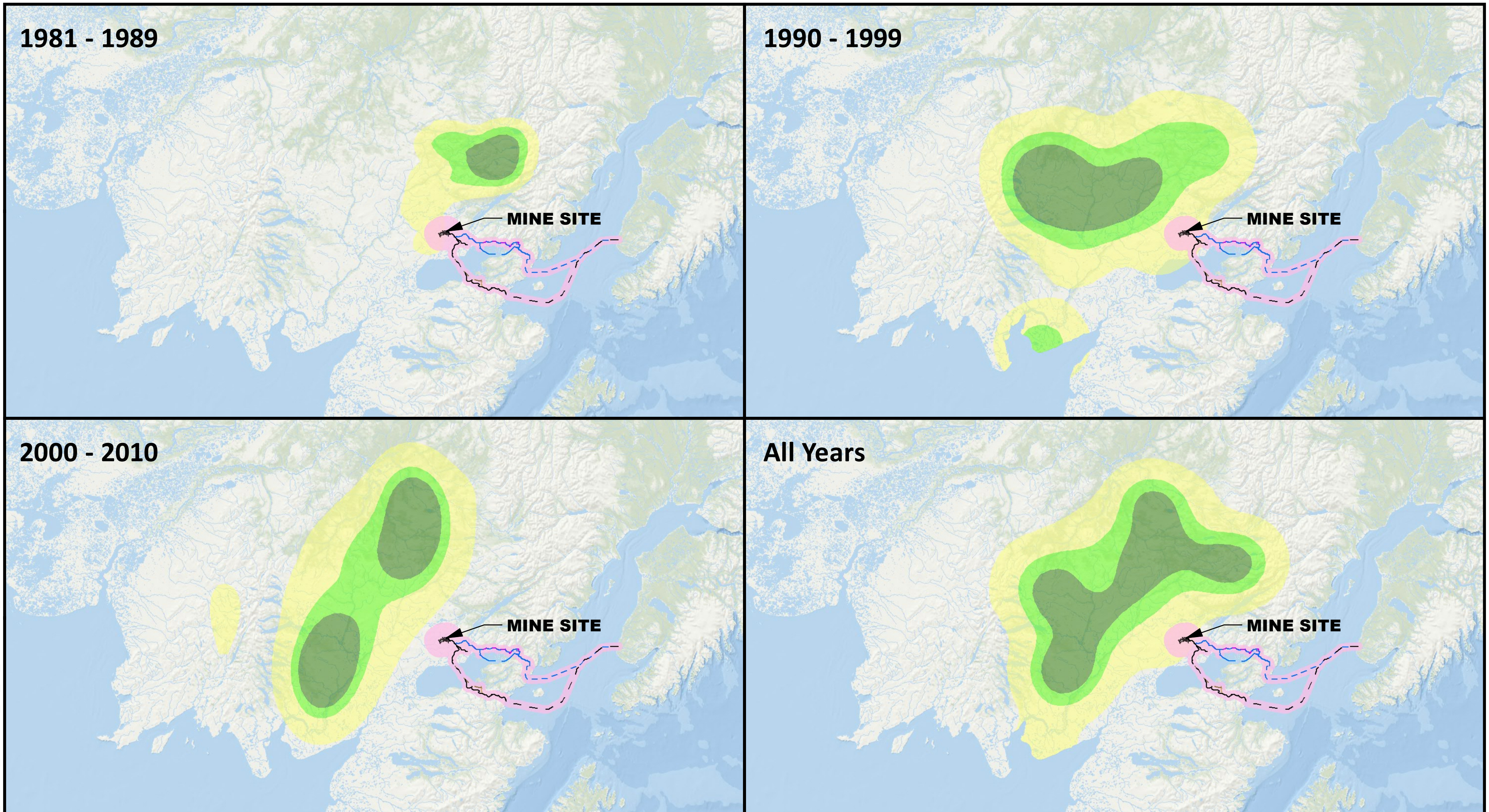
FIGURE 3.23-5



CARIBOU GROUP LOCATIONS FROM RADIO-TELEMETRY SURVEYS NEAR THE MINE SITE

PEBBLE PROJECT EIS

FIGURE 3.23-6



Sources: PLP 2005, 2018

US Army Corps of Engineers

25 0 25 50
Miles

Areas of Concentrated Use
- High Density
- Medium Density
- Low Density
- Analysis Area

Alternative 1
- Mine Site
- Transportation Corridor
- Natural Gas Pipeline

Alternative 2
- Transportation Corridor
- Ferry Route

Alternative 2/3
- Natural Gas Pipeline

Alternative 3
- Transportation Corridor

MULCHATNA CARIBOU HERD SEASONAL RANGE USE, CALVING 1981 - 2010

PEBBLE PROJECT EIS

FIGURE 3.23-7

Brown Bear

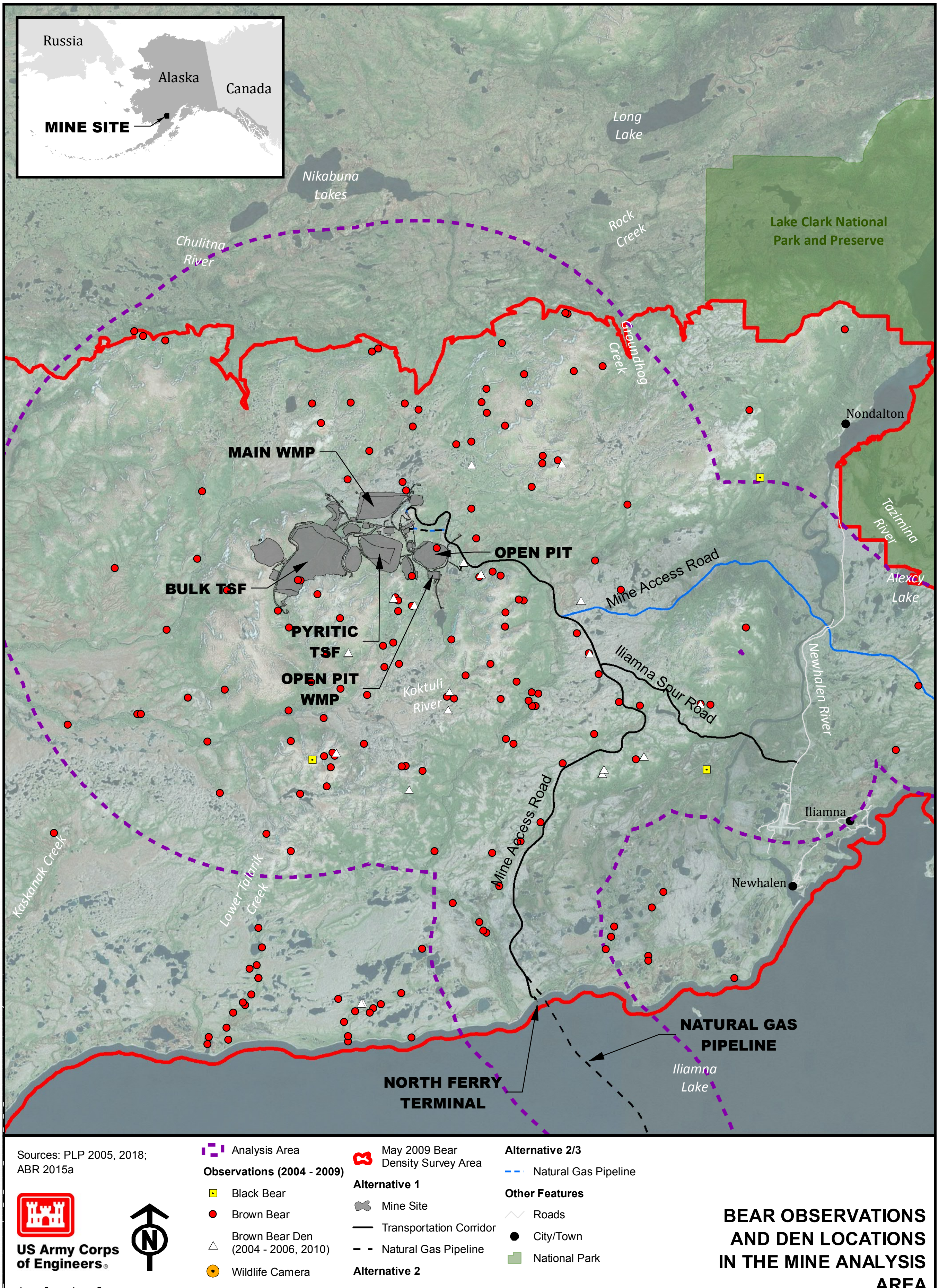
Brown bears are widespread and common in the Bristol Bay and Cook Inlet drainages, primarily because of large salmon runs that provide an abundant source of protein. Brown bears are relatively common tundra inhabitants in the mine survey area (Figure 3.23-8) (ABR 2011a). Standardized surveys specifically for the mine site were conducted in 2009 by ABR and the ADF&G (Becker 2010). Aerial line-transect surveys flown in May 2009 used two similar analytical methods to determine the density of brown bears in the survey area surrounding the mine site, which included all of Iliamna Lake (which overlaps with the transportation and natural gas pipeline corridors). One analytical method (double-count method) resulted in a population density of 47.7 brown bears per 386 square miles (Becker 2010), and the second method (using the plane model) resulted in 58.3 brown bears per 386 square miles (ABR 2011a). Using the double-count method, the survey area supported approximately 412 brown bears. Per Becker (2010), the estimate of 47.7 brown bears per 386 square miles is similar to brown bear population estimates for other nearby areas. Surveys north of the Iliamna survey area around Lake Clark National Park and Preserve in 1999 and 2000 (Becker 2003; Butler 2007a) yielded estimates of 38.6 brown bears per 386 square miles, and to the south in GMU 9C (in spring 2005 and 2006), densities were estimated to be 78.4 brown bears per 386 square miles (Olson and Putera 2007). Overall, brown bears were not common in the mine site footprint itself, but were distributed throughout the mine survey area, primarily along streams and waterways.

Helicopter surveys of salmon-spawning streams around the mine site on August 18 and 19, 2004 recorded 16 brown bears mainly 9 to 18 miles south and southeast of the mine site. Dense vegetation along streams limited visibility, and therefore the number of bears reported is likely under-estimated. The survey area included the NFK and SFK rivers, and the mine survey area south to Iliamna Lake and east to the Newhalen River (ABR 2011a). More-recent surveys of bear use at select salmon-spawning streams from July to September 2012 used timelapse remote-sensor wildlife cameras positioned at one location in UTC (Figure 3.23-8). Overall, low bear activity was recorded (0.03 percent of useable photographs contained bears), with most activity in the late afternoon in July and August. No bears were recorded during September. Bears spent little time fishing at the location visible to the camera (ABR 2015a).

Surveys of bear dens and incidentally detected brown bear dens (during other biological surveys) from 2004 through 2006 indicated suitable denning habitat was common in the mine survey area, and dens were generally found in low-elevation wooded sites and high-elevation scree slopes. Brown bear dens were not found in the mine site footprint.

Black Bear

Black bears (*Ursus americanus*) are uncommon in forested areas around the mine site, and tend to be more common on the eastern side of Iliamna Lake. Black bears were not observed in the mine survey area during project wildlife surveys in 2004 through 2007 (Figure 3.23-8). During regional surveys in May 2009, which encompassed the mine survey area and Iliamna Lake, black bears were found in more forested habitats (which are lacking in the mine survey area) on the eastern side of Iliamna Lake. During the survey, which covered 1,004 12.4-mile-long transects, only 18 black bear groups were observed. Given the intensive survey effort and scarcity of black bear sightings, abundance estimates were not developed. Black bears were almost absent from the survey area in spring 2009 (Becker 2010).



BEAR OBSERVATIONS AND DEN LOCATIONS IN THE MINE ANALYSIS AREA

Gray Wolf

Wolves are generalist species found and able to thrive in a wide variety of habitats, whose main prey items in the northern Bristol Bay region include moose, caribou, and beaver (Woolington 2006), and salmon seasonally, among other items. Several individual wolves were detected scattered across the mine site over multiple years, but no packs or groups of wolves were detected (ABR 2011a). Three wolf dens were found during bear den surveys and during other biological surveys (one in UTC, one at the base of Sharp Mountain, and one on the eastern side of the Newhalen River), but none appeared to be active (ABR 2011a).

Currently, the ADF&G has an intensive caribou management plan for the Mulchatna caribou herd involving wolf predation control (ADF&G 2014). The wolf control area is west and southwest of the EIS analysis area. In 2017, ADF&G conducted a study to map wolf pack territories in the intensive management area for the Mulchatna caribou herd using global positioning system (GPS) collars (ADF&G 2018r). Preliminary density estimates, based on seven months of GPS data and observed seasonal pack sizes, resulted in spring and fall wolf densities of 2.2 and 3.0 wolves, respectively, per 386 square miles in the Mulchatna and lower Nushagak River drainages (ADF&G 2018r).

Small Terrestrial Vertebrates

No project-specific surveys were conducted for small mammal species, but they were incidentally recorded during biological surveys in the EIS analysis area. Some species are managed by the ADF&G as “furbearers,” which are trapped or hunted for hides, fur, or meat. Population information for these species is limited to trapper questionnaires (Parr 2018). Trapper questionnaires provide relative abundance information for the region based on perceptions and responses from relatively few trappers. Table 3.23-2 lists species with their relative abundance, if known, based on the limited information from trapper questionnaires for GMU 17, where the mine site facilities are located; and for GMU 9, where the transportation and natural gas pipeline corridors exist (west of Cook Inlet) (Parr 2018).

Table 3.23-2: Furbearer Species Status

Common Name	Scientific Name	General Habitat	Mine Site (GMU 17[1])	Transportation and Natural Gas Pipeline Corridors (west of Cook Inlet; GMU 9[1])
Coyote	*Canis latrans*	Diverse	scarce	scarce
Red fox	*Vulpes vulpes*	Diverse	abundant	abundant
Arctic fox	*Vulpes lagopus*	Tundra/grassland	not present	scarce
Canadian lynx	*Lynx canadensis*	Forests and shrubs	scarce	common
American marten	*Martes americana*	Conifer and mixed forests	abundant	scarce
American mink	*Mustela vison*	Mixed forests	common	common
Ermine	*Mustela erminea*	Diverse	common	common
River otter	*Lutra canadensis*	Riparian	abundant	common
Wolverine	*Gulo gulo*	Diverse	common	scarce
Beaver	*Castor canadensis*	Wetlands/riparian	abundant	abundant
Muskrat	*Ondatra zibethicus*	Wetlands	common	common

Table 3.23-2: Furbearer Species Status

Common Name	Scientific Name	General Habitat	Mine Site (GMU 17[1])	Transportation and Natural Gas Pipeline Corridors (west of Cook Inlet; GMU 9[1])
Red squirrel	*Tamiasciurus hudsonicus*	Forests	common	abundant

[1]Source: Parr 2018

Of the fur-bearers listed above, only two coyotes were observed in the mine survey area; with red foxes more common, and observed on numerous occasions. Two groups of river otters were detected in the mine survey area in 2005, and two wolverines were incidentally detected in the mine survey area during avian surveys in 2004 and 2005. Aerial surveys for beaver colonies were conducted in October 2005, and recorded 113 active colonies in the mine survey area. Active colonies were also found along UTC, and in both NFK and SFK rivers, as well as isolated tundra ponds. The locations of these species in relation to the mine site are shown on figures in ABR 2011a.

There are additional mammal species that are not considered “furbearers,” and are known to occur in the mine survey area, as detailed in ABR 2011a. These include hoary marmot (*Marmota caligata*), arctic ground squirrel (*Spermophilus parryii*), snowshoe hare (*Lepus americanus*), Alaska hare (*Lepus othus*), collared pika (*Ochotona collaris*), and various species of mice, lemmings, shrews, and voles. These species are generally common to abundant, depending on their population cycles.

Wood Frog

The wood frog is the most widely distributed amphibian in Alaska, ranging from the mainland of southeast Alaska north to the Brooks Range, and is the sole amphibian found north of Prince William Sound (ADF&G 2015b). Wood frogs breed virtually anywhere that has standing water for at least part of the summer, including ponds, bogs, marshes, temporary pools, tire tracks, or roadside ditches. However, specific studies have shown that the highest breeding activity is in waters from about 1 to 7 feet deep (ABR 2011a). The waterbodies must remain long enough for the tadpoles to mature and metamorphose. Another important habitat factor is vegetation nearby for hibernating (typically, forest vegetation with enough dead leaves and duff covering the ground to form suitable hibernating sites).

The ADF&G has a wood frog monitoring program, with the goal of assessing the current status of wood frogs in Alaska (ADF&G 2018i). Therefore, wood frog studies were conducted in 2007 by ABR to determine their occupancy and distribution in the mine survey area, as detailed below.

Occupancy surveys for wood frogs were conducted in the mine survey area in 2007 to determine their distribution and rate of occupancy for waterbodies in the mine survey area, and to describe the important habitat characteristics associated with breeding waterbodies. ABR conducted ground-based surveys in May 2007, in which 119 randomly selected waterbodies (out of 1,668 potential waterbodies) were sampled for wood frogs. Surveys were conducted by passive listening for vocalizing male wood frogs from these preselected waterbodies at locations spaced around each waterbody, following standard amphibian-calling survey protocols, with slight modifications for time of day (USGS 2005). The sampling design involved a repeat survey for each waterbody (2 to 4 days apart) during peak breeding.

Wood frogs were detected at waterbodies throughout the mine survey area, and the occupancy rate of wood frogs breeding in the mine survey area was estimated at approximately 50 percent of all waterbodies surveyed (ABR 2011a). In the mine site facilities, several waterbodies contained wood frogs. Deep waterbodies, greater than 5 feet deep, were 10 times more likely to be occupied by wood frogs than waterbodies less than 5 feet deep. Wood frogs seemed to prefer waterbodies with herbaceous, low shrub shoreline vegetation and aquatic vegetation.

3.23.1.2 Transportation Corridor and Natural Gas Pipeline Corridor

Terrestrial wildlife resources along the transportation and natural gas pipeline corridors from the mine site to the Kenai Peninsula in the EIS analysis area are described below. The EIS analysis area includes the transportation and natural gas pipeline corridor, plus a surrounding 1- or 3-mile-radius buffer, depending on the resource. For most species, a 3-mile-radius buffer was used (apart from waterbirds, and landbirds and shorebirds, where a 1-mile-radius buffer was used).

As detailed in Chapter 2, Alternatives Including Applicant's Proposed Alternative, the portion of the natural gas pipeline corridor that occurs on the Kenai Peninsula would be trenched into the ground (via horizontal directional drilling), tie into an existing pipeline near Anchor Point, and connect to a compressor station constructed on private land. Wildlife resources in the area are representative of the wildlife in the region, including brown and black bears, moose, and smaller terrestrial wildlife. There are no adjacent anadromous streams, and the area is currently bisected by the Sterling Highway, with several residences nearby.

The portion of the transportation and natural gas pipeline corridors from the mine site south to the north ferry terminal (mine access road) was previously surveyed as part of the mine survey area. The methods used for biological surveys for this portion of the transportation and natural gas pipeline corridors are the same methods used for the mine survey area, and are not repeated in the individual sections below. Surveys were conducted by ABR in spring, summer, and fall 2018 along the port access road from the south ferry terminal to Amakdedori port. The survey methodologies and results are included below.

Birds

In general, many of the same species that were documented in the mine survey area also occur along the transportation and natural gas pipeline corridors. The main difference is that portions of the corridor on the northern side of Iliamna Lake and south of the mine site tend to lack the high-elevation alpine tundra habitats that characterize the mine site, and the corridor includes a greater portion of lowland marsh, meadows, scrub, and boreal forest habitat types. This is reflected in a transition of avian species where obligate-tundra nesting species are less common, and species that prefer more scrub and forested habitat types are more common, as detailed in the following sections. However, the port access road is similar in habitat types and vegetation communities to the mine site, with similar bird species composition.

Raptors

Raptor data along the mine access road was collected by ABR during surveys in 2004 and 2005, and are included in the mine site section above, and shown on Figure 3.23-1. The main species documented along the mine access road include bald eagles along UTC, osprey, and cliff-nesting raptors such as gyrfalcons and rough-legged hawks. Based on surveys in 2004 and 2005, bald eagles were the major raptor species nesting in trees along the Newhalen River. On the hills and bluffs to the west of the Newhalen River were several cliff-nesting species, including golden eagle, gyrfalcon, rough-legged hawk, and common ravens (Figure 3.23-1). Several of these nests are in close proximity to the mine access road. One bald eagle nest was less than 0.5 mile from the Iliamna spur road.

Project-specific raptor surveys were also conducted in summer 2018, but for areas south of Iliamna Lake along the port access road, bald eagles were the most commonly detected nesting raptor species, followed by golden eagles (Figure 3.23-9). Overall, there were few nests along the port access road due to a lack of large trees and limited cliff habitat. Several nests were on the northern and southern sides of Gibraltar Lake, with additional nests clustered along the coastal bluff around Cook Inlet. The closest golden eagle nest was approximately 0.2 mile north of the port access road, near one of the proposed material sites. The nest was not active in 2018, but may be active in the future. The closest bald eagle nest was 0.3 mile north of the Kokhanok east spur road, and the nest was active in 2018 (Figure 3.23-9). Overall, most raptor nests were over 0.5 mile away from the port access road, but at least eight bald and golden eagle nests were within 1 mile of the road or a material site.

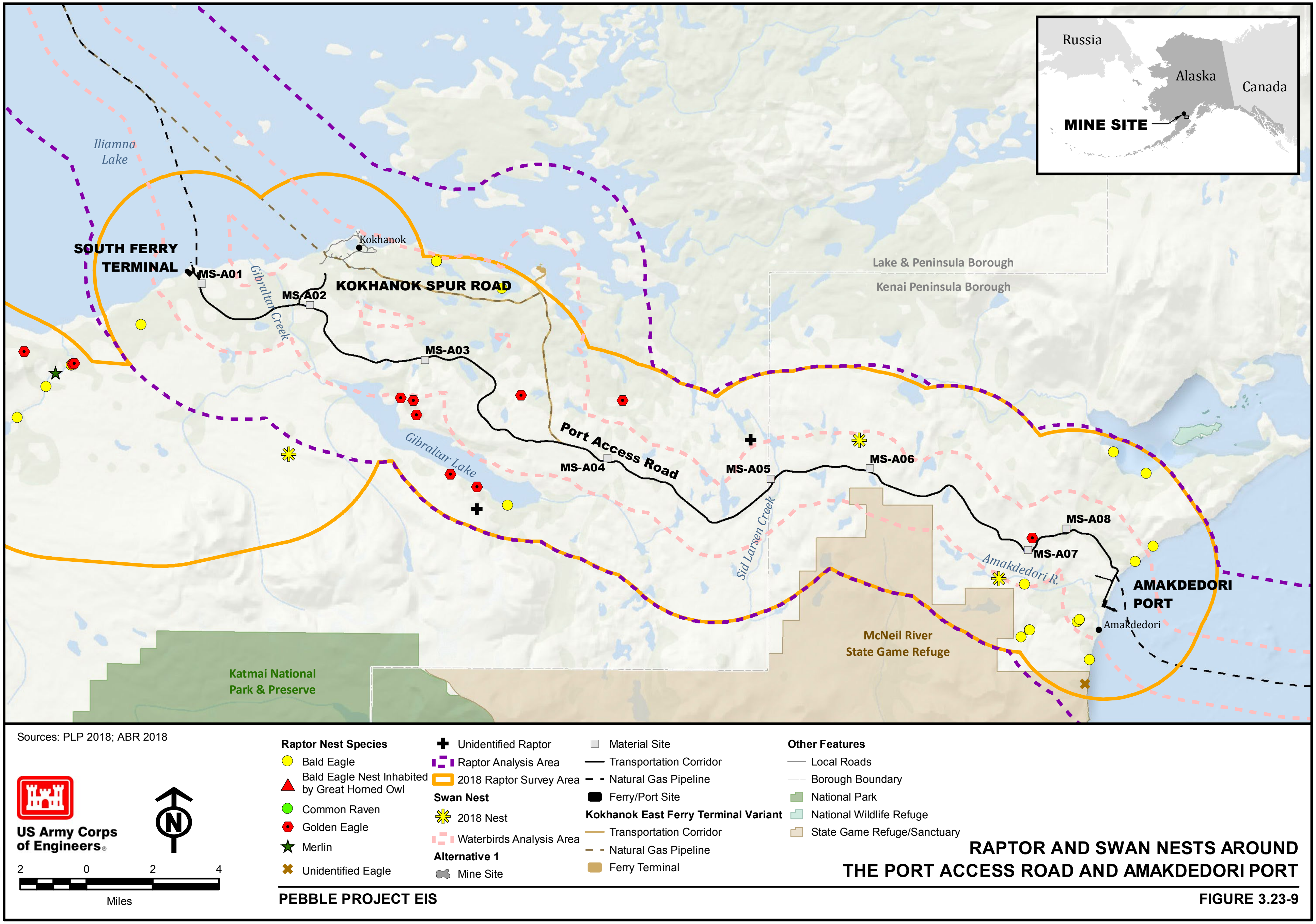
Waterbirds

This section details the waterbirds present in the transportation and natural gas pipeline corridor for areas outside of the mine survey area (which are discussed above). This includes the area east of the mine survey area along the Newhalen River, along the Iliamna spur road, the port access road, Kokhanok east spur road, and the waterbirds present along the natural gas pipeline corridor through Cook Inlet. There is overlap between the waterbirds present at Amakdedori port (discussed in a subsequent section below) and the waterbirds along the natural gas pipeline corridor in Cook Inlet. Seabirds are a subset of waterbirds that are discussed in this section, and include seabird colonies that occur around the natural gas pipeline analysis area (which has a 1-mile-radius buffer around the pipeline), and seabird colonies around the lightering locations.

Waterbird data north of Iliamna Lake were collected in 2004 and 2005 during surveys in the mine survey area, and are described above under the mine site. This section details waterbird distribution and abundance along the Newhalen River near the Iliamna spur road, based on surveys conducted by ABR in 2004 and 2005 (ABR 2011a), as well as data from 2018 surveys along the port access road (ABR 2018b-h). No offshore waterbird surveys have specifically been conducted for the project in Cook Inlet along the natural gas pipeline corridor; however, existing data for Cook Inlet are used as the basis for the existing conditions along the natural gas pipeline corridor.

For surveys conducted in 2004 and 2005, the timing of waterbird migration in spring and fall was similar to the mine survey area, with similar species detected. During spring, the highest concentrations of swans, geese, and ducks were found in an area of the Newhalen River known as Three-mile Lake (Figure 3.23-2). During fall migration, concentrations of waterbirds occurred at many of the same locations as in spring (Figure 3.23-3). No groups of swans or geese were observed staging in the area during fall; only brood-rearing groups and adult swans as singles and pairs. Thousands of ducks and gulls were recorded during fall surveys, with duck abundance remaining high from mid-August to mid-October, and gull abundance peaking in mid- to late-September. The northern part of Iliamna Lake (near creek outflows) also supports large concentrations of staging and migrating waterbirds. Waterfowl breeding density was estimated at 31.6 birds per square mile in 2004, and 17.6 birds per square mile in 2005.

Waterbird data for the port access road were collected in spring (April and May) and fall (September and October) 2018 (ABR 2018g, 2018h). All waterbodies greater than 5 acres in size and selected rivers and streams within a 1-mile buffer around the port access road were surveyed, in addition to smaller waterbodies in the corridor (ABR 2018g, 2018h).



Sources: PLP 2018; ABR 2018

RAPTOR AND SWAN NESTS AROUND THE PORT ACCESS ROAD AND AMAKDEDORI PORT

PEBBLE PROJECT EIS

FIGURE 3.23-9

Surveys from the end of April and May 2018 in a 1-mile buffer of the port access road documented 598 birds of 17 species, with an additional seven unidentified species groups (loons, swans, etc.). The most common species with 50 or more individuals detected (in descending order of abundance) were unidentified scaup, northern pintail, mallard, and red-breasted merganser.

Based on the early September and October 2018 surveys, approximately 647 waterbirds from at least 13 species (plus nine unidentified species groups) were detected in the surveyed area. The main species detected with 50 or more individuals (in descending order of abundance) were glaucous-winged gull (*Larus glaucescens*), unidentified gull, mallard, and unidentified scaup (ABR 2018g, 2018h). Waterbirds were sparse directly along the port access road, because it occurs at high elevation with rocky ponds and little vegetation. Waterbirds were more common around rivers, streams, and waterbodies at lower elevations around Iliamna Lake and Cook Inlet.

Waterbird data in Kamishak Bay and along the natural gas pipeline corridor were also incidentally collected during marine-based field surveys from March through July 2018 (ABR 2018b-f). No transects or systematic sampling techniques were used; therefore, density estimates were not determined. Within a 3-mile radius of Amakdedori port, the main species detected with more than 50 individuals observed were (in decreasing order of abundance): unidentified scoter, surf scoter, harlequin duck, glaucous-winged gull, and pigeon guillemot. The highest numbers of birds were typically recorded in June.

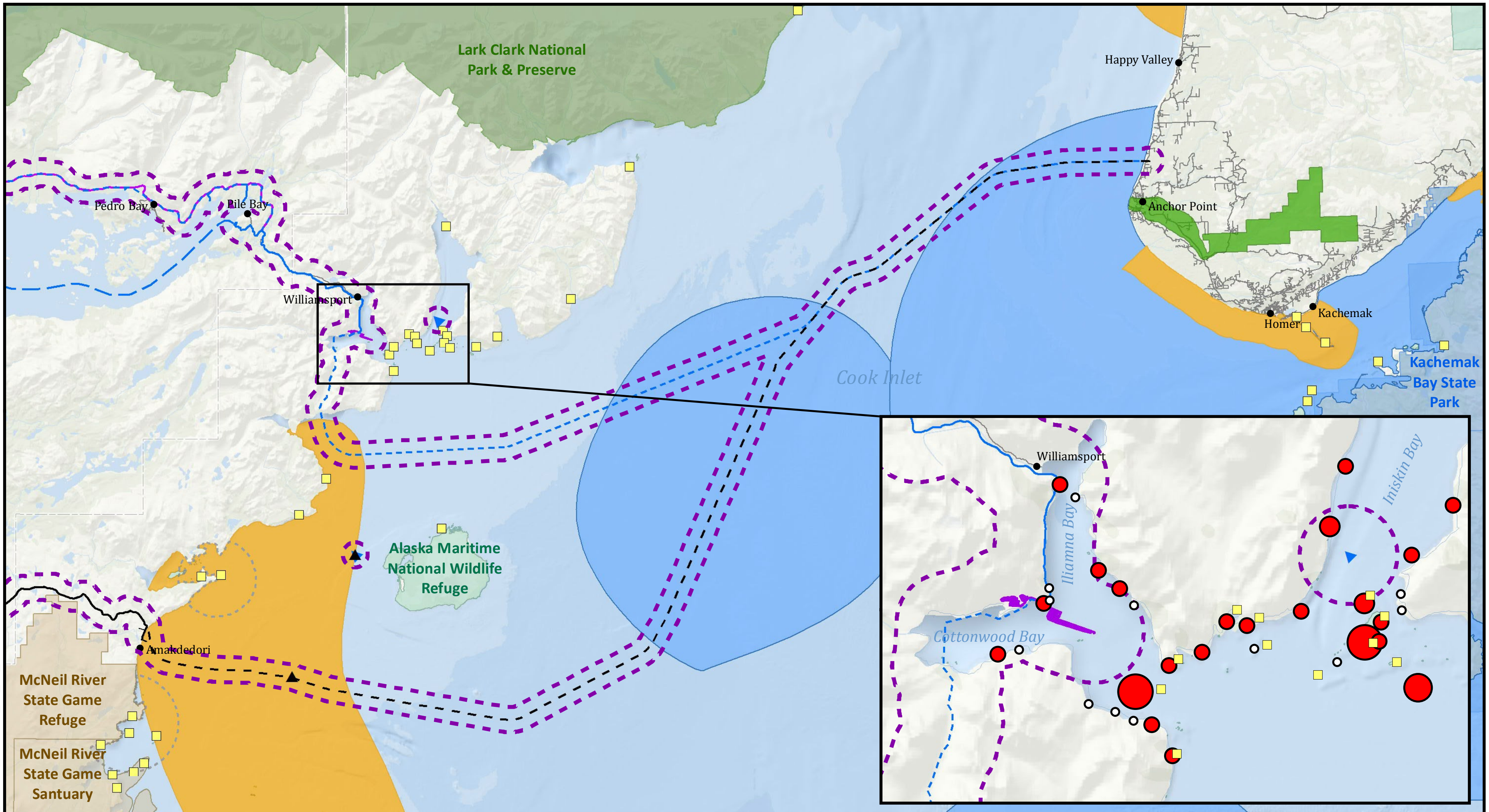
During ABR surveys in spring and summer 2018, low numbers of swans (species not identified) were identified along the port access road (Figure 3.23-9). There was at least one swan nest within 1 mile of the port access road, and an additional nest further away. The species of swan was not identified, but both tundra and trumpeter swans occur in this area of the Alaska Peninsula. Historical trumpeter swan surveys from 2010 and 2015 documented similar densities of trumpeter swans (16 to 30 swans) in the survey area that overlaps with the port access road (Groves and Hodges 2013; Groves 2018). These 2 years show consistency in the number of swans estimated, and indicate that the area has a moderate density of trumpeter swans near the southwestern limit of the species range in Alaska.

In 2004 and 2005, a few pairs of harlequin ducks were found along the Newhalen River during pre-nesting surveys, along with a few broods later in the season. During ABR surveys in 2018, several pairs of harlequin ducks were observed within 3 miles of the port access road in May; however, nesting was not confirmed.

In 2004 and 2005, several common loon broods were detected in lakes in the floodplain of the Newhalen River, with adult birds on several lakes in the vicinity. These were also found on large, deep lakes from early May to late September in 2004 and 2005. No Pacific or red-throated loon (*Gavia stellata*) nests or broods were observed. In 2018, common loons were uncommon along the port access road, primarily in Gibraltar Lake.

In summary, the transportation and natural gas pipeline corridors north of Iliamna Lake do not overlap any areas where large concentrations of waterbirds breed or stage. The Iliamna spur road crosses the Newhalen River several miles south of Three-mile Lake, where the majority of waterbirds are found. The northern part of Iliamna Lake (near creek outflows) also supports large concentrations of staging and migrating waterbirds. Waterfowl breeding density was estimated at 31.6 birds per square mile in 2004, and 17.6 birds per square mile in 2005. The natural gas pipeline corridor traverses lower Cook Inlet, which is an important nesting, wintering, molting, and migrating area for a variety of seabirds. The most recent seabird surveys were conducted by the Bureau of Ocean Energy Management from 2012 through 2016 to document the seasonality of seabird distribution in lower Cook Inlet (Renner et al. 2017). Surveys were conducted from a boat traveling established transects at different times of the year across lower Cook Inlet. Overall, the total marine bird densities were high in winter, spring, and summer; and half as abundant during the fall. Densities were higher on the eastern side of Cook Inlet, especially in the shallow waters close to shore. The most common species were white-winged scoter (*Melanitta deglandi*); common murre (*Uria aalge*), observed year-round; black-legged kittiwake (*Rissa tridactyla*), observed in summer; red-necked phalarope (*Phalaropus lobatus*), observed in spring; and sooty shearwater (*Ardenna grisea*), observed in summer and fall. White-winged scoter was the most abundant marine bird across all seasons, with the highest numbers during winter. High concentrations were located north of Augustine Island near Ursus Cove in Kamishak Bay (Renner et al. 2017). Specifically, in the EIS analysis area for the natural gas pipeline corridor, there are no seabird colonies within a 1-mile-radius buffer (Figure 3.23-10). Several seabird colonies along the western portion of lower Cook Inlet are located around Amakdedori port, and are discussed in the port section below.

Additional waterbirds that occur in lower Cook Inlet include Kittlitz's murrelet (*Brachyramphus brevirostris*) and marbled murrelet (*Brachyramphus marmoratus*). These species occur throughout most of the length of the natural gas pipeline corridor, with a lower distribution along the western side of lower Cook Inlet (Piatt et al. 2007). The most recent at-sea surveys in lower Cook Inlet estimated a population of over 29,000 marbled murrelets, which is roughly 4 percent of the world population of the species (Piatt et al. 2007). Lower Cook Inlet is one of the three main areas where marbled murrelets are concentrated during the breeding season. Marbled murrelets breed and winter in lower Cook Inlet, with the highest densities in early May. One marbled murrelet was detected in the EIS analysis area during surveys by ABR in 2018 in the area around the port. Low numbers of marbled murrelets have been detected in Kamishak Bay during June 1993 surveys of lower Cook Inlet (Kuletz et al. 2011). Although no Kittlitz's murrelets have been detected in the area around Amakdedori port, based on ABR surveys in 2018, low numbers have been detected in the vicinity of the EIS analysis area along the natural gas pipeline corridor (Kuletz et al. 2011). Kittlitz's murrelets are more abundant on the eastern side of Cook Inlet and around Douglas River Shoals. Surveys in 1993 indicate that a minimum of 2,950, or about 5 to 9 percent of the world population of Kittlitz's murrelets, occur in lower Cook Inlet (Kuletz et al. 2011).



Sources: PLP 2018; North Pacific Seabird Data Portal accessed 2019

US Army Corps of Engineers®

5 0 5 10
Miles

2012 Seabird Colony Size
- 0
- 1 - 20
- 21 - 50
- 51 - 100
- 350 - 374

Seabird Colonies
Analysis Area

Audubon Important Bird Area Type
- Coastal
- Colony
- Interior
- Marine

Alternative 1
- Lightering Locations
- Transportation Corridor
- Natural Gas Pipeline
- Ferry/Port Site

Alternative 2
- Transportation Corridor
- Ferry Route

Ferry Site

Alternative 2/3
- Lightering Location
- Natural Gas Pipeline
- Port Site

Alternative 3
- Transportation Corridor

Other Features
- Local Roads
- Borough Boundary
- National Park
- National Wildlife Refuge
- State Game Refuge/Sanctuary

PEBBLE PROJECT EIS

SEABIRD COLONIES IN PROXIMITY TO THE EIS ANALYSIS AREA

FIGURE 3.23-10

Landbirds and Shorebirds

Landbird and shorebird surveys were conducted in 2005 for the Alternative 2 transportation corridor, but a small portion of this corridor overlaps with the proposed corridor where the Iliamna spur road connects to the existing road heading south to the town of Iliamna. The point-count survey methods for conducting landbird and shorebird surveys are detailed above. The survey area for the transportation corridor in 2005 was 2,000 feet wide, and extended from the mine site along the northern side of Iliamna Lake to the Cook Inlet. Only the portion that overlaps with the Iliamna spur road is discussed herein. In this section of the EIS analysis area, 15 point counts (all around the Newhalen River) were conducted in June 2005. Additional point counts were on the eastern side of the Newhalen River near the base of Roadhouse Mountain, but these were considered to be outside of the proposed transportation and natural gas pipeline corridors. The wildlife habitats east of the mine site in the transportation and natural gas pipeline corridors include a large percentage of Upland and Lowland Spruce and Moist Mixed Forest. These wildlife habitats support a slightly different assemblage of bird species that are more dependent on forested habitats. Ten landbird species were considered abundant in the area, and include Wilson's warbler, orange-crowed warbler, Swainson's thrush (*Catharus ustulatus*), yellow-rumped warbler (*Setophaga coronata*), golden-crowned sparrow, dark-eyed junco (*Junco hyemalis*), ruby-crowned kinglet (*Regulus calendula*), American robin (*Turdus migratorius*), varied thrush (*Ixoreus naevius*), and hermit thrush (*Catharus guttatus*); with Wilson's warbler, orange-crowned warbler, and Swainson's thrush being the most abundant. The two most frequently observed common breeding shorebirds were greater yellowlegs and Wilson's snipe. Upland and Lowland Moist Mixed Forest, Upland and Lowland Spruce Forest, and Riverine Moist Mixed Forest had the highest numbers of breeding landbird and shorebird species.

The vegetation around the south ferry terminal and around Kokhanok is similar to the vegetation along the Iliamna spur road, and includes scattered sections of forest interspersed with types of low and tall shrubs. Avian species composition is similar to birds found on the northern side of Iliamna Lake. However, a large portion of the port access road south of Kokhanok consists of rocky terrain with low-growing tundra vegetation interspersed with small ponds. This habitat is similar and adjacent to the montane areas of Katmai National Park and Preserve. From 2004 to 2006, the National Park Service (NPS) conducted an inventory and monitoring program to document bird species in montane regions of Katmai National Park and Preserve and Lake Clark National Park and Preserve (Ruthrauff et al. 2007). Both Katmai National Park and Preserve and the port access road are in the Alaska Peninsula ecoregion. From late May to early June 2004 through 2006, biologists conducted avian counts at sample plots across both national parks. The most commonly detected species were golden-crowned sparrow, fox sparrow, and American pipit (*Anthus rubescens*). High-elevation sites (those most similar to the middle portion of the port access road) were composed of a high-percentage cover of dwarf shrub and bare ground habitat. This type of habitat supported species such as rock ptarmigan (*Lagopus muta*), American golden-plover, wandering tattler (*Tringa incana*), surfbird (*Aphriza virgata*), and snow bunting (*Plectrophenax nivalis*).

Species of greatest conservation need in Alaska that were only detected in the transportation and natural gas pipeline corridors (and not in the mine site) include black-backed woodpecker (*Picoides arcticus*), olive-sided flycatcher (*Contopus cooperi*), varied thrush, rusty blackbird (*Euphagus carolinus*), and solitary sandpiper (*Tringa solitaria*). These species, detected in low densities, are associated with coniferous-forested habitats, which are generally lacking in the mine survey area. A list of all species of greatest conservation need in Alaska that were detected in the transportation and natural gas pipeline corridors are included in the Pebble Project Environmental Baseline Data Reports (ABR 2011a-e).

Two avian transect surveys were conducted along the port access road: with one transect west of Amakdedori port; and another one near Kokhanok in June 2018 (ABR 2018i, 2018j). Surveys followed the standardized point-count procedures developed for the statewide Alaska Landbird Monitoring Surveys, and have been adopted for shorebirds (Handel and Cady 2004). The most commonly detected species in decreasing order of abundance were Wilson's warbler, golden-crowned sparrow, savannah sparrow, fox sparrow, orange-crowned warbler, common redpoll, hermit thrush, American robin, gull species, varied thrush, and yellow warbler. Three species of shorebirds were also detected in low numbers: semipalmated plover, greater yellowlegs, and least sandpiper (ABR 2018j). Overall, the seven most common species were an order of magnitude more abundant than the remaining landbird species, and shorebirds were much less abundant (ABR 2018j). Of the 10 most commonly detected landbird species, all except for American robin and gull species are considered either ADF&G at-risk or stewardship species (ADF&G 2015a).

Specific to the portion of the natural gas pipeline corridor on the Kenai Peninsula, the North American Breeding Bird Survey (BBS) includes one survey point along the Anchor River on the western side of the Sterling Highway and it has been monitored for 33 years from 1983 to 2017 (no data for 1985 and 1988; Pardieck et al. 2018). Raw count data totaled across all 33 years indicate these are the ten most common species (listed in order or abundance): orange-crowned warbler, varied thrush, fox sparrow, American robin, hermit thrush, alder flycatcher, ruby-crowned kinglet, Wilson's warbler, golden-crowned sparrow, and yellow-rumped warbler. These ten most common species are generally found in scrub and coniferous forest habitats, which are typical of the vegetation in this portion of the Kenai Peninsula.

The most commonly detected breeding shorebird species at the Anchor River BBS was the Wilson's snipe (Pardieck et al. 2018). Many other shorebird species migrate through and use the habitat around the Anchor River and adjacent intertidal zone during migration. The only shorebird species that remains in the area during winter is the rock sandpiper. Groups of rock sandpipers winter within the Cook Inlet, especially along areas of exposed mudflats in upper Cook Inlet (Ruthrauff et al. 2013).

Terrestrial Mammals

The transportation and natural gas pipeline corridors, including the mine access road, Iliamna spur road, and the northern two-thirds of the port access road, are in GMU 9B. The southern third of the port access road is in GMU 9A. The portion of the natural gas pipeline corridor on the Kenai Peninsula is in GMU 15C. Because the natural gas pipeline would connect below ground to existing infrastructure on the Kenai Peninsula (as detailed in figures in Chapter 2), and is less than 0.5 mile long, a detailed discussion of terrestrial mammals on the Kenai Peninsula is not included here. The natural gas pipeline corridor on the Kenai Peninsula is adjacent to single-family residences, and is not near any stream, creek, or other areas where wildlife may congregate. There are no caribou herds in the immediate vicinity, and common terrestrial mammals on the Kenai Peninsula in this area include moose, bears, and smaller terrestrial vertebrates.

The methods used for biological surveys for this portion of the transportation and natural gas pipeline corridors are the same methods used for the mine survey area, and are not repeated in the individual sections below. Only specific results that relate to the portion of the Iliamna spur road and mine access road are discussed.

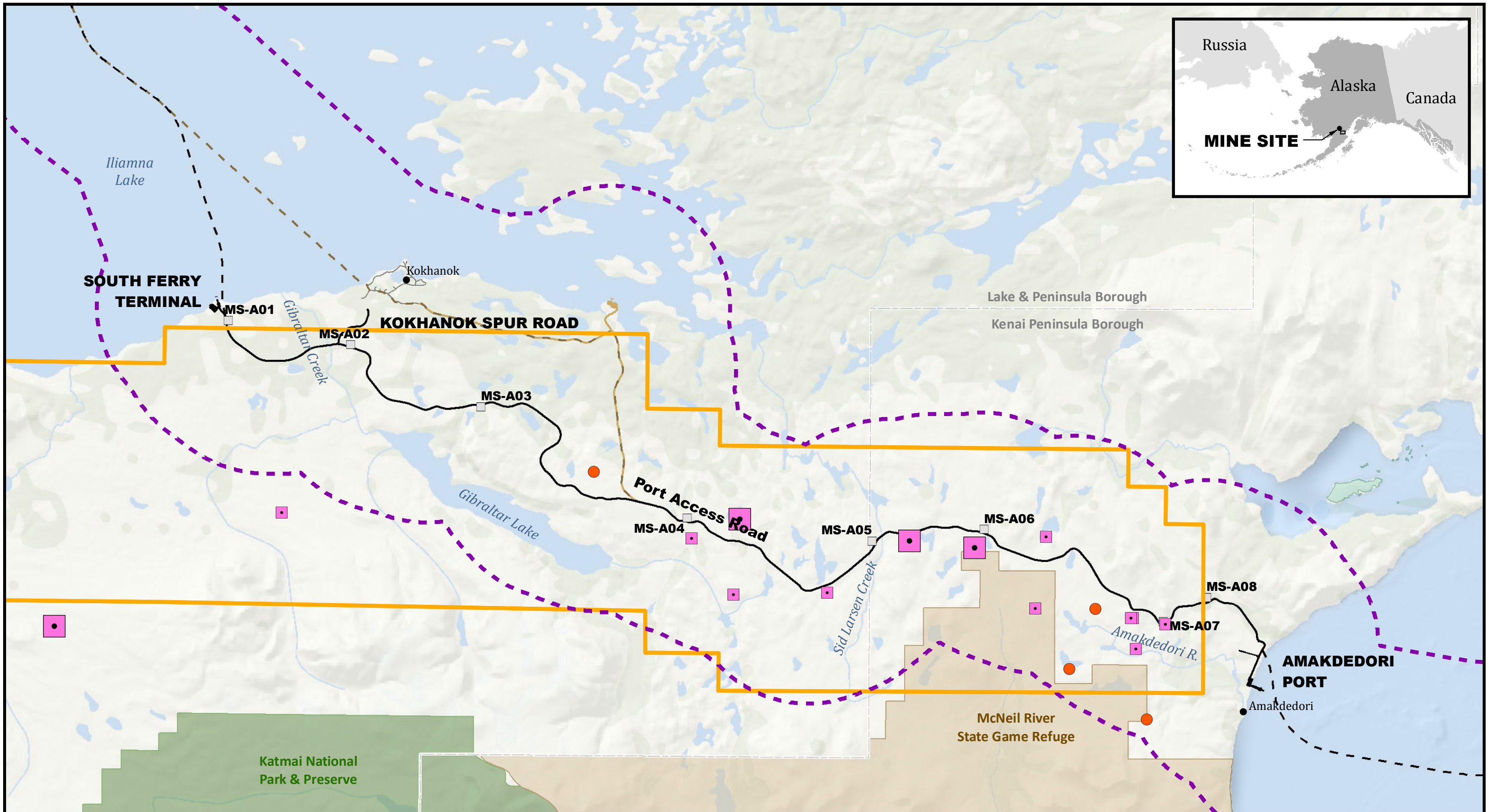
The general vegetation types along the transportation and natural gas pipeline corridors consist of spruce forest and mixed-species forest. This change in vegetation from an open landscape in the mine site to a more closed, forest-dominated landscape in the corridor is reflected in the species type and abundance, as detailed in the following sections.

Large Mammals

The majority of the Mulchatna caribou herd does not typically range in the area of the transportation and natural gas pipeline corridors (Figure 3.23-5). They tend to occur farther north and west, and the 29 years of telemetry data that were analyzed found few instances of caribou in the area covered by the transportation and natural gas pipeline corridors. The Northern Alaska Peninsula caribou herd occurs in GMUs 9E and 9C, with the northern extent of their current range approximately 70 miles south of the transportation and natural gas pipeline corridor around Naknek Lake (ADF&G 2015b). The population of the Northern Alaska Peninsula caribou herd is approximately 2,700 individuals (ADF&G 2015b), and it is possible that the herd may expand its range north in the future. Although there are no designated herds that regularly use the transportation and natural gas pipeline corridor as part of their home range, isolated groups of caribou use the area. Some of these groups may be associated with the Mulchatna caribou herd. According to the ADF&G, localized herds inhabit parts of the transportation and natural gas pipeline corridors, such as a herd in the area south and east of Kokhanok, in the higher country around Kukaklek and Nonvianuk lakes, and east to the Kamishak Bay coast (ADF&G 2018s). Aerial surveys of caribou were conducted during the end of May and early October 2018 along the port access road (ABR 2018m, 2018n). These surveys documented a few individual caribou (usually one or two caribou, with one group of four individuals) between Iliamna Lake and the port, but no large groups or congregations were detected (Figure 3.23-11). Low numbers of caribou were also recorded incidentally during other surveys along the port access road, and are shown on Figure 3.23-11.

Brown bear density estimates from the bear population survey in May 2009 ranged from 47.7 to 58.3 brown bears per 386 square miles (Becker 2010). The area covered by the survey included the southern portion of GMU 9B, plus a small section of the eastern part of GMU 17B. All but one of the black bear sightings occurred east of Nondalton and north of Kokhanok. Therefore, black bears appeared to be more closely tied to forested environments, with brown bears occurring in more open terrain and around salmon streams during periods of salmon spawning. Specific to areas outside the transportation and natural gas pipeline corridors, brown bears were concentrated around the northern portion of Katmai National Park and Preserve, south of Gibraltar Lake (Becker 2010) (Figure 3.23-12).

Surveys conducted by the NPS in May 2003 using an aerial line-transect double-count technique estimated that in GMU 9A, the brown bear density was 150 bears per 386 square miles, with a standard error of +/- 28 bears; and for black bears, the density was 85 +/- 20 bears per 386 square miles. This corresponds to a population of 703 +/- 134 brown bears and 413 +/- 62 black bears in GMU 9A (Olson and Putera 2007). No surveys were conducted in 2003 to determine a density estimate for GMU 9B. The aerial surveys by Becker (2010) included GMU 9B; therefore, in conjunction with the National Park Service survey in 2003 (Olson and Putera 2007) for GMU 9A, the entire transportation and natural gas pipeline corridors has been surveyed. Overall, brown bears were more common along the coast and around the southern part of Iliamna Lake, with black bears more common to the east of Iliamna Lake and areas adjacent to Lake Clark National Park and Preserve.



Sources: PLP 2018; ABR 2018

- Analysis Area

Survey Observations
- 1 - 4 Caribou Observed
- 2018 Survey Area

Incidental Observations
- 1 - 4 Caribou Observed
- 2 - 8 Caribou Observed

Alternative 1
- Mine Site
- Material Site
- Transportation Corridor
- Natural Gas Pipeline
- Ferry/Port Site

Kokhanok East Ferry Terminal Variant
- Transportation Corridor
- Natural Gas Pipeline
- Ferry Terminal

Other Features
- Local Roads
- Borough Boundary
- National Park
- National Wildlife Refuge
- State Game Refuge/Sanctuary

US Army Corps of Engineers

2 0 2 4
Miles

N

CARIBOU OBSERVATIONS AROUND THE PORT ACCESS ROAD AND AMAKDEDORI PORT

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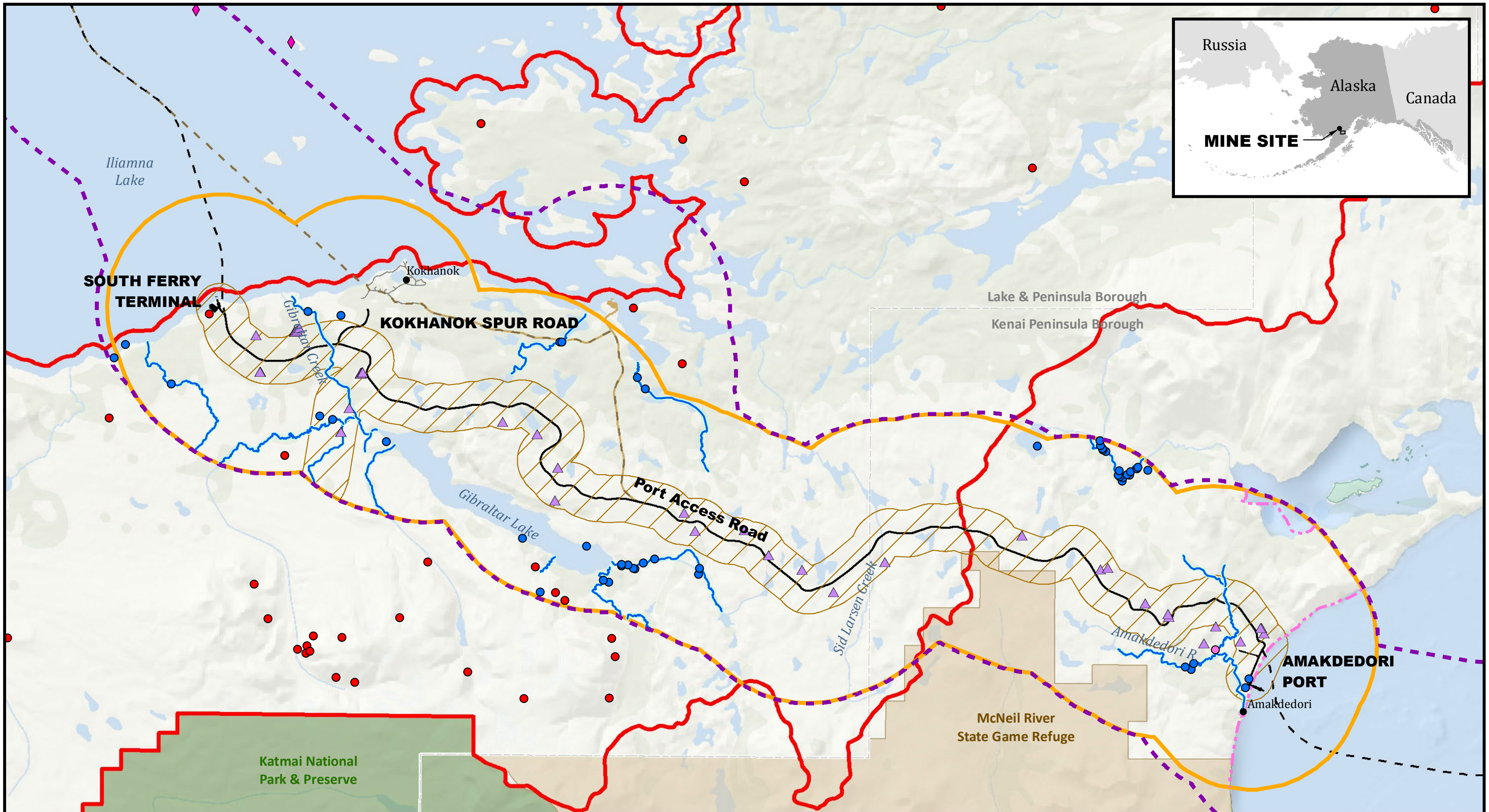
FIGURE 3.23-11



Sources: PLP 2005, 2018

US Army Corps of Engineers

2 0 2 4
Miles

Analysis Area

Observations (2004 - 2009)
- Black Bear
- Brown Bear
- Brown Bear Den (2004 - 2006, 2010)
- May 2009 Bear Density Survey Area

2018 Study
- Brown Bear Salmon Stream
- Brown Bear Coastal
- Brown Bear Den
- Brown Bear Salmon Stream Transect
- Brown Bear Coastal Survey Transect
- Brown Bear Den Survey Area
- Brown Bear Salmon Survey Area

Iliamna Lake Seal
- Haulout Location (2005-2008)

Alternative 1
- Mine Site
- Transportation Corridor
- Natural Gas Pipeline
- Ferry/Port Site

Kokhanok East Ferry Terminal Variant
- Transportation Corridor
- Natural Gas Pipeline
- Ferry Terminal

Other Features
- Local Roads
- Borough Boundary
- National Park
- National Wildlife Refuge
- State Game Refuge/Sanctuary

BEAR OBSERVATIONS, DEN LOCATIONS, AND ILIAMNA LAKE SEAL HAUL-OUTS AROUND THE PORT ACCESS ROAD AND AMAKDEDORI PORT

PEBBLE PROJECT EIS

FIGURE 3.23-12

A series of three surveys for bears was conducted along the port access road in the spring and summer of 2018 (ABR 2018p, 2018k, 2018o). The first aerial surveys were conducted to locate bear dens within 0.6 mile of the port access road, and a separate corridor around the western end of Iliamna Lake. In total, the survey area was 151 square miles. Aerial surveys were flown from April 30 to May 1, 2018, and May 13-16, 2018, to assess den emergence. During these survey windows, snow was largely gone or patchy in the survey area, which limited the ability to track bears. Surveys located 64 bear dens throughout the survey area, but only a portion of these dens were in the survey area around the port access road. Specific to the port access road, dens were located in two main areas. Several dens were found from Gibraltar Lake west to Iliamna Lake, and the remaining were clustered near Cook Inlet north of Amakdedori Creek (Figure 3.23-12). Surveys documented a concentration of brown bear dens on each side of the port access road and around Amakdedori port (Figure 3.23-12). Several of the dens were close to the port access road, with the closest approximately 300 feet north of the road (ABR 2018p). Results indicated that bear dens were located at lower elevations, steeper slopes, higher topographic positional indices, higher ruggedness, more north and west-facing aspects, and more often in shrubs (ABR 2018p). This indicates that bears in the Iliamna area are more likely to den in shrubby areas with steep slopes. A model was created to estimate density using the relative probability of detecting a bear den based on resource selection function analysis. The model predicted that the 151-square-mile survey area had an estimated density of 164 dens per 386 square miles (ABR 2018p).

The second set of aerial surveys assessed the prevalence of bears using coastal sedge meadows or other areas along the coast of Cook Inlet. These surveys were conducted on May 20, 28, and July 2, 2018 (ABR 2018k). Bear observations were widely dispersed, and no concentration areas were observed (Figure 3.23-12). Only one brown bear was detected in the port access road analysis area on May 28, 2018. Brown bears were more abundant further north around Bruin Bay and Ursus Cove.

The third set of surveys was focused on bear use of salmon streams. Three surveys were conducted during July 14-15, August 16-18, and September 7-8, 2018 (ABR 2018o). During each survey, all streams and rivers in the ADF&G anadromous waters catalog within 3 miles of the transportation corridor outside of the mine site were surveyed. Two replicate surveys of the entire area were flown on each trip (ABR 2018o). Specific to the port access road, during the July survey, bears congregated at the mouth of Amakdedori Creek, with a few individuals along streams around Gibraltar Lake. During the August surveys, bears were primarily near the southern shore of Iliamna Lake, at the eastern end of Gibraltar Lake, fishing in the river flowing into Bruin Bay; and a few bears were upstream in Amakdedori Creek. During September surveys, bears were concentrated around the stream flowing into Bruin Bay, at the eastern end of Gibraltar Lake, along the westerns shore of Iliamna Lake, and around Kokhanok. These surveys of brown bear activity in the area around the port access road illustrate bear use of Amakdedori Creek, Gibraltar Lake, and other anadromous streams in the area (Figure 3.23-12).

The moose density was estimated at 0.13 moose per square mile, based on data from the April 2010 aerial survey (ABR 2011a). Moose were more heavily concentrated in river drainages, due to the presence of suitable forage. Per ADF&G area management biologist Dave Crowley, for GMUs 9 and 10, there are approximately 0.50 moose per square mile or less for most of the Alaska Peninsula, due to limited habitat (Lill 2017). Generally, the habitat along the south mine access road is rocky substrate covered in low-growing tundra plant species. Therefore, moose densities are generally low along the south mine access road, with moose limited to river valleys and drainages with appropriate forage and cover. Surveys in summer 2018 documented very low numbers of moose along the port access road, primarily in drainages on the south side of Iliamna Lake.

Multiple beaver colonies were detected on the western side of the Newhalen River, but were generally absent from the port access road.

In summary, the transportation and natural gas pipeline corridors contain more suitable caribou and brown bear habitat compared to habitat for moose and black bears. The port access road is in an area known for high brown bear densities, because it includes both coastal vegetation communities and salmon streams.

Small Terrestrial Vertebrates

Although no specific small mammal surveys were conducted for the project, Table 3.23-1 details the relative abundance of furbearers in GMU 9, based on the results of limited trapper questionnaires (based on individual perceptions and responses of relatively few trappers) from 2013 (Parr 2018). Many of the same species have abundance indices similar to the mine site. Main differences include lynx, which are considered common; and American martins and wolverines, which are considered scarce in GMU 9. Additional non-furbearer small mammal species occur in the transportation and natural gas pipeline corridors, including Alaska hare and species of squirrels, mice, lemmings, voles, and others previously mentioned under the mine site.

Other mammal species were incidentally detected during surveys conducted by ABR, and included red fox and river otter around the mouth of the Newhalen River (ABR 2011a). During surveys conducted in summer 2018, both red fox and wolverine were detected.

Surveys for wood frogs were not conducted; however, the species is anticipated to occur throughout the region in freshwater ponds, lakes, streams, and adjacent wetland vegetation.

3.23.1.3 Amakdedori Port

Birds

Existing data for avian surveys conducted in lower Cook Inlet, along with vegetation community mapping and aerial imagery, were used to describe the avian community around the Amakdedori port. Surveys in the vicinity of Amakdedori port were conducted in spring, summer, and fall 2018 by ABR, and include aerial surveys for nesting raptors, waterbird breeding observations, waterbird spring and fall observations, waterbird observations in Cook Inlet, and landbird and shorebird point counts (ABR 2018g, h, i, j, and l).

Raptors

The area immediately adjacent to Amakdedori port is not habitat for tree-nesting raptors due to a lack of large trees, including those to support bald eagle nests. Coastal bluffs to the north and south of the port do support nesting bald eagles. These nests were approximately 0.6 and 0.7 mile north and south of the port, respectively (Figure 3.23-9). Both nests successfully raised one young eagle in 2018 (ABR 2018l). Additional nearby nesting raptor species include golden eagles. A northern harrier and short-eared owl were observed in 2018 in the vicinity of Amakdedori port, and suitable nesting habitat is present. However, locating the nests of ground nesting species is difficult.

Waterbirds

The terrestrial habitat around the Amakdedori port contains small waterbodies where waterbirds may breed and stage, although a large portion of the area is also upland habitat (see Section 3.22, Wetlands and Other Waters, for additional information). The port location itself does not contain rocky outcrops, crags, or other features along the water's edge that may support nesting seabirds.

The marine portion of the Amakdedori port is in Kamishak Bay, a globally important bird area (IBA) located along the Pacific Flyway (Figure 3.23-10). Kamishak Bay was designated by the National Audubon Society as an IBA due to large numbers (i.e., over 9,000) of breeding glaucous-winged gulls (National Audubon Society 2013a; Smith et al. 2012). In Kamishak Bay, there are multiple colony IBAs, all of which are outside of the EIS analysis area. In particular, two colony IBAs, Amakdedulia Cove Colony and Contact Point Colony, are over 6 miles from Amakdedori port (Smith et al. 2012; National Audubon Society 2014). Amakdedulia Cove is over 6 miles south of the proposed port location in Kamishak Bay, and supports 1 percent of a sub-species of double-crested cormorant (*Phalacrocorax auritus*), small numbers of glaucous-winged gulls, tufted puffins (*Fratercula cirrhata*), and large numbers (i.e., 272 birds per square mile) of seaducks (National Audubon Society 2013b). Over 7 miles north of the port location is Contact Point, which forms the southeastern border of Bruin Bay. A large seabird nesting colony exists here, and includes over 1,000 seabirds of several species, including red-faced cormorants (*Phalacrocorax urile*), pelagic cormorants (*Phalacrocorax pelagicus*), common murres (*Uria aalge*), pigeon guillemots (*Cepphus columba*), tufted puffins, and horned puffins (*Fratercula corniculata*). Large numbers (i.e., 140 birds per square mile) of seaducks raft in the nearby waters (National Audubon Society 2013c). There are multiple other seabird colonies along the rocky islands along the western edge of Cook Inlet both north and south of Amakdedori port.

Additionally, Kamishak Bay is an important molting and wintering location for a variety of waterbirds, including the federally threatened Steller's eider (*Polysticta stelleri*) (discussed in detail in Section 3.25, Threatened and Endangered Species), and merganser and scoter species (Larned 2005). In Kamishak Bay, the area around the Douglas River Delta (a series of shoals, reefs, and islands at the mouth of the Douglas River), approximately 15 to 20 miles south of the port location, is the primary location where waterbirds congregate in the winter.

During spring migration surveys on April 30, 2018 in the nearshore waters around Amakdedori port, common waterbirds observed were harlequin ducks, black scoters, red-breasted mergansers, and glaucous-winged gulls. No major congregations of waterbirds were detected; rather, small groups of various species were observed in Amakdedori Creek and the surrounding ponds.

During waterbird breeding surveys on May 30, 2018, red-breasted mergansers were the most common waterbirds in the vicinity of Amakdedori port, followed by mallards and American wigeon. During fall waterbird surveys in early September and early October 2018 (ABR 2018g, 2018h), commonly observed species included harlequin ducks in nearshore waters, species of mergansers, bald eagles, and gull species. No large congregations of fall-migrating waterbirds were detected during these surveys.

Landbirds and Shorebirds

The main landbird and shorebird species at the Amakdedori port are similar to species that breed in various shrub habitats in the mine site (listed above), including species of sparrows, warblers, and flycatchers. The main difference is that rock sandpipers (*Calidris ptilocnemis*) use the mudflats at the Amakdedori port for foraging during the winter. Rock sandpipers that winter along the shores of Cook Inlet are the northernmost wintering shorebird species in the Pacific Basin (Ruthrauff et al. 2013). They often gather in large flocks numbering in the thousands during the winter, and forage on a variety of bivalve species, depending on shore ice accumulation. Although rock sandpipers generally winter in a few locations in upper Cook Inlet, during periods of extreme cold, they shift their distribution to more southerly locations in the inlet (Ruthrauff et al. 2013). The subspecies of rock sandpiper that typically winters in Cook Inlet is the sensitive *Calidris ptilocnemis ptilocnemis* (Ruthrauff et al. 2013). Data from the citizen science project, eBird, have documented rock sandpipers in Amakdedulia Cove and Kamishak Bay in September and early October, and early March and late April (eBird 2018). Numbers range from several individuals to several hundred birds, and there is likely great fluctuation in numbers throughout the fall, winter, and spring. Small numbers of rock sandpipers were also detected in the EIS analysis area by ABR during late April and early May 2018 field surveys around Amakdedori port.

Additional avian species that use the area around the Amakdedori port include a variety of shorebird species that may rest, forage, and stage; and then continue migration. One historical survey conducted across four seasons in 1976 documented roughly 20,000 shorebirds using the embayments along the western side of lower Cook Inlet, of which 80 percent occurred during spring (Erikson 1977). Surveys conducted each spring between 1994 and 1996 documented 86,000 to 122,000 shorebirds using Tuxedni and Chinitna bays (Bennett 1996). Therefore, the Cook Inlet provides important migratory and breeding habitat for a variety of shorebird species. Surveys conducted from February 1997 to February 1999 in upper Cook Inlet from Susitna Flats south to Tuxedni Bay (approximately 80 miles north of Amakdedori port) confirmed that the Cook Inlet is important migratory bird habitat (Gill and Tibbits 1999). Twenty-eight species of shorebirds were recorded using the area, with a rapid increase in numbers of birds during early May, followed by an abrupt departure in mid- to late-May. During this time, the total number of birds frequently exceeded 150,000 birds per day, with western sandpiper (*Calidris mauri*) accounting for three-fourths of all birds recorded (Gill and Tibbits 1999). Approximately 20 to 47 percent of the Pacific Flyway population of western sandpipers used Cook Inlet embayments, especially southern Redoubt Bay (approximately 100 miles north of Amakdedori port). Cook Inlet also supported approximately 11 to 21 percent of the population of dunlin (*Calidris alpina*), which travel in the Pacific Flyway. The main areas along the western side of Cook Inlet that provided shorebird habitat included southern Redoubt Bay (an average of 32,000 birds per day during spring) and Susitna Flats (8,400 rock sandpipers per day during winter) (Gill and Tibbits 1999). Therefore, the intertidal habitats and coastline around Amakdedori port likely provide important shorebird migration habitat, and support winter habitat for rock sandpipers.

Avian surveys were conducted along the port access road in June 2018 (ABR 2018i, 2018j). Surveys followed the standardized point-count procedures developed for the statewide Alaska Landbird Monitoring Surveys and adopted for shorebirds (Handel and Cady 2004). The results for transects along the port access road are detailed above under transportation and natural gas pipeline corridor. Because one of the two transects (consisting of 10 point-count locations per transect) was conducted at Amakdedori port, with the other transect in similar habitat around Kokhanok, the data are combined for both transects. The most commonly detected species in decreasing order of abundance were Wilson's warbler, golden-crowned sparrow, savannah sparrow, fox sparrow, orange-crowned warbler, common redpoll, hermit thrush, American robin, gull species, varied thrush, and yellow warbler. Three species of shorebirds were also detected in low numbers: semipalmated plover, greater yellowlegs, and least sandpiper (ABR 2018j). Overall, the seven most common species were an order of magnitude more abundant than the remaining landbird species, and shorebirds were much less abundant (ABR 2018j). Of the ten most commonly detected landbird species, all of them except for American robin and gull species are considered either ADF&G at-risk or stewardship species (ADF&G 2015a).

Terrestrial Mammals

The Amakdedori port would be in GMU 9A, on the northern side of Amakdedori Creek. Primary vegetation communities are shrub-dominated, with small, isolated wetlands. Amakdedori Creek is an anadromous creek surrounded by shrubs, and supports brown bears, gray wolf, moose, and other wildlife. Studies around Amakdedori port in summer 2018 included aerial surveys for a variety of terrestrial mammals, including bear dens and bear use at salmon-spawning streams and along the coast. The results are detailed above under transportation and natural gas pipeline corridors, and generally not repeated here.

Large Mammals

Large mammal species around the port are similar to those in the mine site and along the transportation and natural gas pipeline corridor, including caribou, brown and black bear, and moose. Although the primary range of the Mulchatna caribou herd does not extend to Cook Inlet based on the 29 year radio-telemetry data, there may be groups of caribou that occasionally move through the area. In 2018, the ADF&G observed caribou at Chenik Lake, about 5.5 miles south of the Amakdedori port site (ADF&G 2018s). The current range of the Northern Alaska Peninsula herd is approximately 70 miles south of the Amakdedori port site around Naknek Lake (Demma 2011; ADF&G 2015b). Additional scattered individual caribou were observed in 2018, between 3 and 5 miles west of Amakdedori port (Figure 3.23-11).

As detailed in Section 3.24, Fish Values, sockeye and pink salmon are abundant in Amakdedori Creek near the port. Amakdedori port would be approximately 13 miles north of McNeil River Falls at McNeil River State Game Sanctuary, which is a world-famous brown bear viewing location, due to the world's largest concentration of wild brown bears (ADF&G 2018g). During bear surveys in May 2009 for the mine site, brown bears were common on the southern side of Iliamna Lake near Gibraltar Lake. Surveys for bears around salmon-spawning streams in summer 2018 documented brown bears fishing in Amakdedori Creek in July and August (ABR 2018o) (Figure 3.23-12).

During ABR surveys in 2018, caribou and moose were incidentally observed in low numbers during surveys around Amakdedori port.

Two gray wolves were incidentally detected at the Amakdedori port site during summer 2018 aerial surveys of bears at salmon streams (ABR 2018k).

Small Terrestrial Vertebrates

The same small mammal species and furbearers listed in Table 3.23-1 would be anticipated to occur around the Amakdedori port, with abundance in proportion to their respective habitats. Additionally, wood frogs would be expected to occur in freshwater ponds around Amakdedori port, although specific surveys were not conducted at this location.

Marine Mammals

This section addresses non-ESA–listed whales, porpoises, seals, and sea otters that occur in the marine waters in Cook Inlet surrounding the project components of Alternative 1, which includes the Amakdedori port, the natural gas pipeline corridor, and lightering locations. Information on ESA species potentially found in the project area can be found in Section 3.25, Threatened and Endangered Species.

The Marine Mammal Protection Act (MMPA) (16 USC 1361 et seq.) mandates management of marine mammal population stocks, and was enacted in 1972 to prevent the decline of marine mammal species and populations. Additional information on the MMPA is provided in Appendix E, Law, Permits, Approvals, and Consultations Required.

Under Section 3 of the MMPA, the "…term 'population stock' or 'stock' means a group of marine mammals of the same species, or smaller taxa in a common spatial arrangement, that interbreed when mature" (16 USC 1362 (11)). "Population stock" (usually referred to simply as "stock") designations of many groups of marine mammals have changed over the past decade, in large part due to focused efforts to define the stocks, coupled with the availability of relatively new tools from molecular genetics. In the cases of marine mammals for which separate stocks have been delineated, the description and evaluation of potential effects on those stocks are focused on those that may occur in the Cook Inlet project area. However, information on the biological species as a whole is included if it enhances the understanding of the relevant stock(s) or aids in evaluation of the significance of any potential effects on the stock that occurs in or near the program area.

Gray Whale

There are two recognized stocks of gray whales (*Eschrichtius robustus*): the Eastern North Pacific (ENP), and Western North Pacific (WNP). The ENP gray whale stock range includes the project area.

The ENP stock has been reported feeding along the Pacific Coast during their annual northern summer migration in waters off southeastern Alaska, British Columbia, Washington, Oregon, and California. Northward migration, primarily of individuals without calves, begins in February; some cow/calf pairs delay their departure from the calving area until well into April (Muto et al. 2017).

Generally, gray whales arrive in the Gulf of Alaska between March and June, and typically depart in November and December (Consiglieri et al. 1982). Most of the population follows the outer coast of the Kodiak Archipelago to the Kenai Peninsula in spring, or the Alaska Peninsula in fall (Consiglieri et al. 1982). This annual migration takes them past the mouth of Cook Inlet to northern feeding grounds in the Bering and Chukchi seas. Although most gray whales migrate past Cook Inlet on their way north, small numbers have been reported near Kachemak Bay, roughly 80 miles from the Cook Inlet project area (USDOI BOEM 2015). During NMFS aerial surveys in Cook Inlet, gray whales were observed in June in 1994, 2000, 2001, 2005, and 2009 on the western side in Kamishak Bay (Shelden et al. 2013) near the project area.

Studies by ABR in spring and summer 2018 did not detect any gray whales in the EIS analysis area.

Minke Whale

Minke whales (*Balaenoptera acutorostrata*) are most abundant in the Gulf of Alaska during summer, where they occupy localized feeding areas (Zerbini et al. 2006). Minke whales become scarce in the Gulf of Alaska in fall; most whales are thought to leave the region by October. The current estimate for minke whales between Kenai Fjords and the Aleutian Islands is 1,233 individuals (Zerbini et al. 2006).

During NMFS Cook Inlet-wide aerial surveys conducted from 1993 through 2004, minke whales were observed on three separate occasions (1998, 1999, and 2006) near Anchor Point, approximately 90 miles south of the project area (Shelden et al. 2013, 2015, 2017). A minke whale was also reported in the same general location in 2011 and 2013 (Owl Ridge 2014).

Surveys by ABR in spring and summer 2018 documented four sightings of minke whales in Kamishak Bay, with three of them just offshore from Amakdedori port.

Killer Whale

The killer whales (*Orcinus orca*) inhabiting Cook Inlet are thought to be a mix of resident and transient individuals from two different stocks: the Alaska Resident Stock, and the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient Stock (Muto et al. 2017). Both stocks have the potential to occur in the project area. The Alaska Resident Stock is estimated at 2,347 individuals, with a minimum population estimate of 2,084 (Muto et al. 2017). The Gulf of Alaska, Aleutian Islands, and Bering Sea Transient Stock is estimated at a minimum of 587 individuals (Muto et al. 2017).

Killer whales are occasionally observed in lower Cook Inlet, especially near Homer and Port Graham (Rugh et al. 2005), approximately 80 miles south of the project area. Killer whales are not expected to occur in the project area.

Surveys by ABR in spring and summer 2018 documented two sightings of killer whales; both of them north of the mouth of the Seldovia River along the eastern side of Cook Inlet.

Dall's Porpoise

Dall's porpoises (*Phocoenoides dalli*) are present year-round throughout their entire range, including the Cook Inlet area and Kamishak Bay (Morejohn 1979). They are regularly observed throughout Cook Inlet (Nemeth et al. 2007), particularly during spring eulachon and summer salmon runs. They have been observed in lower Cook Inlet around Kachemak Bay (USDOI BOEM 2015), approximately 80 miles east of the project area.

Dall's porpoises were observed on NMFS aerial surveys during June 1997 (Iniskin Bay, approximately 40 miles north of Amakdedori port), 1999 (Barren Island, approximately 70 miles east of Amakdedori port), and 2000 (Barren and Elizabeth islands, approximately 70 and 80 miles east of Amakdedori port, respectively; and Kamishak Bay) (Shelden et al. 2013).

Surveys by ABR in spring and summer 2018 incidentally documented two groups of Dall's porpoise: one group of eight in the middle of Cook Inlet, and one individual north of the natural gas pipeline corridor west of Augustine Island.

Harbor Porpoise

In Alaskan waters, three stocks of harbor porpoises (*Phocoena phocoena*) are currently recognized: Gulf of Alaska, Southeast Alaska, and Bering Sea stocks (Muto et al. 2017). Only the Gulf of Alaska Stock has the potential to occur in Cook Inlet near the project area.

Harbor porpoises have been reported in lower Cook Inlet from Cape Douglas north to the West Foreland and offshore (Rugh et al. 2005). They have been frequently observed during aerial surveys in Cook Inlet; most sightings are of single animals, and are concentrated at Chinitna and Tuxedni bays (north of the project area) on the western side of lower Cook Inlet, and in the upper inlet (Shelden et al. 2014). The most recent population estimate for the Gulf of Alaska Stock is 31,046 individuals (Muto et al. 2017).

NMFS aerial surveys for beluga whales have documented harbor porpoise presence throughout Cook Inlet since 1993, except in 2002, 2003, 2006, and 2013. These surveys encompass the project area, and typically included Chinitna, Iniskin, and Iliamna bays and connecting coastline—all north of the project area.

Surveys by ABR in spring and summer 2018 documented several groups of harbor porpoises, primarily along the western edge of lower Cook Inlet west of Augustine Island, including several just south of Amakdedori port.

Harbor Seal

Harbor seals (*Phoca vitulina*) are common in Alaskan waters, with statewide abundance estimates at 152,602 animals (Muto et al. 2017). There are 12 recognized stocks of harbor seals in Alaska. The Cook Inlet/Shelikof Strait harbor seal stock range extends from Unimak Islands along the coast north into upper Cook Inlet, and includes the project area. The current Cook Inlet/Shelikof Strait harbor seal stock population estimate is 27,386 individuals (Muto et al. 2017).

Harbor seals are found throughout the entire lower Cook Inlet coastline, hauling-out on beaches, islands, mudflats, and at the mouths of rivers, where they whelp and feed (Muto et al. 2017). Montgomery et al. (2007) recorded over 200 haul-out sites in lower Cook Inlet alone. Harbor seal haul-out areas occur in Kamishak Bay in close proximity to the project area, including the Amakdedori port.

A strong seasonal pattern of more coastal and restricted spatial use has been documented during the spring and summer for breeding, pupping, and molting, and more wide-ranging seal movements in and outside of Cook Inlet during the winter months (Boveng et al. 2012). Large-scale patterns indicate that a portion of harbor seals tagged in Cook Inlet move out of the area in the fall, and into habitats in Shelikof Strait, North of Kodiak Island; and coastal habitats of the Alaska Peninsula, considerably south of the project area. In the fall, harbor seals are concentrated in Kachemak Bay on the eastern side of Cook Inlet, Iniskin and Iliamna bays on the western side of Cook Inlet, and south through the Kamishak Bay to Cape Douglas (Boveng et al. 2012). A portion of the Cook Inlet seals move into the Gulf of Alaska and Shelikof Strait during the winter months (London et al. 2012). Seals move back into Cook Inlet as the breeding season approaches (London et al. 2012).

NMFS has conducted annual aerial surveys for beluga whales in Cook Inlet since 1993, which encompass the project; these surveys have also included incidental sightings of harbor seals every year from 1993 to 2016. Bennett (1996) counted a maximum of 90 harbor seals hauled-out along tidal channels in inner Chinitna Bay during aerial surveys conducted from 1994 to 1996.

Surveys by ABR in spring and summer 2018 documented harbor seals throughout the area surveyed in Kamishak Bay, with the largest concentrations south of Amakdedori Creek around the mouth of Amakdedulia Cove.

Iliamna Lake Seal

A discrete (Burns et al. 2013) population of approximately 400 harbor seals inhabit the freshwater environment of Iliamna Lake (Boveng et al. 2016). Iliamna Lake seals forage mainly on salmonids (salmon, trout, char, and grayling), but also forage heavily on lamprey, smelt, sculpin, whitefish, and stickleback (Hauser et al. 2008).

In spring, when the ice breaks up, seals begin to redistribute broadly in Iliamna Lake. When migrating salmon arrive in the summer and into autumn, seals may be found throughout the lake, but are especially common near and in spawning streams, including the lake’s outflow, the Kvichak River, and along nearshore areas. Iliamna Lake seals are thought to overwinter in Iliamna Lake (Boveng et al. 2016). The peak date of births in Iliamna Lake was based on the peak percentage of pups found in aerial surveys of the lake during May through August of 2010 to 2013 (excluding 2012), compared to those in Nanvak Bay. The average peak pup-count dates were determined to be anywhere from July 12 to July 20 (Boveng et al. 2016).

A few seals are occasionally observed in small areas of open water in the southwestern portion of the lake during the ice-cover period, such as the head of the Kvichak River at Igiugig, roughly

40 miles from the ferry route over Iliamna Lake near Kokhanok; however, these are not regular occurrences (Burns et al. 2013). There are known and potential haul-out sites on islands found in the central portion of Iliamna Lake (Figure 3.23-12) (ABR 2011a).

Sea Otters

Northern sea otters occur year-round throughout lower Cook Inlet (Garshelis 1987), which spans southwest from the North Forelands to the inlet mouth between English Bay and Cape Douglas. Two stocks of sea otters occur in Cook Inlet: the Southwest and Southcentral. The federally listed Southwest stock, which occurs along the western side of Cook Inlet, is discussed in Section 3.25, Threatened and Endangered Species. The Southcentral Alaska Stock extends from Cape Yakataga to the eastern shoreline of lower Cook Inlet, including Prince William Sound, Kachemak Bay, and the Kenai Peninsula coast (Allen and Angliss 2014; USFWS 2014d), and is mostly localized to Kachemak Bay, and south and east of Prince William Sound (Gill et al. 2009). The southcentral stock is discussed because the natural gas pipeline corridor overlaps with the eastern part of Cook Inlet where the stock occurs.

A series of aerial surveys conducted between 2000 and 2010 were used to estimate the current overall Southcentral Alaska Stock population size. The combined population estimate is 18,297 sea otters for the Southcentral Alaska stock (USFWS 2014d). Overall abundance assessments show a stable or increasing trend (USFWS 2014d); and the Kachemak Bay population in particular experienced a 26 percent annual increase between 2002 and 2008 (Gill et al. 2009). Except in Kachemak Bay, this stock typically occurs at low densities throughout its range (Gill et al. 2009; USFWS 2014d). Very few otters from the Southcentral Alaska Stock occur north of Anchor Point (Rugh et al. 2005; Gill et al. 2009), especially during winter months (USFWS 2014d).

Sea otters typically forage in nearshore waters at depths up to 131 feet in the nearshore benthos of rocky and soft-sediment communities (Marshall 2014). Approximately 40 percent of sea otters' daily activity is spent foraging, and they primarily feed on benthic invertebrates, including mussels, crabs, urchins, sea cucumbers, and clams. Sea otters encountered on the eastern Cook Inlet portion of the pipeline route would be considered part of the Southcentral stock. Sea otters encountered at the Amakdedori site, lightering locations, and western portion of the pipeline route would be considered part of the Southwestern stock.

3.23.2 Alternative 2 – North Road and Ferry with Downstream Dams

The components of Alternative 2 are described in Chapter 2. The mine site footprint is generally the same (apart from acreage differences detailed in Chapter 2) between Alternatives 1 and 2, with no expected difference in wildlife species presence and abundance; therefore, the affected environment is considered the same for the mine site and mine analysis area, and not repeated here. The major differences in the affected environment between Alternative 1 and 2 is the north road and ferry that traverses the northern side of Iliamna Lake, and ends at the Diamond Point port at Iliamna Bay. The Alternative 1 mine analysis area and transportation corridor analysis area included the Iliamna spur road, which terminates east of the Newhalen River. Therefore, wildlife resources that occur in the area around the Newhalen River are previously discussed under Alternative 1. This section focuses on wildlife resources in the transportation and natural gas pipeline analysis area along the northern side of Iliamna Lake east of the Newhalen River to the Diamond Point port. It includes wildlife resources around the Eagle Bay and Pile Bay ferry terminals, and those that occur along the mine access road and port access road.

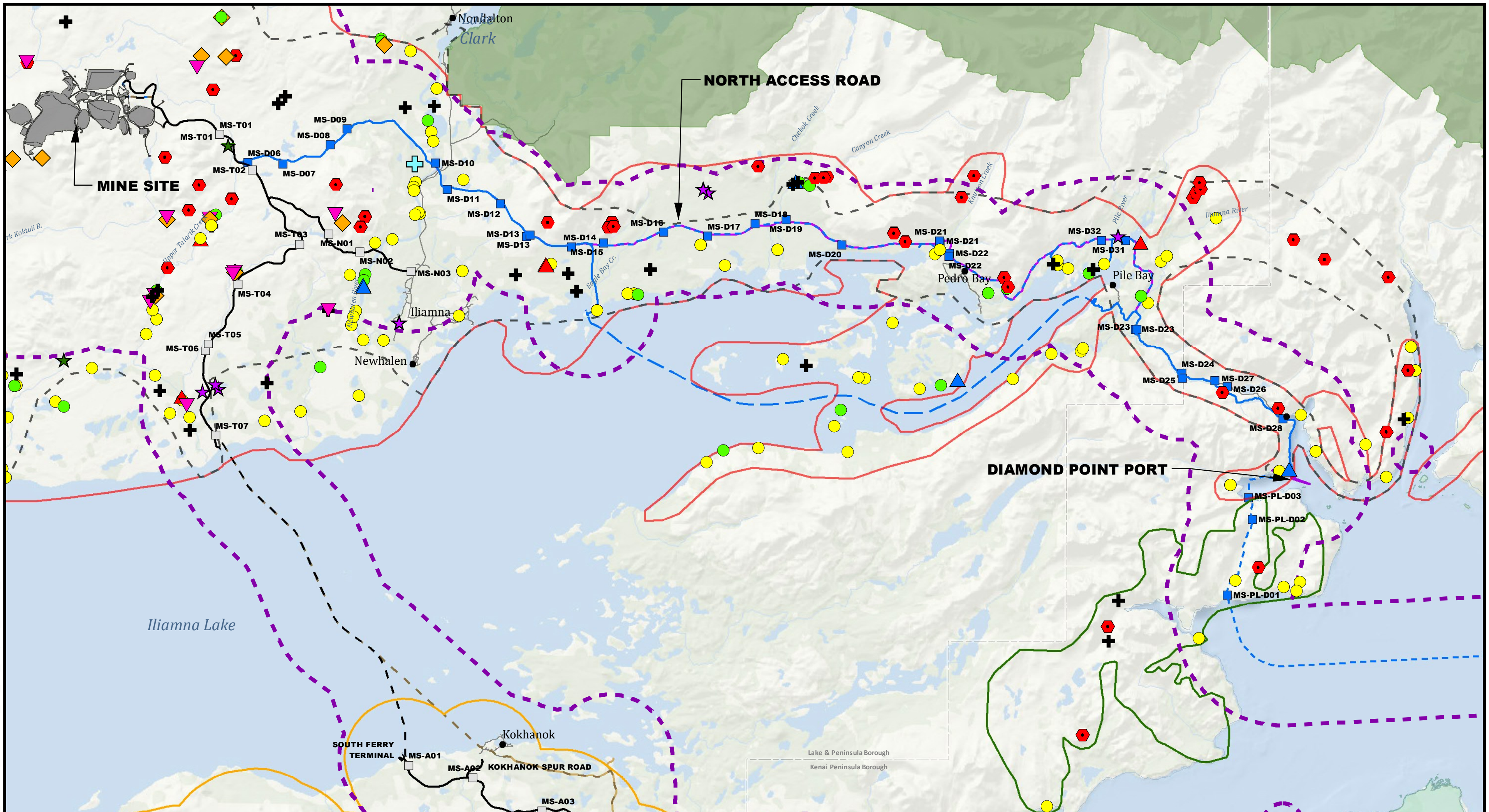
The most recent comprehensive biological surveys of the Alternative 2 area were conducted by ABR, primarily between 2004 and 2006, with additional surveys conducted up until 2012. These surveys are detailed in the various chapters of the Environmental Baseline Document (ABR 2011a, 2011c, 2011d, 2013a, 2013b, 2015a, 2015b, 2015c) and are summarized briefly below. Details of the specific survey methods and results are referenced, and a summary of the results is provided. The area where biological surveys were conducted for the Environmental Baseline Document (referred to as the transportation corridor survey area) extends approximately from the Newhalen River east along the northern shore of Iliamna Lake to Williamsport, and then along the western edge of Cook Inlet to Chinitna Bay. The transportation corridor survey area included a section of land between the northern edge of Iliamna Lake and the base of the nearby mountains (Roadhouse and Knutson mountains) to the north of the lake. Specific to the project, the survey area included the area around Eagle Bay, Pedro Bay, Pile Bay, Diamond Head, Williamsport, Cottonwood Bay, Iliamna Bay, and Iniskin Bay. Therefore, the entire terrestrial portion of Alternative 2 was surveyed, apart from the portion of the natural gas pipeline corridor from Ursus Cove to Diamond Point. The only survey conducted in this section was an aerial raptor nesting platform survey in 2012, as detailed below.

3.23.2.1 Birds

Project-specific avian surveys conducted by ABR in 2004 and 2005 are the most comprehensive surveys that have been conducted for the region along the northern and eastern edge of Iliamna Lake from the mine site to Cook Inlet (ABR 2011a, 2011c, 2011d). Additional avian surveys were conducted up until 2012, primarily along the western side of Cook Inlet in the area around Iliamna and Iniskin bays, and Ursus Cove.

Raptors

Raptor surveys were conducted in 2004 and 2005 for all large tree- and cliff-nesting raptor species. Winter surveys for bald eagles were conducted in 2005 and 2006. Bald eagles were the most abundant nesting species (43 percent of all nests), followed by golden eagles (19 percent of nests), with low numbers of nesting common ravens, osprey, peregrine falcon, gyrfalcon, rough-legged hawk, great horned owl, and red-tailed hawk (ABR 2011a, 2011c) (Figure 3.23-13). The greatest densities of tree-nesting raptors were along the Newhalen and Iliamna rivers and along the shoreline of Iliamna Lake. Scattered bald eagle nests were also distributed on various islands in the eastern edge and along shoreline of Iliamna Lake. The greatest densities of cliff-nesting raptors were found in Canyon Creek and along the southern edge of the Alaska Range north of Iliamna Lake (Figure 3.23-13). Around Roadhouse Mountain, four golden eagle nests were located within approximately 1 mile of a material site. In the reach north of Pedro Bay, at least four golden eagle nests were found less than 0.5 mile from the northern side of the corridor, along with several bald eagle nests slightly further away along the shore of Iliamna Lake. Near Cook Inlet, most bald eagle nests were in the trees along the coastline or in the lower reaches of rivers draining into Iliamna Lake and Cook Inlet. One bald eagle nest was located approximately 0.5 mile east of the Eagle Bay ferry terminal and 660 feet south of the access road. One peregrine falcon nest and several bald eagle nests were detected around Diamond Point. Two golden eagle nests were along the steep cliffs around Williamsport, less than 0.5 mile from the transportation and natural gas pipeline corridor, with one nest 0.28 mile from a material site (Figure 3.23-13). The peregrine falcon nest at Diamond Point was approximately 500 feet to the west of the proposed road to Diamond Point. In September 2012, additional surveys were conducted by ABR for nesting raptors (ABR 2013a). One bald eagle nest in a tree was immediately adjacent to the Diamond Point port (Figure 3.23-13). An additional bald eagle and one golden eagle nest were in the valley between Ursus Cove and Cottonwood Bay, adjacent to the proposed natural gas pipeline corridor (ABR 2013a).



RAPTOR NESTS ALONG ALTERNATIVES 2 AND 3 TRANSPORTATION AND NATURAL GAS PIPELINE CORRIDOR

PEBBLE PROJECT EIS

FIGURE 3.23-13

During surveys for wintering congregations of bald eagles around Iliamna Lake, bald eagles were detected in February and November 2005, and November and December 2006, with a drastic decline in numbers by mid-winter, suggesting that the area is not heavily used as a wintering area for bald eagles (ABR 2011a).

Waterbirds

The Iliamna Lake region of the Alaska Peninsula is an important migration route for many species of waterbirds moving to and from breeding areas in western and northern Alaska (Conant and Groves 2005). Waterbird surveys were conducted along the transportation and natural gas pipeline corridors by ABR in 2004 and 2005, with a 2006 survey for swans. Thirty-four species of swans, ducks, loons, cranes, and gulls were observed, with 14 of them recorded as breeding in the area. Waterbirds used lakes, rivers, and bays for staging during spring and fall migration. During spring migration, most swans, geese, and dabbling ducks arrived by late April to early May, and staged along rivers and areas of open water on lakes and bays of Iliamna Lake (Figure 3.23-14). The highest concentrations were along the Newhalen River at Three-mile Lake, Goose Cove, and in Chekok Bay. Other locations where species staged included the floodplain of the Iliamna River, and Eagle, Fox, and Pile bays. Diving ducks arrived in mid- to late-May, and staged in large flocks in Whistlewing Bay, Alexcy Lake, and on the Iliamna and Newhalen rivers (ABR 2011a).

During fall migration, waterbirds congregated in many of the same locations as in spring, with additional concentrations of gulls and mergansers on Iliamna Lake at Knutson and Pile bays, and along the southern shore of the lake (Figure 3.23-15). The highest numbers of birds were detected along the lower reaches of the Iliamna River and the southern shore of Iliamna Lake.

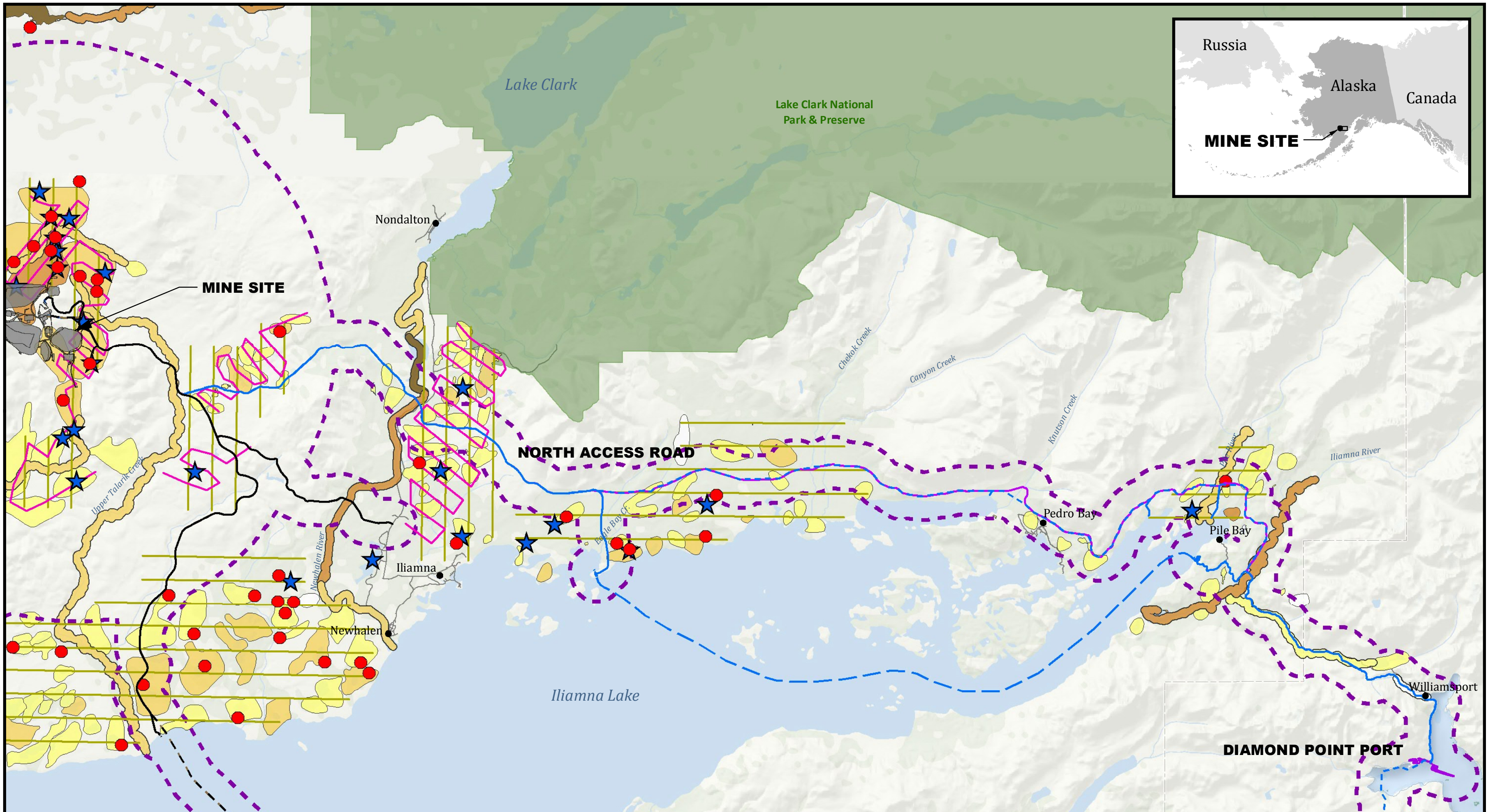
Thousands of ducks and gulls were observed during fall surveys, with high duck abundance during mid-August to mid-October (ABR 2011a). In contrast to the vast numbers of ducks and gulls, no groups of swans or geese were observed staging during the fall; only local groups that bred in the area were observed. Overall, there were low numbers of grebes, cormorants, cranes, and shorebirds during spring and fall migrations periods in 2004.

Tundra swans were documented breeding between Chekok Creek and the Newhalen River, with more nests located in 2005 between UTC and the Newhalen River north of Iliamna Lake. Several tundra swan nests (four nests in 2004 and two in 2005) were observed around the Newhalen River, primarily on the eastern side in the greater floodplain area of the river (Figure 3.23-14). Swans returned to the same territories on subsequent years, and were on nests by early May. One pair of trumpeter swans (*Cygnus buccinator*) that bred locally was located near the Pile River, which is near the western edge of their breeding range.

Harlequin duck pairs were found along streams flowing into Iliamna Lake, with broods on Stonehouse Lake, and on the Newhalen, Pile, and Iliamna rivers.

Common loons were found on deep and large lakes between UTC and the Iliamna River, with most broods locations near the Newhalen and Iliamna rivers. Both Pacific and red-throated loons were uncommon, and no nests or broods were documented.

The marine waters of Iliamna, Cottonwood, and Iniskin bays are important year-round habitat for a variety of waterbird species. A list of all avian species detected in this area during biological surveys from 2004 to 2008 is provided in ABR 2011d. Three main types of surveys were conducted in the marine environment around the Alternative 2 analysis area. These include boat-based nearshore and offshore surveys, fixed-wing surveys, and helicopter-based surveys, as detailed below.



Sources: PLP 2005, 2018

US Army Corps of Engineers

2 0 2 4
Miles

Maximal Number of Birds
- 0
- 1 - 25
- 26 - 100
- 101 - 250
- 251 - 500
- Analysis Area

Swans
- 2004 Swan Nest
- 2005 Swan Nest
- 2004 Survey Transect
- 2005 Survey Transect

Alternative 1
- Mine Site

- Transportation Corridor
- Natural Gas Pipeline
- Ferry/Port Site

Alternative 2
- Transportation Corridor
- Ferry Route

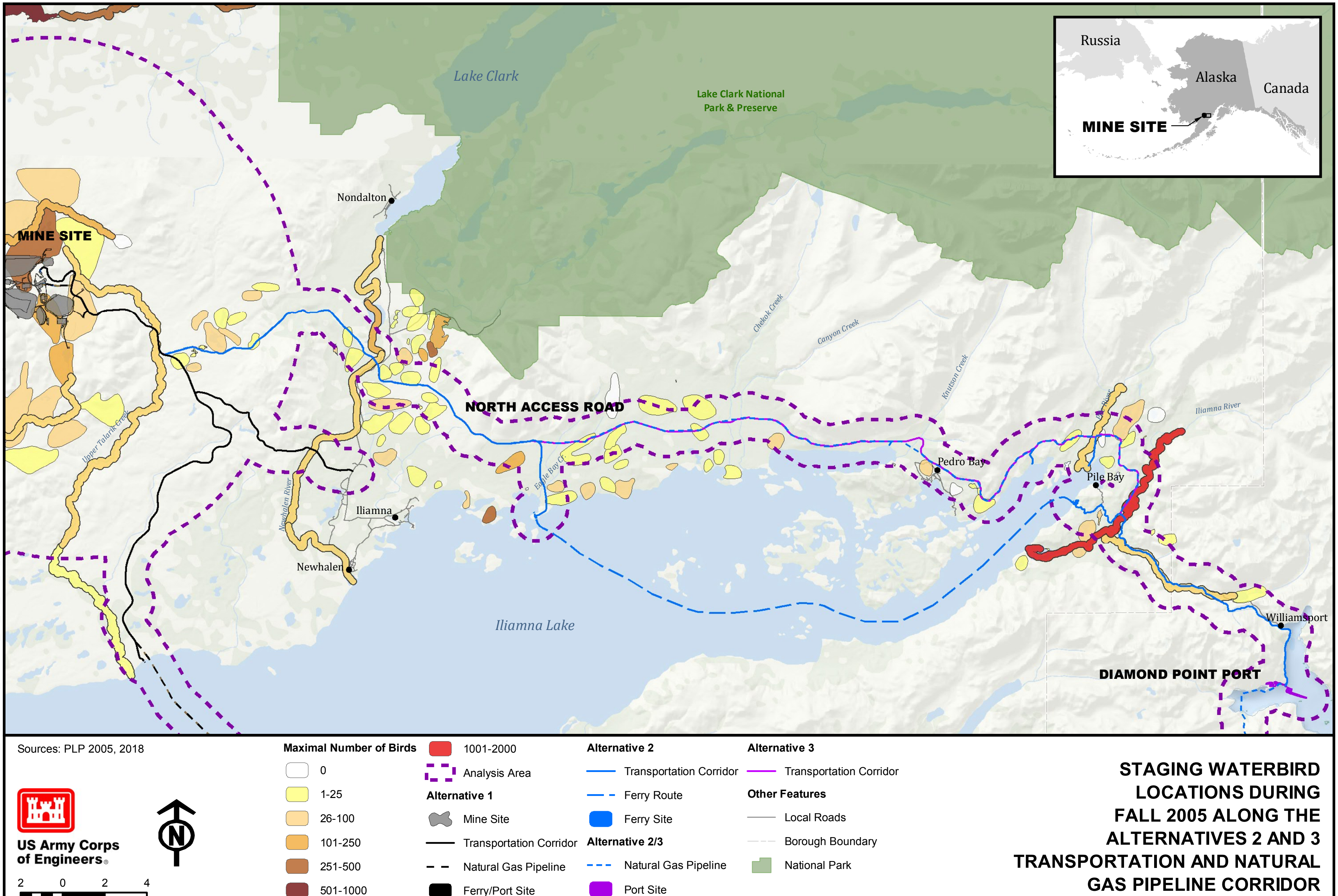
- Ferry Site

Alternative 2/3
- Natural Gas Pipeline
- Port Site

Alternative 3
- Transportation Corridor

Other Features
- Local Roads
- Borough Boundary
- National Park

STAGING WATERBIRD LOCATIONS DURING SPRING 2005 AND SWAN NESTS ALONG THE ALTERNATIVES 2 AND 3 TRANSPORTATION AND NATURAL GAS PIPELINE CORRIDOR



STAGING WATERBIRD LOCATIONS DURING FALL 2005 ALONG THE ALTERNATIVES 2 AND 3 TRANSPORTATION AND NATURAL GAS PIPELINE CORRIDOR

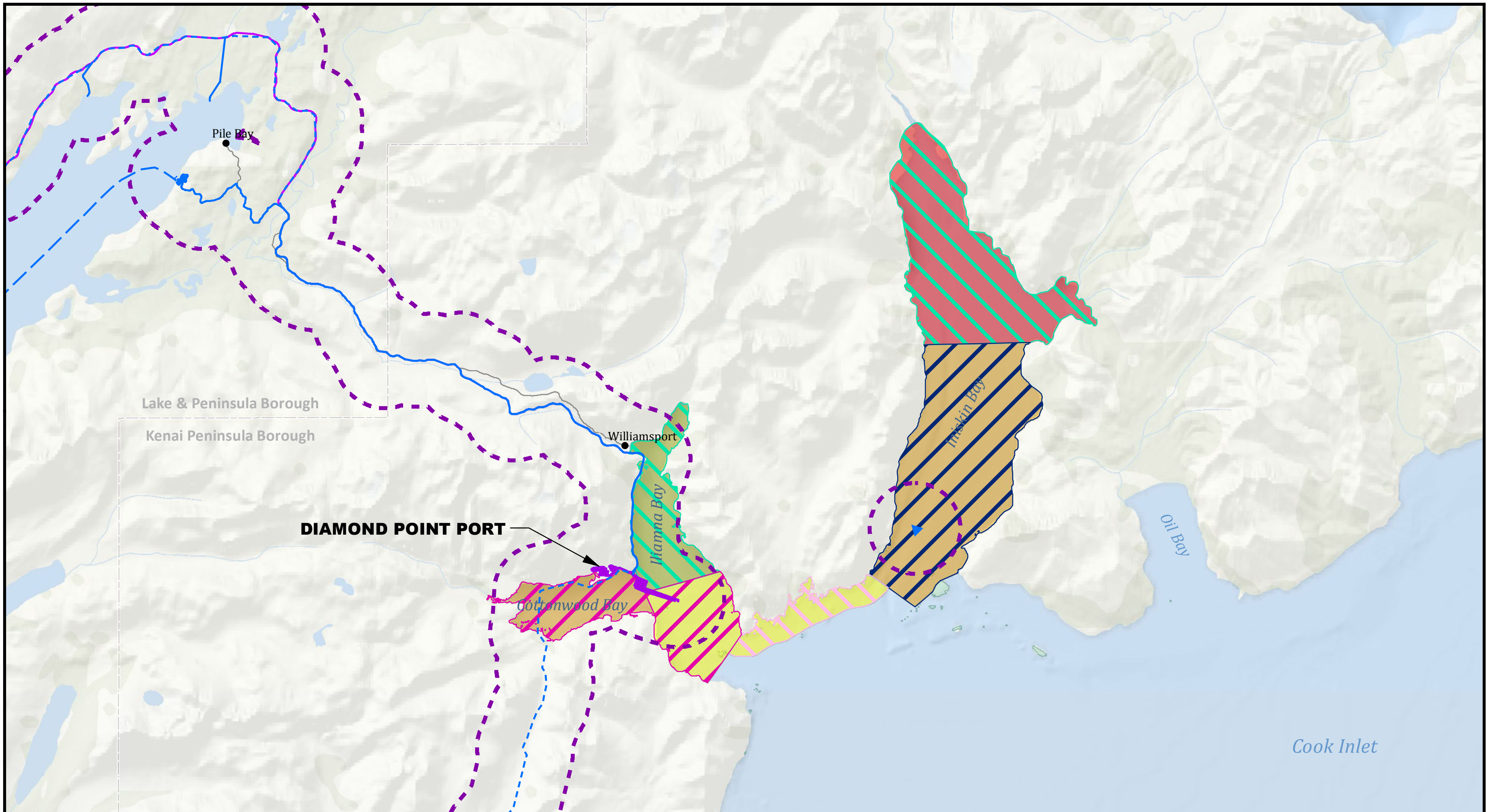
PEBBLE PROJECT EIS

FIGURE 3.23-15

Boat-based nearshore surveys were conducted from summer 2004 to spring 2006. The most commonly detected waterbird species (where over 1,000 birds were detected), in decreasing order of abundance summed across all surveys, were glaucous-winged gull (9,317 birds), harlequin duck (3,809 birds), greater scaup (1,958 birds), long-tailed duck (1,714 birds), Barrow's goldeneye (1,140 birds), and green-winged teal (1,040 birds) (ABR 2011d). Boat-based offshore surveys from summer 2004 to spring 2006 documented fewer birds; and when all surveys were summed, white-winged scoters (356 birds), glaucous-winged gulls (263 birds), and long-tailed ducks (172 birds) were the most abundant.

Nine fixed-wing marine surveys were conducted during spring and fall 2004. When all nine surveys were summed, gulls were the most common group (3,656 unidentified, and 1,457 glaucous-winged gulls) followed by unidentified scoters (2,942 birds) and surf scoters (670 birds). Waterbird numbers were higher during fixed-winged surveys in spring and fall 2005, when 11 surveys were conducted. Figure 3.23-16 illustrates the maximal number of birds from fixed-wing marine surveys in spring 2005 and fall 2005. Large numbers of waterbirds were detected in both spring and fall 2005, primarily in Iniskin Bay, with estimates of several thousand birds. In spring 2005, higher densities of waterbirds were located near the mouth and middle of Iniskin Bay; and in fall 2005, higher densities were further back in Iniskin Bay. The most abundant species were gulls (15,399 unidentified and 1,899 glaucous-winged gulls), surf scoters (10,084 birds), unidentified scoters (8,804 birds), unidentified scaup (4,430 birds), mallards (3,248 birds), and white-winged scoters (2,237 birds). Fixed-wing marine surveys by ABR from summer 2004 to spring 2006 documented similar results from previous surveys, which indicated that the number of birds in Iliamna and Iniskin bays is substantial. In the mid-1970s, the largest wintering concentration of seaducks in all of lower Cook Inlet occurred in Iniskin Bay; Iliamna and Iniskin bays contained a large concentration of summering scoters; and gulls, dabblers, and scaup all concentrated in Iniskin and Chinitna bays in the summer (Erikson 1977). Agler et al. (1995) documented large concentrations of birds on the western side of lower Cook Inlet in summer, and the number of wintering birds (primarily waterfowl) in Iliamna and Iniskin bays was the highest in western Cook Inlet.

During helicopter-based marine surveys during fall 2006 through 2008, high waterbird densities (518 to 1,748 birds per square mile) were documented at ends of Cottonwood, Iliamna, and Iniskin bays and near Knoll Head, at the mouth of Iniskin Bay (ABR 2011d). During helicopter-based mid-winter marine surveys from 2006 to 2008, pockets of high bird densities (259 to 518 birds per square mile) were recorded in Iniskin Bay. During late winter and spring 2006 to 2008, bird densities were still high, with some bird located in the middle of Iliamna Bay, and other birds near the mouths of Iliamna and Iniskin bays and the nearby rock islands. Non-federally listed bird species with the highest numbers summed during winter months from late February 2006 to early December 2006 were long-tailed ducks (2,051 birds), glaucous-winged gulls (1,704 birds), and harlequin ducks (667 birds). Surveys in 2007 from late January through the middle of December documented a total of 8,114 gull species, 5,564 long-tailed ducks, 3,276 unidentified scoters, 3,060 surf scoters, and 2,168 black scoters, among others (ABR 2011d; ABR 2015c). Fewer surveys were conducted in early and late winter 2008, but results showed lower numbers of birds of similar species composition to previous surveys.



Sources: PLP 2018; ABR 2005

Spring 2005 Maximal Number of Birds
- 1 - 100
- 101 - 500
- 501 - 1,000
- 1,001 - 2,000
- 2,001 - 3,500
- 3,501 - 5,500

Fall 2005 Maximal Number of Birds
- 101 - 500
- 501 - 1,000

Analysis Area

Alternative 2
- Transportation Corridor
- Ferry Route
- Ferry Site

Alternative 2/3
- Lightering Location
- Natural Gas Pipeline
- Port Site

Alternative 3
- Transportation Corridor

Other Features
- Local Roads
- Borough Boundary
- National Wildlife Refuge

US Army Corps of Engineers

1 0 1 2
Miles

N

WATERBIRD DISTRIBUTIONS SPRING AND FALL 2005 FOR ALTERNATIVE 2 AND 3 IN COOK INLET

To summarize the waterbird surveys, ABR (2011d, 2015c) recorded 70 species of birds in marine waters of Cook Inlet, including Iliamna, Iniskin, and Chinitna bays. The greatest number of bird species and density occurred in spring (primarily due to large numbers of shorebirds). Large numbers of waterfowl migrate through the area in spring and fall, and a substantial number of birds winter in the protected bays, especially seaducks. The highest densities of birds in spring and summer occur in nearshore waters and near the mouths of the bays, while the highest densities in winter occur in the offshore waters of the bays (ABR 2011d).

For seabirds, the rocky shoreline, adjacent cliffs, islands, and rock outcrops around Iliamna and Iniskin bays provide important breeding habitat. Some of the first intensive surveys of this area in 1976 detected the following species breeding around the mouths of Iliamna and Iniskin bays: common eider (*Somateria mollissima*), double-crested cormorant, pelagic cormorant, black oystercatcher (*Haematopus bachmani*), glaucous-winged gull, pigeon guillemot, horned puffin, and tufted puffin (Erikson 1977). The North Pacific Seabird Data Portal (an online database of seabird colony population numbers from various surveys[1] includes several seabird colonies in this area. These are South Head, White Gull Island, North Head, Knoll Head, Toadstools, Entrance Rock, Vert Island, Scott Island, Mushroom Islets, Iniskin Island, Twin Rocks, Pomeroy Island, and Oil Reef (Figure 3.23-10; USFWS 2012b). Several of these islands (White Gull Island, Vert Island, Iniskin Island, and Pomeroy Island) had greater than 500 breeding birds in the late 1970s (Erikson 1977; ABR 2011a). Most of these seabird colonies occur outside of the EIS analysis area around the Diamond Point port and Iniskin Bay lightering location; however, barges, concentrate vessels, and other project-related boat traffic would travel past these seabird colonies. In total, breeding birds recorded in 1976 and 1978 totaled 4,172 birds. ABR resurveyed many of these islands and the surrounding area, and observed 1,264 and 1,585 breeding birds in 2004 and 2005, respectively (ABR 2015c). The main differences between surveys in the 1970s and 2004-2005 surveys were a drastic decrease in the number of breeding tufted puffins, and a smaller decrease in the number of most other species. The only species that increased in number between the 1970s and in the mid-2000s were red-faced cormorant and mew gull, both of which were not documented breeding in the 1970s (ABR 2015c). Overall, since the 1970s, the number of breeding seabirds has declined drastically, with the most recent surveys documenting 1,740 to 1,195 birds in 2011 and 2012, respectively (ABR 2015c). Seabird colony densities from June 2011 and June 2012 are shown on Figure 3.23-10. In June 2011, the most commonly detected species with nests were glaucous-winged gulls (467 nests), followed by tufted puffins (109 nests), unidentified puffins (59 nests), pelagic cormorants (30 nests), and double-crested cormorants (13 nests). In June 2012, the most commonly detected species with nests were glaucous-winged gulls (242 nests), pigeon guillemot (13 nests), tufted puffin (11 nests), and pelagic cormorant (11 nests). Since the 1970s, numbers of nesting double-crested cormorants, common eiders, glaucous-winged gulls, pigeon guillemots, and tufted puffins showed declines. Tufted puffin populations have declined by approximately 97 percent, and double-crested cormorants by 88 percent. These declines may have been due to a collapse of Pacific herring (*Clupea harengus*) in the region (ABR 2015c).

A supplemental reconnaissance-level waterbird survey was conducted in September 2012 between Iniskin and Bruin bays (ABR 2013b). This survey covered the area of the natural gas pipeline corridor between Ursus Cove and Cottonwood Bay. Several groups of waterbirds were located in the river delta at the end of Ursus Cove, but none were detected along the creek between Ursus Cove and Cottonwood Bay (ABR 2013b).

[1] Analyses and conclusions contained in this document are based wholly or in part on information obtained from the North Pacific Pelagic Seabird Database. The author(s) have complied with published guidelines for the ethical use of such data.

Landbirds and Shorebirds

Point-count surveys were conducted throughout the transportation corridor survey area in June 2005, and consisted of 154 point-count locations. The habitat types with the highest bird abundance (more than five birds per point count) were Riverine Moist Mixed Forest, Riverine Low Willow Scrub, Upland and Lowland Moist Mixed Forest, Upland and Lowland Spruce Forest, Upland Moist Tall Alder Scrub, and Upland Moist Low Willow Scrub. Forty-six species of landbirds (mainly passerines) and seven shorebird species were recorded. Warblers were the most abundant birds, followed by thrushes, waxwings, sparrows and allies, finches, and kinglets. Lower numbers of flycatchers, woodpeckers, swallows, corvids, shrikes, chickadees, nuthatches, and sandpipers were recorded.

The 10 most common landbird species (in descending order of abundance) were Wilson's warbler, orange-crowned warbler, Swainson's thrush, yellow-rumped warbler, golden-crowned sparrow, dark-eyed junco, ruby-crowned kinglet, American robin, varied thrush, and hermit thrush. The two most common shorebird species, which constituted 92 percent of all shorebird detections, were greater yellowlegs and Wilson's snipe. Seven of the 53 landbird and shorebird species detected are considered species of greatest conservation need in Alaska (ADF&G 2015a), and include olive-sided flycatcher, gray-cheeked thrush, varied thrush, blackpoll warbler, rusty blackbird, American golden-plover, and solitary sandpiper. Olive-sided flycatchers were considered common (25 detections), and were detected in upland and lowland coniferous and mixed forest. Gray-cheeked thrush were considered common (26 detections), and were most frequently detected in Upland Moist Tall Alder Scrub; and were less common in Riverine Moist Mixed Forest and Upland and Lowland Spruce Forest. Varied thrush were considered abundant (91 detections), and were frequently found in coniferous and mixed forests in upland, lowland, and riverine areas, including Upland Moist Tall Alder Scrub. Blackpoll warblers were also considered common (52 detections), and were observed in Riverine Moist Mixed Forest and riverine tall alder or willow scrub. Rusty blackbird was uncommon (three detections), and was detected in Upland and Lowland Moist Mixed Forest. American golden-plover was uncommon (1 detection), and one solitary sandpiper was incidentally detected (ABR 2011a).

The nearshore marine waters of Iliamna, Cottonwood, and Iniskin bays are important year-round habitat for a variety of shorebird species, primarily during spring migration. Surveys conducted from 2006 to 2012 documented a wide variety of species in Iliamna and Iniskin bays, with the highest numbers of shorebirds moving through the area in early May on their northern spring migration. Surveys from summer 2004 through spring 2006 documented the numbers and species of shorebirds in Iliamna and Iniskin bays. On May 3, 2005, more than 5,000 shorebirds were recorded in Iliamna and Iniskin bays (ABR 2011c). During spring 2006, the most common shorebirds were western sandpiper (5,682 birds), followed by unidentified sandpipers (17,322 birds), and dunlin (2,157 birds) (ABR 2011c). These birds fed on the mudflats at the back end of Iniskin Bay. Low numbers of rock sandpipers (generally less than 200 birds) also used the bays during fall, winter, and spring from late October through late April; however, they were most abundant in November, when a high of 406 were observed in early November 2006 (ABR 2015c). The largest flocks of rock sandpipers were found foraging on the soft-sediment substrates of inner Iliamna and Iniskin bays.

The only breeding shorebird species detected around Iliamna and Iniskin bays was the black oystercatcher. This species breeds in low numbers among the rocky edges around the bay and surrounding areas; with seven nests recorded in 2011, and five nests in 2012 (ABR 2015c). Historical data from 1976 and 1978 documented 42 black oystercatchers in the area, and surveys in 2005 documented 41 birds; therefore, numbers had remained relatively constant (ABR 2011c).

3.23.2.2 Terrestrial Mammals

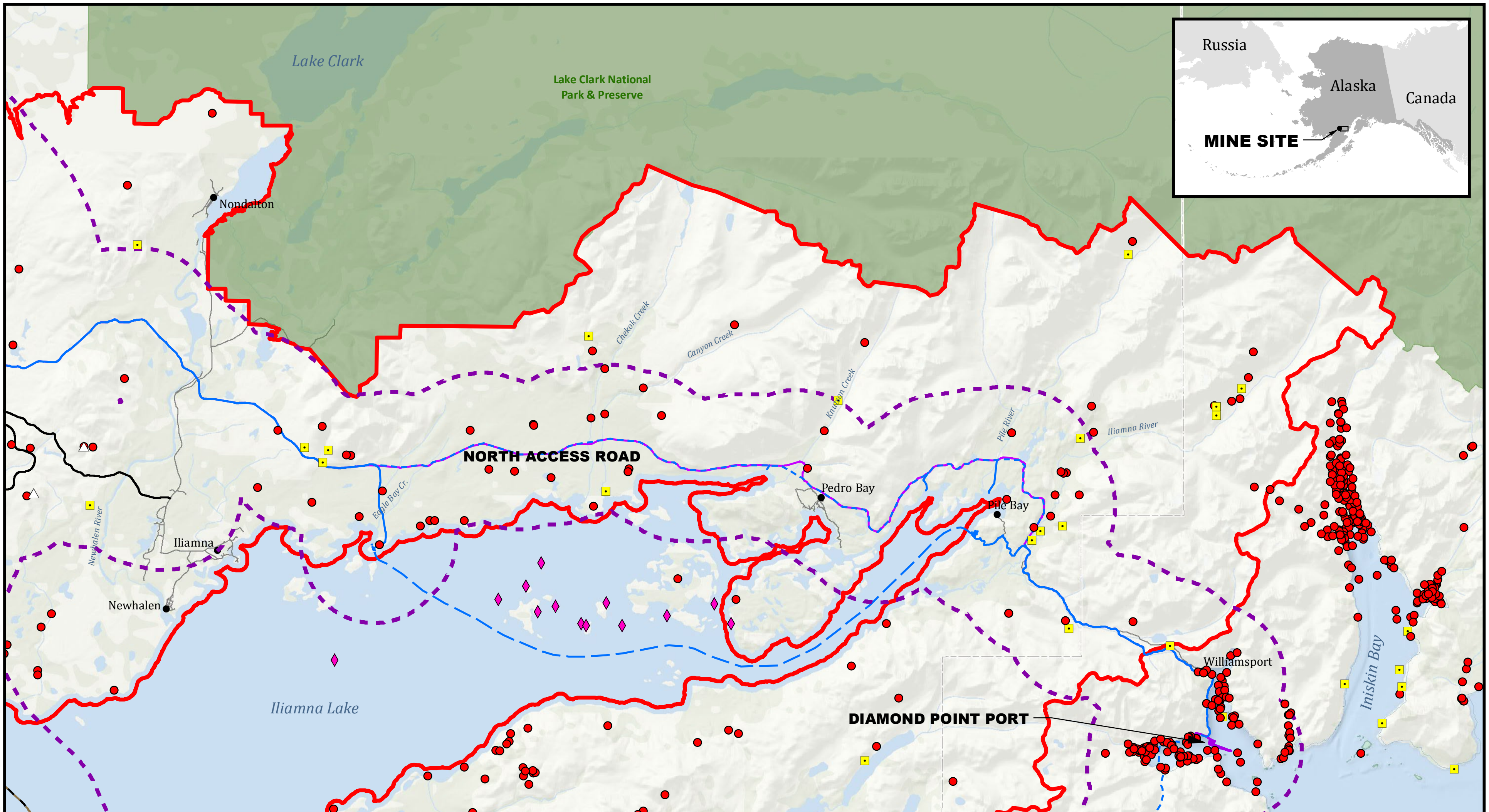
Large Mammals

Very few caribou were observed during wildlife surveys in 2004 or 2005; the area is almost completely outside of the range of the Mulchatna caribou herd, and the steep coastal mountains that dominate the area are not preferred caribou habitat (ABR 2011a; ABR 2011d). A few caribou were located around the Newhalen River, and both radio and satellite-collared data indicate the species rarely occurs along the northern shore of Iliamna Lake.

Moose were detected throughout the survey area in low density, with the greatest local densities east of Roadhouse Mountain. The highest numbers of moose observations were at lower elevations along the Pile River and Chekok Creek. The estimated density of moose in the transportation corridor survey area was 0.13 moose per square mile (ABR 2011a). Historical surveys in late March 1992 in the area between the Newhalen River and Williamsport showed an estimated density of 0.18 moose per square mile, and 0.41 moose per square mile in the area between the mine site and Iniskin Bay (ABR 2011a).

The transportation corridor survey area is in an area of transition between substantially higher coastal densities of brown bears and lower inland densities. Historical surveys have estimated 50 bears per 386 square miles in GMU 9B (excluding Lake Clark National Park and Preserve and Katmai National Park and Preserve lands) (Butler 2005). A more rigorous survey from May 1999 to 2000 estimated 38.6 brown bears per 386 square miles in GMU 9B North, including the area east of Iliamna Lake and Lake Clark National Park and Preserve (Becker 2003; Butler 2007a). The line-transect bear survey in May 2009 (Becker 2010), which encompassed the transportation corridor survey area (plus a large area around Iliamna Lake), resulted in two different brown bear estimates, based on different models; and ranged between 47.7 and 58.3 brown bears per 386 square miles.

Bear surveys around the eastern part of Iliamna Lake to Diamond Point and Iliamna and Iniskin bays between 2004 and 2007 documented high densities of brown bears, particularly along the Iniskin River and the end of Iniskin Bay (Figure 3.23-17; ABR 2011c). Brown bears were also detected around Cottonwood and Iliamna bays, but in lower numbers. Large aggregations of brown bears were observed in the sedge meadows and mudflats at the heads of Iniskin and Chinitna bays during spring and summer each year, with highest numbers in June (ABR 2011c). Brown bears shifted to salmon-spawning streams later in July and August, which are primarily in the eastern portion of the survey area (ABR 2011a). Little evidence was found for bears digging clams, with only one observation of this behavior in May 2006. Brown bears were observed fishing for salmon in Iniskin River, and Portage Creek in Iniskin Bay. Overall, brown bears were concentrated foraging on vegetation early in the summer, and transitioned to salmon later in the summer and fall, following the season salmon runs in the area.



Sources: PLP 2005, 2018

US Army Corps of Engineers®

2 0 2 4
Miles

Analysis Area

Observations (2004 - 2009)
- Black Bear
- Brown Bear
- Brown Bear Den (2004 - 2006, 2010)
- Wildlife Camera

May 2009 Bear Density Survey Area

Iliamna Lake Seal
- Haulout Location (2005-2008)

Alternative 1
- Transportation Corridor
- Natural Gas Pipeline

Alternative 2
- Transportation Corridor
- Ferry Route
- Ferry Site

Alternative 2/3
- Natural Gas Pipeline
- Port Site

Alternative 3
- Transportation Corridor

Other Features
- Local Roads
- Borough Boundary
- National Park

BEAR OBSERVATIONS, DEN LOCATIONS, AND ILIAMNA LAKE SEAL HAUL-OUTS ALONG THE ALTERNATIVES 2 AND 3 TRANSPORTATION AND NATURAL GAS PIPELINE CORRIDOR

From July through September 2012, ABR conducted a study of bear activity using timelapse cameras placed near the location where the transportation corridor and natural gas pipeline would cross UTC, to capture bear activity along the stream. Overall, little bear use was recorded on photographs, but bear activity peaked from late July to early August. The highest level of activity occurred late in the evening. Despite the abundance of salmon in UTC, it did not appear that the location where the camera was placed was important to foraging bears during daylight and twilight hours (ABR 2015a). Additional cameras were placed along seven anadromous streams along the northern shore of Iliamna Lake, from Roadhouse Mountain to the Pile River. Bear use reflected salmon run timing, with the highest activity from late July to early August. Small, shallow streams with high numbers of spawning salmon were the preferred foraging areas. The highest level of activity occurred during early morning and late evening, but bears spent limited time fishing in the portions of the river in the camera's viewshed, according to the timelapse photography (ABR 2015a).

Black bears were more common in the area north and east of Iliamna Lake than other locations around Iliamna Lake (Figure 3.23-17); their density estimate from 1999 to 2000 for GMU 9B North was 76.7 black bears per 386 square miles (with most bears in the northernmost portion of the subunit) (Becker 2003). Most black bears were observed in the eastern part of the survey area around the Iliamna River. Timelapse cameras placed along salmon-spawning streams in 2012 did not document any black bears.

Few wolves were detected during surveys along the northern shore of Iliamna Lake to Diamond Point, but tracks of a pack of six individuals were noted during late fall 2004 along Chekok Creek (ABR 2011a). A lone wolf was incidentally detected along the Iliamna River. Therefore, the species is anticipated to occur in low numbers in the transportation and natural gas pipeline corridors.

Beavers were recorded west of the Newhalen River, along the Pile and Iliamna rivers, and west of Pile Bay north of Iliamna Lake.

Small Terrestrial Vertebrates

Small mammals were incidentally recorded during surveys in 2004 and 2005. Species detected included red fox, river otter, wolverine, and coyote (ABR 2011a). No particular spatial distribution for these species was noted, because most were incidental detections, and dense vegetation made observations for less visible species difficult.

Wood frog studies were not conducted for the transportation and natural gas pipeline corridors or the Diamond Point port. The species is expected to occur in suitable habitat in ponds, lakes, streams, and other waterbodies along the northern shore of Iliamna Lake to Cook Inlet.

3.23.2.3 Marine Mammals

Alternative 2 includes a ferry route across Iliamna Lake (Figure 3.23-17), which does not affect the species descriptions in this section, except for harbor seals, which occur year-round, primarily in the eastern portion of Iliamna Lake. The species discussed in this section have broad distributions and are expected to occur in similar densities throughout the marine environment. A general description of marine mammals in the project area is provided above. Where there are differences between species' distribution and habitat use, or specific sightings during surveys identified during literature review between the preferred alternative and the other alternatives, further discussion is provided.

Gray Whale

During boat-based nearshore (Iliamna, Iniskin, and Chinitna bays) surveys, one gray whale was recorded off-transect in the summer of 2004, near the mouth of Iniskin Bay (ABR 2011d).

Minke Whale

Surveys conducted in Iliamna, Iniskin, and Chinitna bays did not record any sightings of minke whales (ABR 2015c). A single minke whale was recorded just inside the entrance of Iliamna Bay in 2006 (ABR 2015c).

Killer Whale

A single killer whale was recorded near North Head, at the mouth of Iliamna Bay, in 2009 (ABR 2015c). This is the only record of this species on all aerial and boat-based surveys combined (ABR 2015c).

Dall's Porpoise

During surveys of the northern portion of the EIS analysis area between 2006 and 2012, ABR (2015c) observed one Dall's porpoise near North Head in 2009.

Harbor Porpoise

During helicopter-based surveys of the northern portion of the EIS analysis area between 2006 and 2012, harbor porpoises were observed in Iniskin, Iliamna, and Chinitna bays, as well as offshore; but were most common near the mouths of Iliamna and Iniskin bays (ABR 2015c)—all north of the project area. Harbor porpoises exhibited seasonality in abundance and inter-annual variation in abundance (ABR 2015c). There was a pronounced increase in the number and frequency of observations of harbor porpoise in the spring; specifically, in late April and May. Harbor porpoises were recorded in every month except for January, June, and October, although in generally low numbers, and with a low frequency of observations (ABR 2015c).

Harbor Seal

Marine mammal surveys (Iliamna, Iniskin, and Chinitna bays) were conducted between 2004 and 2008 (ABR 2011d). Harbor seals were recorded during all seasons, and were the most abundant marine mammal encountered (ABR 2011d). During the boat-based surveys in Iliamna, Iniskin, and Chinitna bays, harbor seals occurred primarily in nearshore waters, and were present primarily in the summer, with lower densities in the spring, and much lower densities in the winter and late winter (ABR 2011d). During offshore boat-based surveys, harbor seals were observed in the spring surveys in low densities, but higher in the summer, early winter, and late winter (ABR 2011d). In the spring, harbor seals occurred mostly in the nearshore waters, with only one recorded in the offshore area (ABR 2011d). The seals occurred throughout the entire bay systems, but were commonly hauled-out on the mudflats in upper Iniskin Bay. In the summer, harbor seals were primarily observed on the islands near the mouth of the bays, and secondarily on the mudflats in upper Iniskin Bay. In early winter, few seals were seen during the offshore surveys; those that were seen during the nearshore surveys were concentrated in the bays, and secondarily on the mudflats in upper Iniskin Bay (ABR 2011d). In the late winter, few seals were seen during the offshore surveys, and the few seals that were seen during the nearshore surveys were concentrated on the Iniskin Islands; few seals were seen in the bays, likely due to ice presence (ABR 2011d).

During fixed-wing surveys described above, the highest counts of harbor seals were during July and August. Most seals were recorded on the Iniskin Islands, but some seasonal variation occurred, especially with respect to the increased numbers hauled-out on Gull Island in Chinitna Bay (ABR 2011d).

<u>Iliamna Lake Seal</u>

Iliamna Lake seals are primarily found in the northeastern half of Iliamna Lake near Pedro Bay; however, depending on the time of year, stage of fish migrations, and state of ice cover on the lake, seals may be distributed throughout the lake (Burns et al. 2013).

The highest use of haul-outs was in the Flat/Seal Island group (southwest of Pedro Bay) and the Thompson Island group (north of Kokhanok) (Figure 3.23-17) (ABR 2011a). Two haul-out locations identified during aerial surveys accounted for two-thirds of all the seals observed in Iliamna Lake (ABR 2011a).

In winter, the number of seals observed is relatively low, because the vast majority of the lake surface freezes solid in winter; but is greatest in the northeastern parts of the lake (Burns et al. 2013). Small areas of water remain open, particularly in the northeastern portion of the lake, where harbor seals most commonly occur (Figure 3.23-17) (Boveng et al. 2016).

Pupping and nursing occur in June through August, taking place at haul-out sites in the northeastern half of the lake (Burns et al. 2013) near Pedro Bay.

<u>Sea Otter</u>

The federally listed southwestern stock of sea otters occurs along the western side of lower Cook Inlet, where the Diamond Point port and western portion of the natural gas pipeline are located. This stock of sea otters is discussed under Section 3.25, Threatened and Endangered Species. The nonlisted southcentral stock occurs along the eastern side of Cook Inlet. This stock of sea otters, which overlaps with the eastern portion of the natural gas pipeline near the Kenai Peninsula, is discussed above under Alternative 1.

3.23.3 Alternative 3 – North Road Only

There are no new geographic areas that are exclusive for Alternative 3, and not previously addressed under the EIS analysis areas for Alternatives 1 and 2. Although Alternative 3 includes a road along the northern side of Iliamna Lake, the affected environment would be the same geographical area as Alternative 2; because under Alternative 2, there would be a natural gas pipeline in the same location where the Alternative 3 access road would be located. The main difference is the Alternative 3 north road would be a wider permanent footprint than the natural gas pipeline. Therefore, the affected environment for Alternatives 2 and 3 along the northern side of Iliamna Lake is the same, and not repeated herein. The affected environment descriptions associated with all other components of this alternative are previously described for Alternatives 1 and 2 in the sections above.

3.23.4 Climate Change

Climate change trends are common to all alternatives and their variants.

Potential impacts from climate change on bird species are closely tied to changes in the physical and biological environment, including water resources (e.g., timing of spring thaw, freezing, ice/snow cover) and vegetation changes. Changes to vegetation from climate change are discussed in Section 3.26, Vegetation, and would directly impact avian communities. Changes in temperature, precipitation, their level of intensity, and timing all have the potential to impact avian species. Waterbird and shorebird species may experience a shift in habitat availability due to increased thawing that may permit the habitat to become available earlier in the season. Increased storm surges may also alter the habitat through increased erosion and an influx of salt water. Warmer winters may permit an expansion of spruce bark beetles, which would attract various woodpecker species, but result in forest habitat loss. Some species, such as ptarmigan, which depend on adequate snow cover to survive winter, are likely to be adversely impacted. There is the potential for trophic mismatch where seasonally timed migration events and reproduction are not synchronized with vegetation and insect population fluctuations. Overall, some bird species may increase in abundance, while others may decline due a warming climate.

Climate change is anticipated to have a wide variety of impacts for various terrestrial species. An overall warming/drying trend would tend to convert some wetlands to uplands, and tend to increase the cover of shrubs and trees in previously open areas. For terrestrial wildlife, a combination of more open water and more nearby upland or forested areas may benefit species like beavers, river otters, wood frogs, and others. An increase in fires due to drying may benefit caribou that use early successional habitat areas, but would be a detriment to species that rely on forested cover. Habitat important for moose would be affected, but effects are uncertain. Warming conditions may also lead to increases in infectious disease in wildlife (Bradley et al. 2005).

Climate change may cause shifts in plant phenology; species that cannot shift the timing of their reproductive cycle may be adversely impacted. This potential mismatch between a wildlife species and its food may vary, depending on the degree to which they depend on dietary consumption and stored fat reserves (Gustine et al. 2017). A recent study in Alaska by Gustine et al. (2017) examined the long-term (i.e., from 1970 to 2013) changes in temperatures, and characteristics of the growing seasons in relation to forage quality for caribou during important life stages. Despite advanced thaw dates and increased growing season lengths, no decline in forage quality and no evidence for trophic mismatch were found during peak parturition or peak lactation. Another study in northern Canada examined the impacts of climate change on the seasonal distribution of two migratory caribou herds (Sharma et al. 2009). The study found consequences of climate change may include alteration in habitat use, migration patterns, foraging behavior, and demography. Migratory caribou preferred regions with higher snowfall and lichen availability in fall and winter, and cooler areas in summer. Both herds of caribou avoided disturbed and recently burned areas.

Habitat changes in southwest Alaska have been documented by traditional ecological knowledge (TEK), which has resulted in improved moose forage, with areas of taller and denser willows, dwarf birch, and alders (Van Lanen 2018). Traditional knowledge has documented ice breakup occurring earlier in the spring, freeze-up occurring later in the fall, lower than normal snowfall amounts, and other climatic changes. This has translated into earlier spring thaw, lakes opening up faster, expanding and taller-growing deciduous shrubs, and earlier leaf-out in spring (Van Lanen 2018). The result has been increased moose abundance, due to increasing range expansion of moose. See Section 3.9, Subsistence, for additional discussion on TEK and habitat change.

Climate change may have synergistic adverse effects on marine mammals, and may include increased incidence of disease (Guimarães et al. 2007); exacerbation of the effects of illness; increased bioavailability of contaminants (Schiedek et al. 2007); increased ocean noise levels (Reeder and Chiu 2010); changes to the density and distribution of prey species (Welch and Batten 1999); and habitat changes. These potential effects would be a result of primary and secondary changes to ecological processes that mammalian species depend on, such as water quality and water circulation. Additional consequences of climate change may include sea level rise; coastal erosion; changes in ocean heat content; ocean acidification; shifts in the amount and distribution of precipitation; changes in ice extent and snow melt; changes in stream flow and runoff patterns; changes in the timing of spring events, such as migration; poleward shifts in ranges of plant and animal species; and changes in the frequency and intensity of storm events.

Habitat alteration, changes in water quality, and food availability could occur as a consequence of climate change. Climate change may affect marine mammals indirectly, because a change in the environment is more likely to have direct effects on marine mammal prey. Changes in the climate may limit the production of forage species that marine mammals rely on. Likewise, ocean acidification (habitat alteration) could adversely affect the population of invertebrates that marine mammals feed on by limiting their growth and shell development. Under such conditions, benthic creatures such as bivalves and polychaete worms would have difficulty creating and maintaining shells, while species such as jellies, squid, etc., might flourish. Climate change could cause or contribute to further regime shifts in the lower trophic, and therefore, the fish communities of Cook Inlet. At the microbial level, blue-green algae could have limited ability to create the calcium carbonate matrices needed to permit them to remain near the surface of the ocean, and such a situation could have severe repercussions throughout the oceanic food web (Raven et al. 2005; Riebesell and Tortell 2011).

Climate change could be beneficial to some marine mammal species, but detrimental to others, depending on a species' ability to cope with the environmental changes. Such effects could affect species demographics, behavior, numbers, diet, hearing, and distributions. In Cook Inlet, marine mammal distribution is dependent on ice formation and prey availability, among other factors. The overall impact on marine mammals would vary, because species such as sea otters would likely encounter difficulty finding and foraging on bivalves, while other species such as harbor seals and Steller sea lions may experience changes in fish availability, and an increase in squid or other invertebrate prey numbers. Beluga whales often travel just along the ice pack and feed on prey beneath it (Richardson et al. 1991). Any loss of ice could result in prey distribution changes or loss. Threats to quantity and quality of beluga prey species may occur due to climate change. Freshwater flow into Cook Inlet, specifically from the melting snow pack, may be altered during climate change, affecting salinity, water nutrient composition and levels, and prey fish density and distribution in the upper inlet, where beluga whales feed and reside.

3.24 FISH VALUES

The Environmental Impact Statement (EIS) analysis area includes watersheds and downgradient aquatic habitats that could be affected by project components from streams to marine waters. Potential direct and indirect impacts to fish and aquatic habitat and aquatic invertebrates include:

- Physical loss of stream, lake, estuarine, and marine habitat.
- Blockage of stream channels preventing fish or other aquatic species passage.
- Aquatic habitat effects due to instream flow reductions from mine water withdrawal or capture and redirection of groundwater.
- Sedimentation of aquatic habitat due to surface erosion of mine and port access roads, stockpiles, or other activities.
- Erosion from vegetation removal; shoreline erosion associated with ship or ferry wakes; benthos disturbance/mortality from docks and pipelines.
- Changes of freshwater and marine water quality such as temperature, turbidity, pH, dissolved oxygen, and metal or chemical contaminants.
- Injury or mortality of fish or other aquatic species.

Permit compliance requirements, including standard and special terms and conditions, best management practices (BMPs), and environmental monitoring, would be established by regulatory agencies and landowners with permitting authority. These requirements would be implemented as part of construction management and facility operations to avoid, minimize, and control risks to fish and aquatic habitat in the project area. Specific measures proposed by the Pebble Limited Partnership (PLP) to mitigate impacts are discussed in Chapter 5, Mitigation.

The EIS analysis area for the mine site includes the North Fork Koktuli (NFK), South Fork Koktuli (SFK), and Upper Talarik Creek (UTC) watersheds, and a 1,000-foot buffer around the mine site to account for blasting disturbance. This area includes all aquatic habitats potentially impacted by changes in streamflow from the diversion, capture, and release of water associated with the project that result in a modeled reduction in streamflow greater than 2 percent. The EIS analysis area for the port, and transportation and natural gas pipeline corridors, includes all aquatic habitats within 0.25 mile of the proposed infrastructure. This is the area where potential effects are expected to occur from construction and operations under all alternatives.

3.24.1 Alternative 1 – Applicant's Proposed Alternative

3.24.1.1 Aquatic Habitat

<u>Mine Site</u>

The mine site would be situated in the Koktuli River and UTC watersheds. The EIS analysis area for the mine site includes the mainstem NFK and the mainstem SFK from reaches adjacent to the mine site downstream to their confluence; the mainstem UTC from the reach adjacent to the mine pit downstream to Iliamna Lake; and tributaries directly draining the mine site (Figure 3.24-1).The 36-mile NFK and 40-mile SFK rivers join to form the Koktuli River, which flows 39 miles downstream into the Mulchatna River. The Mulchatna River continues 44 miles before joining the Nushagak River, which then flows another 109 miles into Bristol Bay. UTC flows for approximately 39 miles into Iliamna Lake, which drains into the Kvichak River, which flows 50 miles downstream into Bristol Bay. The two forks of the Koktuli River and the UTC subbasins encompass approximately 355 square miles, representing approximately 0.9 percent of the

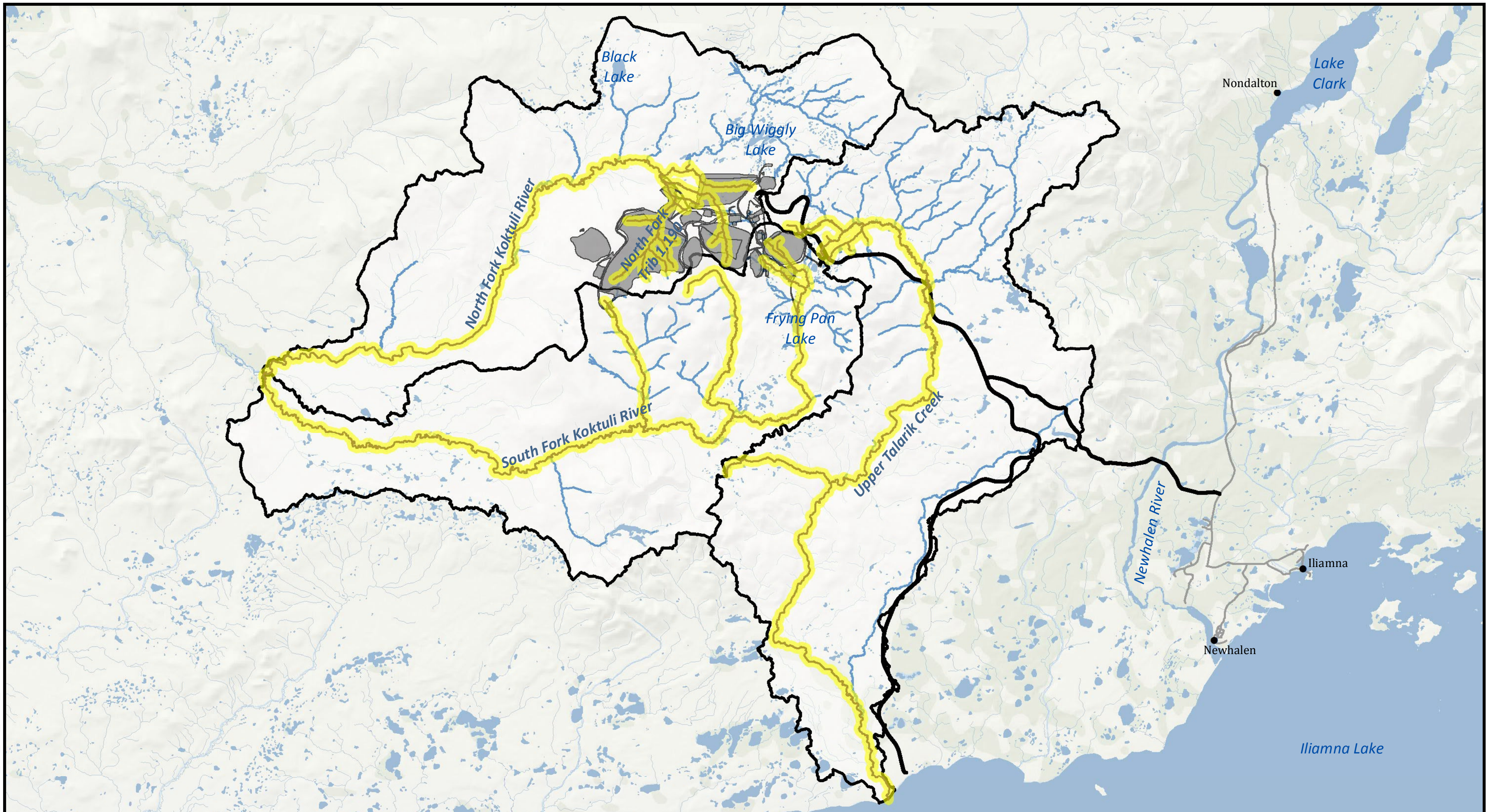
39,184-square-mile Bristol Bay watershed. The general characteristics and features of the NFK, SFK, and UTC drainage basins are described in Section 3.16, Surface Water.

North Fork Koktuli River

The majority of the mine site facilities would be in the NFK watershed, including the most of the tailings storage facility (TSF), pyritic TSF, water management ponds (main and open pit), millsite/camp, and water treatment plant #2 discharge location – north (Figure 3.24-1). The NFK River watershed extends northeast from the confluence with the SFK River to Groundhog Mountain, approximately 7 miles northeast of the mine site (Figure 3.24-1). The NFK drains 64.7 miles of currently documented anadromous stream channels, with a total basin area of about 113 square miles, which represent 0.3 percent of Bristol Bay's 39,184-square-mile watershed area. Approximately 23 percent of the NFK basin area and 8.3 miles of mainstem channel are upstream of tributaries 1.19 and 1.20 and the mine site footprint (Figure 3.24-1). The Alaska Department of Fish and Game (ADF&G) Anadromous Waters Catalog (AWC) (Johnson and Blossom 2018) lists 12 anadromous fish-bearing tributaries entering the NFK, including Tributary 1.19, which would contain the majority of the mine site footprint. More than 20 miles of fish-bearing stream channel would be blocked or filled by mine components, including approximately 7 miles of anadromous waters (see Section 4.24 for habitat loss details).

Mainstem base flows in the NFK at the mine site (just above the Tributary 1.19 confluence) were typically 15 to 20 cubic feet per second (cfs) in winter, and 40 cfs in summer, with Tributary 1.19 contributing another 4 to 5 cfs and 20 cfs in winter and summer, respectively.

Throughout most of its length, the mainstem NFK is a low-gradient (mostly 0.1 to 0.8 percent), unconfined, meandering, single-thread channel bordered by shrub and dwarf shrub riparian species dominated by willows (R2 et al. 2011a). Habitat typing, as listed in Table 3.24-1, shows that the mainstem NFK below the mine site is dominated by riffle habitat with few mainstem pools. Upstream of the mine site, the NFK contains equal proportions of riffle and run/glide habitats, with increasing frequency of beaver-formed pools in headwater reaches where mainstem flows are lower. The upper 10 miles of the NFK flow through a region with small (less than 3 acres) shallow lakes, dominated by Big Wiggly Lake (Figure 3.24-1).



Sources: HDR 2012

US Army Corps of Engineers®

2 0 2 4
Miles

Mine Site EIS Analysis Area
Alternative 1 Footprint
Water Basin

NORTH FORK KOKTULI, SOUTH FORK KOKTULI AND UPPER TALARIK BASINS

PEBBLE PROJECT EIS

FIGURE 3.24-1

Table 3.24-1: Frequency of Habitat Types in the NFK, SFK, and UTC Mainstem and Off-Channel Areas in the Mine Site Analysis Area[1]

Tributary	Mainstem Reach	Riffle	Run/Glide	Pool	Beaver Pond	Other[2] Off-Channel
NFK	A	0.64	0.35	0.01	0.00	N/A
	B	0.65	0.34	0.01	0.00	N/A
	C	0.56	0.42	0.02	0.00	N/A
	Off-Channel	N/A	N/A	N/A	0.85	0.15
SFK	A	0.65	0.32	0.03	0.00	N/A
	B	0.44	0.54	0.02	0.00	N/A
	C	0.27	0.64	0.05	0.04	N/A
	D	0.55	0.24	0.03	0.18	N/A
	Off-Channel	N/A	N/A	N/A	0.91	0.09
UTC	A	0.54	0.45	0.01	0.00	N/A
	B	0.53	0.44	0.03	0.00	N/A
	C	0.24	0.74	0.02	0.00	N/A
	D	0.16	0.77	0.07	0.00	N/A
	E	0.19	0.69	0.12	0.00	N/A
	F	0.20	0.51	0.22	0.07	N/A
	Off-Channel	N/A	N/A	N/A	0.93	0.07

Notes:
[1]Includes mileage from mainstem reaches adjacent to and downstream of the mine site and tributaries draining the mine site (Figure 3.24-1)
[2]Other off-channel habitats include beaver pond outlets, alcoves, isolated ponds, side channels, and percolation channels
N/A = Not Applicable
NFK = North Fork Koktuli
SFK = South Fork Koktuli
UTC = Upper Talarik Creek
Source: R2 et al. 2011a

Beaver ponds and other features are widely distributed in off-channel habitats throughout most of the NFK (Table 3.24-1). Off-channel habitats, which include side channels, percolation channels, alcoves, isolated ponds, riverine wetlands, and beaver ponds, are hydrologically connected to the NFK via surface flows or groundwater upwelling (for groundwater assessment, see Schlumberger 2011a). See Section 3.22, Wetlands and Other Waters, for a description of riverine wetlands in the analysis area.

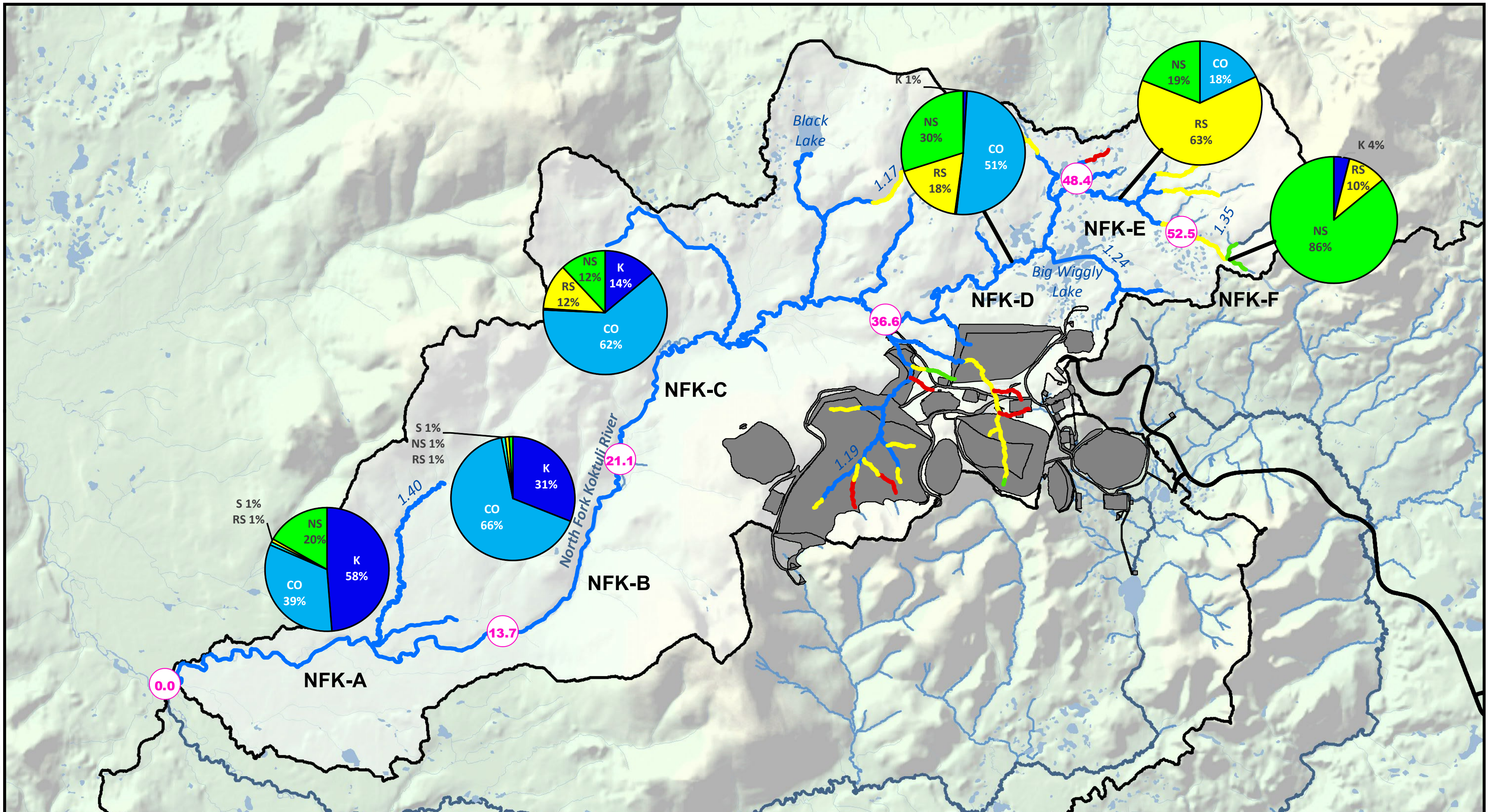
Instream cover for fish rearing is relatively scarce in the mainstem NFK due to the absence of large riparian trees and associated woody debris; but cobble substrates, undercut banks, and overhanging vegetation provide some refugia (R2 et al. 2011a). Small, woody debris and increased depths associated with beaver dams provide cover in many off-channel locations. Substrate is dominated by gravel, with low amounts of fine sediments (less than 10 percent) in reaches below the mine site. The prevalence of non-embedded gravel substrates and dominance of riffle and run/glide habitats provides spawning habitat for salmonids. A summary of anadromous and resident fish habitat for the NFK, SFK, and UTC is provided in Table 3.24-1. In contrast to the lower river, substrate in the mainstem above the mine site contained higher amounts of sand and silt derived from glacial lacustrine and lacustrine deposits underlying the Big Wiggly Lake basin (Schlumberger 2011a).

Chinook salmon (*Oncorhynchus tshawytscha*) spawning habitat occurs throughout the lower 20 miles of the NFK below the mine site (Figure 3.24-2), and extends into the upper NFK adjacent to Big Wiggly Lake. The majority of spawning habitat occurs in the first 10 miles of the NFK (NFK-A), approximately 20 miles downstream from the mine site (R2 et al. 2011a). Juvenile Chinook rearing habitat occurs throughout most of the NFK mainstem (Table 3.24-2), as well as several NFK tributaries, including Tributary 1.40 in the lower reach; Tributary 1.17 below Black Lake; Tributary 1.19 and its primary sub-tributary at the mine site; and Tributary 1.24, which flows through Big Wiggly Lake. Juvenile Chinook were most commonly observed in riffles and other mainstem habitats, but were also found to occupy low-velocity off-channel habitats.

Coho salmon (*O. kisutch*) spawning and rearing habitat is widely distributed in the NFK basin (Table 3.24-2). Preferred coho spawning habitat appears to be in the 10 miles of mainstem immediately downstream of the mine site (NFK-C), based on field observations (R2 et al. 2011a).

Sockeye salmon (*O. nerka*) spawning habitat primarily occurs in the lower 10 miles of the NFK (NFK-A), but the run extends upstream to the vicinity of Big Wiggly Lake (R2 et al. 2011a). Although some spawning habitat has been documented in the upper NFK basin, most juvenile rearing habitat occurs downstream of the mine site, based on field observations.

Fixed hydrologic station data and multiple surveys from 2004 to 2008 show that the mainstem NFK remains perennial during base flow levels at all fish-bearing study sites (R2 et al. 2011a). The NFK's seasonal hydrograph shows periods of maximum flows during spring snowmelt and late summer/fall rain events, with low flows during mid-summer, and minimum base flows in winter/early spring (Knight Piésold et al. 2011a). Mean monthly base flows in the lower reach of the NFK averaged 60 to 90 cfs during winter months (January-March), 700 cfs during spring snowmelt (May), 200 cfs during summer base flow (July), and 350 to 450 cfs during fall rains (September-October). All three tributaries (i.e., NFK, SFK, and UTC) display sequences of losing and gaining reaches due to groundwater percolation and emergence, respectively (Schlumberger 2011a, 2015a).



Sources: USGS; ADF&G; Pebble (R2 et al. 2011)

US Army Corps of Engineers

1 0 1 2
Miles

Fish Distribution and Relative Composition

- Anadromous Salmonids (K=Chinook, CO=Coho, S=Sockeye)
- Resident (non-anadromous) Salmonids (RS)
- Non-Salmonid Fish (NS)
- No Fish Observed

- Mainstem Reaches with River Mile
- Alternative 1 Footprint
- Water Basin

NORTH FORK KOKTULI
FISH DISTRIBUTION AND RELATIVE COMPOSITION

PEBBLE PROJECT EIS

FIGURE 3.24-2

Groundwater studies indicate that surface waters percolating into the NFK groundwater remain in the NFK subbasin, and do not transfer to either the SFK or UTC subbasins (Schlumberger 2011a). Emerging groundwater is important to aquatic species due to its cooling effect on mainstem flows during summer, its warming effect during winter, and its direct relationship with spawning site selection for several salmonid species. Areas of groundwater upwelling are most evident in the mainstem NFK downstream of the mine site, in a reach 15 to 20 miles upstream of its confluence with the SFK. Seasonal hydrographs for several reaches of the mainstem NFK are presented in Section 3.16, Surface Water Hydrology.

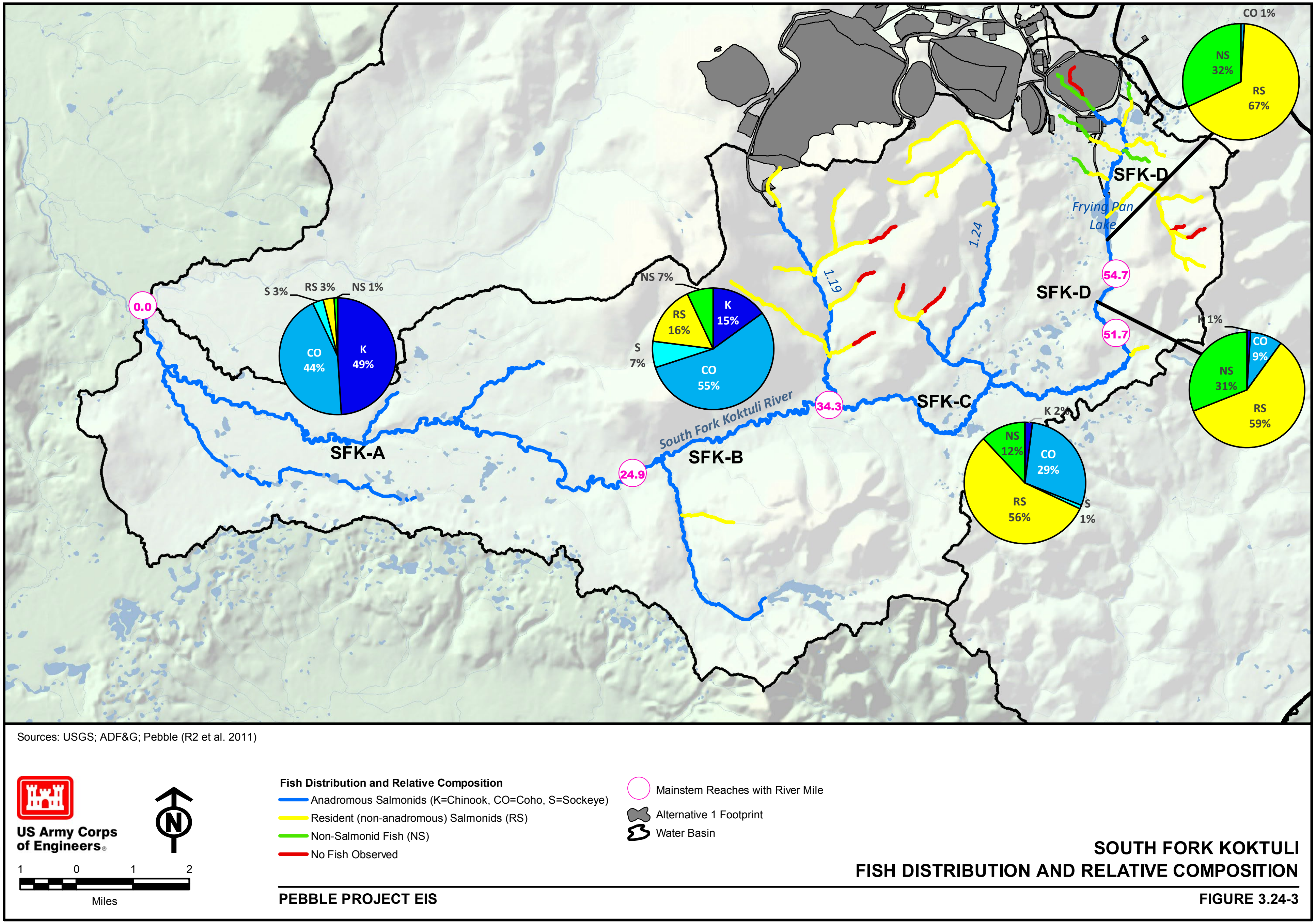
The observed water temperatures in the NFK ranged from a low of 0.3 degrees Celsius (°C) to a maximum of 21.9°C (R2 et al. 2011a). Water temperatures in the NFK downstream of the mine site generally remain cool during the summer and cold during winter months, with mean daily temperatures typically between 10°C and 15°C during July and August. However, maximum summer water temperatures did exceed the Alaska Department of Environmental Conservation (ADEC) 15°C criteria for aquatic life and fish life-stages (ADEC 2018b) at some locations in the upper basin. For a more detailed description of surface and groundwater baseline conditions, see Section 3.16, Surface Water; Section 3.17, Hydrogeology; and Section 3.18, Water and Sediment Quality.

Tributary 1.190 and Sub-tributaries

Tributary 1.190 and it's sub-tributaries to the NFK would contain the majority of the mine site footprint. These streams are incised coarse gravel, cobble, and boulder bed stream flowing through moraine and colluvial deposits with heavily vegetated banks, and a slope of 2 to 3 percent that drains approximately 8 square miles. It is a first-order stream characterized by flashy runoffs during snowmelt and rainstorm events due to higher precipitation, steep catchment in the surrounding uplands, full exposure to incoming storms, and lack of surface flow losses to groundwater in the lower reaches. Channel habitat features are dominated by short rapids/riffle reaches and irregularly spaced scour pools. Documented anadromous fish habitat use includes rearing habitat for Chinook salmon, and rearing and spawning for coho salmon. Resident fish species include Arctic grayling (*Thymallus arcticus*), Dolly Varden (*Salvelinus malma*), rainbow trout (*O. mykiss*) and slimy sculpin (*Cottus cognatus*).

South Fork Koktuli River

The SFK extends approximately 40 miles upstream from the confluence with the NFK to the headwaters, including 60.0 miles of documented anadromous stream habitat and a 107-square-mile drainage area, representing 0.3 percent of the Bristol Bay watershed (Figure 3.24-1). Approximately 18 percent of the mine site footprint occurs in the headwaters of the SFK basin, including the mine pit, overburden stockpile, pit water management and treatment facilities, and miscellaneous facilities (Figure 3.24-3). These mine site components would occupy approximately 1.9 square miles of the upper watershed, or 1.8 percent of the SFK basin area. The mine pit and associated sediment pond embankment are expected to capture or block approximately 1.4 miles of stream channel known to support resident fish habitat.



SOUTH FORK KOKTULI
FISH DISTRIBUTION AND RELATIVE COMPOSITION

FIGURE 3.24-3

Like the NFK, the SFK is a low-gradient (0.03 to 0.6 percent), riffle- and shrub-dominated meandering stream with an abundance of off-channel habitat (R2 et al. 2011a), especially in the lower 20 miles downstream of the mine site where the floodplain broadens (Table 3.24-1). Stream gradient increases in the uppermost 1.5 miles, just downstream and into the footprint of the mine pit. Small, shallow lakes are common adjacent to the mainstem channel in the upper 10 miles of the watershed. The low-gradient and gravel-dominated substrate of the mainstem SFK below the mine site provides spawning and rearing habitat for resident and anadromous salmonids. Gravel quality is suitable for spawning and egg incubation, although the proportion of fines in the mainstem substrate is somewhat higher than in the NFK and UTC basins. The lack of large riparian tree species along the SFK mainstem yields little large, woody debris cover; but undercut banks, overhanging vegetation, instream cobbles, and beaver-related small, woody debris are available as cover for rearing fish.

Streamflow patterns in the SFK reflect those in the NFK, with two base-flow periods (summer post-snowmelt and winter) and two high-flow periods (spring snowmelt and fall rain events). Unlike the NFK, the mainstem SFK has a 10-mile reach from 2 miles below Frying Pan Lake to SFK Tributary 1.19 that frequently exhibits zero or intermittent flows during winter and summer months (R2 et al. 2011a). Dry or intermittent conditions were observed in this reach during January (2008, 2009), February (2006 – 2009), March (2005-2008, 2010, 2012), April (2007, 2008) and May (2012), as well as in July (2007), August (2004, 2005, 2007), and September (2004, 2007) (Knight Piésold 2011g). The duration of intermittent flows varied among years, but sometimes persisted for multiple months in winter and early spring, and up to 40 consecutive days in August to early September 2007 (R2 et al. 2011a). Loss of surface flow in this reach is due to thick, permeable glacial deposits and an average transfer of 22 cfs from the SFK basin into the UTC basin via groundwater exchange. Groundwater remaining in the SFK basin reemerges at the downstream end of the dry reach 20 miles above the NFK confluence (Knight Piésold et al. 2011a).

Chinook salmon spawning habitat has been documented from the SFK/NFK confluence upstream to Frying Pan Lake (Table 3.24-2, Figure 3.24-3), although more recent sampling indicated preferred spawning habitat occurs in the lower 20 miles of the SFK (reaches SFK-A and B) (R2 et al. 2011a). As noted above, the mainstem SFK between SFK Tributary 1.19 and the Frying Pan Lake outlet routinely dries up during base-flow periods; consequently, that reach is not considered quality habitat. Chinook habitat does not extend into the upper SFK basin above Frying Pan Lake or in the footprint of the mine site. However, rearing habitat occurs throughout the mainstem below Frying Pan Lake, and in the lower 4 miles of SFK Tributary 1.19, which drains the southern side of Kaskanak Mountain.

Coho spawning habitat in the mainstem SFK extends almost up to the outlet of Frying Pan Lake, although spawning habitat is limited in the middle intermittent reach. Most spawning habitat was observed via aerial surveys in the lower 20 miles of the mainstem (Figure 3.24-3, reaches A and B), and in two tributaries: SFK 1.13 and SFK 1.19 (R2 et al. 2011a). Juvenile coho rearing habitat occurs throughout the SFK basin, including the mainstem, tributaries, and headwaters upstream of Frying Pan Lake. Juvenile coho in the SFK routinely use off-channel habitats, including beaver ponds, side channels, and alcoves. Juvenile coho overwintering habitat has been documented in reaches SFK-A and SFK-B.

Sockeye salmon spawning habitat is limited to lower reaches SFK-A, SFK-B and SFK-C, and rearing habitat occurs throughout the SFK (Figure 3.24-3).

Table 3.24-2: Estimated Mileage of Habitat for Pacific Salmon and Rainbow Trout in Tributaries in the Mine Site Analysis Area[1]. (Numbers in parenthesis are percentages of total known anadromous habitat (miles) within subbasin[2]).

Subbasin	Species	Spawning (mi)[3]	Rearing (mi)[3]	Present (mi)[3]
NFK	Chinook salmon	21.4 (33%)	24.8 (38%)	0.6 (1%)
NFK	Coho salmon	26.4 (41%)	28.8 (44%)	0.2 (0%)
NFK	Sockeye salmon	22.5 (35%)	18.2 (28%)	0
NFK	Chum salmon	19.5 (30%)	4.8 (7%)	0
NFK	Pink salmon	0	0	0
NFK	Rainbow trout[4]	N/A	N/A	27
SFK	Chinook salmon	30.0 (50%)	32.1 (53%)	1.4 (2%)
SFK	Coho salmon	31.6 (53%)	43.4 (72%)	4.3 (7%)
SFK	Sockeye salmon	19.4 (32%)	24.4 (41%)	9.0 (15%)
SFK	Chum salmon	19.2 (32%)	1.9 (3%)	2.3 (4%)
SFK	Pink salmon	0	0	0
SFK	Rainbow trout[4]	N/A	N/A	19
UTC	Chinook salmon	31.0 (41%)	24.6 (32%)	2.7 (4%)
UTC	Coho salmon	34.8 (46%)	35.6 (47%)	0
UTC	Sockeye salmon	32.5 (43%)	30.9 (41%)	1.1 (1%)
UTC	Chum salmon	52.0 (68%)	0	2.1 (3%)
UTC	Pink salmon	N/A	N/A	4.0 (5%)
UTC	Rainbow trout[4]	N/A	N/A	42

Notes:
[1] Includes mileage from mainstem reaches adjacent to and downstream of the mine site and tributaries draining the mine site (Figure 3.24-1)
[2] Total anadromous mileages per subbasin are 64.7 miles in NFK, 60.0 miles in SFK, and 76.2 miles in UTC
[3] Includes AWC (Johnson and Blossom 2018) listing as "spawning" or "rearing"; lakes not included; additional waters listed as species "present" but not specified by life stage
[4] Stream mileage based on highest reported rainbow trout observation in AWC (Johnson and Blossom 2018) (life-stages not specified)
AWC = Anadromous Waters Catalog
N/A = Not Applicable
NFK = North Fork Koktuli
SFK = South Fork Koktuli
UTC = Upper Talarik Creek

Chum (*O. keta*) spawning habitat is limited to the lower 20 miles of the river, downstream of the seasonally dry channel (Table 3.24-2). Adult chum salmon appear to target areas of rising groundwater during redd site selection; consequently, the highest densities of chum salmon redds occurred in the reach immediately downstream of the dry channel (SFK-C), where accretion of groundwater is most evident (R2 et al. 2011a). Rainbow trout habitat occurs in several reaches of the SFK, including upstream of Frying Pan Lake and tributaries; however, densities of this species were lower than for other resident salmonids (R2 et al. 2011a).

Water temperature in the SFK ranged from an observed low of 0.7°C to a maximum of 24.4°C. Similar to the NFK, water temperatures tended to be warmer in the upper watershed, where lakes are prevalent; and cooler in the lower reaches, due to emerging groundwater (R2 et al. 2011a). Average daily temperatures during July and August were typically 13°C to 16°C in the upper half of the SFK mainstem, but only 8°C to 12°C below the intermittent reach. Maximum summer water temperatures exceeded the ADEC 15°C criteria for aquatic life and fish life-stages (ADEC 2018b) at several water quality stations in the upper SFK.

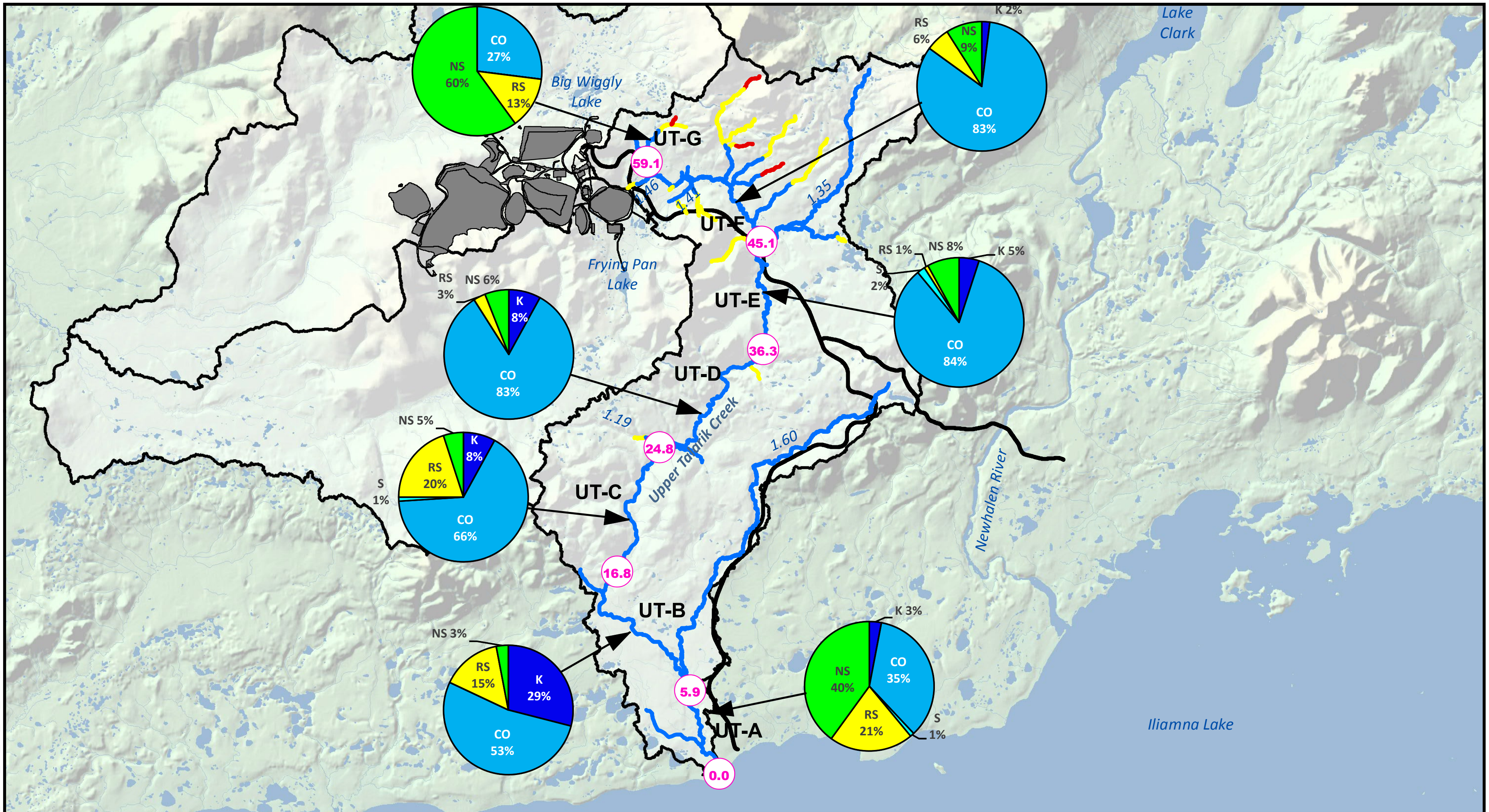
Upper Talarik Creek

UTC flows south approximately 39 miles from its headwaters on the eastern edge of the mine site downstream into Iliamna Lake near the town of Iliamna (Figure 3.24-4). The UTC watershed contains 76.2 miles of documented anadromous habitat in a 135-square-mile watershed, which represents 0.3 percent of the entire Bristol Bay watershed area. Mine site facilities in the UTC basin would be limited to the mine access road and a water treatment discharge pipe, or less than 0.5 percent of mine site footprint. However, the eastern edge of the mine pit is at the SFK and UTC watershed boundary; consequently, the mine pit (primarily through pit dewatering) and associated roads and facilities, could affect aquatic habitat in the UTC. Stream channel gradient is steeper in the UTC, compared to the NFK and SFK, at less than 1 percent to 2 percent (R2 et al. 2011a). Aquatic habitat in the UTC varies from riffle-dominated to run/glide-dominated reaches, with relatively few mainstem pools (Table 3.24-1). The upper reach and much of the lower reach of the UTC possess relatively wide floodplain, with associated off-channel habitat; but the middle reach is more confined, and largely restricted to a single channel. Unlike the NFK and SFK, this middle reach of the UTC is forested, which contributes large, woody debris into the stream channel (R2 et al. 2011a); whereas shrub and dwarf shrub species (including willows [*Salix* spp.]) dominate the upper and lower reaches of the UTC. In addition to large, woody debris, undercut banks, overhanging vegetation, and small, woody debris associated with beaver dams also provide instream and overhead cover. The UTC mainstem contains an abundance of gravel substrate relatively free of fine sediments, providing spawning habitat.

Chinook salmon spawning and rearing habitat is interspersed throughout the entire length of the 39-mile mainstem UTC; however, Chinook spawning habitat in UTC tributaries is limited to a very short reach of UTC Tributary 1.41, and in UTC Tributary 1.19, which receives groundwater flow from the SFK (R2 et al. 2011a). Juvenile Chinook rearing habitat was observed in mainstem habitat features such as run/glide, pool, and riffles in reaches UT-C through UT-E; juvenile Chinook overwintering habitat has been documented in reaches UT-C, UT-D, and UT-E of the UTC (Figure 3.24-4).

Coho salmon spawning habitat extends almost the entire length of the mainstem UTC and into several tributaries (UTC tributaries 1.60, 1.35, 1.31, and 1.41). The distribution of juvenile coho was similar to that for spawning, with the addition of several minor tributaries. Densities of juvenile coho were generally similar in mainstem and off-channel habitat; and maximum densities were observed in UTC Tributary 1.41, which drains the western side of the upper basin immediately proximal to the mine pit (R2 et al. 2011a). Coho were observed in November, and again the following April, in reaches UT-D through UT-F, suggesting these reaches may provide overwintering habitat (Figure 3.24-4).

Sockeye spawning habitat has been documented in most of the mainstem UTC up to the headwaters bordering the mine site; and also encompassed several tributaries, including 1.60, 1.90, 1.35, 1.39, and 1.41 (Table 3.24-2). Although the spawning habitat is widespread in the UTC, preferred spawning habitat occurs in reaches UTC-A (R2 et al. 2011a); and in Tributary 1.60, where up to 43 percent of the UTC sockeye run spawned in 2008 (Figure 3.24-4). Sockeye rearing habitat is also widespread in the UTC basin, although field observations indicate habitat is somewhat limited in the mainstem and tributaries, likely due to the early emigration of juveniles into Iliamna Lake. Rainbow trout use multiple habitats, including riffle, glides, pools, and beaver ponds throughout all reaches of the UTC.



Sources: USGS; ADF&G; Pebble (R2 et al. 2011)

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Miles

Fish Distribution and Relative Composition

- Anadromous Salmonids (K=Chinook, CO=Coho, S=Sockeye)
- Resident (non-anadromous) Salmonids (RS)
- Non-Salmonid Fish (NS)
- No Fish Observed
- Mainstem Reaches with River Mile
- Alternative 1 Footprint
- Water Basin

UPPER TALARIK
FISH DISTRIBUTION AND RELATIVE COMPOSITION

PEBBLE PROJECT EIS

FIGURE 3.24-4

The annual hydrograph for the UTC shows the two high-flow and two base-flow periods, similar to the NFK and SFK (Knight Piésold et al. 2011a). An exception is UTC Tributary 1.19, which receives groundwater accretion from the SFK. Mean monthly streamflows in this tributary were consistently 20 to 30 cfs throughout the year. The groundwater inflow from Tributary 1.19 also reduced water temperatures in the lower mainstem UTC, which generally remained below 10°C. Measured water temperatures in the UTC ranged from a low of 2.5°C to a maximum of 18.8°C (R2 et al. 2011a). Although summer water temperatures did sometimes exceed the ADEC 15°C criteria for aquatic life and fish life-stages (ADEC 2018b), summer water temperatures in the UTC were generally 3°C to 5°C cooler than comparable temperatures in the NFK and SFK, due in part to the abundance of groundwater emergence and the relative lack of inflow from warm, shallow lakes.

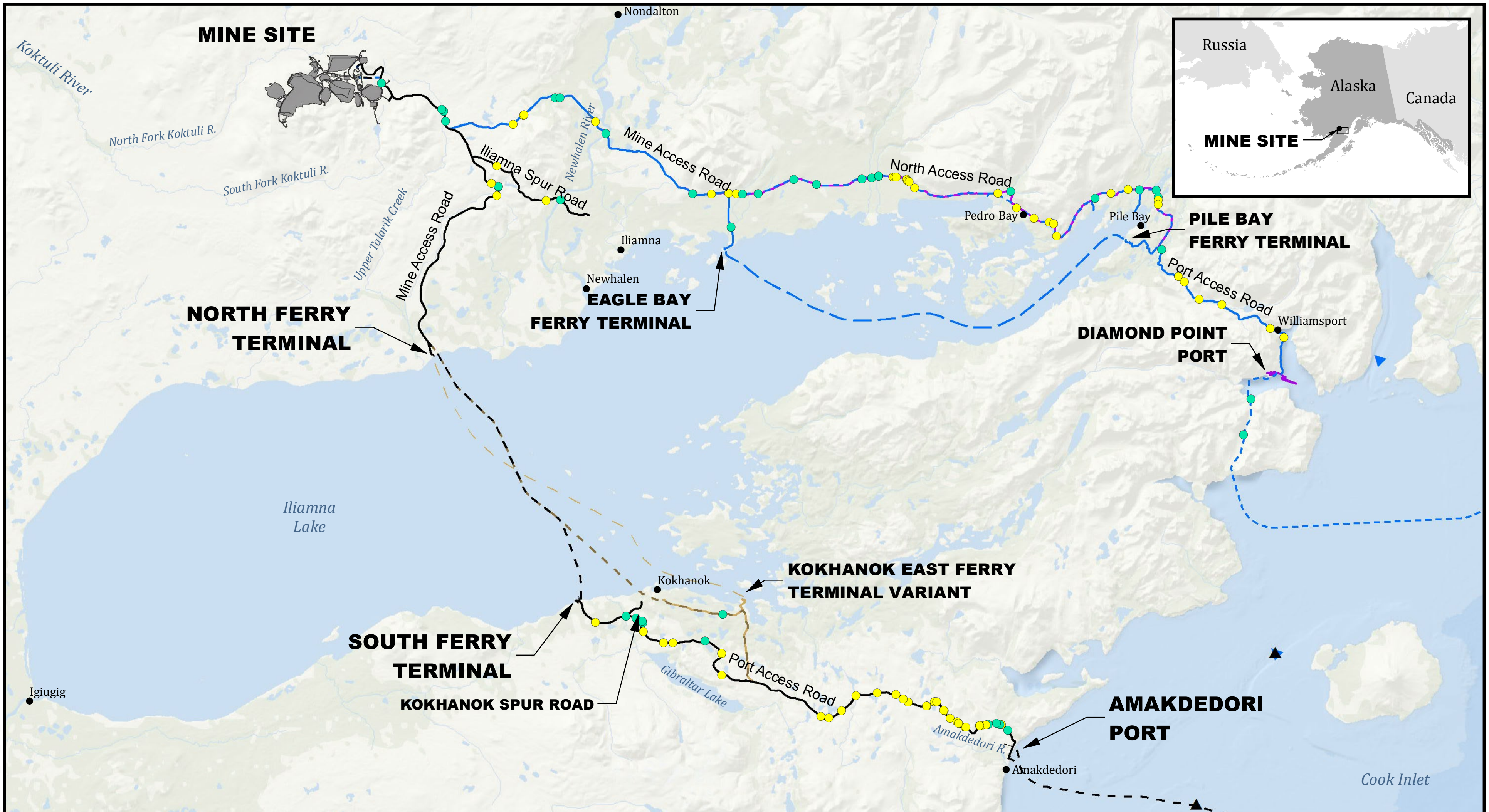
Transportation and Natural Gas Pipeline Corridors

The EIS analysis area for the transportation and natural gas pipeline corridors and port location includes all aquatic habitats within 0.25 mile of the proposed infrastructure, and all habitats within 1,000 feet of blasting areas (Figure 3.24-5). This is the area where potential effects are likely to occur from construction and operations under all alternatives. The corridor, including mine access and port access roads, would cross a total 44 waterbodies documented to support fish.

Table 3.24-3 lists the 16 anadromous streams that would be crossed by the access roads from the mine site to Amakdedori port.

Mine Access Road

The mine access road, including the Iliamna spur road, would cross 16 waterbodies documented to support fish, 6 of which are classified as anadromous fish habitat (Figure 3.24-5, Table 3.24-3). The road would cross the major drainages of UTC and the Newhalen River. As previously described, the UTC and tributaries support spawning, rearing, and migratory habitat for all five species of Pacific salmon and resident fish species. The Newhalen River provides important migratory fish habitat for sockeye and Chinook salmon migrating between Iliamna Lake and Lake Clark. Chinook salmon spawning habitat has been documented 0.75 mile downstream from the Newhalen River crossing. Tributaries of the Newhalen River upstream of the crossing provide spawning and rearing habitat for both resident and anadromous species. Arctic char (*Salvelinus alpinus*) are also known to inhabit the Newhalen River between Six Mile Lake and Iliamna Lake. The species and life-stages known to occur at each crossing location were identified from AWC listings or recent field sampling by Pebble Limited Partnership (PLP 2018b).



Sources: PLP 2018; ADF&G; ADNR

Stream Crossings	Alternative 1	Kokhanok East Ferry Terminal Variant	Alternative 2	Alternative 3
Anadromous Fish	Lightering Locations	Transportation Corridor	Lightering Location	Transportation Corridor
Resident Fish	Transportation Corridor	Ferry Route	Transportation Corridor	Port Site
	Natural Gas Pipeline	Natural Gas Pipeline	Ferry Route	
	Ferry/Port Site	Ferry Terminal	Natural Gas Pipeline	
	Mine Site			

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Miles

TRANSPORTATION CORRIDOR FISH STREAM CROSSINGS

PEBBLE PROJECT EIS

FIGURE 3.24-5

Table 3.24-3: Anadromous Waters Crossed by Access Roads and Pipeline along the Alternative 1 Transportation and Natural Gas Pipeline Corridor

Road	Tributary[1]	AWC Code	R.M.[2]	Feature	Species/Life-stage[3]
Mine Access Road	UTC 1.36	324-10-10150-2183-3057	0.4	culvert	COr
Mine Access Road	UTC mainstem	324-10-10150-2183	17	bridge	Ks, Kr, Ss, Sr, COs, COr, CHs, Pp
Mine Access Road	UTC 1.34	324-10-10150-2183-3050	0.1	culvert	COr
Mine Access Road	UTC 1.60 (2 crossings)	324-10-10150-2183-3010	14	Bridge + culvert	COs
Mine Access Road (Iliamna Spur)	Newhalen River	324-10-10150-2207	9	bridge	Kp, Ss, COp
Port Access Road	Gibraltar River	324-10-10150-2196	1.2	bridge	Ss, COp, CHs, ACp
Port Access Road	trib to Gibraltar River	N/A[4]	N/A	culvert	COr
Port Access Road	trib to Gibraltar River	N/A[4]	N/A	culvert	COr
Port Access Road	trib to Gibraltar River	N/A[4]	N/A	bridge	COr
Port Access Road	trib to 324-10-10150-2206	N/A[4]	N/A	bridge	COr
Port Access Road	N/A	N/A[4]	N/A	culvert	COr
Port Access Road	N/A	N/A[4]	N/A	culvert	COr
Port Access Road	trib to Amakdedori Creek	243-40-10010-2008	2.2	bridge	Ss, COs
Port Access Road	trib to 243-40-10010-2008	N/A[4]	<0.1	culvert	COr
Port Access Road	trib to 243-40-10010-2008	N/A[4]	0.6	culvert	COr
Port Access Road (Kokhanok East Variant section only)	trib to Kokhanok Bay	324-10-10150-2206	1.0	bridge	Ss, ACp

Notes:
[1] Tributary name from R2 et al. 2011a, if available
[2] R.M. = river miles at crossing above mouth or confluence of tributary (approx.); n/a = distance unknown, channel not defined on map
[3] Species/Life-stage at crossing from AWC or PLP sampling. Species: K=Chinook, S=sockeye, CO=coho, CH=chum, P=pink; AC=Arctic char; Life-stage: s=spawning, r=rearing, p=present (life-stage not specified)
[4] New observation not listed in AWC at time of writing; lifestage based on species observation
AWC = Anadromous Waters Catalog
N/A = Not Applicable
UTC = Upper Talarik Creek

In addition to the channel crossings listed above (Table 3.24-3), two additional anadromous tributaries to UTC occur within 0.25 mile of the mine access road corridor or project facilities, and could be affected by mine operations (UTC tributaries 1.46 and 1.35).

Iliamna Lake

Iliamna Lake is a large lake with a surface area of 1,012 square miles. Iliamna Lake and its numerous tributaries provide spawning and rearing habitat for all five species of Pacific salmon and resident salmonid species, including Dolly Varden and rainbow trout. Major tributaries associated with the project area include the Newhalen River, UTC, and the Gibraltar River. The western half of Iliamna Lake is wide, with linear margins and few islands; whereas the eastern half (particularly the far northeastern end) has a contorted shoreline with an abundance of bays, islands, and rocky shoals. The majority of tributaries, including those supporting anadromous species, enter Iliamna Lake on the northern shoreline and surrounding the eastern basin, including Kokhanok Bay; tributaries are relatively uncommon on the western shoreline.

Geomorphic studies conducted in 2018 describe beaches and nearshore lake habitats of the terminal locations (Paradox 2018b). The north ferry terminal site is characterized by a wide, gently sloping sand/gravel beach. Beach slopes averaged 13 to 18 percent at three measured transects; substrate consists of sand and rounded gravel with some cobbles at depth. The south terminal site consists of a gravel beach backed by a 20- to 30-foot bluff that transitions to a boulder beach at the bedrock point to the east. Average gradients at the three transects range from 11 to 17 percent. A small stream to the west of the terminal infiltrates the gravelly beach and provides a potential source of upwelling groundwater in the lake. Physical characteristics of Iliamna Lake are described in Section 3.16, Surface Water Hydrology.

Of the anadromous salmonids, sockeye is the most common species in Iliamna Lake, where they are known to use shoreline habitat for spawning (EPA 2014), particularly in the northeastern portion of the lake (Figure 3.24-5). Juveniles also immigrate to the lake from spawning tributaries to use lacustrine rearing habitats, particularly in the eastern half of the lake. Iliamna Lake is also heavily used by rainbow trout, which use a variety of lake habitats for summer foraging (PLP 2018b; Minard et al. 1992).

Port Access Road

The port access road would extend from the south ferry terminal on the southern shore of Iliamna Lake to Amakdedori port, and includes eight material sites (Figure 3.24-5). The port access road would cross 39 fish-bearing streams, 10 of which are anadromous fish habitat (Table 3.24-3). The first would be a multi-span bridge over the Gibraltar River approximately 1.2 miles upstream of where it flows into Iliamna Lake. The Gibraltar River and Gibraltar Lake drainage and tributaries provide spawning and rearing habitat for sockeye, coho, chum, Arctic char, whitefish, and other resident species, including Dolly Varden and lake trout (*S. namaycush*). No stream crossings would occur on the 1.4-mile spur road that connects the south access road to the town of Kokhanok. In addition to the streams crossed by the port access road and pipeline, the lower mainstem Amakdedori Creek passes within 0.25 mile of the port facilities.

Kokhanok East Ferry Terminal Variant

This variant brings the ice-breaking ferry to a terminal in the more protected waters of Kokhanok Bay, approximately 10 miles east of the south terminal (Figure 3.24-5). The ferry route would pass within 0.2 to 1.5 miles of several islands and Lookout Peninsula, over depths mostly between 60 and 150 feet. The shoreline of this variant location is generally rocky and deepens rapidly, suggesting that it is unlikely to be preferred spawning habitat (PLP 2018-RFI 078). The pipeline corridor in Iliamna Lake would mostly follow the same path as Alternative 1, but would come ashore east of Kokhanok, joining a road corridor extending east 5.4 miles to the ferry terminal variant, then south 6 miles to join the Alternative 1 route to Amakdedori port, 21 miles to the east. The variant portion of the road and pipeline corridor would cross seven non-anadromous channels requiring culverts, and one bridge crossing an anadromous stream supporting sockeye salmon spawning and the presence of Arctic char. The road and pipeline route is six miles shorter, and would avoid 18 crossings that occur under Alternative 1, including six channels with resident fish species, and five channels with anadromous fish, and the bridge crossing over the Gibraltar River.

Cook Inlet Portion of Natural Gas Pipeline Corridor

Cook Inlet is a semi-enclosed estuary in southcentral Alaska that extends northeast approximately 180 miles from the Gulf of Alaska north to Anchorage. Cook Inlet is fed by a wide variety of rivers, the largest being the Susitna River at the northern end of the inlet, and the Kenai River draining into the middle reach of the inlet. The substrate composition of Cook Inlet is mostly mudflats along the margins, with sand, clay, pebbles, and cobbles farther offshore. Rocky outcrops and shoals occur in many areas, especially in association with bays and islands. An assessment of nearshore substrate composition between Cook Inlet and Shelikof Strait showed extensive boulder armoring, with approximately 49 percent exposed rocky shore, 31 percent mixed sand and gravel, 12 percent gravel beaches, 3 percent exposed tidal flats, and 2 percent coarse-grained sand (BOEM 2016). General flow patterns include a net inflow along the eastern side of the inlet, including the Alaska Coastal Current, with net outflow along the western side (Burbank 1977). Inflow of turbid glacial streams generally produces low visibility, particularly in proximity to river mouths and along the western outflow. Cook Inlet is subject to large tidal fluctuations (up to 40 feet), which results in strong rips and currents in many locations. Winter temperatures result in extensive ice formation in the upper inlet and in isolated bays, with maximum ice coverage in January; breakup typically occurs between March and May.

The natural areas of Cook Inlet most likely to be affected by the pipeline are the Lower Cook Inlet central zone and Kamishak Bay (Science Applications, Inc. 1977). The lower central zone is defined as the region north of the Barren Islands between Kamishak and Kachemak bays, and south of a line from Anchor Point to Chinitna Bay. This zone is an area dominated by tidal circulation, with mostly poorly sorted sands as bottom sediments (Science Applications, Inc.1977). Approximately half of the 104-mile pipeline route would traverse depths of 200 feet or more, with a substrate largely composed of sand, shells, and pebbles.

Amakdedori Port

The Amakdedori port would be in the central portion of Kamishak Bay, which is a relatively shallow, rocky bay with low-energy tidal circulation (Science Applications, Inc. 1977). The southward net transport of water from upper Cook Inlet along the western shore carries heavy loads of suspended matter into Kamishak Bay. This transportation of water also results in the movement of drift ice, which forms in the shallow tidal flats of upper Cook Inlet, into Kamishak Bay. The drift ice thoroughly scours extensive stretches of the intertidal zone, resulting in relatively poor development of eelgrass beds (Science Applications, Inc. 1977). Rocky substrates (intertidal reefs and subtidal rocky substrate) occur along a substantial portion of the shorelines of Kamishak Bay, and on many offshore reefs and islets (GeoEngineers 2018b,c). Rock is the dominant substrate into the intertidal zone. Mud or other unconsolidated sediments composing beaches extend from the toe of the rocky habitat down into the subtidal zone.

Amakdedori Beach has a number of distinct reef complexes that occur in the vicinity of the port site, with varying proximity to the mainland nearshore environment. These range from rock reefs immediately adjacent to land (North Reef), to detached; but near the mainland (Thumb and Thumbnail) to offshore (Palmaria Plains and No Name). In the immediate vicinity of the port site is a moderate-gradient sand-gravel beach extending for approximately 5 miles (GeoEngineers 2018b,c). The environmental sensitivity index is defined as mixed sand and gravel beaches; and the coastal class is sand and gravel flat fan and/or narrow sand and gravel beach (NOAA 2018g).

The backshore is composed of a storm berm formed by large, woody debris with a broad flat riparian upland composed primarily of dune grass transitioning to low/dwarf shrub vegetation (GeoEngineers 2018b, 2018c). A substantial sandy-silt flat is present immediately south of the mouth of Amakdedori Creek. Along the periphery of the beach (north, south, and offshore) lie extensive intertidal and subtidal reefs that extend as much as 8 miles offshore, with gaps of deeper subtidal habitat mostly less than 30 feet between them. These reef habitats support dense marine macrovegetation dominated by rockweed, red algae, and kelps. The nearest documented eelgrass (*Zostera* spp.) bed to the Amakdedori port location is in a small cove about 4.4 miles south (NOAA 2018h).

Subtidal habitats are composed primarily of sand, cobbles, boulders, and bedrock. South of Amakdedori is an extensive reef complex dominated by Nordyke Island and Chenik Head Reefs (GeoEngineers 2018b, 2018c). The rocky shores of Nordyke Island and the large reef systems to north, east, and south of the islands include a complex of conglomerate rock with lower-elevation intrusions of sandstone, providing a variety of elevations and exposures. Broad reefs are also found south of Chenik Head into Amakdedulia Cove. Between Chenik Head and Nordyke Island, the subtidal habitat consists of mixed fines. North Reef is an extended reef system that starts at the northern end of Amakdedori Beach, and continues to Contact Point. The area of reef most proximal to the project is the southern periphery of the reef adjacent to the broad cobble-gravel habitat of Amakdedori Beach.

3.24.1.2 Resident and Anadromous Fishes

This section describes fish species that have the potential to occur in the EIS analysis area. Expected periodicity for each species and life-stage in the project area is shown in Table 3.24-4. Other fish life history characteristics are available through the ADF&G fish webpages (ADF&G 2018u). For a description of Bristol Bay and Cook Inlet commercial fisheries, refer to Section 3.6, Commercial and Recreational Fisheries.

Mine Site

North Fork Koktuli River

Chinook salmon, coho salmon, sockeye salmon, and chum salmon have been documented in the NFK watershed (Johnson and Blossom 2018). Pink salmon (*Oncorhynchus gorbuscha*) are documented in the mainstem Koktuli River and the UTC, but do not occur in the NFK. Other species found in the NFK watershed include rainbow trout, Dolly Varden, Arctic grayling, threespine stickleback (*Gasterosteus aculeatus*), ninespine stickleback (*Pungitius pungitius*), sculpins (including species such as slimy and coast range sculpin [*Cottus aleuticus*]), northern pike (*Esox lucius*), and whitefish (various species, including round whitefish [*Prosopium cylindraceum*], humpback whitefish [*Coregonus pidschian*], and least cisco [*Coregonus sardinella*]). The approximate stream mileage listed in the AWC (Johnson and Blossom 2018) for anadromous species and rainbow trout in the NFK by life-stage is given in Table 3.24-2. The relative distribution and composition of anadromous and resident salmonid species, based on AWC data (Johnson and Blossom 2018) and 2004-2008 Environmental Baseline Document s(EBD) (R2 et al. 2011a), is shown in Figure 3.24-2. Blue channels represent anadromous waters; yellow channels contained resident salmonids (RS), but anadromous fish were not recorded; green channels only contained resident non-salmonid fish species (NS). Red channels represent sampled stream reaches where no fish were captured or observed. Note that resident salmonids and non-salmonids generally occurred throughout the distribution of anadromous species.

Table 3.24-4: Estimated Life-Stage Periodicities of Select Fish Species in NFK, SFK, and UTC Waterbodies

Species[1]	Life Stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chinook salmon	Adult Migration							■	■				
	Spawning							■	■				
	Fry Emergence				■	■							
	Juvenile Rearing	■	■	■	■	■	■	■	■	■	■	■	■
	Outmigration				■	■	■						
Coho salmon	Adult Migration								■	■	■		
	Spawning								■	■	■	■	
	Fry Emergence				■	■							
	Juvenile Rearing	■	■	■	■	■	■	■	■	■	■	■	■
	Outmigration				■	■	■						
Sockeye salmon	Adult Migration							■	■	■			
	Spawning							■	■	■	■	■	
	Fry Emergence				■	■							
	Juvenile Rearing	■	■	■	■	■	■	■	■	■	■	■	■
	Outmigration				■	■	■						
Chum salmon	Adult Migration						■	■					
	Spawning							■	■				
	Fry Emergence				■	■							
	Juvenile Rearing				■	■							
	Outmigration				■	■							
Pink salmon	Adult Migration							■	■	■			
	Spawning							■	■	■			
	Fry Emergence				■	■							
	Juvenile Rearing												

Table 3.24-4: Estimated Life-Stage Periodicities of Select Fish Species in NFK, SFK, and UTC Waterbodies

Species[1]	Life Stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Outmigration				■	■							
Rainbow trout	Adult Rearing	■	■	■	■	■	■	■	■	■	■	■	■
	Spawning					■	■						
	Fry Emergence							■	■	■			
	Juvenile Rearing	■	■	■	■	■	■	■	■	■	■	■	■
Dolly Varden	Adult Rearing	■	■	■	■	■	■	■	■	■	■	■	■
	Spawning								■	■			
	Fry Emergence				■	■							
	Juvenile Rearing	■	■	■	■	■	■	■	■	■	■	■	■
Arctic grayling	Adult Rearing	■	■	■	■	■	■	■	■	■	■	■	■
	Spawning				■	■							
	Fry Emergence					■	■						
	Juvenile Rearing	■	■	■	■	■	■	■	■	■	■	■	■
Whitefish[2]	Adult Rearing	■	■	■	■	■	■	■	■	■	■	■	■
	Spawning									■	■		
	Fry Emergence				■	■							
	Juvenile Rearing	■	■	■	■	■	■	■	■	■	■	■	■
Northern[2] pike	Adult Rearing	■	■	■	■	■	■	■	■	■	■	■	■
	Spawning				■	■							
	Fry Hatching					■	■						
	Juvenile Rearing	■	■	■	■	■	■	■	■	■	■	■	■

[1] Unless otherwise noted, periodicities taken from project baseline data documents or agency recommendations
[2] Periodicities estimated from Morrow 1980.
NFK = North Fork Koktuli
SFK = South Fork Koktuli
UTC = Upper Talarik Creek

The Nushagak drainage, which includes the NFK and SFK, supports the largest run of Chinook salmon in the Bristol Bay watershed, with annual escapements averaging about 80,000 fish (Brookover et al. 1997; ADF&G 2018w). The NFK supports greater numbers of Chinook and chum salmon than the SFK and UTC, and is second only to UTC for coho salmon. The majority of Chinook spawn in the first 10 miles of the NFK (NFK-A, Figure 3.24-2), approximately 20 miles downstream from the mine site (R2 et al. 2011a). Adult Chinook salmon have been documented entering the NFK as early as July 12, with peak documented spawner counts occurring between July 23 and August 4. Juvenile Chinook salmon are present year-round in the project area, consisting of three age classes, young-of-the-year (0+), yearlings (1+), and 2+. Surveys have shown highest abundance of summer and overwintering juvenile Chinook in the mainstem, 30 miles downstream of the NFK Tributary 1.19 and the mine site.

Adult sockeye have been documented entering the NFK as early as July 5, with peak documented spawner counts occurring in a 1-week window between July 27 and August 4. Juvenile sockeye salmon were observed in April, July, and August; and based on length frequency distributions, were young-of-the-year fish. Juvenile densities were low throughout the NFK, suggesting typical downstream migration to lake-rearing habitat soon after emergence.

Adult coho salmon have been documented entering the NFK as early as August 15, with peak documented spawner counts occurring between September 5 and September 28. Juvenile coho salmon are present year-round in the project area, consisting of four age classes: young-of-the-year (0+), yearlings (1+), 2+, and 3+ age; with the preponderance young–of-the-year overwintering and outmigrating as 1+ fish. Juvenile coho were the most common Pacific salmon inhabiting the NFK basin, where they used most of the mainstem and nearly all of the surveyed tributaries, including the upper headwaters.

Adult chum salmon have been documented entering the NFK as early as July 5, with peak documented spawner counts occurring between July 12 and July 20. In addition to Pacific salmon, rainbow trout were observed at several locations in the mainstem NFK downstream of the mine site, as well as in NFK Tributary 1.19, but their relative abundance was low compared to most other salmonids (R2 et al. 2011a).

South Fork Koktuli River

Chinook, coho, sockeye, and chum salmon have been documented in the SFK watershed (Johnson and Blossom 2018). Pink salmon have not been documented in the SFK. Other fish species documented in the SFK watershed include rainbow trout, Dolly Varden, Arctic grayling, lamprey, threespine and ninespine stickleback, sculpin (may include slimy and/or coastrange sculpin), northern pike, whitefish (round whitefish, humpback whitefish, and/or least cisco), and burbot (*Lota lota*). Arctic char have also been documented in the SFK; however, fish surveys did not encounter this species (R2 et al. 2011a). Overall, the SFK supports more fish species than either the NFK or UTC. The approximate stream mileage listed in the AWC (Johnson and Blossom 2018) for anadromous species and rainbow trout in the SFK analysis area by life-stage is given in Table 3.24-2. The relative distribution and abundance of anadromous and resident salmonid species, based on AWC (Johnson and Blossom 2018) and EBD data (R2 et al. 2011a), are shown on Figure 3.24-3.

No anadromous fish were documented in the mine pit and associated sediment pond area during sampling in 1991, 2004, or 2008, although coho juveniles were observed in the mainstem SFK immediately downstream of the southern edge of the open pit and associated service road in a 2008 survey (Johnson and Blossom 2018).

Adult Chinook salmon have been documented entering the SFK as early as July 5, with peak documented spawner counts occurring between July 20 and August 1. Juvenile Chinook salmon are present year-round in the project area, consisting of 3 age classes: young-of-the-year (0+), yearlings (1+), and 2+. Densities of juvenile Chinook were higher in the mainstem SFK than in off-channel habitats, similar to the distribution seen in the NFK. Adult sockeye have been documented entering the SFK as early as July 5, with peak documented spawner counts occurring between July 23 and August 3. Densities of adult sockeye salmon were highest in the lower 20 miles of the mainstem SFK, as was noted for both Chinook and coho salmon (R2 et al. 2011a). Juvenile sockeye salmon were observed in April, July, and August; based on length frequency distributions, two age classes are indicated: young-of-the-year, and 1+ age fish. Juvenile densities were low throughout the SFK, suggesting typical downstream migration to lake rearing habitat soon after emergence. Adult coho salmon have been documented entering the SFK as early as August 15, with peak documented spawner counts occurring between September 5 and September 28. Coho salmon are more abundant and widely distributed in the SFK than are the other species of Pacific salmon (Table 3.24-2). Juvenile coho salmon are present year-round in the project area, consisting of four age classes: young-of-the-year (0+), yearlings (1+), 2+, and 3+ age; with the preponderance young–of-the-year overwintering and outmigrating as 1+ fish. The known upper limit of juvenile coho above Frying Pan Lake extends to the immediate region of the mine pit; however, juvenile densities are highest in the most-downstream reaches. Juvenile coho were observed in the lower reaches of the SFK during overwintering surveys.

Adult chum salmon have been documented entering the NFK as early as July 5, with peak documented spawner counts occurring between July 11 and July 26. Juvenile chum salmon were only observed in the vicinity of high redd densities, likely due to the abbreviated rearing periodicity of this species.

Ten resident fish species, including burbot and lamprey species, are found in low abundance throughout the SFK, with Dolly Varden and Arctic grayling considered the most widely distributed (R2 et al. 2011a).

Upper Talarik Creek

In addition to the four species of Pacific salmon found in the NFK and SFK, the UTC also contains an intermittent run of pink salmon in the lower reaches. The UTC is also known as important habitat for large, adfluvial rainbow trout. Other resident species found in the UTC include Dolly Varden, Arctic grayling, whitefish (may include round whitefish, humpback whitefish, and/or least cisco), sculpin (may include slimy and/or coastrange sculpin) and two species of stickleback (i.e., threespine and ninespine). Arctic char have been documented in the UTC; however, no Arctic char were observed in environmental baseline studies (R2 et al. 2011a). The approximate stream mileage listed in the AWC (Johnson and Blossom 2018) for anadromous species and rainbow trout in the UTC by life-stage is given in Table 3.24-2. The relative distribution and abundance of anadromous and resident fish species, based on AWC data (Johnson and Blossom 2018) and EBD surveys (R2 et al. 2011a), are shown on Figure 3.24-4.

Pink salmon, which follow a strict 2-year lifecycle, are not common to the project area. However, more than 300 adult pink salmon were documented in the lower 4 miles of the UTC in 2006. Because only three pinks were observed in 2007, and zero in 2004, 2005, 2008, and 2009 (PLP 2018b), it is uncertain if the migrants represented a native run, or if they were strays from other watersheds. No juvenile pink salmon were observed during fish sampling surveys, which is not unexpected given that particular species' rapid seaward emigration as newly emerged fry.

Adult sockeye salmon were the most abundant salmonid in the UTC basin, which drains directly into Iliamna Lake, a major spawning and rearing area for sockeyes. Abundance of sockeye salmon in the UTC exceeded abundance in both the SFK and the NFK basins combined (R2 et al. 2011a). Chum salmon occur in the mainstem UTC up to Tributary 1.35, about 25 miles above the UTC mouth (Table 3.24-2) (Johnson and Blossom 2018). Chum salmon were the least-abundant salmonid species in the UTC basin (R2 et al. 2011a), with most observations of adult fish made during aerial surveys; terrestrial surveys documented very few juveniles, likely due to this species' early seaward migration.

The distribution of juvenile Chinook in the UTC is similar to the distribution of spawning, although juveniles have been observed higher in the headwater reaches, and also are known to inhabit additional tributaries, including UTC 1.35 and a west-side tributary immediately adjacent to the mine pit (R2 et al. 2011a). Chinook are also presumed to use the lower reaches of the UTC's largest tributary—First Creek or UTC 1.60—which flows into UTC 4 miles above Iliamna Lake.

Adult Chinook salmon have been documented entering the UTC as early as July 6, with peak documented spawner counts occurring between July 31 and August 8. Juvenile Chinook salmon are present year-round in the project area, consisting of three age classes: young-of-the-year, (0+), yearlings (1+), and 2+. Adult sockeye have been documented entering the UTC as early as July 5, with peak documented spawner counts occurring between July 17 and August 3. Juvenile sockeye salmon were observed in April, July, and August; and based on length frequency; distributions indicate two age classes: young-of-the-year, and 1+ age fish. Juvenile densities were low throughout the UTC, suggesting typical downstream migration to lake-rearing habitat soon after emergence.

Adult coho salmon have been documented entering the UTC as early as August 8, with peak documented spawner counts occurring between September 2 and September 5. Juvenile coho salmon are present year-round in the project area, consisting of four age classes: young-of-the-year (0+), yearlings (1+), 2+, and 3+ age; with the preponderance young–of-the-year overwintering and outmigrating as 1+ fish. Juvenile coho were observed in the upper reaches of the UTC during overwintering surveys.

Adult chum salmon have been documented entering the NFK as early as July 15, with peak documented spawner counts occurring between July 31 and August 3. Low numbers of juveniles have been observed in the UTC, consistent with the species life history of abbreviated river residence time after emergence.

Rainbow trout, Dolly Varden, slimy sculpin, and Arctic grayling are the only resident fishes documented in the headwater reaches near the mine site during baseline field surveys. Unlike the NFK and the SFK, rainbow trout were relatively common and widely distributed in the UTC basin, although only juveniles were observed in the headwater reaches near the mine site. Overall, densities of rainbow trout in surveyed reaches were low compared to most of the Pacific salmon species (R2 et al. 2011a). Non-migratory stream-resident rainbow trout are thought to occur in all three tributaries, but UTC also supports an adfluvial population of large trout that migrate between UTC, Iliamna Lake, and other lake tributaries. This species was targeted in a radio telemetry study in 2007 and 2008, where 97 adult trout were captured and tagged in UTC; 70 fish were subsequently tracked throughout the western half of Iliamna Lake and many of the lake's western tributaries through spring of 2009 (PLP 2018b). UTC-tagged trout visited 10 tributaries to western Iliamna Lake, with most detections in UTC, Lower Talarik Creek, Pete Andrews Creek, the Newhalen River, and the Kvichak River. Migration patterns included spring immigration into tributaries (presumably for spawning), and summer foraging throughout the western half of Iliamna Lake or in several tributaries; followed by fall immigration and overwintering in the lower mainstem reaches or outlet lagoon habitats of the five tributaries listed above (Minard et al. 1992). Only 12 to 13 percent of tagged trout returned to UTC for spring spawning or summer foraging, suggesting that some of the tagged fish were transients from other natal tributaries. Relatively few tag detections in Iliamna Lake occurred east of the line between Gibraltar Creek and the Newhalen River; however, a large proportion of detections occurred in offshore areas of western Iliamna Lake, suggesting a pelagic migratory pattern.

Transportation and Natural Gas Pipeline Corridors

Mine Access Road

Anadromous fish distributed in the UTC basin include Chinook, coho, sockeye, and pink salmon. Resident salmonid species found in the UTC include Dolly Varden, Arctic grayling, rainbow trout, and whitefish (may include round whitefish, humpback whitefish, and/or least cisco). Resident non-salmonid fishes observed during sampling in the 1990s and 2004-2008 were sculpin (may include slimy and/or coastrange sculpin) and two species of stickleback (threespine and ninespine). The AWC (Johnson and Blossom 2018) also lists Arctic char in the UTC; however, sampling conducted in the 1990s and in 2004-2008 did not encounter this species (R2 et al. 2011a).

As noted in Table 3.24-3, the mine access road would cross channels tributary to the UTC that support rearing and/or spawning by coho salmon, and the mainstem UTC at the bridge location is listed for spawning and rearing for Chinook, coho, and sockeye salmon, as well as spawning by chum and pink salmon. The crossing at First Creek (UTC 1.60) has coho-spawning life-stage in the immediate vicinity of the crossing, but there is also sockeye spawning and coho rearing downstream, and Chinook are listed as present. Sockeye spawning is the only life-stage specified at the Newhalen River bridge crossing, but the AWC lists unspecified life-stages for Chinook and coho as present at that location. Arctic char are also known to inhabit the Newhalen River between Sixmile Lake and Iliamna Lake. The Newhalen River serves as an important link between Iliamna Lake and Lake Clark, which supports large populations of sockeye salmon. Resident fish identified at that location include Arctic grayling, humpback and round whitefish, longnose sucker (*Catostomus catostomus*), rainbow trout, and slimy sculpin (Frissel 2014).

Iliamna Lake

Over 20 fish species have been reported from Iliamna Lake, including all five anadromous Pacific salmon (Chinook salmon, coho salmon, chum salmon, pink salmon, and sockeye salmon), Arctic char, and lamprey spp. Eight non-anadromous salmonids (adfluvial populations of rainbow trout, Dolly Varden, lake trout, Arctic grayling, humpback whitefish, round whitefish, pygmy whitefish (*P. coulterii*), and least cisco) occur in Iliamna Lake, along with numerous non-salmonid species, including northern pike, slimy sculpin, threespine and ninespine stickleback, burbot, Alaska blackfish (*Dallia pectoralis*), longnose sucker, and pond smelt (*Hypomesus olidus*). The most common subsistence fishery is for sockeye salmon; but targeted fisheries also include Arctic grayling and whitefish (Holen and Lemons 2012). See Section 3.9, Subsistence, for more information on subsistence use.

The Kvichak Basin supports a genetically diverse assemblage of sockeye salmon, including 4 sub-stocks and 22 genetically distinct populations (T. Dann, Fisheries Geneticist, ADF&G, Anchorage, personal communication). Iliamna Lake is noted for supporting still-water spawning by large numbers of sockeye salmon. With some exceptions, annual aerial surveys of spawning salmon areas have been conducted since 1920 by ADF&G (Morstad 2003), which have detected shoreline spawning in most areas of Iliamna Lake, with heaviest spawning along island and bay habitats in the eastern lake basin. Aerial counts have shown wide annual and spatial variability, with index estimates for Woody Island (for example) ranging from 500 spawners to over 194,000 fish. Index counts from Knutson Bay have ranged from 1,000 to 1,000,000. Spawning in Iliamna Lake has typically represented between 1 to 3 percent of sockeye escapement in the Kvichak watershed (Morstad 2003). Input of marine-derived nutrients from carcasses of spawned-out salmon (particularly sockeye) is an important factor in the productivity of Iliamna Lake and its primary spawning tributaries (EPA 2014). The migration of juvenile sockeye leaving Iliamna Lake in late May and early June after lake ice-melt has been estimated at over 200 million fish over a 3-week period.

Fish and habitat surveys were conducted in 2018 near the ferry terminal locations in Iliamna Lake (Paradox 2018b, 2018c, 2018d). Nearshore fish were surveyed May through August near the ferry terminal locations using seine nets, snorkel surveys, and aerial visual surveys from a helicopter. The two most abundant species captured or observed in the seine and snorkel surveys were threespine stickleback and sockeye salmon. Other species captured or observed near the ferry terminal sites were chum salmon, coho salmon, pink salmon, Dolly Varden, longnose sucker, ninespine stickleback, pond smelt, and sculpin. No salmon spawning or pre-spawning behaviors were observed at the north or south ferry terminal locations, although adult sockeye salmon were observed from aerial surveys at every location in July and August.

Rainbow trout are widely distributed in the Iliamna Lake basin. Seventy of 97 radio-tagged adult trout were tracked throughout the western half of Iliamna Lake and many of the lake's western tributaries through spring of 2009 (PLP 2018b). UTC-tagged trout migrated from 10 tributaries to western Iliamna Lake, with most detections in UTC, Lower Talarik Creek, Pete Andrews Creek, the Newhalen River, and the Kvichak River. Migration patterns included spring immigration into tributaries (presumably for spawning), and summer foraging throughout the western half of Iliamna Lake or in several tributaries, followed by fall immigration and overwintering in the lower mainstem reaches or outlet lagoon habitats of the five tributaries listed above (Minard et al. 1992). Relatively few tag detections in Iliamna Lake occurred east of the line between Gibraltar Creek and the Newhalen River; however, a large proportion of detections occurred in offshore areas of western Iliamna Lake, suggesting a pelagic migratory pattern.

Port Access Road

Four anadromous species/life-stages are listed in the AWC (Johnson and Blossom 2018) for the lower Gibraltar River (Table 3.24-3): coho present, chum spawning, sockeye spawning, and Arctic char present. Adult pink salmon were observed by snorkelers in the Gibraltar River in July 2018. Whitefish are also distributed throughout the lower Gibraltar River. The Amakdedori Creek tributary is an anadromous stream listed for coho spawning and sockeye spawning life-stages at the crossing location, and chum spawning is listed downstream of the location. Juvenile coho were the only salmon observed in the other eight streams with anadromous fish. Resident fish species observed in the 44 fish-bearing streams during 2018 sampling included chars (Dolly Varden or Arctic char), rainbow trout, Arctic grayling, stickleback (threespine and ninespine), northern pike, longnose sucker, burbot, and sculpin (not identified to species).

Kokhanok East Ferry Terminal Variant

Specific fish sampling data are not currently available on fish resources for the Kokhanok East Ferry Terminal Variant or the seven channels crossed via culverts along the Kokhanok east section of the transportation and natural gas pipeline corridor; however, a single bridge crossing occurs over AWC stream 324-10-10150-2206, which is listed as supporting sockeye spawning and the presence of Arctic char.

Cook Inlet Portion of Natural Gas Pipeline Corridor

All five species of Pacific salmon, Pacific herring (*Clupea pallasii*) and pond smelt are found in the Cook Inlet management area (Hammarstrom and Ford 2009). The Cook Inlet area also supports several important groundfish species, including sablefish (*Anoplopoma fimbria*), Pacific cod (*Gadus macrocephalus*), walleye pollock (*G. chalcogrammus*), lingcod (*Ophiodon elongatus*), and pelagic shelf rockfish species (*Sebastes* spp.). Other fish species includes sculpins, skates (*Rajidae*), sharks, commander squid (*Berryteuthis magister*), giant Pacific octopus (*Enteroctopus dofleini*), shortspine thornyhead (*Sebastolobus alascanus*), and numerous other rockfish species (Rumble et al. 2016). Flatfish species known to occur in Cook Inlet and/or Kamishak Bay include flathead sole (*Hippoglossoides elassodon*), rock sole (*Lepidopsetta bilineata*), arrowtooth flounder (*Atheresthes stomas*), and Pacific halibut (*H. stenolepis*), the latter of which are highly valued in both commercial and recreational fisheries. Other marine forage species that may occur proximal to the Cook Inlet pipeline route and/or the Amakdedori port include capelin (*Mallotus villosus*), Pacific sand lance (*Ammodytes hexapterus*), eulachon (*Thaleichthys pacificus*), gunnels (*Pholidae*), Pacific sandfish (*Trichodon trichodon*), pricklebacks (*Stichaeidae*), and lanternfish (*Myctophidae*).

Robards et al. (1999) conducted beach seines and mid-water trawls in nearshore habitats of lower Cook Inlet, and found a diverse near-shore fish community of at least 52 species. Spatial differences in species diversity and abundance were observed in Cook Inlet, likely due to local oceanographic conditions and sediment inflow. The study also found significant changes in fish community abundance and diversity between 1976 and 1996, apparently related to large-scale climate changes in the North Pacific.

Clams are abundant along many Cook Inlet beaches. Stocks of razor clams (*Siliqua patula*) are concentrated in the Polly Creek area on the western side of Cook Inlet, and along the eastern side from Anchor Point to Kasilof River. Other clam species include littleneck (*Protothaca staminea*) and butter clams (*Saxidomus giganteus*), (Szarzi et al. 2007). Several species of crab are found in the Cook Inlet area, including Tanner (*Chionoecetes bairdi* and *C. opilio*), and Dungeness crabs (*Metacarcinus magister* or *Cancer magister*) (ADF&G 2002b). Several species of shrimp are also found in Cook Inlet, including pink (*Pandalus borealis*), sidestripes (*P. dispar*), humpy shrimp (*P. goniurus*), coonstripe shrimp (*P. hypsinotus*), and spot shrimp (*P. platyceros*) (ADF&G 2002b). Other shellfish species include octopus, green urchin (*Strongylocentrotus droebachiensis*), sea cucumber (*Echinozoa*), and scallops (*Pectinoidea*). The predominant octopus species in Cook Inlet is the giant Pacific octopus (*Enteroctopus dofleini*).

Amakdedori Port

Sockeye are abundant in several tributaries to Kamishak Bay, including the Kamishak, Paint, and McNeil rivers, and Kirschner, Mikfik, and Chenik lakes. The Amakdedori port site is in the historic floodplain of Amakdedori Creek, which currently enters Kamishak Bay 0.7 mile south of the port site. Amakdedori Creek had average annual sockeye salmon runs of 1,200 fish between 1970 and 1980, which increased to an average of 2,364 fish over the past 10 years (Hollowell et al. 2017). The recent 10-year average escapement of pink salmon to Amakdedori Creek was 7,500 fish (Hollowell et al. 2017). Other basins supporting strong runs of pink salmon in Kamishak Bay include the Bruin Bay River, Sunday Creek, and Browns Peak Creek. Principal chum salmon streams entering Kamishak Bay include the McNeil, Bruin, Iniskin, Kamishak, and Little Kamishak rivers, and Cottonwood Creek. See Section 3.6, Recreational and Commercial Fisheries, for more details on salmon runs and commercial fisheries proximal to the port site.

The existing fishery data were expanded by fish community sampling (March-July 2018) conducted by GeoEngineers (2018d) at seven locations, including Amakdedori Beach. In total, 27 beach seine samples were collected from the transportation and natural gas pipeline locations. Over 20 fish species (>1,400 specimens) were collected, with juvenile salmonids as the dominant group in all three areas. The number and density of species differed between areas. At Amakdedori Beach, 23 species were collected with juvenile salmonids (mostly pink and chum salmon), larval and adult surf smelt (*H. pretiosus*), juvenile whitespotted greenling (*Hexagrammos stelleri*), and starry flounder (*Platichthys stellatus*), making up 95 percent of the catch. Other species collected in low numbers included walleye pollock, flatfish (no ID), several sculpin species (*Cottidae*), Pacific sandlance (*Ammodytes hexapterus*), tomcod (*Microgadus proximus*), threespine stickleback, tubesnout (*Aulorhynchus flavidus*), and tubenose poacher (*Pallasina barbata*). Catch of larval surf smelt suggested drift of these larvae from other locations. Focused spawning surveys (8 sediment samples) at suitable spawning substrate at Amakdedori Beach yielded no forage fish eggs. These findings are similar to those from the earlier sampling. Trawl sampling at several locations in 2013 and 2018 produced relatively low catch rates (2 to 3 fish/set) near Amakdedori, in comparison to sets in the Iliamna and Iniskin Estuaries (IIE) and Ursus Cove areas.

Pacific herring spawning surveys in 2018 (GeoEngineers 2018d) were undertaken at low tides searching for eggs on eel grass and marine algae along Amakdedori Beach. Pacific herring spawn survey data suggested that the Amakdedori port facility is isolated from known spawning areas. Seine hauls along Amakdedori Beach caught an average of only 0.75 herring/set in 2018, compared to catches in the hundreds per set in surveys in the IIE. Due to low stock size, the commercial fishery for herring roe in Kamishak Bay has been closed since 1999 (Hollowell et al. 2017). Herring spawn primarily on eelgrass and rockweed, which is found predominantly south of the port facility around reefs associated with Nordyke Island and Chenik Head, and also north of the port near Contact Point. The reefs associated with areas closer to the Amakdedori port facility (North Reef, Palmaria Plains, and Thumb/Thumbnail) were dominated by *Palmaria* spp., kelp, and other species that are little used by spawning herring. Pacific herring have been documented to spawn on marine macrovegetation, particularly in May, along the northern and southern edge of the Amakdedori Beach sampling area. In 2018, however, no spawning activity was observed in or near the project footprint at Amakdedori Beach (GeoEngineers 2018d). The only observed spawning activities were more than 5 miles to the south of the port site near Nordyke Island in late April and mid-May; with heaviest spawning activities associated with a large contiguous bed of eel grass. Spawning was also observed on other species including rockweed (*Fucus distichus*).

3.24.1.3 Aquatic Invertebrates

Mine Site

Macroinvertebrates and periphyton (freshwater organisms attached to or clinging to plants and other objects projecting above the bottom sediments) community assemblages are an important component of the aquatic food web for salmonids, and effective indicators of habitat and water quality (Barbour et al. 1999). Due to their mobility, long lifecycle, and sensitivity to environmental conditions, macroinvertebrates have been frequently used for long-term monitoring, and have demonstrated their sensitivity to changes in ecological conditions (EPA 2002). Macroinvertebrate biological assessment indices have been developed for Cook Inlet Basin Ecoregion streams (Rinella and Bogan 2007), which demonstrated important macroinvertebrate community response to disturbance intensity in the region. Metrics such as number of taxa, percentage Ephemeroptera, Plecoptera, and Trichoptera genera (together referred to as “EPT genera”), and Shannon’s Diversity Index (SDI) were found to decrease at sites with increased disturbance intensity, while other metrics such as percentage of dominant taxa increased with disturbance intensity (Rinella and Bogan 2007).

The Koktuli River watershed supports a rich and diverse macroinvertebrate community (Bogan et al. 2012). Sampling of wadeable streams of the Kvichak and Nushagak watersheds in the Bristol Bay region of Alaska, including the Koktuli and UTC watersheds, found mean site richness to be similar across four subwatersheds (ranging between 23 and 30 taxa), with Chironomidae family members the most common across all sites (Bogan et al. 2012).

Freshwater macroinvertebrate and periphyton surveys were conducted between 2004 and 2008 in the project area to characterize species diversity, abundance, density, and community structure. Study locations included the NFK River, SFK River, Kaskanak Creek, UTC, Chulitna River, Frying Pan Lake, and Big Wiggly Lake. Study locations correspond to monitoring sites for water quality, hydrology, and fisheries (Figure 3.24-2).

The methodological details for the 2004 to 2008 study period can be found in Chapter 15, Chapter 40, and Appendix F of the Pebble Project EBDs (R2 et al. 2011a). The resulting inventories serve as a basis for assessing potential project impacts.

Macroinvertebrates

A total of 132 primary macroinvertebrate samples and duplicates at a minimum frequency of 10 percent were collected from the monitoring sites established in the project area. Macroinvertebrate metrics, as described in the Alaska Stream Condition Index (ASCI) protocol (Major et al. 2001) were calculated from macroinvertebrate data collected using the ASCI method and the Surber method (R2 et al. 2011a). These metrics are indicators of habitat change (Major et al. 2001), and include taxa richness, percentage EPT taxa; percentage Chironomidae family taxa (Chironomidae is within order Diptera); percentage other Diptera order taxa; percentage dominant taxon; and Community Tolerance Index (CTI).

The overall results for both the Surber method and the ASCI method indicate that Diptera, including the Chironomidae family, is the dominant taxon in the mine site project area; and Ephemeroptera is the majority taxa of EPT. Macroinvertebrate populations with a high proportion of Chironomidae family members in the population can indicate a more stressful aquatic habitat in general (Barbour et al. 1999). The aquatic conditions at the mine site include high numbers of Chironomidae family, which is considered typical for this area (Oswood et al. 1995).

These observations are consistent with aquatic-habitat surveys, which indicate that the analysis locations in the mine site area are composed mainly of riffle/cobble stream habitats with few to no human-caused effects. Measurements of habitat parameters at each location were found to be within ranges considered good to optimal for aquatic habitat (Major et al. 2001). Analysis of water quality results indicated good to optimal parameter levels for diverse macroinvertebrate communities, as is generally the case.

CTI reflects aquatic habitat quality, and is based on the relative tolerance of macroinvertebrate taxa to stressful conditions. CTI scores in 2004, 2005, and 2007 ranged from 3.9 through 6.1, 4.9 through 6.0, and 4.5 through 6.6, respectively (possible range of values 0-10).

Periphyton

A total of 115 periphyton samples were collected, and additional duplicate samples were collected at a frequency of approximately 10 percent. The 2004 data indicated relatively uniform taxa richness across all seasons. Periphyton metrics were based on the taxa identifications. Taxa richness at all sample locations ranged from 12 to 19. The percentage dominant taxon at all sample locations ranged from 21 to 72 percent. The percentage dominant taxon in periphyton samples at times totaled more than 50 percent. This result is generally considered a negative indicator for stream health (Wehr and Sheath 2003). However, the stream reaches sampled are considered representative of unimpaired conditions, and occur in a region of minimal human effect. Measurements of water-quality parameters consistently fell within ranges considered good to optimal for aquatic habitat health. These results exhibit the natural variability in these environments.

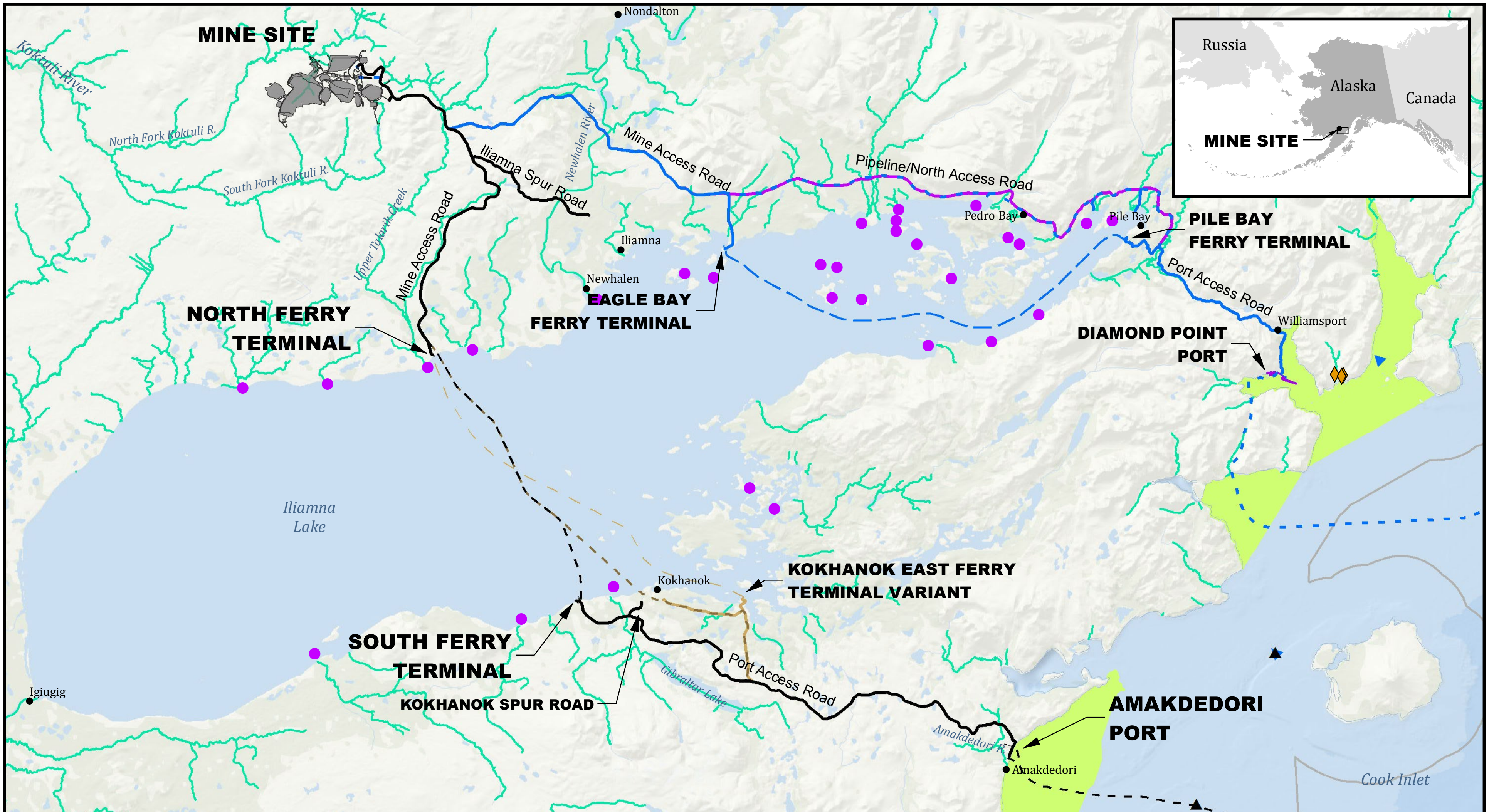
In 2005 and 2007, periphyton samples were analyzed for chlorophyll-a to quantify productivity. In 2005, average chlorophyll-a concentrations ranged from 2.1 milligrams per square meter (mg/m^2) to 17.0 mg/m^2, with variability among the samples. In 2007, average chlorophyll-a concentrations ranged from 2.3 mg/m^2 to 30.2 mg/m^2. No consistent temporal trends were observed in the chlorophyll data between 2005 and 2007, nor was there a trend found between macroinvertebrate taxa richness or percentage EPT and chlorophyll-a concentrations. However, Chironomidae often made up a high percentage of the taxa composition; and in many cases, was the dominant taxon, encompassing more than 50 percent of the sample. Some Chironomidae genera feed on periphyton, or prey on taxa that consume periphyton. In 2005, percentage Chironomidae was found to be highly correlated with chlorophyll-a concentrations ($R^2 = 0.7908$), but this trend was not as evident in 2007 ($R^2 = 0.1157$).

The survey results show that sample locations were composed largely of riffle/cobble habitat. Riffle/cobble is the preferred habitat of EPT taxa. The sampling results for the mine site indicate low-percentage EPT, high-percentage Chironomidae, and high-percentage dominant taxon, conditions which have been associated with poor stream health in other Alaska-based studies (Ott and Morris 2008). No statistically significant relationship was found between most water quality results and the macroinvertebrate metrics data. However, taxa richness in ASCI samples was negatively correlated with temperature.

Transportation and Natural Gas Pipeline Corridors

Locations for macroinvertebrate and periphyton studies were selected to characterize conditions in the project area. Sampling was conducted at two sites: Y Valley Creek, and an unnamed creek site (see Figure 3.24-6). Because a relatively small portion of the transportation corridor would be in Cook Inlet drainages, only two locations were established for macroinvertebrate and periphyton sampling. Sample locations in the project area were selected based on undisturbed habitat with few to no human-caused effects. The methodological details for the 2004 to 2008 study period can be found in Chapter 15, Chapter 40, and Appendix F of the Pebble Project EBDs (R2 et al. 2011a).

Macroinvertebrate taxa richness was higher in the ASCI samples than in the Surber and the drift samples; and community assemblages were largely driven by Diptera taxa; and in most cases, Chironomidae. Of the Diptera taxa, the Orthocladiinae subfamily (within the Chironomidae family) tended to make up a large percentage of the samples. Of the EPT taxa, the Heptageniidae, Baetidae, Chloroperlidae, and Brachycentridae families were well represented in the Surber samples. The presence of these sensitive species is indicative of the comparatively optimal conditions at the site for macroinvertebrate colonization (Merritt and Cummins 1996).



Sources: PLP 2018; EPA; ADF&G; ADNR

- Sockeye Salmon Spawning Locations
- Invertebrate Sampling Site
- Anadromous Stream
- Marine Habitat/Fish Sampling Site

Alternative 1
- Lightering Locations
- Transportation Corridor
- Natural Gas Pipeline
- Mine Site
- Ferry/Port Site

Kokhanok East Ferry Terminal Variant
- Transportation Corridor
- Ferry Route
- Natural Gas Pipeline
- Ferry Terminal

Alternative 2
- Transportation Corridor
- Ferry Route
- Natural Gas Pipeline
- Ferry Site

Alternative 2/3
- Lightering Location
- Port Site

Alternative 3
- Transportation Corridor

US Army Corps of Engineers

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Miles

MARINE & INVERTEBRATE SAMPLING LOCATIONS AND ILIAMNA LAKE ALTERNATIVES

A range of macroinvertebrate habitats was sampled using the ASCI method, while only riffle/cobble habitat was sampled using Surber samplers. Taxa richness was greater in ASCI samples (15 to 16 taxa) than compared with Surber and drift samples (five and seven taxa, respectively). The difference in taxa richness indicates that greater taxa diversity is to be found in habitats other than riffle/cobble habitat. Macroinvertebrate studies in other regions have documented variability in taxa richness among samples (DePauw et al. 2006). However, there are insufficient data from this study area to statistically define trends or relationships with respect to particular sampling method variability, or timing of sampling.

An assessment of parameters related to habitat quality indicates optimal conditions at the unnamed creek and Y Valley Creek locations during all sampling events. Standard water quality parameter results were in the optimum range for aquatic life (Hem 1985). Dissolved oxygen (DO) levels at the unnamed creek were slightly supersaturated, indicative of cool stream temperatures and swift water conditions at the location. The locations sampled in this study were in an undisturbed area with few to no human-caused effects.

Periphyton metrics for the 2004 data were based on the taxa identifications. Taxa richness was greater for Y Valley Creek than for the unnamed creek (17 and 8 taxa, respectively). The percentage dominant taxon was much higher for the unnamed creek than for Y Valley Creek (79 percent and 35 percent, respectively). The percentage dominant taxon in periphyton samples at times totaled more than 50 percent. This result is generally considered a negative indicator for stream health (Wehr and Sheath 2003). However, the stream reaches sampled are considered representative of unimpaired conditions, pristine, and in a region of minimal human effect. Measurements of water-quality parameters consistently fell within ranges considered good to optimal for aquatic habitat health. These results exhibit the natural variability in these environments.

In 2004, one periphyton sample was collected from each of the two sampling locations, and then analyzed for diatom taxa composition. Results of this analysis indicate 19 diatom genera were present in the project area. In 2005, 10 periphyton samples were collected at one location (Y Valley Creek) and analyzed for chlorophyll-a to quantify productivity. In 2005, average chlorophyll concentrations were 2.4 mg/m^2. Diatom analysis revealed a diverse set of taxa present. Average chlorophyll-a concentrations for Y Valley Creek were in the normal range, compared to other studies in Alaska.

Cook Inlet Portion of Natural Gas Pipeline Corridor

Coastal assessment studies in lower Cook Inlet have shown the area supports a healthy benthic community with balanced populations of species. Species abundance, richness, and diversity indexes are similar to undisturbed habitats and estuaries (Saupe et al. 2005). Investigations of the entire Cook Inlet area have found the lower Cook Inlet to be exposed to fewer contaminants than other locations in Alaska (Saupe et al 2005). Overall, Shannon-Weaver Diversity (H') for benthic communities (Saupe et al. 2005) ranged from 0.91 to 5.64. Polychaete worms have been found to be the most dominant taxonomic group in benthic communities.

Macroinvertebrates such as crabs, butter clams, little neck clams, shrimp, and octopus are present in the habitats of lower Cook Inlet, but are no longer commercially harvested; however, scallops are commercially harvested in lower Cook Inlet. Cook Inlet supports a large numbers of razor clams and a popular sport fishery on the western side of Cook Inlet. The eastern side of Cook Inlet has been closed to clamming since 2015, due to low population levels. This area does include sessile invertebrates such as coral, sponges (*Phylum Porifera),* sea whips (*Protoptilum sp*.), and sea pens (*Order Pennatulacea)* which are known to be import habitat for groundfish and crab and shrimp species. There are extensive sea whip and sea pen colonies in lower Cook Inlet, and these are known to increase survival of early settled weathervane scallops and Tanner crab. Pacific halibut and Pacific cod, two of the most important groundfish species in the area, consume a diverse diet of marine invertebrates, many of which are not commercially fished.

Amakdedori Port

Assessment studies of the marine habitat area of Kamishak Bay have shown that the area largely consists of unconsolidated sediment habitats. These habitats vary widely, and support many species of marine invertebrates. The habitats vary from high-energy, relatively steep, cobble/gravel beaches to very fine silt/clay flats. The cliff bases and mountainsides largely have "mixed-fine" beach types that are often relatively productive due to the rock component, allowing development of epibiota and sediment that provide microhabitats for infauna (GeoEngineers 2018c).

Intertidal unconsolidated habitats were assessed as part of the baseline studies. The beach at Amakdedori is largely devoid of macrobiota, except where barnacles and ephemeral algae attach to larger boulders. This is due to substantial wave energy generated by wind waves and swells. Studies indicated that the lower beach face remains damp at low tides, and harbored epilithic bacterial and diatom films that potentially support smaller grazing crustaceans, which are known to provide prey for smaller fish that feed during high tides. Storm berms at the beach top were dominated by large amounts of large, woody debris interspersed with marine debris. Lower on the beach, accumulations of detached macro-algae were present, deposited by currents and waves that form wrack lines that harbor amphipods and insects feeding both terrestrial birds and shorebirds.

Off the mouth of Amakdedori Creek, a finer-grained delta flat extended out into the subtidal zone. This area supported a population of razor clams. The infauna of the lower beach included a limited variety of polychaetes and bivalves. This finer sand/silt beach supported a number of crustaceans, especially crangonid shrimp that are prey for fish and diving birds.

The area north of Amakdedori Beach includes a sharply rising upland that forms an eroding bluff. The upper beach face was a moderately high-energy boulder-cobble beach with occasional outcrops of bedrock. Elevation and wave energy combine to limit biological activity, except for beach hoppers (gammarid amphipods) associated with the wrack line and decaying algal fragments under boulders. Lower tidal elevations included beach hoppers, barnacles, two barnacle predators (6-rayed seastars, and drills) and scavenger hermit crabs. Grazing and ice scour likely prevented establishment of multi-year barnacles in this habitat. Boulder tops in some areas were coated with green and red algae.

A mix of soft habitat types occupied areas in North Reef, where sediment has accumulated in channels or over underlying bedrock to a depth that allowed the settlement and persistence of infauna, including a variety of bivalves, polychaetes, tube-building taxa, and cockles. The spoonworm was abundant in deeper, harder clay sediments adjacent to the southern portion of North Reef. Cobbles and gravel set in a hard clay matrix in this area limited the numbers of bivalves and polychaetes. Common algal species were present, including sugar kelp, acid kelp, and several reds. Subtidal unconsolidated habitats were assessed as part of the baseline studies. The unconsolidated habitats in subtidal areas of Amakdedori Bay vary. Study samples collected in the area yielded little actual sediment, indicating coarse gravel dominates. Shell fragments from sampling indicate a number of bivalves and several gastropods in this study area. The presence of these gastropods suggested substrate has a substantial hard substrate component (i.e., gravel and or cobble dominance). Samples collected in soft sediments yielded abundant gammarid amphipods, sand dollars, and polychaetes, dominated by relatively large species of Nephtys. Gravel and rock surfaces exposed above the sediment often support encrusting coralline algae, along with encrusting bryozoans and hydroids. Larger cobbles and boulders often were encrusted with barnacles, tube worms, and social tunicates.

3.24.1.4 Fish Tissue Trace Element Analysis

Data collected during the 2004-2008 period indicate that the concentrations of trace elements in fish tissue are generally low, and reflective of the natural conditions of the mine site area drainages. Some trace elements were detected at elevated concentrations. However, these concentrations are attributed to natural conditions, and are documented as existing or baseline conditions.

Fish samples collected between 2004 and 2008 included 345 whole body, 236 muscle, and 87 liver samples. These samples were collected from the waterbodies (NFK, SFK, and UTC) and several lakes in the mine site area, and represented several species of fish, including northern pike, Dolly Varden, Arctic grayling, coho and Chinook salmon, and whitefish. Most of the 14 target trace elements were detected in the samples, including methylmercury. Copper and zinc were present at the highest concentrations across different waterbodies. A wide variability of elemental concentrations was apparent over time and among waterbodies, fish species, and tissue types.

Differences in tissue copper concentrations appeared to reflect the differences in the underlying geology of the drainages. For example, whole-body copper concentrations in coho and Chinook salmon were higher in SFK than in the other two rivers. Copper-rich bedrock in the headwaters of SFK may explain this observation, because the underlying geology contributes significantly to the elemental concentration in the surface water and sediment substrates; and aquatic organisms and the fish uptake of trace elements occur via these environmental media and the food chain. Elemental concentrations were typically higher in liver than in muscle; substantially, for some elements (e.g., zinc).

The existing baseline data on fish tissue elemental concentrations represent the baseline or existing conditions that are reflective of the natural variabilities in the mine site area that arise due to various factors, such as biogeochemical differences among the major drainages, species- and element-specific differences in uptake, and accumulation of different trace elements by different fish species.

Amakdedori Port Fish Tissue

Most inorganic chemicals analyzed were detected in the fish (whitespotted greenling and starry flounder) collected near Amakdedori Beach; except antimony, beryllium, and thallium, which were not detected. Mercury slightly exceeded the tissue screening level in starry flounder. Starry flounder mostly forage on benthic communities found in soft or mixed-soft habitats, which suggests that the source of mercury in this system may be associated with fine-grained sediment habitats. This is supported by the sediment data, where mercury was detected in samples at both sampling sites with concentrations near screening levels. Simple bioaccumulation can explain the presence of mercury at these tissue concentrations (GeoEngineers 2018a.)

Selenium exceeded its screening level in whitespotted greenling. There is no clear source for selenium, based on sediment/water results for the same analyte. The magnitude of the exceedance is likely due to the higher trophic level at which greenling feed; generally, one level higher than starry flounder. Tin exceeded the screening level in the tissue from both marine fishes collected. No other inorganic chemicals were detected above the screening levels in marine fishes analyzed. Concentrations in tissue are representative of existing or background conditions, and are unlikely to represent a risk to the fishes sampled. Mercury may be a possible exception in that regional and global sources have contributed to elevated fish tissue concentrations; however, the exceedances of the screening level were low. In the case of the concentration in white-spotted greenling, it was lower than the average concentration ADEC reported in greenling from Alaskan waters. For a detailed report on fish tissue trace metals analysis, refer to EBD Chapter 10, Section 10.3.

3.24.1.5 Alternative 1 Variants

Alternative 1 – Kokhanok East Ferry Terminal Variant

See "Aquatic Habitat" section for descriptions of habitat and fishery resources associated with the Kokhanok East Ferry Terminal Variant.

Alternative 1 – Summer-Only Ferry Operations Variant

Aquatic habitat and fish distribution would be the same for this variant as that described in Alternative 1.

Alternative 1 – Pile-Supported Dock Variant

Aquatic habitat and fish distribution would be the same for this variant as that described in Alternative 1.

3.24.2 Alternative 2 – North Road and Ferry with Downstream Dams

Mine Site

The affected environment as described under Alternative 1 is applicable to Alternative 2.

3.24.2.1 Aquatic Habitat

Transportation Corridor and Natural Gas Pipeline Corridor

The Alternative 2 transportation corridor includes; the northernmost section the Alternative 1 mine site road, a spur road to a ferry terminal at Eagle Bay on Iliamna Lake, a stand-alone section of natural gas pipeline corridor north of Iliamna Lake, a ferry terminal at Pile Bay, and a spur road from Pile Bay to Diamond Point port following the existing Williamsport-Pile Bay Road alignment. Alternative 2 would include a total of 117 waterbody crossings, including 24 crossings of anadromous habitat and 32 crossings over resident fish habitat. Of this total, 82 drainages, including 34 fish stream crossings (15 over anadromous waters) would be crossed by the natural gas pipeline only (i.e., no adjacent road).

The stand-alone overland portions of the natural gas pipeline corridor are north of Iliamna Lake between Eagle Bay and Pile Bay ferry terminals (see Chapter 2). The gas pipeline would cross 82 stream channels, with 15 crossings over anadromous waters, 19 crossings over resident fish habitat, and 48 small channels designated as fishless (Table 3.24-5). The total number of crossings for this alternative is largely identical to Alternative 3, except in this alternative most crossings involve only the natural gas pipeline corridor (e.g., the ferry replaces most road crossings), whereas all of the Alternative 3 crossings involve both the road and adjacent natural gas pipeline. In addition to the anadromous channels crossed by the natural gas pipeline, the transportation corridor passes within 0.25 miles upslope of 3 other anadromous waters; a tributary to Pedro Bay (AWC 324-10-10150-2317-3035), Russian Creek (AWC 324-10-10150-

2323), and a tributary to Lonesome Bay (AWC 324-10-10150-2335), each of which are designated as sockeye spawning habitat.

Because of the large number of stream crossings associated with the Alternative 3 road and pipeline corridor (and the Alternative 2 pipeline corridor, Table 3.24-5), habitat and fish sampling was conducted and summarized according to six watershed groupings (R2 et al. 2011a, R2 and HDR 2011). The Isolated Watershed Group includes two watersheds that drain the southwestern flanks of Roadhouse Mountain; however, these isolated watersheds did not appear to have any surface connection to the Newhalen River or Iliamna Lake. The Roadhouse/Northeast Bay/Eagle Bay Watershed Group includes three watersheds that drain into Iliamna Lake: Roadhouse Creek, an unnamed tributary to Eagle Bay, and Eagle Bay Creek. The Youngs/Chekok/Canyon Watershed Group includes three watersheds that drain into the northern edge of Iliamna Lake: Youngs Creek, Chekok Creek, and Canyon Creek. The Knutson Bay/Pedro Bay Watershed Group consists of Knutson Creek and eleven unnamed tributaries that drain the western and southern sides of Knutson Mountain into Pedro Bay. The Pile Bay/Lonesome Bay Watershed Group includes the Pile River and two unnamed tributaries that flow into Lonesome Bay. The Iliamna River Watershed Group originates on the western side of the Chigmit Mountains and flows southwest into Pile Bay. Williams Creek is the only stream associated with the northern access corridor that drains into Cook Inlet.

The affected environment as described under Alternative 1 for the Cook Inlet portion of the natural gas pipeline is applicable to Alternative 2.

Mine Access Road

The mine access road follows the Alternative 1 route from the mine site to 1 mile south of the bridge crossing the mainstem UTC (see Chapter 2); it then follows a route across the Newhalen River to the ferry terminal in Eagle Bay. Along this route, the road and adjacent pipeline would cross 22 stream channels, 8 of which are listed in the AWC as anadromous waters (Table 3.24-5), with another 7 channels inhabited by resident fish species. As noted above, the Newhalen River provides a migratory connection between Iliamna Lake and Lake Clark for large numbers of adult and juvenile sockeye salmon. Beyond the Newhalen River, the road and pipeline skirt the western and southern flanks of Roadhouse Mountain, where the road turns south to Eagle Bay, and the pipeline continues east towards Williamsport. See “Alternative 3 – North Road Only” section, below, for a description of the natural gas pipeline route east of Eagle Bay.

Table 3.24-5: Anadromous waters crossed by access roads and pipeline along the Alternative 2 and Alternative 3 Transportation and Natural Gas Pipeline Corridor[1]

Tributary[2]	AWC Code	R.M.[3]	Feature	Species/Life-stage[4]
UTC 1.36, 1.34, and mainstem	See Table 3.24-2 for details			
N/A (tributary to Newhalen River)	324-10-10150-2207-3027-4011	1.9	culvert	COp
N/A (tributary to Newhalen River)	324-10-10150-2207-3027-4011-5005	0.6	culvert	COr
Newhalen River	324-10-10150-2207	15.5	bridge	Kp, Ss, COp
N/A (tributary to Eagle Bay)	324-10-10150-2235	5.8	culvert	Ss, ACp
Eagle Bay Creek[5]	324-10-10150-2239	0.8	n/a	COr, Ss, ACp
N/A (tributary to Eagle Bay Creek)[6]	324-10-10150-2239-3005	2.4	bridge	Ss, ACp
N/A (tributary to Chekok Bay)[6]	324-10-10150-2261	5.6	bridge	COp, Ss, ACp
N/A (tributary to Chekok Bay)[6]	324-10-10150-2261-3006	1.0	bridge	COp, Ss, ACp
N/A (tributary to Chekok Bay)[6]	324-10-10150-2267-3001	2.7	culvert	COp, Ss, ACp
Chekok Creek[6]	324-10-10150-2267	3.3	bridge	COp, Ss, ACp
Knutson Creek[6]	324-10-10150-2301	1.6	bridge	Ss, ACp
N/A (tributary to Lonesome Bay)[6]	324-10-10150-2333	0.9	bridge	Ss
Pile River[6]	324-10-10150-2341	1.6	bridge	Ss, ACp
Long Lake outlet[6]	324-10-10150-2343	1.8	bridge	Kp, Sp
N/A (3 crossings)[6]	324-10-10150-2343-3006	0.4, 0.7, 0.9	Culvert, bridge, culvert	Sp
Iliamna River	324-10-10150-2402	4.1	bridge	CHp, COp, Kp, Pp, Ss
Browns Peak Creek[7]	248-10-10040	3.8	N/A[7]	COr
Un-named[7]	248-20-10030	0.2	N/A[7]	CHp

Notes:

[1] Listing represents stream crossings for Alternative 2 mine and port access roads and pipeline, and Alternative 3 north access road and pipeline
[2] Tributary name from R2 et al. 2011a, if available
[3] R.M. = river miles at crossing above mouth or confluence of tributary (approx.)
[4] Species/Life-stage at crossing (from AWC). Species: K=Chinook, S=sockeye, CO=coho, CH=chum, P=pink; AC=Arctic char; Life-stage: s=spawning, r=rearing, p=present (life-stage not specified)
[5] Eagle Bay Creek crossed by mine access road at RM 0.8 (Alternative 2 only) and pipeline at RM 4.0
[6] Streams crossed by pipeline only for Alternative 2, by both pipeline and north access road for Alternative 3
[7] Streams crossed only by pipeline for Alternatives 2 and 3; crossing feature not specified
AWC = Anadromous Waters Catalog
N/A = Not Applicable
UTC = Upper Talarik Creek

Iliamna Lake

This alternative includes a ferry terminal site at Eagle Bay, approximately 20 miles east of the terminal for Alternative 1, with another ferry terminal site further east in Pile Bay (see Chapter 2, Alternatives). The 29-mile ferry route is adjacent to sockeye salmon spawning beaches on the southern side of Pile Bay (Southeast Beaches and Finger Beaches), and the along the islands important to spawning sockeye salmon (Porcupine Island, Flat Island, Ross Island, Triangle Island, and Eagle Island) (Morstad 2003). Although the islands contain extensive littoral shoal habitat, the ferry route would remain well offshore, where depths range from 200 to over 900 feet. Annual aerial surveys of spawning sockeye salmon in littoral habitats along Iliamna Lake have been conducted by ADF&G since 1920 (Morstad 2003). Spawning surveys have shown heavy use of the northeastern arm of Iliamna Lake, with highest densities associated with the main island archipelagos, Pedro Bay, and the Newhalen shoreline. Lower densities of spawning have been observed near Eagle Bay or along the southern shore of Pile Bay, which possesses minimal littoral habitat. Consequently, the midwater route of the ferry would not intersect known sockeye spawning habitat, except at the ferry terminal site in Eagle Bay. However, Pile Bay serves as a migration route for upstream migrant salmon (and trout) to the Iliamna River, Pile River, and several other anadromous tributaries, as well as an outmigration pathway for ocean-bound juvenile salmon.

Geomorphic studies conducted in 2018 describe beaches and nearshore lake habitats at the ferry terminal locations, including Eagle Bay North and Eagle Bay South (Paradox 2018a). Two habitat transects were measured at the Eagle Bay North location, which revealed an average slope of 13 percent, and substrates dominated by clean rounded gravel with few fines. The two Eagle Bay South transects had average gradients of 10 and 11 percent, with substrates ranging from rounded gravel on the beach sub-angular cobbles and boulders below depths of 5 feet.

Port Access Roads

The Pile Bay ferry terminal site would connect to the existing Williamsport-Pile Bay Road via a 2-mile spur road. Realignments and improvements would be made to the existing road to Williamsport. From Williamsport, a new 3-mile spur road would extend south to the Diamond Point port site. No stream crossings are associated with the Pile Bay spur road, and a single crossing of a channel with resident fish species is associated with the Diamond Point spur road. The existing Williamsport-Pile Bay Road between the two spur roads contains 12 stream crossings, including a bridge over the anadromous Iliamna River (Table 3.24-5). Three other bridges and two culverts cross resident fish streams, with six culverts crossing fishless streams. Although the existing Williamsport-Pile Bay Road or natural gas pipeline would not cross Chinkelyes Creek, it would parallel anadromous waters for approximately 2 miles.

Diamond Point Port

The port site at Diamond Point would be at the intersection of Iliamna and Cottonwood bays. Both bays are relatively shallow (mostly less than 40 feet in depth), with rocky substrates (intertidal reefs and subtidal rocky substrate) along a substantial portion of the shorelines and on many offshore reefs and islets (GeoEngineers 2018b, 2018c). Rock is the dominant substrate into the intertidal zone. Mud or other unconsolidated sediments composing beaches extend from the toe of the rocky habitat down into the subtidal zone. North of Diamond Point, the western side of Iliamna Bay has generally angular rubble or rocky upper reaches transitioning to mudflats at mid-tidal elevations. An extensive rock buttress projects into the intertidal zone from the base of a high cliff at the face Diamond Point. At the lower edge of this rock habitat, a sand/mud flat extends to the west into Cottonwood Bay, and to the north into Iliamna Bay. The lower elevations at Diamond Point are composed in part of bedrock similar to that at higher elevations. However, boulder /cobble habitat is found at the base of the bedrock and forms the upper edge of the lower mudflat. Scattered eelgrass is present along the shoreline between Diamond Point and Williamsport, as well as west of the point in Cottonwood Bay. More extensive reefs and eelgrass beds are found in the larger Iniskin Bay to the north of Iliamna Bay. Compared to IIE, minimal rock habitat exists on the northern shore of Ursus Cove in the vicinity of the natural gas pipeline route. Occasional ribs of bedrock and a few large boulders break up the generally uniform gravel and cobble beach.

3.24.2.2 Resident and Anadromous Fish

Transportation Corridor and Natural Gas Pipeline Corridor

The affected environment as described under Alternative 1 for the Cook Inlet portion of the natural gas pipeline is applicable to Alternative 2.

Mine Access Road

The eight anadromous streams that would be crossed by the mine access road and adjacent natural gas pipeline between the mine site and Eagle Bay have been documented to contain Chinook, coho, sockeye salmon, and Arctic char (Table 3.24-5). Resident species include slimy sculpin, rainbow trout, Dolly Varden, longnose suckers, and ninespine stickleback. See "Alternative 3 – North Road Only" section, below, for a description of fish resources along the natural gas pipeline route east of Eagle Bay.

Iliamna Lake

The ferry route for this alternative traverses the eastern portion of Iliamna Lake, including the vicinity of Eagle Bay and Eagle Islands, as well as the full length of Pile Bay. Lower densities of spawning have been observed near Eagle Bay or along the southern shore of Pile Bay—which possesses minimal littoral habitat—than in other bays and islands in the eastern basin (Morstad 2003). Fish and habitat surveys were conducted in 2018 near the ferry terminal locations in Iliamna Lake (Paradox 2018b, 2018c, 2018d). Nearshore fish were surveyed May through August, with spawning surveys conducted into September at the ferry terminal locations, using seine nets, snorkel surveys, and aerial visual surveys from a helicopter. The two most abundant species captured or observed in the seine and snorkel surveys were threespine stickleback and sockeye salmon. Other species captured or observed near the ferry terminal locations were Chinook salmon, coho salmon, ninespine stickleback, pond smelt, and sculpin.

Adult sockeye were observed swimming along the northern and southern shorelines of the Eagle Bay terminal site in July and August, with greater abundance of fish along the northern margin, and reduced numbers of fish in August (Paradox 2018c, 2018d). Although small areas of cleaned substrate was observed by snorkelers along the margin near the terminal site, none were subsequently developed into redds. A repeat survey in September revealed few adult sockeyes along the northern margin, and no further evidence of spawning or spawning behaviors was observed, although heavy spawning activities had already commenced in Knutson Bay during August. Additional information on fish resources in Iliamna Lake is described under Alternative 1, above.

Two anadromous tributaries flow into Eagle Bay, including Eagle Bay Creek (AWC 324-10-10150-2239), which is listed for coho rearing, sockeye spawning, and presence of Arctic char. The AWC tributary 324-10-10150-2235 is on the opposite shore of Eagle Bay from the port site, and is listed for sockeye spawning and presence of Arctic char. Historical spawner counts in Eagle Bay Creek have ranged from zero in 1963 to over 30,000 fish in 1975 (Morstad 2003).

Port Access Roads

The port access road serving the Pile Bay ferry terminal would cross the Iliamna River approximately 4 miles above its mouth (Table 3.24-5). The Iliamna River supports all five species of Pacific salmon, including important spawning habitat for sockeye salmon. The Iliamna River and Chinkleyes Creek are important habitat spawning habitat for sockeye salmon. Aerial survey estimates indicate that hundreds of thousands of spawning sockeye salmon use the system in some years (Morstad 2003). Chinkelyes Creek is listed for sockeye spawning and presence of coho, with rainbow trout, Dolly Varden, and slimy sculpin also known to be present. The spur road from Williamsport to Diamond Point crosses a channel supporting resident fish species. All other streams crossed contain only resident fish species, or are expected to be fishless.

Diamond Point

Pacific salmon return to numerous rivers in Kamishak Bay in proximity to the Diamond Point port site, including rivers entering Bruin Bay, Ursus Cove, Cottonwood Bay, and Iniskin Bay. Additional information on salmon runs in Kamishak Bay can be found under Alternative 1, above.

Marine fish and invertebrates were sampled in the IIE by beach seining, otter trawling, and gill or trammel netting in two different time periods (2004 to 2008, and 2010 to 2012) to establish baseline conditions and temporal variations in species composition and abundance in the marine habitat (Pentec Environmental/Hart Crowser 2011b). Additional sampling occurred in 2012 outside of the IIE, in the adjacent Cottonwood Bay, and immediately south in Rocky and Ursus coves for preliminary characterizations of the fish community (Hart Crowser 2015b). The use of multiple sampling gears provided a better coverage of several habitat types, potential spawning area, nursery areas, species distribution, and use in and outside of embayment in marine and estuarine environments.

Beach seine capture data from the IIE indicate that in the nearshore sandy/cobble habitats, 41 fish species were collected; however, not all species were captured at all stations and months. Overall, Pacific herring, juvenile pink salmon, juvenile chum salmon, Dolly Varden, surf smelt, and Pacific sand lance were the most common species captured in beach seines. The fishes captured in otter trawl represented fauna of open water and deeper waters than represented by seine. Some 28 species were captured, dominated by snake prickleback (*Lumpenus sagitta*), yellowfin sole (*Limanda aspera*), starry flounder, Pacific herring, and walleye pollock. In gill nets, Pacific herring (multiple-year classes) dominated the catch, followed by Dolly Varden in both sampling periods. Trammel nets mostly captured spiny dogfish (*Squalus acanthias*), starry flounder, Pacific halibut, and whitespotted greenling.

The capture of young Pacific herring and salmonids suggests that these species use these areas for rearing. The Pacific herring supported a strong commercial fishery for roe until 1998; it was closed for fishing in 1999 due to low abundance. However, biomass of Pacific herring has not improved to historical levels (ADF&G 2009). Pacific Herring spawning surveys in 2018 (GeoEngineers 2018a) were undertaken at low tides searching for eggs on eel grass and marine algae in the IIE. Surveys conducted in both 2013 and 2018 indicate that herring spawn primarily on eelgrass and rockweed in May. In the IIE, a light density of herring eggs was documented on eel grass in a small area containing depressions in the mudflat habitat. No other spawning events were documented in the IIE. Past and present surveys suggest that the IIE represents a minor contribution to Pacific herring spawning in Cook Inlet (Owl Ridge et al. 2019). Due to low stock size, the commercial fishery for herring roe in Kamishak Bay has been closed since 1999 (Hollowell et al. 2017). However, the capture of young Pacific herring and salmonids suggests that these species use these areas for rearing.

Studies conducted in 2018 involved 27 beach seine samples, from which over 20 fish species (>1,400 specimens) were collected, with juvenile salmonids as the dominant group in all three areas. The number and density of species differed between areas. Focused spawning surveys in IIE yielded no forage fish eggs. These findings are similar to those from the earlier sampling (GeoEngineers 2018d). The presence of both juvenile and larger salmonids indicated that species use the nearshore locations as migration corridors between marine and freshwater environments. Catch of larval surf smelt suggested drift of these larvae from other locations.

3.24.2.3 Aquatic Invertebrates

Locations for macroinvertebrate and periphyton sampling were selected to characterize diversity, abundance, and density in freshwater habitats in the transportation and natural gas pipeline corridor study area. The sampling locations are representative of streams in the Bristol Bay drainage. The study area for macroinvertebrates and periphyton consists of three stream-sampling sites. These sites occurred in unnamed streams that were named Bear Den Creek, Red Creek, and Ursa 100B for reporting purposes. The transportation corridor study area extends eastward beyond the Bristol Bay drainages into the Cook Inlet drainages. Section 15.4 in Chapter 15 (EBD) describes the macroinvertebrate and periphyton studies in the Bristol Bay drainages study area.

Aquatic habitat surveys indicate that the sample sites consisted largely of riffle/cobble habitat, which is the highest-quality habitat for EPT taxa. At sites sampled in 2005, the proportion of riffle/cobble habitat in each stream reach ranged from 70 to 85 percent.

A range of macroinvertebrate and periphyton sample-collection methods was employed during the field sampling. Slightly more taxa per site were collected using the ASCI method in 2004 than in 2005, indicating possible inter-annual variability. The number of taxa collected in 2005 from riffle/cobble areas by Surber sampler was generally less than in the ASCI samples, which were collected in more diverse habitats. Macroinvertebrate studies in other regions have documented variability in taxa richness among samples (DePauw et al. 2006). However, there are insufficient data from this study area to statistically define trends or relationships with respect to particular sampling method variability, or timing of sampling.

There were 235 macroinvertebrate taxa, including 64 Chironomidae taxa, identified in the Bristol Bay drainages study area (which includes both the mine and the transportation corridor study areas). Three of the non-Chironomidae macroinvertebrate taxa and three of the Chironomidae taxa were identified only in transportation corridor study area samples. The differences in numbers of taxa collected between the two sampling years are attributed to changes in the sampling program.

Dipteran taxa were not dominant at sampling sites in the transportation corridor study area. In 2005, Diptera composed a higher percentage than EPT in ASCI samples from all the sites, while EPT taxa composed a higher percentage than Diptera in Surber samples from all the sites. This may indicate that there were more Dipteran taxa in the variable habitats sampled using ASCI methods. Periphyton taxa richness and chlorophyll-a concentrations were both higher at Bear Den Creek than at the other two sites.

In 2005, Diptera comprised a higher percentage than EPT in ASCI samples from all the sites, while EPT taxa comprised a higher percentage than Diptera in Surber samples from all the sites.

Measurements of water-quality and habitat-quality parameters at each site fall within ranges considered good to optimal for aquatic and riparian habitat (Major et al. 2001). The concentration of DO was consistently high at all sites, and supersaturation (DO higher than 100 percent) was found at some sites. Water temperature ranged from 5.5°C to 13.2°C, and was much lower in 2005 than in 2004, except at Ursa l00B. No statistical analyses were performed on water quality and macroinvertebrate metric data because of limited data, and no trends were noted.

Epibiota

Epibiota surveys were conducted in intertidal zones representing a wide range of habitats (Figure 3.24-6). Diverse intertidal habitat types provide feeding areas for numerous pelagic fish (which live in the open ocean) and demersal fish (which live close to the ocean floor), and invertebrates in lower Cook Inlet. In the rocky intertidal habitats, the distribution of vegetation and invertebrates is determined by elevation, substrate, season, and exposure to physical stressors, such as waves, sun, and ice scour. Diversity of both plants and animals among the rocky stations tend to increase with declining wave exposure and salinity, and increasing sediment load. Ice is another major stressor of the biologic communities, because winter ice can severely reduce or completely remove sessile epibiota (immobile organisms that live on the surface of other organisms) each winter.

Baseline sampling results indicated several trends in the data. Fewer species of algae less tolerant of saline and variable light (i.e., more estuarine) conditions were present; and areas with high wave exposure had the greatest potential for high macroalgal diversity due to the high levels of disturbance, and greatest exposure to a larger recruiting stock, particularly at Cook Inlet waters.

Subtidal sampling for epifauna had limited visibility and detected relatively sparse epifaunal abundance. Kelp was prevalent closest to shore. Rocky substrate dominated most diver transects; therefore, invertebrate fauna was dominated by mobile organisms. Common attached invertebrates included sponges, hydroids, sea anemones, rock jingle, and bryozoans. Common mobile invertebrates included snails, chitons, nudibranchs, crabs, and sea stars. Few demersal fish were observed. Bottom-oriented fish like whitespotted greenling, starry flounder, and other flatfishes were common.

Infauna

Intertidal infauna (animals that live in ocean floor sediments) studies were conducted at multiple intertidal stations between 2004 and 2008 (Figure 3.24-6).

Intertidal infauna study results indicate that all animals identified at the genus level are abundant in marine assemblages elsewhere in Alaska (Blanchard et al. 2003). Between 2004 and 2008, differences in abundance, biomass, and diversity were found in the infauna sampling results. These differences reflect small-scale spatial and temporal occurrences, and illustrate the constantly shifting baseline conditions in the intertidal infauna assemblage.

Intertidal studies found that the average number of infaunal taxa observed per square meter ranged from 1.6 to 8.0 in 2004, and ranged from 1.6 to 14.2 in 2008.

Subtidal study results indicate stability in subtidal ecology through time. The variability of the results of subtidal faunal measures was considerable, but is comparable to the results of studies of similar marine assemblages elsewhere (Feder et al. 2005). Communities are dominated by a few taxa with high abundance, and there is a moderately diverse assemblage of taxa within sites.

Subtidal infauna was, overall, more abundant and more diverse than intertidal infauna. Greater stability and lower stress in subtidal environments lead to more abundance and diversity. Intertidal environments experience increased wave action, large temperature and salinity shifts, and seasonal ice-gouging, which exert more stressful influences not experienced in subtidal habitats. Despite the physical stresses, some areas of the intertidal environment exhibited substantial biomass of large infauna that far exceeded the subtidal biomass. In addition, the infauna at subtidal stations exhibited a higher degree of within-station similarity than did the infauna at intertidal stations—a reflection of the greater diversity of intertidal substrates; again, likely a consequence of the harsher nature of the intertidal environment.

Subtidal studies found that coarse substrates dominated the area, and the biota therefore reflected this habitat type. Attached and burrowing animals, rather than burrowing infauna, dominated the diverse transects. The average abundance of all taxa observed ranged from 2,210 to 5,150 per square meter. Biomass ranged from 25.9 to 298 grams per square meter. The number of taxa observed ranged from 26 to 40 among sites sampled.

3.24.2.4 Alternative 2 Variants

Alternative 2 – Summer-Only Ferry Operations Variant

Aquatic habitat and fish distribution would be the same for this variant as that described in Alternative 2.

Alternative 2 – Pile Supported Dock Variant

Aquatic habitat and fish distribution would be the same for this variant as that described in Alternative 2.

3.24.3 Alternative 3 – North Road Only

Mine Site

The affected environment as described under Alternative 1 is applicable to Alternative 3.

3.24.3.1 Aquatic Habitat

Transportation and Natural Gas Pipeline Corridors

The north access road and natural gas pipeline route would include an 82.3-mile-long corridor that would skirt the eastern edge of Iliamna Lake, thereby avoiding a ferry crossing of Iliamna Lake (Figure 3.24-5). The natural gas pipeline would be buried adjacent to the road alignment to Diamond Point, then would cross Cook Inlet to the Kenai Peninsula, as described above.

The affected environment associated with the natural gas pipeline described under Alternative 2 is applicable to the transportation and pipeline route in Alternative 3. The number of road and pipeline crossings for Alternative 3 is very similar to Alternative 2 (Table 3.24-5), with one fewer crossing of an anadromous channel. Alternative 2 crosses Eagle Bay Creek in two locations (one for the road, one for the natural gas pipeline), whereas the Alternative 3 road and adjacent natural gas pipeline crosses it in a single location.

Diamond Point Port

The affected environment as described under Alternative 2 is applicable to Alternative 3.

3.24.3.2 Resident and Anadromous Fish

Transportation and Natural Gas Pipeline Corridors

As described above, the transportation and natural gas pipeline corridors would cross numerous rivers, lakes, streams, and lake outlets in several different watersheds. Most of these watersheds drain into Iliamna Lake, with the exception of the Isolated Watershed Group, where precipitation, evaporation, and groundwater exchange appear to be the dominant hydrologic process.

See Table 3.24-2 for a description of fish species found in the UTC and Newhalen watershed groups. No fish were found in the Isolated Watershed survey sites during the October 2007 sampling. Four fish species were documented at the primary survey sites in the Roadhouse/Northeast Bay/Eagle Bay Watershed Group: slimy sculpin, Dolly Varden, rainbow trout, and ninespine stickleback. Coho salmon, sockeye salmon, and Arctic char are also known to occur in this watershed group. Sockeye salmon, rainbow trout, Dolly Varden, and slimy sculpin were found at sites in the Youngs/Chekok/Canyon Watershed Group. Other fish known in this group include coho salmon and Arctic char. In the Knutson Bay/Pedro Bay Watershed Group, sockeye salmon, Dolly Varden, and slimy sculpin were documented at several sites, and Arctic char are also known to be present in this watershed. Slimy sculpin and threespine stickleback were documented in primary and support survey sites in the Pile Bay/Lonesome Bay Watershed Group. Although no salmon were observed during the fish surveys, sockeye salmon and Arctic char are known to be present. Sockeye salmon, Dolly Varden, and slimy sculpin were observed in the Iliamna River Watershed Group. Approximately 3,000 adult sockeye salmon were observed at two support survey sites in August 2004. Williams Creek, which drains into Cook Inlet at Williamsport, contained Dolly Varden when sampled in 2004.

Diamond Point Port

See description of fish resources at Diamond Point under Alternative 2.

Alternative 3 – Concentrate Pipeline Variant

The habitat and fishery attributes associated with this variant are expected to be similar to Alternative 3, except the road footprint would typically be widened by less than 10 percent to place the 6.25-inch-diameter concentrate pipe alongside the natural gas pipeline. A slight increase in the footprint of the port facility would be required to store concentrate and to treat and discharge the filtrate water. If the filtrate water is pumped to the mine site rather than discharged at the port site, an 8-inch return-water pipe would be placed in the concentrate/natural gas pipeline trench, which would widen the road corridor by a few additional feet.

3.24.4 Alternatives Fish Stream Crossing Summary Table

A comparison of number of stream crossings, fish streams, anadromous streams, and resident fish is given in Table 3.24-6.

Table 3.24-6: Fish Stream Summary Table

Alternative	Stream Crossings	Fish Streams	Anadromous[1]	Resident[2]
Alternative 1 – Mine Access Corridor	30	10	6	4
Alternative 1 – Port Access Corridor	65	39	10	29
Alternative 1 – Port Access Corridor – East Kokhanok Variant	55	34	6	28
Alternative 2 – Road Sections	35	22	9	13
Alternative 2 – Pipeline Sections	82	34	15	19
Alternative 3 – Road and Pipeline Sections	116	55	23	32

Notes:
[1] Data from AWC catalog
[2] Resident fish stream data from EBD, RFI 85 2018 fish survey data
AWC = Anadromous Waters Catalog

3.24.5 Climate Change

Detailed analysis of long-term climate change and how it relates to aquatic habitats is discussed in Sections 3.16 and 4.16, Surface Water Hydrology.

3.25 THREATENED AND ENDANGERED SPECIES

This section covers threatened and endangered species (TES) listed under the federal Endangered Species Act (ESA)(16 United States Code [USC] Section 1531 et seq.) of 1973 that occur, or are likely to occur, in the EIS analysis area. This section details the potential impacts of the project alternatives and their variants on TES in the project's EIS analysis area. The EIS analysis area (hereafter referred to as 'analysis area') for TES includes all marine components of the project in Cook Inlet plus a surrounding buffer. Specifically, the analysis area includes a buffer around the port, each lighted navigation buoy (for Alternative 1 only), the natural gas pipeline construction corridor, the anchor mooring system at lightering locations, and a vessel corridor between the port and lightering locations (Table 3.25-1). Additional information on the analysis area buffer distances is provided in Section 4.25, Threatened and Endangered Species. The geographic extent of the analysis area differs between alternatives, but the buffers are the same regardless of alternative. The analysis area does not change for TES regardless of the alternative or variants considered.

Table 3.25-1: EIS Analysis Area for TES[1]

Project Component	Radial Distance for Cook Inlet Beluga Whale, Humpback Whale, Fin Whale, and Steller Sea Lion	Radial Distance for Northern Sea Otter and Steller's Eider
In-water portion of port[2]	11.3 miles	984 feet
Lighted navigation buoys (Alternative 1 only)	33 feet	
Natural gas pipeline construction corridor	4,101 feet (total corridor width is 8,202 feet)	
Lightering location (spread of the anchor mooring system)	1,150 feet (equivalent to a 2,300-foot by 1,700-foot rectangle centered on the mooring location)	
Vessel corridor between port and lightering locations	60 feet (total corridor width is 120 feet)	

1 The radial distances for TES were determined based on direct and indirect impacts, and the justification for the distances is defined in Appendices G and H.

2 The radial distance around the port would be the same distance regardless of the port construction type and alternative. Although the footprint for the Pile-Supported Dock Variant would be slightly smaller than the earthen-filled causeway, the radial distance around the analysis area would remain the same. The same applies to the dredging footprint associated with Alternative 2.

The ESA provides for conservation of fish, wildlife, and plant species considered to be at risk of extinction (threatened or endangered) in all or a substantial portion of their ranges; and to conserve the ecosystems and habitats on which they depend. The US Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) share regulatory authority for implementing the ESA for TES potentially affected by the project. TES known or with a potential to occur in the analysis area are described herein, based on a review of scientific literature and wildlife surveys conducted as part of the environmental baseline survey program. Marine mammal species with NMFS oversight are discussed first, followed by the marine mammal and avian species managed by the USFWS.

The following federally listed species were included due to their known and potential occurrence in the analysis area. These include Cook Inlet beluga whale (*Delphinapterus leucas*), humpback whale (*Megaptera novaeangliae*), fin whale (*Balaenoptera physalus*), Steller sea lion (*Eumetopias jubatus*), northern sea otter (*Enhydra lutris kenyoni*), and Steller's eider (*Polysticta stelleri*). One additional avian species, the short-tailed albatross (*Phoebastria albatrus*), was considered for inclusion. Based on a review of biological data for the region, all components of the project and alternatives are outside of the geographic range of the short-tailed albatross (Audubon Alaska 2017). The species is not known to occur in Cook Inlet, and therefore short-tailed albatross will not be further discussed in this document.

Existing conditions also incorporate climate change trends. Habitat change trends to marine mammal TES from climate change are included in the discussion with all marine mammal species in Section 3.23, and are not repeated here. However, climate change trends for Steller's eider are discussed below.

3.25.1 Alternative 1 – Applicant's Proposed Alternative

3.25.1.1 Cook Inlet Beluga Whale

Stock Identification

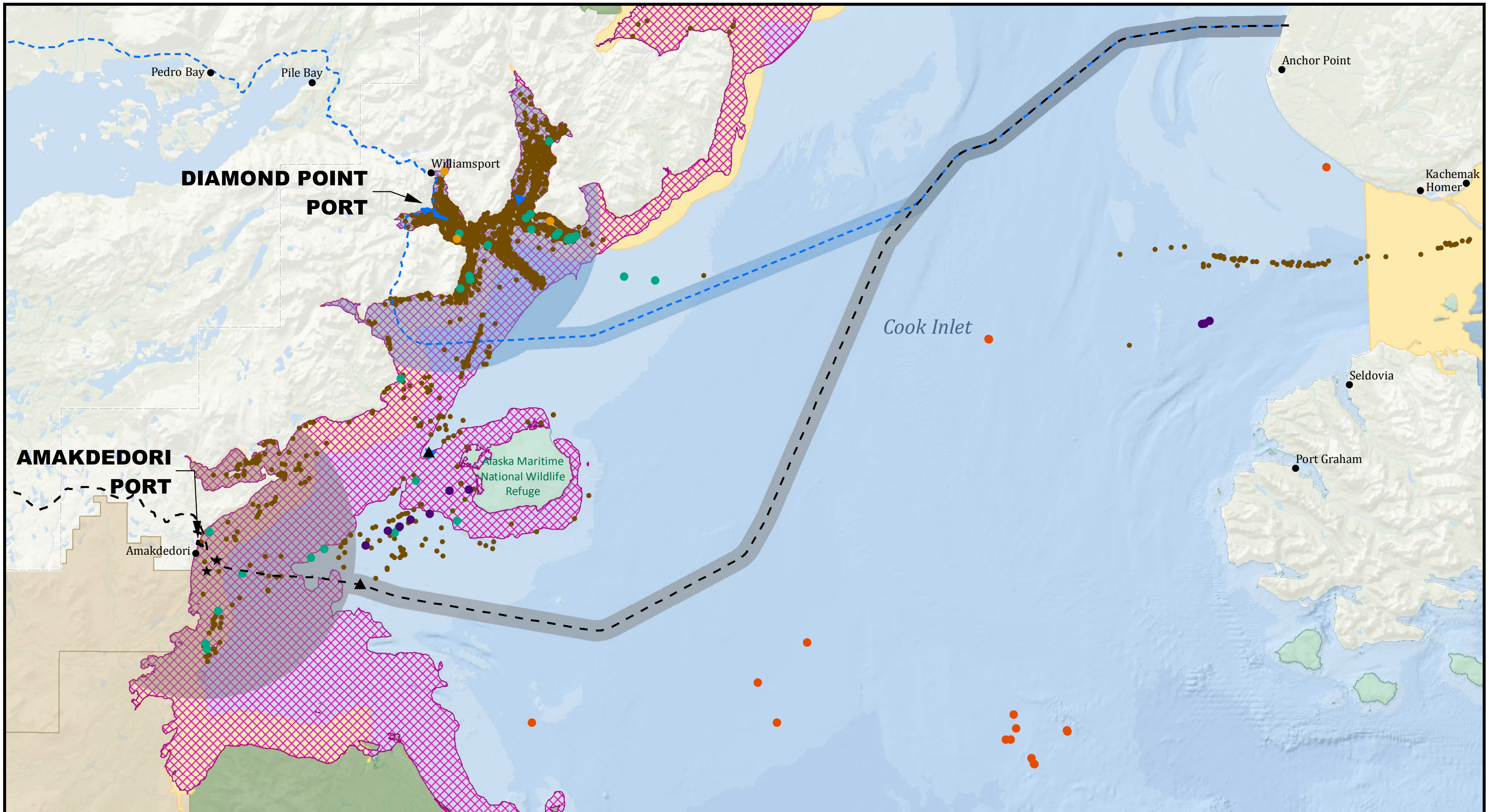
The Cook Inlet beluga whale stock (CIBS) occurs in the analysis area and is the most isolated of the five recognized beluga whale stocks (Laidre et al. 2000). The Cook Inlet beluga whale population was designated as depleted under the Marine Mammal Protection Act (MMPA) in 2000 (65 Federal Register [FR] 34590). In 2006, NMFS announced initiation of another Cook Inlet beluga whale status review under the ESA (71 FR 14836). NMFS issued a decision on the status review on April 20, 2007, concluding that the Cook Inlet beluga whale is a distinct population segment (DPS), in danger of extinction throughout its range; NMFS issued a proposed rule to list the Cook Inlet beluga whale as an endangered species (72 FR 19854). The Cook Inlet beluga whale population was listed by NMFS as endangered under the ESA on October 22, 2008 (73 FR 62919). NMFS published the Cook Inlet Beluga Whale Recovery Plan in 2016 (NMFS 2016b), as required by ESA, as well as the Final Conservation Plan (NMFS 2008a) as required by the MMPA. According to the annual abundance surveys conducted every June and August since 1999, the Cook Inlet beluga whale population has continued to decline at a rate of approximately 0.4 percent per year (Shelden et al. 2017).

Critical Habitat

NMFS announced the designation of critical habitat for the CIBS on April 8, 2011 (76 FR 20180; Figure 3.25-1). Critical habitat includes two areas—Critical Habitat Area 1 and Critical Habitat Area 2—which encompass approximately 3,013 square miles, collectively, of marine and estuarine habitat in Cook Inlet (76 FR 20180).

Critical Habitat Area 1 consists of approximately 738 square miles and encompasses all marine waters of Cook Inlet north of a line connecting Point Possession and the mouth of Three Mile Creek, including waters of the Susitna, Little Susitna, and Chickaloon rivers below mean higher high water. Critical Habitat Area 1 does not overlap with the analysis area.

Critical Habitat Area 2 consists of approximately 2,275 square miles south of Critical Habitat Area 1; includes nearshore areas along western Cook Inlet and Kachemak Bay; and overlaps the analysis area (Figure 3.25-1). Critical Habitat Area 2 includes fall and winter foraging and transit habitat for beluga whales, as well as spring and summer habitat for smaller concentrations of beluga whales (76 FR 20180). This area consists of less-concentrated spring and summer beluga use; however, it includes known fall and winter feeding and transit areas.



Sources: PLP 2018; NOAA 2009, 2011; (Beluga whale [ABR 2006 - 2012]; Steller's sea lion [ABR 2004 - 2006, 2006 - 2012, 2018]; Northern sea otter [ABR 2004 - 2006, 2006 - 2012, 2018]; Humpback whale [ABR 2018]); Rugh et al. 2005; Shelden et al. 2013, 2015, 2017

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Species Observations
- Beluga Whale
- Humpback Whale
- Steller's Sea Lion
- Northern Sea Otter
- Fin Whale

Critical Habitat
- Northern Sea Otter
- Beluga Whale

Alternative 1
- Lightering Locations
- Navigation Lights
- Natural Gas Pipeline
- Amakdedori Port
- Analysis Area

Alternative 2/3
- Lightering Location
- Natural Gas Pipeline
- Diamond Point Port
- Analysis Area

Other Features
- Borough Boundary
- National Park
- National Wildlife Refuge
- Alaska State Park
- State Game Refuge/Sanctuary

FEDERALLY LISTED MARINE MAMMAL CRITICAL HABITAT AND LOCATIONS IN THE ANALYSIS AREA

PEBBLE PROJECT EIS

FIGURE 3.25-1

NMFS considers Primary Constituent Elements (PCE) when designating critical habitat for TES. PCEs are the essential physical or biological features necessary for the conservation of a species on which their critical habitat is based. PCEs for the Cook Inlet beluga whale are listed below:

1. Intertidal and subtidal waters of Cook Inlet with depths less than 30 feet (mean lower low waterline), and within 5 miles of high and medium flow of anadromous fish streams.
2. Primary prey species: four species of Pacific salmon (Chinook [*Oncorhynchus tshawytscha*], sockeye [*Oncorhynchus nerka*], coho [*Oncorhynchus kisutch*] and chum [*Oncorhynchus keta*]), Pacific eulachon (*Thaleichthys pacificus*), Pacific cod (*Gadus macrocephalus*), walleye pollock (*Gadus chalcogrammus*), saffron cod (*Eleginus gracilis*), and yellowfin sole (*Limanda aspera*).
3. Waters free of toxins or other agents of a type and amount harmful to Cook Inlet beluga whales.
4. Unrestricted passage in or between the critical habitat areas.
5. Waters with in-water noise below levels resulting in abandonment of critical habitat areas by Cook Inlet beluga whales.

Habitat Use and Distribution

The CIBS remains in Cook Inlet throughout the year (Goetz et al. 2012), although Rugh et al. (2010) documented a significant northward contraction in the early summer range of Cook Inlet beluga whales since the 1970s (Shelden et al. 2016; NMFS 2016b). During ice-free months, Cook Inlet beluga whales are typically concentrated near river mouths (Rugh et al. 2010) that are considered primary foraging locations for Pacific salmon species and other fish, and include the Susitna River Delta (the Big and Little Susitna rivers), Eagle Bay, Eklutna River, Ivan Slough, Theodore River, Lewis River, and Chickaloon Bay and River (NMFS 2008a, 2016b). All of these locations are considerably north of the analysis area.

NMFS has conducted aerial surveys to estimate abundance of the beluga whale population in Cook Inlet every June, July, or during both months, from 1993 to 2012. Biennial surveys began in 2014, and have included the analysis area. Results of these surveys indicate that the majority of Cook Inlet beluga whales are concentrated in shallow areas near river mouths north of the analysis area, and do not occur as frequently in the central or southern portions of Cook Inlet (Shelden et al. 2017). The concentration of beluga whales in the northernmost portion of Cook Inlet appears to be consistent from June to October (Rugh et al. 2000, 2004, 2005, 2006, 2007).

The fall/winter/spring distribution of CIBS is not fully determined; however, there is evidence that most whales in this stock inhabit upper Cook Inlet year-round (Muto et al. 2018). A study of 20 satellite-tagged Cook Inlet beluga whales from January through March (when upper Cook Inlet is partly ice-covered) found that the beluga whales disperse from Point Possession and North Foreland south to Kalgin Island in lower Cook Inlet (north of the analysis area) (Ezer et al. 2013). However, the small sample size may not be indicative of the whole CIBS. Another satellite telemetry study by NMFS to track the movements of 14 beluga whales from September 2000 through March 2003 provided additional detail on seasonal movements and habitat use. None of the tagged beluga whales in the study moved south of Chinitna Bay (Hobbs et al. 2005), which is north of the analysis area; however, the small sample size may not be indicative of the whole CIBS. NMFS aerial surveys have not reported beluga whale sightings south of Tuxedni Bay (Shelden et al. 2015).

In the fall, as anadromous fish runs begin to decline, beluga whales return to the lower to middle Cook Inlet to forage on resident fish species (e.g., cod and groundfish) found in nearshore bays and estuaries. Groundfish include Pacific staghorn sculpin (*Leptocottus armatus*), starry flounder (*Platichthys stellatus*), and yellowfin sole.

Boat-based surveys by ABR in the spring and summer of 2018 (ABR 2018b-f) and aerial surveys conducted by USFWS for northern sea otters in May 2017 did not detect any beluga whales (Garlich-Miller et al. 2018). Both surveys included Kamishak Bay and the surrounding area in Lower Cook Inlet.

3.25.1.2 Humpback Whale

Stock Identification

Humpback whales were designated as endangered under the ESA in 1973 (35 FR 18319). No critical habitat has been designated for the humpback whale. In 2013, NMFS published a 90-day finding to identify the Central North Pacific population of humpback whales as a DPS under the ESA, and recommended that this DPS be delisted from the ESA, based on population abundance (78 FR 53391). On September 8, 2016, NMFS revised the listing status of the humpback whale. NMFS divided the globally listed species into 14 DPSs, removing the current species listing and replacing it with four endangered DPSs (Cape Verde Islands/Northwest Africa, Western North Pacific, Central America, and Arabian Sea), and one threatened DPS (Mexico). The remaining nine DPSs did not warrant listing. Critical habitat for the three endangered or threatened DPSs found in US waters (Western North Pacific, Central America, and Mexico) has not been determined (81 FR 62260). The Western North Pacific DPS (endangered), the Hawaii (Central North Pacific) DPS (not listed) and the Mexico DPS (threatened) are the DPSs most likely present in the Gulf of Alaska waters, which includes the analysis area. However, most of the individuals that migrate to the Gulf of Alaska Cook Inlet area are likely from the Hawaii DPS, and not the Western North Pacific or Mexico DPSs (NMFS 2017c).

Habitat Use and Distribution

North Pacific humpbacks spend the winter mating and calving in the subtropical and tropical waters of the Northern Hemisphere and the Southern Hemisphere. In the spring, humpback whales migrate north and feed in the prey-rich, sub-polar waters of southern Alaska, British Columbia, and the southern Chukchi Sea. The Hawaii DPS breeds in the Hawaiian Islands area, and feeds in most of the known feeding grounds in the North Pacific, particularly Southeast Alaska and northern British Columbia (Muto et al. 2018). The Western North Pacific DPS breeds in the areas of Okinawa, Japan and the Philippines, and feeds in the northern Pacific, primarily off the Russian Coast (Muto et al. 2018). The Mexican DPS breeds along the Pacific Coast of Mexico, the Baja California Peninsula, and the Revillagigedo Islands, and feeds across a broad range from California to the Aleutian Islands (Muto et al. 2018).

Small numbers of humpback whales are anticipated to occur in the analysis area during summer and fall. Humpback whales have been observed during the NMFS beluga whale aerial surveys conducted in Cook Inlet from 2000 to 2016. These surveys were adjacent to and overlapped the analysis area, but most humpback whale sightings occurred outside of the analysis area near Augustine, Barren, and Elizabeth Islands (Shelden et al. 2013, 2015, 2017). Aerial surveys in May 2018 for northern sea otters incidentally documented several humpback whales in Kamishak Bay, including north of Augustine Island (Garlich-Miller et al. 2018). Additionally, ABR surveys in spring and summer 2018 documented several humpback whales in Kamishak Bay southwest of Augustine Island (ABR 2018c, 2018e; Figure 3.25-1).

Primary foraging areas for humpback whales in the Gulf of Alaska region are south of the analysis area, including the waters east of Kodiak Island (the Albatross and Portlock Banks), waters along the southeastern side of Shelikof Strait, and in the bays along the northwestern shore of Kodiak Island (Ferguson et al. 2015).

3.25.1.3 Fin Whale

Stock Identification

Fin whales were listed as endangered under the ESA in 1973 (35 FR 18319). No critical habitat has been designated for the fin whale. For management purposes, NMFS divided fin whales in US waters into several management units or "stocks." One of these stocks, the Alaska (Northeast Pacific) stock, occurs in Alaskan waters. The Northeast Pacific stock is seasonally found off the coast of the Chukchi and Bering seas and the Gulf of Alaska during the summer (Muto et al. 2018). Fin whale surveys in the Gulf of Alaska in 2013 and 2015 estimated an abundance of 3,168 fin whales (Rone et al. 2017). Abundance surveys have not been conducted for fin whales in Cook Inlet or the analysis area.

Habitat Use and Distribution

Fin whales range across the entire North Pacific Ocean in both pelagic and shelf waters, and especially use shelf edge upwelling and mixing zones. Fin whales have been acoustically detected in the Gulf of Alaska year-round, with highest acoustic detections rates from August through December, and lowest call occurrence rates from February through July (Moore et al. 2006; Stafford et al. 2007). In July and August, fin whales concentrate in the Bering Sea/ eastern Aleutian area (Mizroch et al. 2009) and are regularly seen in the Gulf of Alaska (Muto et al. 2018). During the remaining months, fin whales are typically sighted around the Aleutian Islands and Kodiak Island, and in the Bering Sea. Results from a study off the Kenai Peninsula and the central Aleutian Islands indicate that in the summer months, fin whales occurred primarily from the Kenai Peninsula to the Shumagin Islands, and were most abundant near the Semidi Islands and Kodiak Island (Zerbini et al. 2006). In this study, all fin whales were detected south of the mouth of Cook Inlet.

Fin whale sightings in Cook Inlet are rare (NMFS 2017b). The NMFS beluga whale aerial surveys from 1993 through 2016 report only 10 fin whales widely distributed offshore between Anchor Point and Cape Douglas, mostly near the mouth of Cook Inlet and south of the proposed natural gas pipeline corridor. Panigada et al. (2006) found water depth to be the most significant variable in describing fin whale distribution, with more than 90 percent of sightings occurring in waters deeper than 6,562 feet. Fin whales are rare in Cook Inlet, and they are not expected to be encountered in the analysis area due to the relatively shallow water depths, compared to their preference for deeper waters.

3.25.1.4 Steller Sea Lion

Stock Identification

Steller sea lions inhabit waters of Alaska year-round; however, large numbers of individuals may widely disperse from concentrated breeding areas and rookeries after the breeding season (late May through early July), likely to access seasonally important prey resources (Muto et al. 2018). NMFS listed the Steller sea lion as a threatened species under the ESA in 1990 (55 FR 49204). In 1997, NMFS reclassified Steller sea lions as two DPSs under the ESA, based on genetic studies and phylogeographical analyses from across the sea lions' range (62 FR 24345). The Eastern DPS (listed as federally threatened) consists of sea lions breeding to the east of Cape Suckling, Alaska (144°W longitude), and the Western DPS (listed as federally endangered) consists of those animals breeding to the west of Cape Suckling (144°W longitude; 62 FR 24345). This document only discusses the Western DPS Steller sea lions, because the range includes the analysis area in the lower Cook Inlet. Animals in this DPS are further classified for purposes of population analysis into regions; those animals that typically use the waters surrounding the analysis area are part of the central Gulf of Alaska region. The 2016 Stock Assessment Report lists a minimum population estimate of 50,983 for the Western DPS (Muto et al. 2018).

Habitat Use and Distribution

Steller sea lions occur in lower Cook Inlet, south of Anchor Point around the offshore islands, and rarely north of Nikiski (NMFS 2008c; Shelden et al. 2017). Steller sea lions have been observed during NMFS beluga whale aerial surveys conducted in Cook Inlet from 2000 to 2016; sightings of Steller sea lions occurred outside of the analysis area on land at the mouth of Cook Inlet (i.e., Elizabeth and Shaw Islands to the south of the analysis area) (Shelden et al. 2013, 2015, 2017).

NMFS published a final rule designating Steller sea lion critical habitat in 1993 (58 FR 45269). Steller sea lion critical habitat does not overlap with the analysis area, because it occurs over 9.5 miles southeast, with the closest major haulout sites and rookeries over 30 miles away near the mouth of Cook Inlet. Because Steller sea lion designated critical habitat does not occur in the analysis area, it will not be discussed further.

Habitat used by the Western DPS of Steller sea lions extends along Alaska's southern coast (NMFS 2008c), including the coastline adjacent to Amakdedori port. Individuals from the Western DPS are expected to occur in the analysis area, because the center of abundance for the Western DPS is considered to extend from Kenai to Kiska Island (NMFS 2008c); however, there are no major haulouts in Cook Inlet.

Steller sea lions feed on a variety of demersal (bottom dwelling fish), semi-demersal, and pelagic prey, indicative of a broad spectrum of foraging behaviors likely based primarily on prey availability (NMFS 2010). Gregr and Trites (2008) determined that juvenile and female Steller sea lions mainly forage relatively close to rookeries and haul-outs, all south of the analysis area.

ABR surveys of Steller sea lions around the mouths of Iliamna and Iniskin Bays from 2004 to 2008 showed consistent occurrence near the Iniskin Islands (ABR 2011d). Steller sea lions were observed hauling-out on islands near and off the mouths of Iliamna and Iniskin bays from January through November. Historical aerial Pacific herring (*Clupea harengus*) surveys conducted by the Alaska Department of Fish and Game (ADF&G) in the spring (April to June 1978 to 2002) suggest a long-standing preference for the Iniskin Islands area by Steller sea lions, with smaller numbers of animals scattered elsewhere (ABR 2011d). In offshore waters, Steller sea lions occurred along the open coastline between Iliamna and Iniskin bays, north of Amakdedori port.

Recent data from ABR surveys during spring and summer 2018 in Kamishak Bay incidentally detected several Steller sea lions (ABR 2018b). These Steller sea lion observations were south and west of Augustine Island, including reefs and shoals close to Amakdedori port (Figure 3.25-1).

3.25.1.5 Northern Sea Otter

Stock Identification

Three sea otter populations are recognized in Alaska: Southcentral, Southwest, and Southeast (70 FR 46366). Two stocks occur in Cook Inlet—the Southwest and the Southcentral; the dividing line between the two stocks is a line in a north-south direction in the middle of Cook Inlet. Only the Southwest stock occurs around Amakdedori port. The Southwest DPS was listed as threatened under the ESA on August 5, 2005 (70 FR 46366), and is classified as a strategic stock under the MMPA. The Southwest DPS range extends along the western shore of lower Cook Inlet (70 FR 46366). The Southcentral stock includes sea otters on the eastern side of Cook Inlet, and is not a federally listed stock. Therefore, this section describes only the southwestern stock and sea otters found on the western side of Cook Inlet.

Critical Habitat

On October 8, 2009, the USWFS designated critical habitat for the Southwest Alaska stock divided into five management units (74 FR 51988; Figure 3.25-1). Critical habitat includes approximately 5,855 square miles, all of which are in Alaska (74 FR 51988). Critical Habitat Management Unit 5, Kamishak Bay, is the only unit that overlaps with the analysis area (Figure 3.25-1). The estimated size of Unit 5 is approximately 2,607 square miles (74 FR 51988). Critical habitat defined in Unit 5 includes the entire nearshore marine environment, ranging from the mean high tide line to the 66-foot depth contour, as well as waters occurring within 328 feet of the mean high tide line (74 FR 51988). The greatest proportion of the critical habitat area in the analysis area is composed of waters in the 66-foot isobath.

The PCEs of critical habitat for the Southwest DPS of northern sea otters and the status of each PCE in the analysis area are summarized below. Critical Habitat Unit 5, Kamishak Bay, Alaska Peninsula, contains all of the PCEs essential for the conservation of the Southwest Alaska DPS of northern sea otters (74 FR 51988).

1. PCE 1: Shallow, rocky areas where marine predators are less likely to forage, which are waters less than 7 feet in depth.
2. PCE 2: Nearshore waters that may provide protection or escape from marine predators, which are those up to 328 feet from the mean high tide line.
3. PCE 3: Kelp forests that provide protection from marine predators, which occur in waters less than 66 feet in depth.
4. PCE 4: Prey resources within the areas identified by PCEs 1, 2, and 3 that are present in sufficient quantity to support the energetic requirements of the species.

Habitat Use and Distribution

Northern sea otters occur year-round throughout lower Cook Inlet (Garshelis 1987), which spans southwest from the North Forelands to the inlet mouth between English Bay and Cape Douglas. The Southwest DPS range is along the western shore of lower Cook Inlet (USFWS 2014d).

Sea otters forage in nearshore waters at depths up to 131 feet in the nearshore benthos of rocky and soft-sediment communities (Marshall 2014), which includes all of Kamishak Bay and Amakdedori port. Approximately 40 percent of sea otters' daily activity foraging, and they primarily feed on benthic invertebrates, including mussels, crabs, urchins, sea cucumbers, and clams.

NMFS beluga whale aerial surveys have documented the presence of sea otters in the analysis area, especially in Kamishak Bay (including Augustine Island). In the greater Kamishak Bay area, groups of over 30 animals were observed in multiple survey years (Shelden et al. 2013, 2015, 2017).

USFWS conducted aerial surveys for northern sea otters in May 2017 in Cook Inlet that encompassed project components (Amakdedori and Diamond Point ports, the natural gas pipeline corridor, and lightering locations), Kachemak Bay, and western Cook Inlet (which includes the upper west Cook Inlet and Kamishak Bay) (Klein, pers comm 2018; Garlich-Miller et al. 2018). The highest sea otter densities were west and north of Augustine Island in Kamishak Bay. Relatively few sea otters were observed north of Kamishak Bay. The 2017 western Cook Inlet survey yielded a total western lower Cook Inlet abundance estimate of 10,737 sea otters (Garlich-Miller et al. 2018).

3.25.1.6 Steller's Eider

The Alaska population of Steller's eider, federally listed as threatened, is the only federally listed avian species known to occur in the analysis area. This section focuses on known locations of Steller's eiders in relation to project components, and includes the Amakdedori port (in Kamishak Bay), and the eastern side of Cook Inlet near Anchor Point. Steller's eiders are generally present in Cook Inlet from fall through early spring. Because the project is outside of the geographic breeding range for Steller's eider and does not support the coastal tundra habitats where the species nests, a review of the species' breeding ecology is not included. The mine site, transportation corridor, and natural gas pipeline corridor (excluding the portion in Cook Inlet) lack suitable breeding, wintering, staging, molting, or foraging habitat for Steller's eider, and are therefore not included in the analysis area. Steller's eiders may rarely fly over the mine site and terrestrial portions of the transportation corridor and natural gas pipeline corridor while moving between Cook Inlet, the Alaska Peninsula, and the western coast of Alaska. Steller's eiders were not documented during any biological surveys at the mine site.

There are three main Steller's eiders breeding populations, with the majority breeding in Russia, and a much smaller Alaska-based breeding population (around 500 individuals) (USFWS 2011a, 2012a). The Alaska-based breeding population was listed as federally threatened on June 11, 1997 (62 FR 31748). The Alaska-based breeding population nests primarily along the Arctic Coastal Plains around Utqiaġvik, with a small sub-population nesting in the Yukon-Kuskokwim Delta (Y-K Delta). USFWS designated critical habitat for Steller's eider does not occur in the analysis area (66 FR 8850); therefore, critical habitat will not be discussed.

In addition to areas in Russia and the Alaska Peninsula, Steller's eiders molt and winter in nearshore waters in lower Cook Inlet, which includes the analysis area. Therefore, this section is focused on Steller's eiders' fall molt, winter distribution, and migration in lower Cook Inlet.

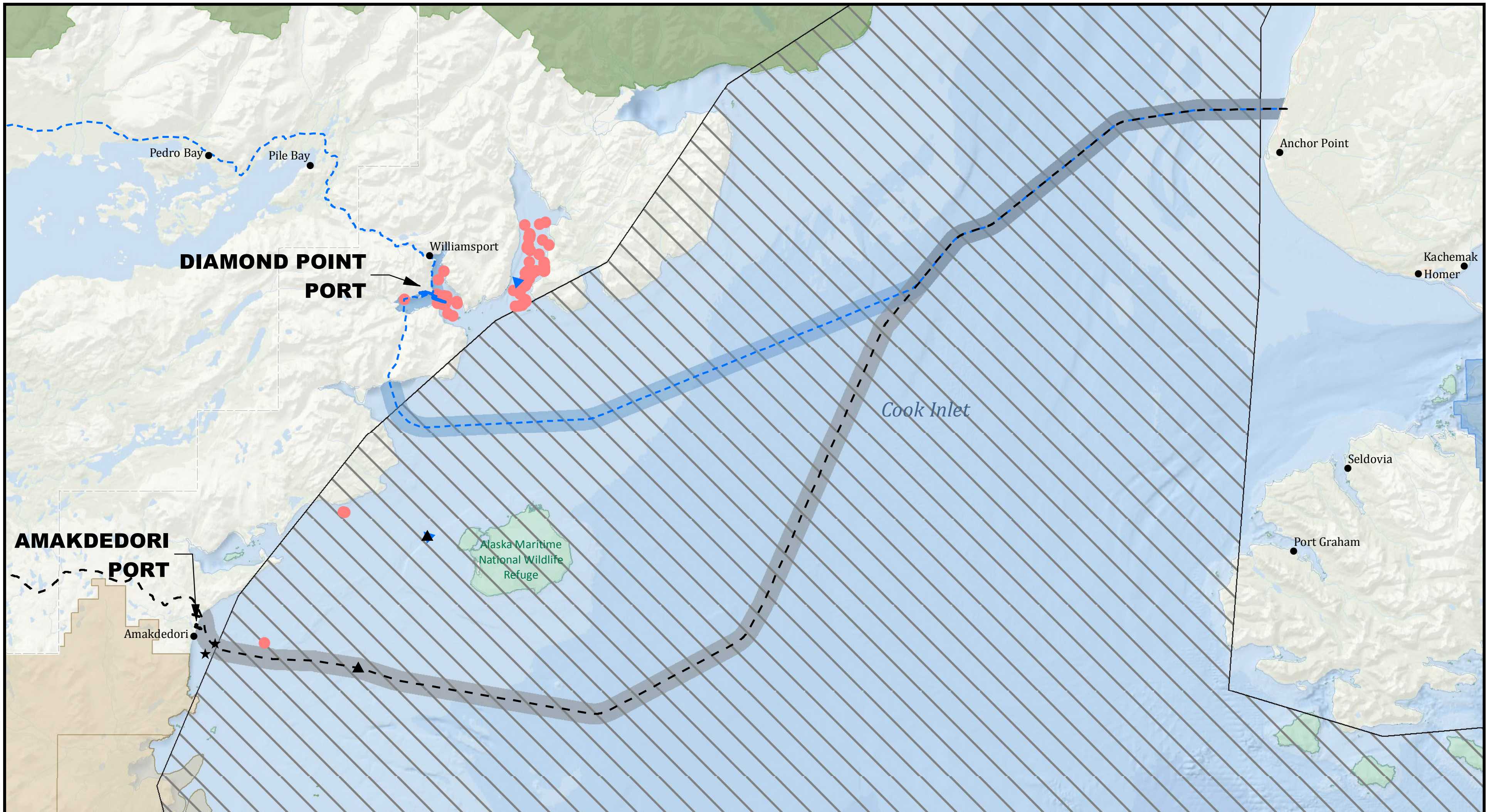
Fall Molt and Winter Distribution

Of the Steller's eiders that winter and molt in Cook Inlet, the USFWS assumes that less than 1 percent is from the listed Alaska-based breeding population (USFWS 2008b). After breeding in the Arctic Coastal Plains and Y-K Delta, Steller's eiders move to marine waters, where they mix with birds from the Russian-based breeding population and undergo a 3-week flightless molt. Adult birds undergo a flightless molt in fall, with most birds molting in a few lagoons on the northern side of the Alaska Peninsula and along the western Alaska coast (USFWS 2011a). During the fall molt (from late July until late October; USFWS 2002), eiders undergo a complete molt, including all flight feathers, which renders them flightless. In a study conducted along the northern side of the Alaska Peninsula, sub-adult birds were flightless first, followed by adult males, and then adult females, with eiders maintaining spatial and temporal sex and age class separation during the flightless period (Petersen 1981). Although some Steller's eiders remain in their molting areas throughout winter, other birds disperse to coastal waters that include southern Cook Inlet. Molting and wintering Steller's eiders occur in the western part of Cook Inlet and the adjacent nearshore coastal waters, including the analysis area (Figure 3.25-2).

The preferred marine habitat for Steller's eider includes marine waters up to 30 feet deep; the associated invertebrate communities; and where present, eelgrass beds along with their associated flora and fauna (65 FR 13262). Molting areas tend to be characterized by extensive shallow areas with eelgrass beds and intertidal sand flats and mudflats. Because Steller's eiders prefer to winter in shallow waters, they are usually found within 400 yards of shore, except where shallows extend farther offshore in bays and lagoons or near reefs (USFWS 2002).

An aerial and boat survey conducted in Cook Inlet during February of 1994, reported 1,363 Steller's eiders in nearshore areas of Kamishak Bay, from McNeil Cove to Iniskin Bay (Agler et al. 1995). During a survey from 2004 to 2006, 24 satellite transmitter-tagged Steller's eiders captured during winter at Kodiak Island were documented molting and wintering in Kamishak Bay. Approximately 20 percent of the birds used Kamishak Bay as a molting area, and at least two birds molted on two consecutive years, suggesting some site fidelity. In both 2005 and 2006, an estimated minimum of 2,500 birds molted in Kamishak Bay, based on aerial photography. Most birds were associated with a large reef (Douglas River Shoals) near the southern end of Kamishak Bay, approximately 17 miles south of Amakdedori port (Rosenberg et al. 2016). During aerial transect surveys in 2005, approximately 2,000 molting Steller's eiders were observed in the Douglas River Shoals in late August and September. During winter surveys in 2005, 3,921 Steller's eiders were recorded in southern Kamishak Bay (Larned 2006). The 2004 and 2005 surveys indicate that the number of Steller's eiders in Cook Inlet increases in early winter, peaks in January and February, and then declines from early March through mid- to late-April, as birds depart on spring migration for their breeding grounds (Larned 2006).

Steller's eiders appear to concentrate north and south of Amakdedulia Cove, with low numbers of Steller's eiders around Amakdedulia Cove. Surveys in Kamishak Bay (Larned 2006), including Amakdedulia Cove, indicated that low numbers of Steller's eiders may occasionally be found in the area during winter months. Two groups of between 1 and 37 Steller's eiders were observed during aerial surveys from February 11 to 16, 2004, in the area around Amakdedulia Cove (Larned 2006). Several more groups of between one and 30 Steller's eiders were observed in the same area from March 11 to 17, 2004. Only one group of between 8 and 30 birds was detected during April 12 and 13, 2004, indicating that most wintering Steller's eiders had departed the area by mid-April in 2004. Surveys conducted that following December (December 4 through 8, 2004), detected several small flocks of Steller's eiders of between one and 60 birds. Surveys were repeated again from January through April 2005, with similar results of small flocks of Steller's eiders using the nearshore waters of Amakdedulia Cove (Larned 2006). Most eider flocks were closer to Bruin Bay, near the northern part of Amakdedulia Cove.



Sources: PLP 2018; (Steller's eider [ABR 2006 - 2012, 2018])

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Steller's Eider
- Observations
- Molting & Wintering Habitat

Alternative 1
- Lightering Locations
- Navigation Lights
- Natural Gas Pipeline
- Amakdedori Port
- Analysis Area

Alternative 2/3
- Lightering Location
- Natural Gas Pipeline
- Diamond Point Port
- Analysis Area

Other Features
- Borough Boundary
- National Park
- National Wildlife Refuge
- Alaska State Park
- State Game Refuge/Sanctuary

STELLER'S EIDER MOLTING AND WINTERING LOCATIONS IN THE ANALYSIS AREA

FIGURE 3.25-2

Steller's eiders are known to occur on the eastern side of Cook Inlet around Anchor Point, where the natural gas pipeline would extend from Cook Inlet and connect to an existing pipeline north of Anchor Point. Survey data from Larned (2006) indicate that several small flocks of less than 100 birds each winter around Anchor Point. The actual number of birds and location varies throughout the winter, often depending on the extent of the sea ice cover, but most small flocks congregate around an extensive shoal south of Anchor Point. Clusters of flocks of Steller's eiders were observed in locations ranging from Anchor Point to north of Ninilchik, with numbers of birds ranging from 1,141 in January 2005, to 2,370 in March 2001 (Larned 2006). During surveys in winter 2004 and 2005, the average monthly mean was 463 Steller's eiders in the area north of Anchor Point to Ninilchik, and 1,713 Steller's eiders in Kamishak Bay (Larned 2006). The number of eiders peaked in January, and drastically decreased by early April. Groups of eiders were consistently observed around an extensive shoal south of Anchor Point. Therefore, Steller's eiders are present in both western and eastern parts of Cook Inlet during the winter months. By mid- to late-April, most Steller's eiders have left Cook Inlet for their northern breeding grounds.

Migration

The path of migration for Steller's eiders to and from Cook Inlet during the fall molt and throughout the winter and early spring is not known. However, Steller's eider bird strikes on towers and power lines at Togiak, Naknek, and King Salmon (including inland sites) indicate that there may be some overland pathway that includes Iliamna Lake (USFWS 2008b). Satellite transmitter data from 2004 to 2006 (Rosenberg et al. 2016) documented Steller's eiders molting in Kamishak Bay from mid- to late-August until the middle to the end of November, and through the end of January. Prior to departure for the northern breeding grounds, Steller's eiders stage in several locations along the Alaska Peninsula. In 2005, Rosenberg et al. (2016) documented two satellite transmitter-tagged birds that staged in Kamishak Bay from March 25 to May 8. These data indicate that Kamishak Bay may be used by the same individual eiders during consecutive years, and that the species uses the bay for molting, wintering, and staging. The birds then fly to the northern side of the Alaska Peninsula (exact route is unknown) and up the west coast of Alaska before heading to Russia, the Y-K Delta, and the Arctic Coastal Plains.

Climate Change

Potential trends from climate change on Steller's eider populations have not been well-studied for the species' wintering and molting range. Forecasted trends related to wintering and molting areas of Steller's eiders in the analysis area are decreased levels of sea and shorefast ice in Cook Inlet. Because Steller's eiders travel around Cook Inlet during the winter in response to varying levels of ice, warmer ocean temperatures may influence the wintering and foraging locations of Steller's eiders during the nonbreeding season. Ocean acidification and changes in marine ecosystems (such as a decrease in summer sea ice) may also alter the prey base for Steller's eiders (Markon et al. 2018).

Habitat changes on the breeding grounds could directly affect the number of birds in the winter range. The breeding range for the listed population of Steller's eiders on the North Slope of Alaska is considered moderately vulnerable to climate change due to potential increased rates of shoreline erosion (in part due to reduced sea ice coverage), alterations in water temperatures that alter their prey base, and a modification in nesting habitats (thermokarst ponds and adjacent upland habitats; Liebezeit et al. 2012). Increased storm surges may result in loss of breeding habitat, increased salinity in the intertidal zone, melting of permafrost, and vegetation changes (USFWS 2016b). Additional trends include arctic water bodies draining and drying out during summer; increased productivity in some ponds due to increased nutrient input from thawing soil and warmer days; changes in seas ice coverage; and small mammal population cycle changes (Steller's eiders tend to nest in high lemming [*Lemmus* species] years) (USFWS 2012g). Because the federally listed population of Steller's eiders breeds almost exclusively in the habitat around Utqiaġvik, there is little opportunity for the species to relocate due to habitat loss (Liebezeit et al. 2012).

3.25.2 Alternative 2 – North Road and Ferry with Downstream Dams

Alternative 2 and variants are described in Chapter 2. The Alternative 2 analysis area includes the same project components and their applicable buffers detailed at the beginning of this section, but is located northwards in Iliamna and Iniskin Bays. Additionally, there are no lighted navigation buoys associated with the port at Diamond Point, and dredging would be necessary at Diamond Point. The species discussed in this section have broad distributions; and where there are differences between the species' distribution with Alternative 1 and the other alternatives, further discussion is provided.

3.25.2.1 Cook Inlet Beluga Whale

As discussed under Alternative 1 above, during the summer months (when the majority of construction activities in Cook Inlet would occur), the CIBS range generally contracts to the upper reaches of Cook Inlet following spawning salmon runs. However, beluga whales have still been detected sporadically in the analysis area during the spring and summer. During NMFS beluga whale aerial surveys in Cook Inlet, a group of two beluga whales were seen in Iniskin Bay on June 4, 1994 (Rugh et al. 2000). ADF&G biologists have occasionally recorded beluga whales in the area of Iliamna and Iniskin bays during herring surveys (April to June) from 1978 to 2002. During herring surveys from March 26 through April 1, 1997, an ADF&G biologist recorded a group of 12 to 15 beluga whales off the mouth of Iniskin Bay (ABR 2011d). In September 2007, ADF&G biologists recorded 25 to 30 beluga whales in inner Chinitna Bay (north of the analysis area), and 12 beluga whales were seen in upper Iniskin Bay (ABR 2011d). Twelve beluga whales were seen in Iliamna, Iniskin, and Chinitna bays, as well as near the Iniskin Islands during summer surveys (ABR 2011d). Beluga whales were also recorded along the eastern shore of Iliamna Bay in October 2008 (ABR 2011d). As detailed above under Alternative 1, Cook Inlet beluga whales are expected to occur in similar summer densities throughout the marine environment for Alternative 2, with the majority of beluga whales in Upper Cook Inlet. Similar densities between Alternatives 1 and 2 are also expected during the winter months, when Cook Inlet beluga whales are more commonly found in Lower Cook Inlet. Similar to Alternative 1, CIBS critical habitat area 2 overlaps with the analysis area (Figure 3.25-1).

3.25.2.2 Humpback Whale

Humpback whales have been observed during NMFS Cook Inlet beluga whale aerial surveys from 2000 to 2016. Although a number of humpback whale sightings occurred mid-inlet between the Iniskin Peninsula and Kachemak Bay, most sightings occurred in the area near the Augustine, Barren, and Elizabeth islands (Shelden et al. 2013, 2015, 2016), which are to the south of Alternative 2 and outside of the analysis area. Additional boat-based surveys during the spring and summer 2018 documented several humpback whales south and west of Augustine Island, outside of the analysis area for Alternative 2 (ABR 2018c, 2018e; Figure 3.25-1).

3.25.2.3 Fin Whale

Fin whales are rarely observed in Cook Inlet, with most sightings near the mouth of Cook Inlet. They have not been observed in the Alternative 2 analysis area, and are unlikely to occur in the analysis area.

3.25.2.4 Steller Sea Lion

There are no major Steller sea lion haulouts, rookeries, or critical habitat in the analysis area. Sightings of large congregations of Steller sea lions during NMFS beluga whale aerial surveys occurred outside of the analysis area, on land in the mouth of Cook Inlet (e.g., Elizabeth and Shaw islands)(73 FR 62919). Additionally, the analysis area is more than 40 miles away from the closest known Steller sea lion rookery on Shaw Island, at the southwest entrance of Kamishak Bay.

ABR conducted boat-based surveys during spring and summer 2005 and 2006, and helicopter surveys in 2007 and 2008 in Iliamna and Iniskin bays. Surveys documented small numbers of Steller sea lions from spring to fall, with the majority of observations in April (ABR 2011d). A concentration of Steller sea lions in April (37 animals) suggests they may congregate in the area between Iniskin and Oil bays to eat spawning Pacific herring that sometime spawn there in large numbers (ABR 2011d; Figure 3.25-1). The records of Steller sea lions show consistent occurrence in the Iniskin Islands area. Historical data from aerial herring surveys conducted by the ADF&G in the spring suggest a long-standing preference of the Iniskin Islands by Steller sea lions, with smaller numbers of animals scattered elsewhere throughout the analysis area.

3.25.2.5 Northern Sea Otter

Sea otters were commonly observed during studies in Iliamna and Iniskin bays, and were recorded in the analysis area primarily during winter, with only scattered individuals recorded during the spring and summer. Sea otters were distributed broadly throughout the analysis area, but most otters were found outside Iniskin and Iliamna bays in offshore habitats and among islands at the mouths of the bays (ABR 2011d; Figure 3.25-1). Sea otters were observed moving into the sheltered bays when the sea ice decreased starting in March, and were seen in higher densities offshore in the winter. Sea otters were scarce in Iniskin Bay, although several groups were recorded in the middle of Iliamna Bay during winter months (ABR 2011d). The number of sea otters observed in Iliamna and Iniskin bays increased from fall to mid-winter, presumably as the weather in the exposed Kamishak Bay deteriorated. Numbers decreased in the spring as otters began moving out into Kamishak Bay during summer. This is supported by the most recent survey data from May 2017 (Garlich-Miller et al. 2018). Aerial surveys of lower Cook Inlet documented almost no northern sea otters in Iliamna and Iniskin bays during the May 2017 survey; but instead, found the highest density directly west of Augustine Island, outside of the analysis area. These data suggest that the use of the marine environment associated with Alternative 2 varies seasonally, but is lowest during the spring and summer, and highest during winter. Similar to Alternative 1, Critical Habitat Management Unit 5 coincides with the analysis area (Figure 3.25-1).

3.25.2.6 Steller's Eider

Surveys during winter 1994 in lower Cook Inlet by Agler et al. (1995) documented 435 Steller's eiders ranging among Oil, Iniskin, and Iliamna bays. Larned (2006) consistently observed Steller's eiders at the mouth of Iniskin Bay (160 to 435 individuals) between December 2004 and early spring 2005. Surveys conducted by ABR regularly recorded Steller's eiders in Iniskin and Iliamna bays during winter and early spring during helicopter surveys conducted from 2006 through 2008 (ABR 2011d; Figure 3.25-2). Additional helicopter-based surveys were conducted from 2009 to 2012, with the focus on nearshore marine waters from Iniskin Bay south to Bruin Bay (ABR 2015c). These additional surveys confirmed results from previous surveys, but also documented two flocks totalling 2,462 eiders between Ursus Cove and Bruin Bay along Fortification Bluff (west of Augustine Island) in December 2012 (ABR 2015c; Figure 3.25-2). Steller's eiders were found primarily in offshore waters in the middle portions of Iniskin and Iliamna bays, and occasionally in nearshore waters. Most birds occurred around a shallow shoal in the lower part of Iniskin Bay, and in the middle of the channel between Cottonwood and Iliamna bays. Generally, several hundred Steller's eiders were present in these bays from late November to early December, and through the end of March to early April. In 2006, the highest count was 300 Steller's eiders in early December; numbers increased to 676 Steller's eiders during the surveys in early March 2007. In 2008, the highest number recorded in Iliamna and Iniskin bays was in early March with 275 eiders. Between 2006 and 2008, the total number of Steller's eiders observations in Iliamna and Iniskin bays (which may represent some of the same individuals) ranged from 790 in 2006; 1,636 in 2007; and 808 in 2008 (ABR 2011d). ABR surveys from 2009 through 2012 in the norther portion of their Cook Inlet Marine Study Area (which primarily included Iliamna and Iniskin bays) documented between 1,231 to 265 eiders, respectively (ABR 2015c). The fluctuations in Steller's eider numbers during winter is likely related to the location and presence of sea and shorefast ice, in addition to severity and timing of fall storms (which push eiders from southern locations into more northern protected bays). Therefore, surveys conducted by Agler et al. (1995), Larned (2006), and ABR (2011d, 2015c) indicate that Iniskin and Iliamna bays provide overwintering habitat for several hundred Steller's eiders.

3.25.3 Alternative 3 – North Road Only

There are no new geographical areas in the marine environment that are covered by this alternative and its variants; therefore, no new information is provided for any of the federally listed species. All information for this alternative is previously addressed by Alternatives 1 and 2, above.

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3.26 VEGETATION

The affected environment for vegetation includes all vegetation types that may be directly or indirectly affected in all four components in project alternatives and variants. The affected environment for vegetation is described in terms of the extent and characteristics of predominant vegetation types. Rare or sensitive plant species and invasive plant species are also addressed in this section. There are no federally listed threatened, endangered, or candidate plant species expected to occur in the analysis area.

The affected environment description for vegetation is primarily based on information provided in Chapter 13 of the Environmental Baseline Document (EBD) (3PPI and HDR 2011) and Chapter 38 of the EBD (HDR and 3PPI 2011a) and the project geographic information system (GIS) database, which reflects changes in the project area since publication of the EBD (HDR 2018c).

The affected environment for vegetation supports analysis for other biological resources that are addressed in this Environmental Impact Statement (EIS), including Section 3.23, Wildlife Values and Section 3.22, Wetlands and Other Waters/Special Aquatic Sites. Vegetation is also an important aspect of social resources such as Section 3.5, Recreation and Section 3.9, Subsistence.

3.26.1 EIS Analysis Area

The EIS analysis area (hereafter referred to as "analysis area") includes potential direct and indirect impacts from construction and operations. The analysis area collectively includes areas for all four components (mine site, transportation corridor, ports, and natural gas pipeline) and associated variants, defined below.

Mine Site – The analysis area for the mine site includes a 330-foot buffer around the direct disturbance footprint and potential drawdown zone from the open pit.

Transportation Corridor and Ports – The analysis area for the transportation corridor and ports includes a 330-foot buffer around the direct disturbance footprint.

Natural Gas Pipeline – The analysis area for the stand-alone sections of the natural gas pipeline is a 30-foot corridor through Cook Inlet and Iliamna Lake, and a 100-foot corridor through overland areas.

3.26.2 Analysis Methodology

Vegetation classification systems are a hierarchical organization of levels of broadest types (such as forested or non-forested) classified further into more detailed types (such as white spruce closed forest). This section discusses the classification systems used to determine the vegetation types applied in descriptions and analysis in this section and Section 4.26, Vegetation.

Field-verified vegetation mapping – As part of the project's environmental baseline study program, researchers analyzed vegetation field data and aerial photo signatures to develop a system for describing and identifying vegetation types (3PPI and HDR 2011; HDR and 3PPI 2011a). This classification system is based on the Alaska Vegetation Classification (Viereck et al. 1992), supplemented by Wibbenmeyer et al. (1982), and expanded as necessary to accommodate interpretation of available aerial imagery. Vegetation data collected included estimates of the percent cover of each plant species, site photographs, and classification of vegetation types. The vegetation classification system incorporated information on canopy cover, needleleaf (conifer) versus broadleaf tree species, shrub height and density, and dominant species. Mapping was digitized on aerial photography at a scale between 1:1,200 and 1:1,500. Details on vegetation study methodology and field data collection can be found in Chapter 13 of the EBD (EBD) (3PPI and HDR 2011) and Chapter 38 of the EBD (HDR and 3PPI 2011a). A quick reference guide to the environmental baseline study classification system, including vegetation type definitions and representative photos is included in these chapters of the EBD.

Field-verified vegetation mapping covers approximately 90 percent of the three action alternatives. Figure 3.26-1 illustrates where field-verified vegetation mapping is available. Methodology for determining additional vegetation mapping for areas not covered by field-verified data is discussed below.

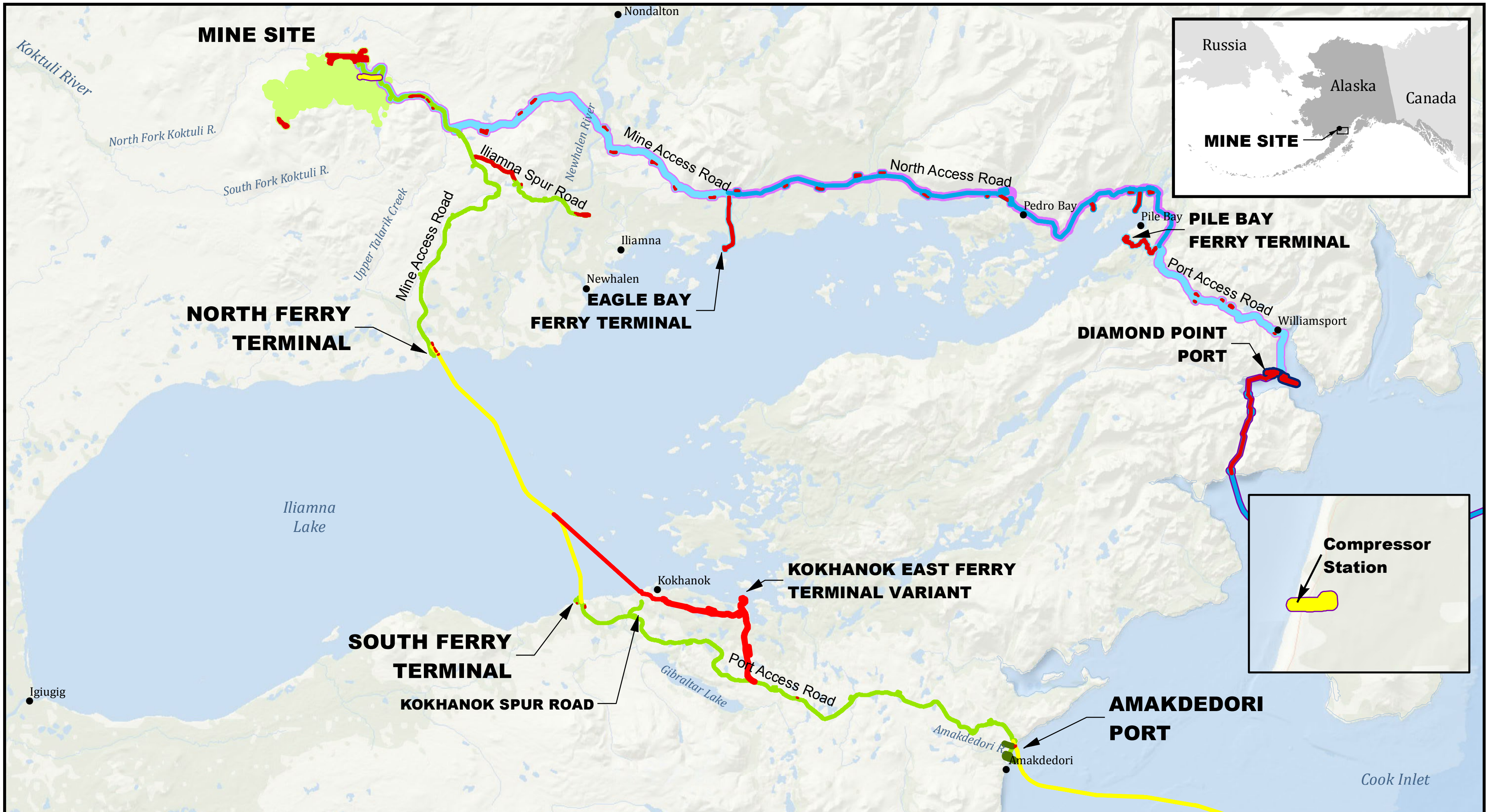
Additional mapping – Field-verified vegetation mapping was not completed for all project components of Alternatives 1, 2 and 3 (see Figure 3.26-1). For areas of the analysis area that fall outside the areas mapped in the field, vegetation mapping is based on comparable data that follows a similar vegetation classification process. Data is taken from the Alaska Center for Conservation Science (ACCS) Vegetation Map and Classification for Northern, Western, and Interior Alaska, and the Vegetation Map and Classification for Southern Alaska and Aleutian Islands (Boggs et al. 2016). The ACCS vegetation classification defines land cover types that were developed using best-available data derived from 18 regional land cover maps that have been developed over the last 31 years. For maps derived from satellite imagery, a 30-meter pixel size or finer was used; for maps derived from aerial photography, a scale of 1:63,360 or finer was used (Boggs et al. 2016).

Vegetation types in this EIS – To compare vegetation types between the three action alternatives in the analysis area for all four components, detailed ACCS land cover types were grouped into the best-corresponding field-verified vegetation types based on comparison of the dominant growth forms (tree, shrub, or herb), vegetation density (open or closed canopy), and average height (tall, low, or dwarf) from each classification system. The seven main resulting grouped vegetation types in the analysis area (hereafter, "vegetation types") are applied in the characterization of vegetation in this section, and in the analysis of direct and indirect impacts in Section 4.26, Vegetation.

There were 48 detailed vegetation types mapped in the analysis area in the field-verified data. To facilitate the direct comparison of these types with ACCS land cover types, vegetation types were aggregated into broader categories, based on structural characteristics including dominant growth form (forested, shrub, or herbaceous), vegetation density (open or closed canopy), and average height (dwarf, low, or tall) (3PPI and HDR 2011; HDR and 3PPI 2011a).

There were 101 ACCS detailed land cover types (within 69 broader land cover types) mapped in areas that did not have field-verified data within the analysis area. These types were aggregated into the same vegetation types as the field-verified vegetation types. In some instances, data had to be summarized at a broader scale than the field-verified mapping. For example, the ACCS vegetation classification system does not break down the tall shrub land cover type by "open" or "closed" like the field-verified mapping does, so the acreages for both open fall shrub and closed tall shrub were be combined into one tall shrub category (open-closed).

See Appendix K3.26 for detailed tables showing the relationship of field-verified vegetation types and ACCS land cover types to the vegetation types applied in this section and in Section 4.26, Vegetation.



Sources: PLP 2018; ADNR

US Army Corps of Engineers®

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Vegetation Analysis Areas

- All Alternatives: Mine Site
- Alternative 1: Transportation
- Alternative 1: Natural Gas Pipeline
- Alternative 1: Port
- Alternative 2: Transportation
- Alternative 2: Natural Gas Pipeline
- Alternative 2 and 3: Port
- Alternative 3: Transportation
- Alternative 3: Natural Gas Pipeline
- Data Gap

ALTERNATIVES 1, 2, AND 3 VEGETATION MAPPING OVERVIEW

PEBBLE PROJECT EIS

FIGURE 3.26-1

Vegetation types description – The following affected environment discussion focuses on the seven main vegetation types, summarized below. These seven types are also referred to in Section 4.26, Vegetation. The seven types include:

- **Open/Closed Forest –** The open or closed forest type has over 10 percent tree species canopy coverage and generally involves vegetation communities such as needle leaf and deciduous forest and woodlands.
- **Open/Closed Tall Shrub –** The open or closed tall shrub type has over 25 percent coverage with shrubs greater than 1.3 m tall, or shrubs greater than 1.3 m as the most common shrubs. This vegetation structure type generally includes communities such as all tall shrub, and open or closed Alder or Willow tall shrub.
- **Open/Closed Low Shrub –** The open or closed low shrub type has either 25 percent coverage with shrubs greater than 0.2 m tall but less than 1.3 m tall, or shrubs greater than 0.2 m but less than 1.3 m as the most common shrubs. This vegetation structure type generally includes communities such as bogs, mixed shrub sedge tussock, all low shrub, low shrub-lichen, and low shrub-tussock tundra.
- **Dwarf Shrub –** The dwarf shrub type includes shrubs less than 0.2 m tall with over 25 percent coverage. This vegetation structure generally includes communities such as dwarf shrub, dwarf shrub-lichen, shrub tundra, and tundra hummock.
- **Dry to Moist Herbaceous –** The dry to moist herbaceous type is dry to moist, has less than 10 percent tree coverage and less than 25 percent shrub coverage. This type generally includes communities such as mesic herbaceous, grasslands, tussock tundra, grass meadows, and sedge meadows.
- **Wet Herbaceous –** The wet herbaceous type is wet (can be tidally influenced; can be permanently or seasonally flooded), has less than 10 percent tree coverage and less than 25 percent shrub coverage. This type generally includes communities such as tidal herbaceous, peatlands, marshes, wet meadows, and mosses.
- **Other –** The "other" type refers to any land with less than 25 percent vegetation coverage, consists mainly of barren ground, or has human development making up over 50 percent of the land cover. This type generally includes land cover such as barren land, rock-talus, sparsely vegetated land, and urban, agriculture, and roads.
- **Open water –** This type refers to any location permanently flooded, and with less than 10 percent vegetation coverage. This type generally includes features such as oceans, lakes, rivers, and streams. Open water is included in the pie charts depicting vegetation types in this section to show the proportion of total land cover in the analysis area, but this type is not considered part of the affected environment for vegetation, and is not included in calculation of impacts to vegetation in Section 4.26.

A series of pie charts are presented below to illustrate the proportion of each of these types in the analysis area in each of the action alternatives and variants for each component. For the production of these pie charts, numbers are rounded. Any apparent inconsistencies in sums are the result of rounding. Also note that the "open water" type is included in the pie charts, but as described above, this type is not considered part of the affected environment for vegetation.

Rare or sensitive plant species – Confirmed or reported populations of species on the ACCS rare vascular plant species list were reviewed from the online ACCS database (ACCS 2018a).

Invasive plant species – Field studies and the online Alaska Exotic Plant Information Clearinghouse database (ACCS 2018b) were reviewed for presence of invasive plant species in the analysis area.

3.26.3 No Action Alternative

Under the No Action Alternative, Pebble Limited Partnership (PLP) would retain the ability to apply for continued mineral exploration activities under the State's authorization process, as well as any activity that would not require Federal authorization. Current State-authorized activities associated with mineral exploration and reclamation and scientific studies would be expected to continue at similar levels. PLP would be required to reclaim any remaining sites at the conclusion of their exploration program. If reclamation approval is not granted immediately after the cessation of reclamation activities, the State may require continued authorization for ongoing monitoring and reclamation work as deemed necessary by the State of Alaska.

3.26.4 Alternative 1 – Applicant's Proposed Alternative

A summary of vegetation types by project components is provided below. Vegetation types were assessed according to the analysis methodology, as described above.

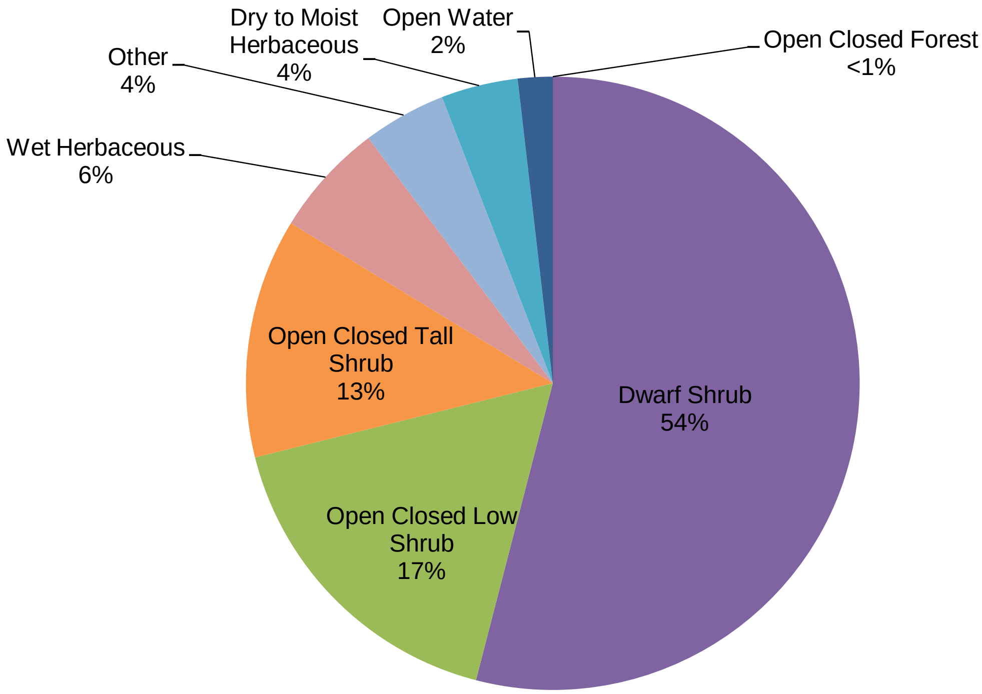
3.26.4.1 Mine Site

The mine site is characterized by a predominance of shrub types, representing approximately 84 percent of the mine site area. Figure 3.26-2 shows the percentages of vegetation types in the mine site area. Human-caused vegetation disturbance in the area was minimal, and appeared to be limited to all-terrain vehicle (ATV) trails or campsites (3PPI and HDR 2011).

Summer-Only Ferry Operations Variant

This variant would increase the size of the mine site by 38 acres associated with a container yard and relocation of a sewage storage tank, therefore increasing the affected environment for vegetation. This increased size is included in the analysis area, and in Figure 3.26-2 below.

Figure 3.26-2: Alternative 1 – Mine Site Vegetation Types



Source: Boggs et al. 2016; 3PPI and HDR 2011; HDR and 3PPI 2011a; HDR 2018c

3.26.4.2 Transportation Corridor

The transportation corridor area includes the 24 miles of the mine access road (5 miles of this road falls within the mine site mapping area) from the mine site to the north ferry terminal at Iliamna Lake, an 18-mile crossing of the lake to the south ferry terminal, and the port access road (37 miles) between the lake and Amakdedori port on Cook Inlet. It also includes spur roads to Iliamna Airport and Kokhanok Airport. The transportation corridor includes segments of the natural gas pipeline that fall within the transportation corridor.

Percentage of vegetation types in the transportation corridor is shown in Figure 3.26-3. This area is characterized by a predominance of shrub types, representing approximately 80 percent coverage. Human-caused vegetation disturbance in the mapping area was minimal, and appeared to be limited to ATV trails, roads, and building pads near the village of Iliamna, Kokhanok Airport, and the shore of Iliamna Lake (3PPI and HDR 2011).

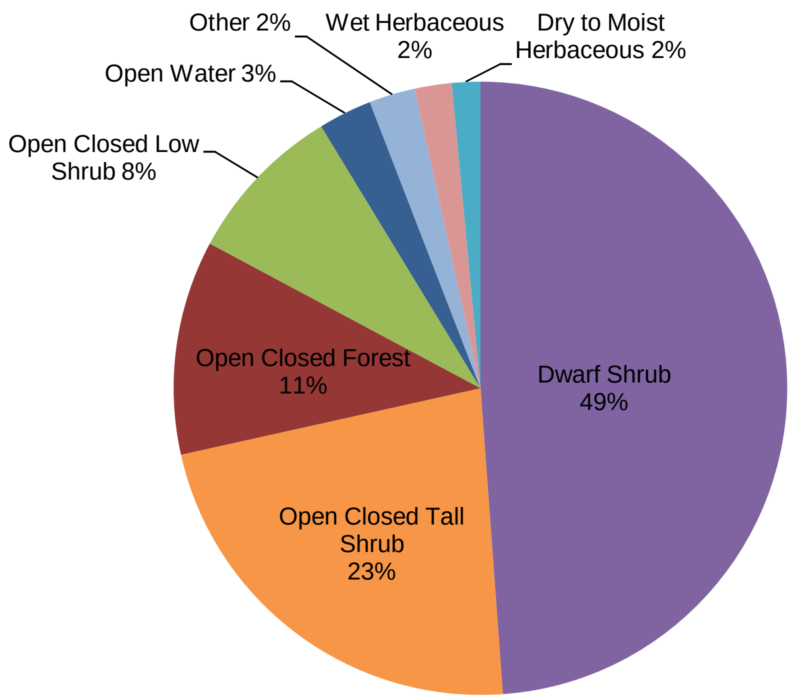
Summer-Only Ferry Operations Variant

This variant would not change the affected environment for vegetation in the transportation corridor component. The increased mine site size associated with this variant was included in the mine site analysis area.

Kokhanok East Ferry Terminal Variant

The affected environment for vegetation would not change, because this variant would only change the amount of open water type.

Figure 3.26-3: Alternative 1 – Transportation Corridor Vegetation Types



Source: Boggs 2016; 3PPI and HDR 2011; HDR and 3PPI 2011a; HDR 2018c

3.26.4.3 Amakdedori Port

Vegetation mapping of the approximately 30-acre port site includes an onshore area to encompass shore-based facilities at the port, as well as an offshore area for waterside structures and improvements associated with the marine facility. Percentages of vegetation types in the Amakdedori port area are shown in Figure 3.26-4.

This area is characterized by a predominance of shrub types, representing approximately 57 percent coverage. The Amakdedori port area extends into the Cook Inlet, and therefore is largely composed of the open water type. No human-caused vegetation disturbance was reported for the Amakdedori port mapping area.

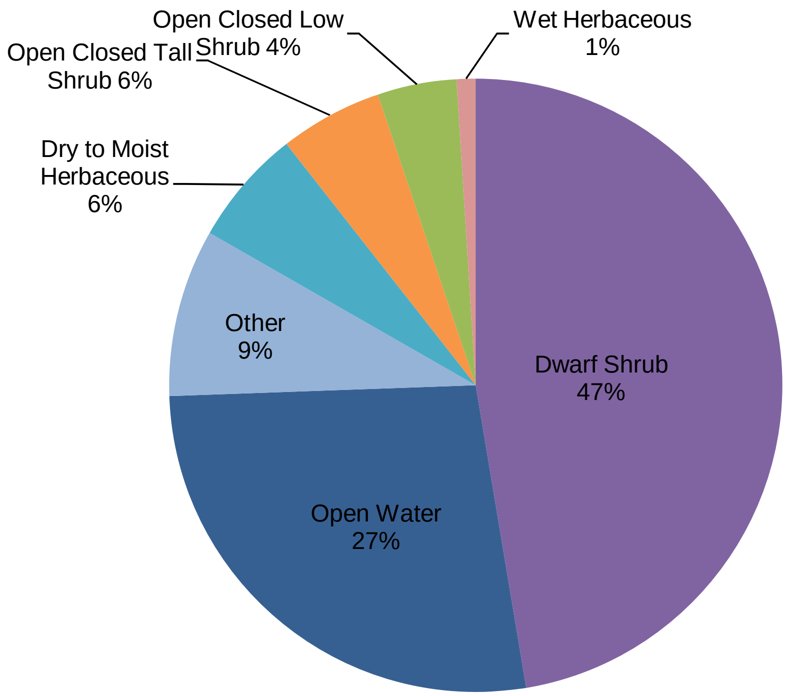
Summer-Only Ferry Operations Variant

This variant would not change the affected environment for vegetation in the port component. The increased mine site size associated with this variant was included in the mine site analysis area.

Pile-Supported Dock Variant

The affected environment for vegetation would not change, because this variant would only change the amount of open water type.

Figure 3.26-4: Alternative 1 – Amakdedori Port Vegetation Types



Source: BOGGS 2016; 3PPI and HDR 2011; HDR and 3PPI 2011a; HDR 2018c

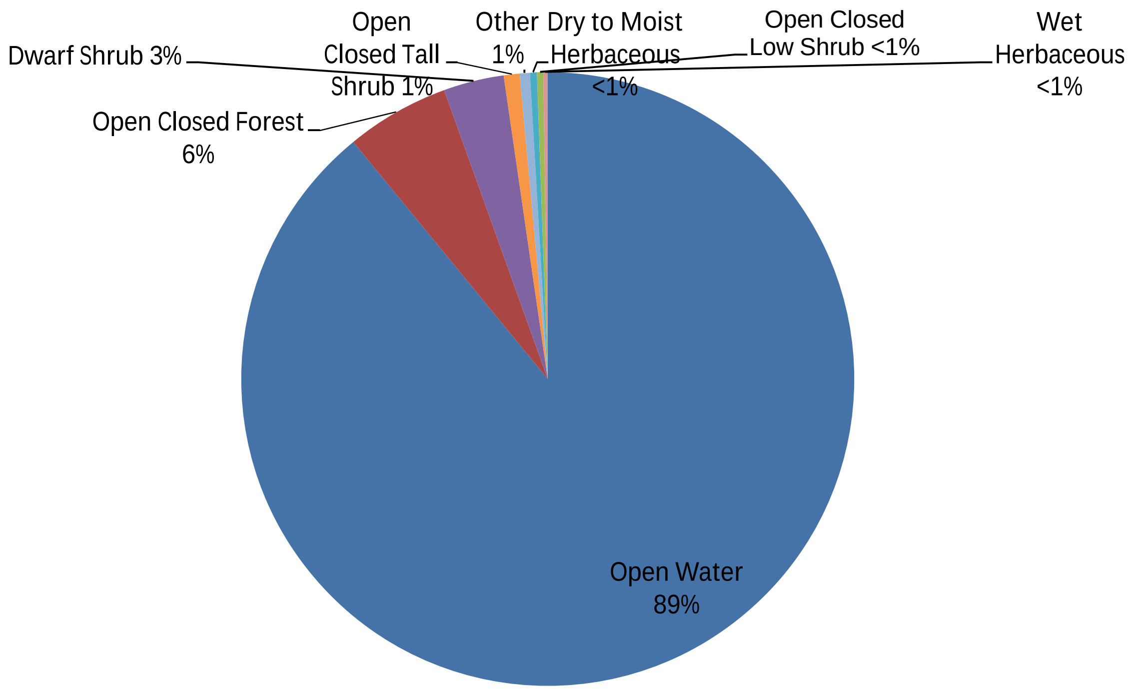
3.26.4.4 Natural Gas Pipeline Corridor

Segments of the natural gas pipeline adjacent to access roads are addressed under the transportation corridor mapping area. Segments of the natural gas pipeline that do not follow the access road corridors are described here, and include the 1 mile Kenai Peninsula Tie-in, the 104-mile Cook Inlet crossing, the 19-mile Iliamna Lake crossing, and the 27-mile North ferry terminal to the mine site. The pipeline corridor is predominantly covered by open water, representing approximately 89 percent of the area. The percentage of vegetation types is shown in Figure 3.26-5.

Kokhanok East Ferry Terminal Variant

This variant would slightly increase (approximately 20 miles) the length of the pipeline crossing of Iliamna Lake. The affected environment for vegetation would not change, because this variant would only change the amount of open water type.

Figure 3.26-5: Alternative 1 – Natural Gas Pipeline Corridor Vegetation Types



Source: BOGGS 2016; 3PPI and HDR 2011; HDR and 3PPI 2011a; HDR 2018c

3.26.5 Alternative 2 – North Road and Ferry with Downstream Dams

A summary of vegetation types by project components is provided below. Vegetation types were assessed according to the analysis methodology described above.

3.26.5.1 Mine Site

The vegetation types at the mine site are the same for all alternatives, as summarized under Alternative 1.

3.26.5.2 Transportation Corridor

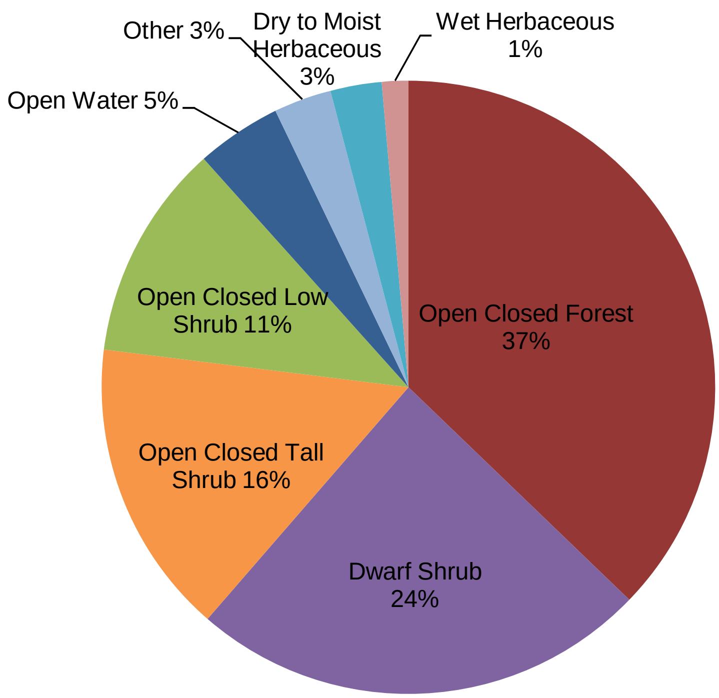
The transportation corridor described herein includes 31 miles of the mine access road (5 miles of this road falls within the mine site mapping area), from the mine site to the Eagle Bay ferry terminal, a 29-mile crossing of the lake to the Pile Bay ferry terminal, and the port access road (18 miles) between the lake and Diamond Point port at Cook Inlet. The transportation corridor mapping area includes segments of the natural gas pipeline that fall within the transportation corridor.

The percentages of vegetation types in the Alternative 2 transportation corridor area are shown in Figure 3.26-6. The transportation corridor is characterized by a predominance of open/closed forest (37 percent) and mixed-shrub classes (51 percent).

<u>**Summer-Only Ferry Operations Variant**</u>

This variant includes an increased footprint associated with container storage at a laydown area along the Pile Bay-Williamsport Road. This increased footprint is included in the analysis area for the transportation corridor, and in Figure 3.26-6, below.

Figure 3.26-6: Alternative 2 – Transportation Corridor Vegetation Types



Source: BOGGS 2016; 3PPI and HDR 2011; HDR and 3PPI 2011a; HDR 2018c

3.26.5.3 Diamond Point Port

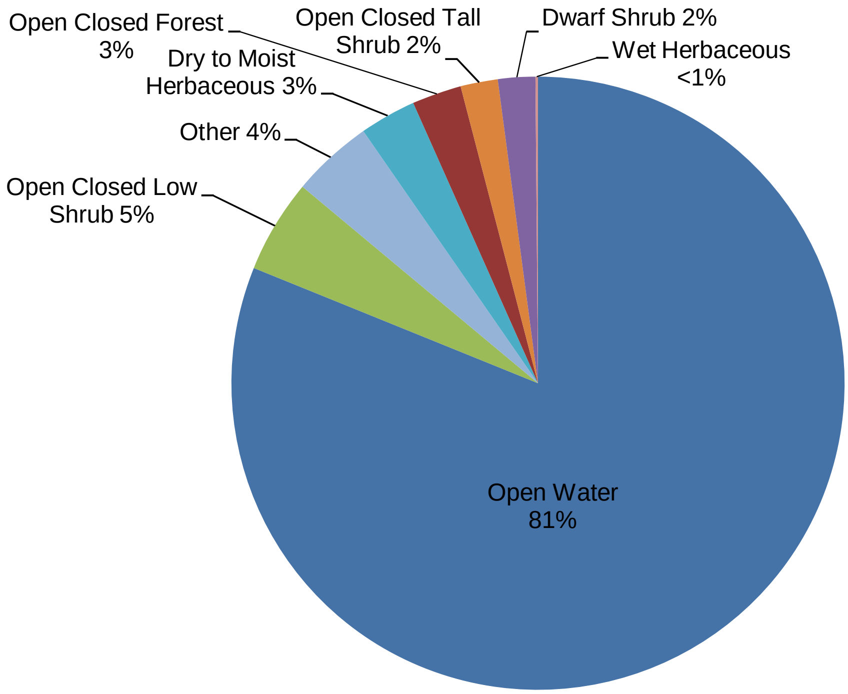
Percentages of vegetation types in the Diamond Point port area are shown in Figure 3.26-7.

This area is characterized predominantly by open water, representing approximately 81 percent coverage. The Diamond Point port area extends into Cook Inlet, and therefore is largely composed of the open water type. No human-caused vegetation disturbance was reported for the Diamond Point port mapping area.

<u>**Pile-Supported Dock Variant**</u>

The affected environment for vegetation would not change, because this variant would only change the amount of open water type.

Figure 3.26-7: Alternative 2 – Diamond Point Port Vegetation Types



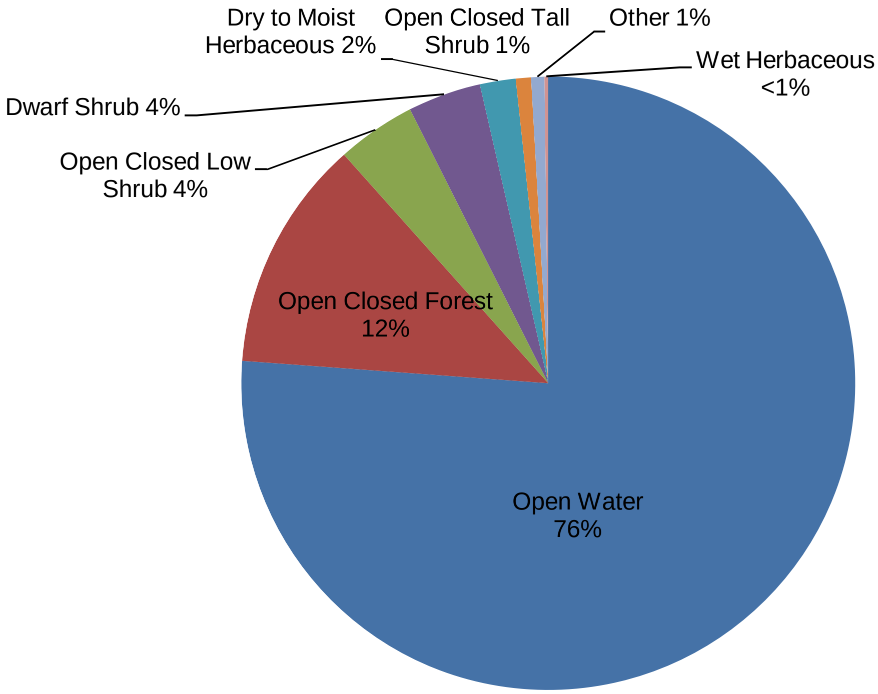
Source: BOGGS 2016; 3PPI and HDR 2011; HDR and 3PPI 2011a; HDR 2018c

3.26.5.4 Natural Gas Pipeline Corridor

Segments of the natural gas pipeline adjacent to access roads are addressed under the transportation corridor. Segments of the natural gas pipeline that do not follow the access road corridors are described here, and include: from the mine access road cut-off to Eagle Bay, to the port access road cut-off to Pile Bay; from the Diamond Point port to Ursus Cove; and from Ursus Cove across Cook Inlet to the compressor station near Anchor Point on the Kenai Peninsula. The area also encompasses construction access roads to the natural gas pipeline corridor on the northern side of Iliamna Lake.

The pipeline corridor is predominantly covered by open water, representing approximately 76 percent of the land cover. Vegetation types in the natural gas pipeline corridor area are shown in Figure 3.26-8.

Figure 3.26-8: Alternative 2 – Natural Gas Pipeline Corridor Vegetation Types



Source: BOGGS 2016; 3PPI and HDR 2011; HDR and 3PPI 2011a; HDR 2018c

3.26.6 Alternative 3 – North Road Only

A summary of vegetation types by project components is provided below. Vegetation types were assessed according to the analysis methodology described above.

3.26.6.1 Mine Site

The vegetation types at the mine site are the same for all action alternatives, as summarized under Alternative 1.

Concentrate Pipeline Variant

This variant would cause an increase to the size of the mine site by 1 acre associated with an electric pump station, and therefore increase the affected environment for vegetation. This increased size is included in the analysis area for the mine sites, and is summarized under Alternative 1.

3.26.6.2 Transportation Corridor

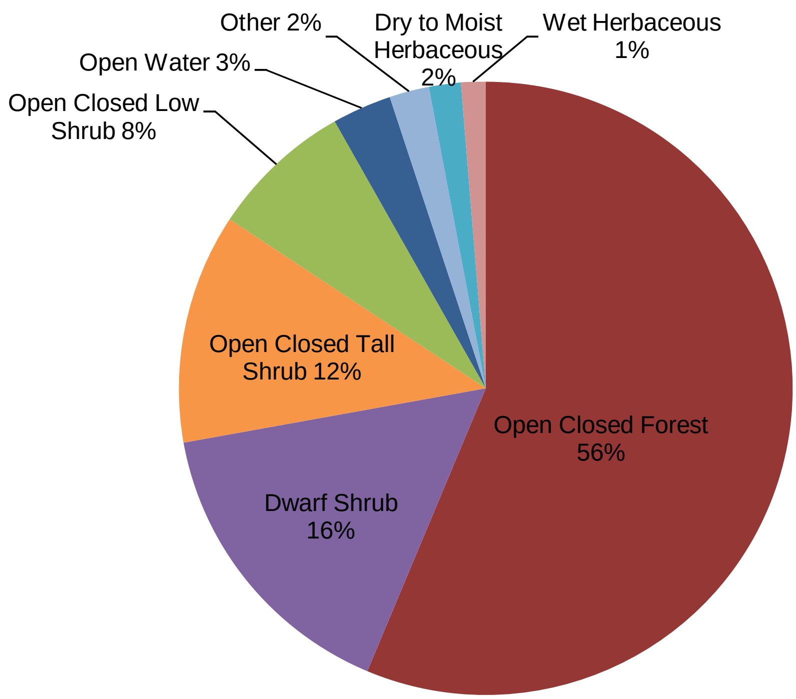
The transportation corridor area includes 77 miles of the north access road (5 miles of this road falls within the mine site mapping area), from the mine site to the Diamond Point port on Cook Inlet. The transportation corridor area includes segments of the natural gas pipeline that fall within the transportation corridor.

Vegetation types in the Alternative 3 transportation corridor are shown in Figure 3.26-9. This area is characterized by a predominance of forested vegetation types, representing 56 percent of the land cover.

Concentrate Pipeline Variant

This variant would slightly increase the road corridor width due to the concentrate pipeline and the optional return water pipeline that would be co-located in a single trench with the gas pipeline at the toe of the north road corridor embankment, increasing the average width of the road corridor by 3 feet. The increase would be less for the concentrate pipeline without a return pipeline (increase in width would be less than 10 percent, compared to Alternative 3 under typical construction) (PLP 2018-RFI 066). This estimated increase in footprint is included in the analysis area and Figure 3.26-9.

Figure 3.26-9: Alternative 3 – Transportation Corridor Vegetation Types



Source: BOGGS 2016; 3PPI and HDR 2011; HDR and 3PPI 2011a; HDR 2018c

3.26.6.3 Diamond Point Port

The vegetation types at the Diamond Point port are the same for Alternatives 2 and 3, as summarized under Alternative 2.

Concentrate Pipeline Variant

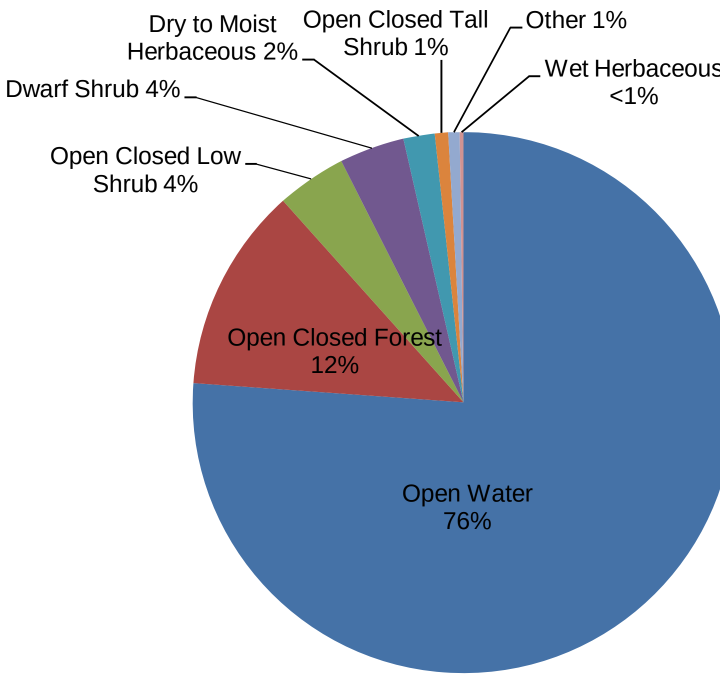
This variant would not change the affected environment for vegetation at Diamond Point port because it would not increase the total footprint. The increased mine site and transportation corridor size associated with this variant were included in the mine site and transportation corridor analysis areas accordingly.

3.26.6.4 Natural Gas Pipeline Corridor

Segments of the natural gas pipeline adjacent to access roads are addressed under the transportation corridor. Segments of the natural gas pipeline that do not follow the access road corridors are included here.

The pipeline corridor is predominantly covered by open water, representing approximately 76 percent of the land cover. Vegetation types in the natural gas pipeline corridor area are shown in Figure 3.26-10.

Figure 3.26-10: Alternative 3 – Transportation Corridor Vegetation Types



Source: BOGGS 2016; 3PPI and HDR 2011; HDR and 3PPI 2011a; HDR 2018c

3.26.7 Rare or Sensitive Plant Species

The ACCS maintains a rare plant list for Alaska, tracking occurrences of more than 300 rare plant species (ACCS 2018a; Nawrocki et al. 2013), some of which occur in the analysis area. However, no special statewide protections are afforded species on this list. ACCS ranks the species with a code that describes their population status on a global level (i.e., G-rank) and on a statewide level (i.e., S-rank). The status levels are ranked on a scale of one to five, where five is a common species with demonstrably secure populations, and one is a critically imperiled species whose populations are vulnerable to extirpation or extinction. Two occurrences of Chukchi primrose (*Primula tschuktschorum*) occur in the analysis area. This species is ranked S2, G2/G3. Both occurrences are in the North Fork Koktuli watershed: one approximately 2 miles west/southwest of Kaskanek Mountain and 22 miles northwest of Iliamna; and the other 40 miles west of Iliamna.

Incidental observations of ACCS-tracked vascular plant species that were recorded during project surveys included one species in the analysis area: Bering Sea dock (*Rumex beringensis*), located between Newhalen and the Upper Talarik Creek. To be confirmed and receive a state herbarium accession number, voucher specimens must be collected or carefully photographed for review and approval by a qualified botany expert. Researchers collected specimens in some, but not all, cases. The occurrence of Bering Sea dock was not positively confirmed, although a voucher specimen was collected.

3.26.8 Invasive Plant Species

Field studies conducted in the analysis area did not provide any recorded instances of invasive plant species. A search on the Alaska Exotic Plant Information Clearinghouse online database for invasive plant species did not indicate presence of any invasive plant species inside of the analysis area. Four invasive species (common dandelion [*Taraxacum officinale*], lambsquarters [*Chenopodium album*], annual bluegrass [*Poa annua*], and pineapple weed [*Matricaria discoidea*] have been documented adjacent to but outside of the analysis area. These four species are considered to be a low ecological risk. See additional information about invasive species trends in the western Alaska region in the climate change section below.

3.26.9 Climate Change

Climate change is currently affecting vegetation in the analysis area and throughout Alaska. Observed and predicted effects include changes in plant phenology (Wolken et al. 2011), vegetation community composition from changes in hydrology, and fire regimes (Calef et al. 2015). Climate models predict that the Bristol Bay region will experience rapid ecological change during the next 100 years. Computer models for climate change consider future "cliomes," areas where temperature and precipitation reflect certain assemblages of wildlife and vegetation. Bristol Bay's current cliome, "boreal forest with coastal influence and intermixed grass and tundra," is expected to shift north, and largely disappear by 2090 (ANTHC 2018). It may be replaced by "prairie and grasslands," a cliome that does not currently occur in Alaska, and is characteristic of southeastern Alberta in Canada (SNAP and EWHALE 2012).

Bristol Bay residents (ANTHC 2018) report changes in vegetation trends due to warmer and wetter conditions, including rapid tree growth and expansion; new coastal wetlands; and spread of invasive plant species. Over the past few decades, the tundra and shrub vegetation types in the vicinity of the analysis area have been replaced by alder and willow trees. In 2013, Nondalton residents reported additional outbreaks of spruce bark beetle and aphids on the Nushagak River (ANTHC 2018).

Higher temperatures are predicted to increase the risk of the spread of invasive plant species. Bella (2009) modeled current and future range map scenarios for sixteen invasive plant species with a high to extremely high invasion potential. The scenarios modeled showed that all sixteen species have current potential ranges in the state that exceeds their known occurrence, and showed a potential invasion range within Alaska in current and in future predicted scenarios. Known current populations indicate these species are not yet filling their current predicted potential range. However, some known occurrences already extend beyond the predicted range for that species in the current climate.

While distant from the analysis area, an inventory of invasive plants, conducted in 18 communities in western Alaska between 2012 and 2014, showed a total of 20 invasive plant species found, including one considered "highly invasive", the rugosa rose (*Rosa rugosa*), found in Chignik Lagoon (Robinette 2015). Three species were found that are "moderately invasive", eight that are ranked as "modestly invasive" and the remaining eight are considered "weakly" and very "weakly" invasive. In addition to documenting the presence of invasive plants, community members were asked about their observations and concerns about vegetation changes near their communities. The most frequently identified concern was linked to increased shrubs, particularly alder, and the potential changes to berry harvest areas.

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