3.22 WETLANDS AND OTHER WATERS/SPECIAL AQUATIC SITES

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

Wetlands in the environmental impact statement (EIS) analysis area are predominantly peatlands, where black spruce (*Picea mariana*) woodlands, low ericaceous and shrub birch (*Betula nana*) scrub, and tussock-forming sedges or grasses are common (Three Parameters Plus 2008). Wet meadows develop in upper drainages, while shrub wetlands become more common along riparian corridors in valley bottoms. In lower drainages, floodplains develop as complex mosaics of forest, shrubland, and aquatic bed in flood channels, bars, and abandoned channels. Saltwater marshes and mudflats are found in protected areas along the coast (HDR 2019a, i).

Other waters in the analysis area include the estuarine and marine waters of Cook Inlet and the unvegetated portions of inland lakes, ponds, rivers, and streams. Cook Inlet fills a shallow marine basin; its waters carry a high load of sediment delivered by large glacial rivers at the head of Knik and Turnagain Arms. Iliamna Lake is the largest lake in Alaska; and although flanked by lowlands, its waters are derived in part from alpine glaciers. Smaller lakes and abundant ponds perch on bedrock or are fed by surrounding wetlands. Although no ephemeral streams have been documented in the analysis area, intermittent streams occupy topographic headwaters and feed clear-running perennial streams and rivers that fall to either Bristol Bay or Cook Inlet.

The special aquatic sites considered here possess unique ecological characteristics of productivity, habitat, wildlife protection, or other important and easily disrupted values. Those occurring in the analysis area include wetlands, mudflats, vegetated shallows, and riffle and pool complexes.

3.22.1 Regulatory Framework

Section 404 of the Clean Water Act (CWA) (33 United States Code [USC] 1344) and Section 10 of the Rivers and Harbors Act (RHA) (33 USC 403) establish programs to regulate dredging and the discharge of dredged or fill material into waters of the United States (WOUS), including wetlands. Section 10 also regulates work and/or structures placed in and over navigable waters of the US (NWUS). Activities in WOUS regulated under this program include fills for development, water resource projects, infrastructure development, and conversion or manipulation of wetlands. For the purposes of this project, all wetlands, streams, rivers, lakes, ponds, tidal waters, and other aquatic resources that would be affected by the activities requiring Department of the Army authorization are treated as waters of the US.

The premise of these programs is that no discharge of dredged or fill material may be permitted if a practicable alternative exists that is less damaging to the aquatic environment, or if the nation's waters would be significantly degraded. Towards this end, mitigation measures to avoid, minimize, rectify, reduce, or compensate for resource losses is considered throughout the application process. Mitigation requirements generally fall into three categories: project modifications to minimize adverse project impacts; mitigation required to satisfy legal requirements; and mitigation required as a result of the public interest review process.

Applicants must demonstrate that steps have been taken to avoid impacts to wetlands and other waters; that potential impacts have been minimized; and that compensation will be provided for remaining unavoidable impacts. Pursuant to 33 Code of Federal Regulations [CFR] Part 320.4(r)(2), all compensatory mitigation required by the US Army Corps of Engineers (USACE) will be for significant resource losses that are specifically identifiable, reasonably likely to occur, and of importance to the human or aquatic environment. In addition, mitigation will be directly related to the impacts of the proposal, appropriate to the scope and degree of those impacts, and reasonably enforceable (see Chapter 5, Mitigation). Pebble Limited Partnership (PLP) has prepared a draft Compensatory Mitigation Plan (CMP) (PLP 2020-RFI 056a) outlining their proposed approach for compensatory mitigation to offset environmental losses resulting from unavoidable impacts to aquatic resources (see Appendix M2.0, Applicant's Draft Compensatory Mitigation Plan).

NWUS overlap with WOUS in that they include the oceans and navigable coastal and inland waters, lakes, rivers, and streams. USACE jurisdiction over NWUS extends shoreward to the mean high-water line. USACE maintains a list of non-tidal, navigable waters in Alaska that have been determined to be NWUS by the district engineer (USACE 2018b). NWUS in the 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 and Gibraltar rivers are also considered navigable by the US Coast Guard (USCG) (see Section 3.12, Transportation and Navigation, for further discussion of navigable waters).

Wetlands are a subset of WOUS and are defined as 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]). Note this definition of wetlands does not include unvegetated waterbodies such as streams and ponds. All wetlands and waterbodies in the study area were assumed to constitute a "significant nexus" to a downstream Traditionally Navigable Water and would be regulated by USACE (HDR 2019i).

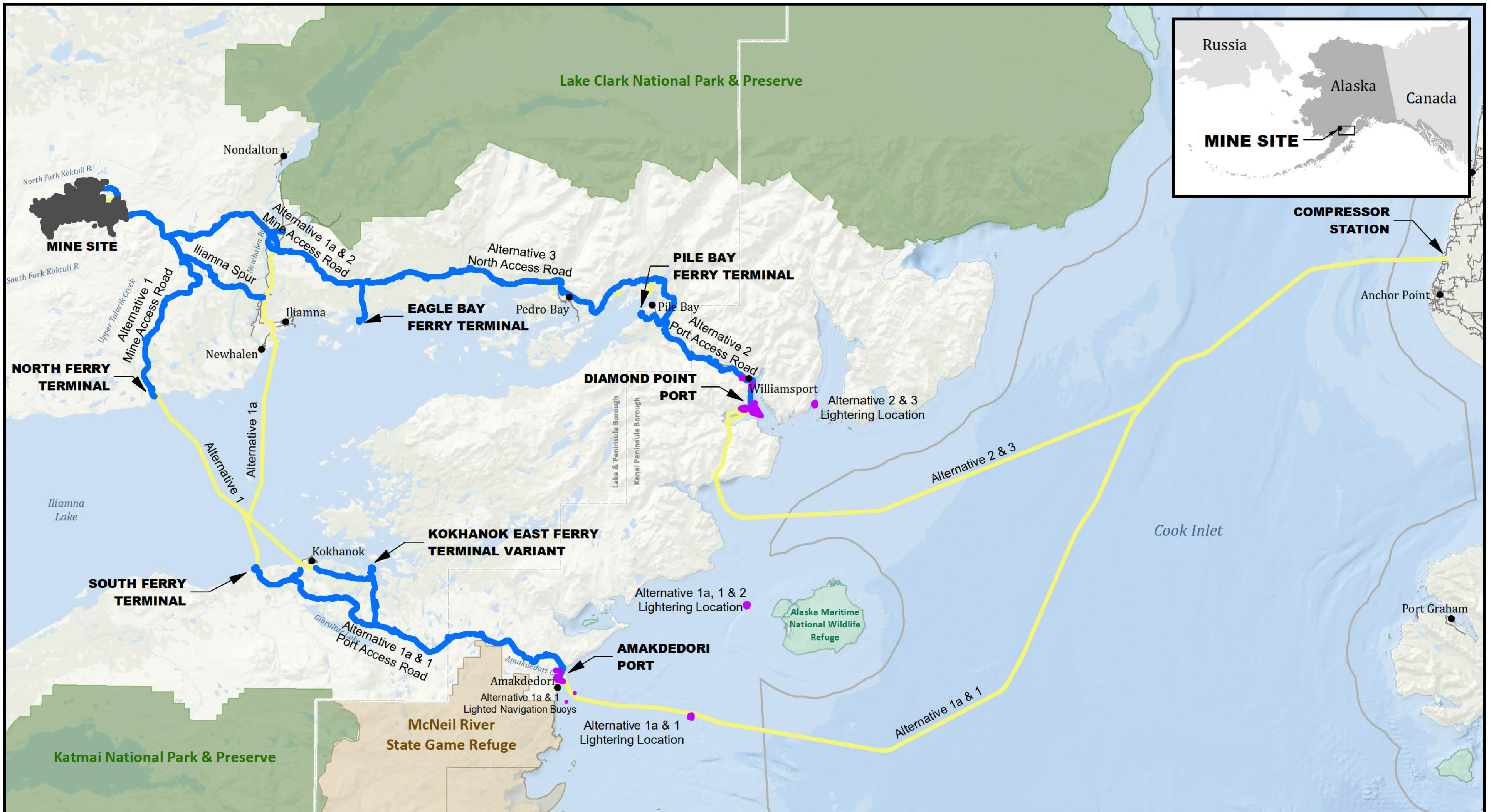
In accordance with national (USACE 1987) and regional (USACE 2007) guidance on wetland delineation, wetlands satisfy the following diagnostic criteria: 1) a prevalence of vegetation typically adapted for life in saturated soil conditions; 2) soils that are formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions; and 3) inundation or saturation of the soil during the growing season. "Other waters" is a term often used to describe those jurisdictional waters such as rivers, streams, lakes, and other aquatic sites that do not meet the definition of wetlands.

Special aquatic sites are a subset of WOUS, and are defined as large or small areas possessing special ecological characteristics of productivity, habitat, wildlife protection, or other important and easily disrupted ecological values (40 CFR Part 230.3). Special aquatic sites include wetlands, sanctuaries and refuges, mudflats, vegetated shallows, coral reefs, and riffle and pool complexes.

3.22.2 EIS Analysis Area

The EIS analysis area includes the area potentially affected by direct and indirect impacts from project construction and operations. The analysis area collectively includes areas for all project components (mine site, transportation corridor, ports, and natural gas pipeline) under each alternative, including their variant(s); see Chapter 2, Alternatives, for an explanation and maps of alternatives, variants, and project components. The analysis area for wetlands and other waters is presented in Figure 3.22-1.

Mine Site—The mine site analysis area includes the direct disturbance footprint extended by the maximum extent of areas of indirect disturbance. Areas of indirect disturbance are: the areas of aquatic resources identified as fragmented; a 330-foot buffer around the direct disturbance footprint to account for the potential deposition of fugitive dust; and the maximum geographic extent of all modeled groundwater drawdown scenarios (i.e., end of mining post-closure, and baseline, high-, and low-permeability scenarios) to account for impacts from dewatering and changes to surface flows.



Sources: PLP 2020-RFI-168;
PLP 2019-RFI153; ADNR

US Army Corps
of Engineers

5 0 5 10

Miles

Analysis Areas
- Mine Site
- Transportation
- Port
- Natural Gas Pipeline

Other Features
- Local Roads
- Borough Boundary
- Three Nautical Mile Line

- National Park
- National Wildlife Refuge
- State Game Refuge/Sanctuary

ANALYSIS AREA FOR WETLANDS AND OTHER WATERS

PEBBLE PROJECT EIS

FIGURE 3.22-1

Transportation Corridor and Ports—The transportation corridor and ports analysis areas include the direct disturbance footprints of access roads, material sites, ferry terminals, and port facilities extended by 330 feet to account for the indirect impacts of fugitive dust deposition. Although the direct disturbance footprints are included for the pile-supported and caisson dock designs (both of which have concrete decking), lightering areas, and mooring buoys, these features are not buffered, because they are not expected to be sources of fugitive dust.

Natural Gas Pipeline—The natural gas pipeline corridor analysis area includes the stand-alone (pipeline-only) sections where the pipeline is not co-located with the transportation corridor. These sections of the natural gas pipeline have a maximum impact width of 91 feet through Iliamna Lake, 101 to 183 feet through Cook Inlet, and 150 feet through overland areas. The overland analysis area includes the direct disturbance footprints for access roads and material sites buffered by a 330-foot zone to account for dust impacts.

3.22.3 Analysis Methodology

3.22.3.1 Wetland and Other Waters Mapping and Classification

Field data collection—Wetland and vegetation surveys were conducted over multiple field seasons. Work conducted from 2004 to 2008 and in 2013 and 2017 is summarized in Chapter 14 and Chapter 39 of the Environmental Baseline Document (EBD) (Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b), and the preliminary jurisdiction determination (PJD) reports (HDR 2019a, i). Supplemental wetland data collected at the mine site in 2018 for Alternative 2—North Road and Ferry with Downstream Dams and Alternative 3—North Road Only, as well as the Kokhanok East variant of Alternative 1 in 2019, are provided in Requests for Information (RFIs) PLP 2018-RFI 082, PLP 2018-085, and PLP 2019-RFI 116.

Field data were collected to satisfy a variety of project needs, and are represented by five different collection types: jurisdictional determination plots, functional assessment plots, shrub height plots, representative photo points, and waterbodies and stream crossing photo points. A total of 1,122 jurisdictional determination plots, which included detailed descriptions of vegetation, hydrology, and soils, were collected for the analysis area. Functional assessment data were collected at sites with primary indicators for wetland vegetation, hydrology, and soils. Shrub height forms documenting structurally dominant vegetation and an abbreviated suite of hydrology and soils variables were completed to locate future jurisdictional determination plots, as well as to ground-truth shrub types in support of digital mapping. Representative photo points were taken to document representative wetland and upland vegetation, also in support of digital mapping. Waterbody and stream crossing photo points were collected to document waterbody characteristics, pH, electrical conductivity, and adjacent vegetation type.

Wetland determinations followed guidance from the USACE. Determinations from 2004 through 2008 were based on the 1987 Wetland Delineation Manual (USACE 1987); determinations after 2013 were based on the 1987 Manual, in conjunction with the 2007 Alaska Regional Supplement (USACE 2007b). Where differences in the two documents occur, the Regional Supplement takes precedence over the USACE 1987 Manual.

Digital mapping—The identification and digital delineation of wetland and deepwater habitat from aerial photography referenced existing geospatial and field data, and required interpretation of photographic signature, hydrologic connectivity and landscape position. Wetland boundaries were digitized on aerial photography at a scale between 1:1,200 and 1:1,500; the digitization of waterbodies used aerial photography scaled at 1:400. An average minimum mapping unit of 0.05 acre was used.

Each mapped polygon was attributed by a vegetation type and wetland status. Vegetation type was assigned in accordance with Alaska Vegetation Classification (Viereck et al. 1992) and was informed by landcover mapping completed by Wibbenmeyer and others (1982); see Section 3.26, Vegetation, for discussion of vegetation. Wetland status was assigned to each polygon following review of field data, site photos, similar sites, and based on criteria put forth in the wetland delineation manual (USACE 1987, 2007b).

Polygons judged to represent wetland or deepwater habitat were further classified in accordance with the National Wetland Inventory (NWI) system. The NWI classification system was proposed by Cowardin and others (1979), formalized by the Federal Geographic Data Committee (FGDC 2013), and is now administered as the national standard for wetland mapping in the US by the US Fish and Wildlife Service (USFWS). Under this classification scheme, wetlands and deepwater habitats are grouped into systems (Marine, Estuarine, Riverine, Lacustrine, and Palustrine) based on shared hydrologic, geomorphologic, chemical, or biological factors; and further divided into classes and subclasses based on water regime, substrate, and vegetation.

Field-verified mapping of wetlands and other waters was completed for the entirety of the EIS analysis area since publication of the Draft EIS (DEIS). The greater resolution and coverage gained through this mapping has eliminated wetlands data gaps, allowing finer-scale mapping of smaller streams and wetland-upland mosaics. As a result of the identification of additional small-scale watercourses, stream miles increased in the direct and indirect impact analysis areas. Conversely, wetlands acreages generally decreased within the direct and indirect impact analysis areas through applying finer-scale mapping because wetland-upland mosaics that were previously assumed to represent 100 percent wetland habitat were classified into discrete areas of wetland and upland, thereby decreasing the overall area of wetland habitat.

A hydrogeomorphic (HGM) class (Brinson 1993) was attributed to each wetland and deepwater polygon, based on field data, topography, and interpretation of site hydrology from landscape position. When polygons were designated as both wetlands and uplands (i.e., a mosaic), the HGM designation applied only to the wetland portion of the mapped polygon; see the Inference of Wetland Functions and Values section below.

Because NWI and vegetation types are numerous, these types were generalized to the broader classes of NWI Group and Project Vegetation Type, respectively. NWI groups included the NWI codes as presented in Table 3.22-1; the generalization of project vegetation types to structural vegetation types is presented in Appendix K3.26, Vegetation.

Other waters—Field-verified stream mapping was completed using the same methods as above; however, these data were collected as polygons (HDR 2019i), and therefore did not include centerlines. Using the Geographic Information System (GIS) polygon-to-centerline tool, centerlines were created for each polygon and classified by stream type (e.g., lower perennial, upper perennial and intermittent), and further by their relationship to the system (e.g., main channel, side channel or minor tributary, or disconnected). For description of the affected environment, both the area and length of streams are presented; total areas for “other waters” includes the areas of streams.

Descriptions of wetlands and other waters provided herein are largely based on information provided in Chapters 14 and 39 of EBD (Three Parameters Plus and HDR 2011a; HDR and Three Parameters Plus 2011b), as well as more recent information provided in the PJD reports (HDR 2019a, i) and the associated GIS database, which reflects changes in the project area since publication of the EBD. The last update to the GIS database was in May 2020. All calculations for areas are rounded to the nearest whole acre, or nearest whole percent; calculations for lengths are rounded to the nearest tenth of a mile. Apparent minor inconsistencies in sums are the result of rounding. The USACE PJD determination letter is provided as Appendix J; a wetlands mapbook of field-verified wetlands mapping (along with impact areas, discussed in Section 4.22, Wetlands and Other Waters/Special Aquatic Sites) is included as Appendix K4.22.

Table 3.22-1: Generalization of NWI Codes to NWI Groups

NWI Group	NWI Codes Included	NWI Systems Represented in the Analysis Area				
		Marine	Estuarine	Riverine	Lacustrine	Palustrine
Aquatic Bed	Any freshwater system including the “Aquatic Bed” class				X	X
Herbaceous	Any freshwater system including the “Emergent” class					X
Broad-Leaved Deciduous Shrubs	Any system including the “Scrub-Shrub” class and “Broad-Leaved Deciduous” subclass					X
Evergreen Shrubs	Any system including the “Scrub-Shrub” class and “Broad-Leaved Evergreen” or “Needle-Leaved Evergreen” subclasses					X
Deciduous Forest	Any system including the “Forested”' class and “Broad-Leaved Deciduous” subclass					X
Evergreen Forest	Any system including the “Forested” class and “Needle-Leaved Evergreen” subclass					X
Estuarine (Intertidal)	Intertidal subsystems of the “Estuarine” system		X			
Estuarine (Subtidal)	Subtidal subsystems of the “Estuarine” system		X			
Lakes	All allowable[1] classes of the “Lacustrine” system				X	
Marine (Intertidal)	Intertidal subsystems of the “Marine” system	X				
Marine (Subtidal)	Subtidal subsystems of the “Marine” system	X				
Ponds	Unvegetated classes of the “Palustrine” system					X
Streams (Intermittent)	Intermittent subclass of the “Riverine” system			X		
Streams (Perennial)	Perennial subclasses of the “Riverine” system			X		
Streams (Tidal)	Tidal subclass of the “Riverine” system			X		

Notes
[1] Allowable per the NWI Water Regime Restriction Table (NWI 2016)
NWI = National Wetland Inventory

3.22.3.2 Inference of Wetland and Other Waters Functions and Values

The HGM classification system was developed by Brinson (1993) as a conceptual framework for the assessment of physical, chemical, and biological functions of wetlands. This approach groups wetlands into categories based on the wetland's geomorphic setting, water source, and hydrodynamics, and recognizes riverine, slope, depressional, flat, lacustrine, and coastal fringe wetland types; the lacustrine, riverine channel, and marine water types are specific to the Pebble Project and were used to attribute other waters. These project-specific HGM classes are equivalent to the NWI subsystems of lacustrine-limnetic and unvegetated classes of lacustrine-littoral, unvegetated classes of the riverine system regardless of subsystem, and marine-subtidal and unvegetated classes of marine-intertidal, respectively.

When used in combination with the NWI classification system, the HGM class can give greater resolution to the ecological processes of wetlands with shared vegetation structure. Because an accepted methodology for wetland functional assessment is not available for this region of Alaska, a formal wetland functional assessment has not been completed; a functional assessment is not required for an EIS. In the absence of a formal assessment, wetland functions in the analysis area can be discussed qualitatively from the intersection of NWI classification and HGM class.

3.22.4 Wetlands and Other Waters

Wetlands—Wetlands occupy approximately 10 percent of the analysis area and are represented by vegetated palustrine and estuarine habitat. Palustrine is the dominant wetland system; estuarine wetlands represent less than 1 percent of analysis area wetlands. Palustrine wetlands may be further subdivided by physiognomic class (e.g., forested, scrub-shrub, moss/lichen, or emergent).

Palustrine scrub-shrub wetlands are the dominant NWI class in the analysis area. These include the "broad-leaved deciduous shrub" wetland type, characterized by broad-leaved deciduous shrubs such as dwarf birch, and willows (*Salix fuscescens*, *S. pulchra*); broad-leaved evergreen shrubs such as sweetgale (*Myrica gale*), Labrador tea (*Ledum palustre, L. groenlandicum*), bog rosemary (*Andromeda polifolia*), black crowberry (*Empetrum nigrum*), lingonberry (*Vaccinium vitis-idaea*), and bog blueberry (*V. uliginosum*). Also included under the palustrine scrub-shrub wetland class is the "evergreen shrub" wetland type, which is characterized by needle-leaved evergreen scrub such as stunted black spruce. Although palustrine moss/lichen wetlands are not represented in the analysis area, peatmosses in the *Sphagnum* genus have nearly constant presence in analysis area bogs.

Palustrine emergent wetlands make up the second-most dominant NWI class in the analysis area. These include the "herbaceous" wetland type and are characterized by persistent, herbaceous species adapted to a wide range of saturation or non-permanent flooding. Dominant graminoids include the sedges (*Carex aquatilis*, *C. lyngbyei*), tall cottongrass (*Eriophorum angustifolium*), and bluejoint grass (*Calamagrostis canadensis*); dominant forbs are field horsetail (*Equisetum arvense*), purple marshlocks (*Comarum palustre*), and cloudberry (*Rubus chamaemorus*).

Palustrine forested wetlands occur in a very small portion of the analysis area. These are primarily the "deciduous forest" wetland type characterized by broad-leaved deciduous tree species and developing in valley bottoms and along toeslopes. Dominant tree species include balsam poplar (*Populus balsamifera* ssp*. balsamifera*) and Kenai birch (*B. papyrifera* var. *kenaica*); dominant shrub species include willows (*Salix pulchra*); and less frequently, alders (*Alnus incana* ssp. *tenuifolia, A. viridis* ssp. *sinuata*). Also included in the palustrine forested wetland class is the "evergreen forest" wetland type characterized by needle-leaved evergreen trees species such as black spruce and developing on flats and in depressions.

Estuarine emergent wetlands are equivalent to the "estuarine (intertidal)" wetland type and develop along protected shores of Cook Inlet where fine sediment can accumulate. These herbaceous communities are tidally influenced and characterized by species adapted to living in saline environments. The dominant species include circumpolar reedgrass (*Calamagrostis deschampsioides*), Lyngbye's sedge, largeflower speargrass (*Poa eminens*), and the forbs Arctic daisy (*Chrysanthemum arcticum*), and Pacific silverweed (*Argentina egedii* ssp. *egedii*).

Other Waters—Other waters, as used in this section, include all non-wetland waters and occupy approximately 19 percent of the analysis area. Most of these areas are deepwater habitats characterized by permanent water and non-soil substrates. In the analysis area, these include marine and estuarine waters, both subtidal (continuously submerged) and unvegetated intertidal habitats (exposed during low tides), as well as ponds, lakes, rivers, and streams; floating or rooted aquatic herbaceous vegetation may be present.

No ephemeral streams were identified in the analysis area; all non-perennial streams were classified as intermittent (Three Parameters Plus and HDR 2011b). 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, whereas intermittent streams flow seasonally (i.e., several weeks or more), with inputs from groundwater, snow melt, and rainfall.

In the analysis area, intermittent streams occupy headwater topographic positions, 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 then gradually declines during winter as snow accumulates, and 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.

Perennial stream habitat may be further divided as either upper perennial, lower perennial, or tidally influenced. Upper perennial streams tend to have higher gradients, faster flows, coarser substrates, and little floodplain development compared to lower perennial and tidally influenced streams (Cowardin et al. 1979). For the purposes of summarizing the affected environment for wetlands and other waters, upper and lower perennial waterways are collectively referred to as "streams (perennial)"; all tidally influenced freshwaters are referred to as "streams (tidal)."

Both Lacustrine and Palustrine aquatic beds occur in the analysis area and are equivalent to the Vegetated Shallow special aquatic site (Section Special Aquatic Sites subsection). These are typically permanently flooded ponds or lakeshores dominated by rooted, aquatic herbaceous species such as pendantgrass (*Arctophila fulva*), common mare's-tail (*Hippuris vulgaris*), greater creeping spearwort (*Ranunculus flammula*), and threadleaf crowfoot (*Ranunculus trichophyllus*).

3.22.5 Regionally Important Wetlands

Although all wetlands are important to the greater function and value of ecosystems and the subsistence cultures they support, EIS scoping comments identified certain wetland types in the analysis area as having specific regional importance. The Regionally Important Wetlands approach is intended, in part, to complement consideration of the Special Aquatic Sites (Section 3.22.6), which represents several non-wetland (i.e., aquatic) types. Regionally important wetlands types provide habitat for culturally important plants and animals, are rare or high-quality, and/or are pristine and/or difficult to replace. Regionally important wetland types and components identified for the analysis area include:

- Riparian wetlands
- Forested wetlands
- Estuarine wetlands
- Fens
- Culturally important wetland plants

Providing habitat for sensitive or regionally important fish, wildlife, birds, or plant species—Many riparian wetlands in the analysis area provide critical habitat functions for ecologically, economically, and culturally important anadromous and resident fish species. Most of these functions are related to contributions from the riparian plant canopy, through inputs of coarse woody debris and nitrogen (from alders); sediment and streambank stabilization; provision of shading and cover; and food chain support. Riverine herbaceous wetlands are also considered regionally important due to their relatively high species richness (ABR 2011a). For calculating impact acres (see Section 4.22, Wetlands and Other Waters/Special Aquatic Sites), jurisdictional wetlands with an HGM class of Riverine are considered regionally important.

Scarce, or rare and high quality, in a given region—Uncommon habitat types are recognized to make disproportionate contributions to regional biodiversity (Williams et al. 2007). Forested wetlands occupy a very small portion of the analysis area but provide important food and cover for wildlife (such as beavers and moose), and woody inputs that are important for fish habitat and stream dynamics. Estuarine wetlands (i.e., tidal marshes) are similarly uncommon in the analysis area and are recognized as an ecosystem of conservation concern in Alaska, largely due to their support of animal communities (Flagstad et al. 2019). For calculating impact acres in Section 4.22, Wetlands and Other Waters/Special Aquatic Sites, jurisdictional wetlands with an NWI group of Deciduous or Evergreen Forest or Estuarine (Intertidal) are considered regionally important.

Undisturbed and difficult or impossible to replace—Although the majority of wetlands in the analysis area are undisturbed, fens are a unique wetland type that rely on groundwater input, take thousands of years to develop, and cannot be easily restored (Weixelman and Cooper 2009). For calculating impact acres in Section 4.22, Wetlands and Other Waters/Special Aquatic Sites, the open willow – low shrub fen vegetation type is considered regionally important. This type may co-occur with regionally important riparian or forested wetlands.

In addition to the ecosystem functions provided by wetlands, certain wetland types and locations are valued by Alaska Natives for their subsistence value (Ellanna and Wheeler 1989; Hall et al. 1994; Jernigan no date). Social, cultural, economic, and valuative components of Alaska Native societies are integrated in hunting, gathering, fishing, and trapping activities, providing for a dynamic adaptive system focused on the use of local resources. In this way, all wetland types are integral to the functioning of subsistence-based economies (Ellanna and Wheeler 1989).

For the purposes of the EIS, culturally important plants were identified from an ethnobotanical study from the Yukon-Kuskokwim region (Jernigan no date). Of the 73 plant species listed, 12 vascular plant species are recognized as obligate wetland species (Lichvar et al. 2016); although not assigned a wetland indicator status, the Sphagnum moss genus (*Sphagnum* spp.) is included due to its high fidelity to wetland conditions (Seppelt et al. 2008). The wetland species identified as culturally important, the wetland community in which they most often occur, and a description of their traditional ethnobotanical uses is below.

Palustrine scrub-shrub wetlands:

- Sweetgale (*Myrica gale*)—has been used by the Inland Dena'ina to externally treat cuts and boils, and for making a tea for tuberculosis.
- Small cranberry (*Vaccinium oxycoccos*)— is used as a food source; berries are eaten plain to treat coughs, colds, sore throat, and mouth sores. The juice can also be squirted in a sore eye.

Palustrine emergent wetlands:

- Water horsetail (*Equisetum fluviatile*)—root nodules taste sweet and are edible; nodules are gathered along with other stored roots and stems from vole nests in the fall.
- Yellow marsh marigold (*Caltha palustris*)—leaves and stem are collected early, before they flower in the summer. They are boiled before eating, changing the water two or three times to leach out toxic chemicals, including protoanemonin.
- Fourleaf mare's-tail (*Hippuris tetraphylla*)—The whole plant (except the roots and submerged stems) is gathered from ponds right after freeze-up by skimming the ice surface with a shovel or rake. Plants can then be put on tarps to dry and store in bags for the winter. Alternatively, the plants may be gathered in the spring from the lakes when the ice is lifting. Freezing makes the plants soft and easier to cook. The plant is not eaten when green in the summer because it is too bitter.
- Common mare's-tail (*Hippuris vulgaris*)—considered another edible species of mare's-tail (see previous).
- Purple marshlocks (*Comarum palustre*)—tea is brewed from the fruit, flowers, and leaves.
- Palla's buttercup (*Ranunculus pallasii*)—young rhizomes can be harvested when they are just sprouting in the spring. They are boiled and eaten in soups; plants are not edible raw.
- Mackenzie's water hemlock (*Cicuta virosa*)—considered very poisonous; contains the toxic polyacetylene cicutoxin, which acts as a convulsant.
- Sedges (*Carex spp.*)—the fleshy stem base of these sedges is harvested from the nests of voles in the fall, then cooked and eaten.
- Lyngebye's sedge (*Carex lyngbyei*)—Elders said the white base of the stem is edible and contains nutrients, including B vitamins. The roots can also be cut up and cooked. Seeds are collected and used like rice, putting them in seal or duck soup. The stems can be dried and braided into mats or used as insoles for fish-skin boots; blades can also be used to make baskets.
- Tall cottongrass (*Eriophorum angustifolium*) and white cottongrass (*E. Scheuchzeri*)—the base of the stem and underground tuber, or "nut," are edible and can be gathered from the plant itself, or in the fall from vole nests; these are eaten raw or cooked. The flowering tops can be put on sores and boils. These plants are also important as an indicator species. For example, cottongrass blooms are said to be plentiful in years when the berries are plentiful.

Palustrine moss/lichen wetlands:

- Sphagnum moss *(Sphagnum spp.)*—In former times, during famines, Sphagnum moss was dried and eaten with rancid seal oil or whatever was on hand. Sphagnum moss was picked and stored to use for scrubbing dishes and cleaning one's hands after eating. In former times, this species was used as diapers and as the wicks of seal oil lamps. They were also soaked with seal oil and aged to close seams on skin kayaks and boats.

3.22.6 Special Aquatic Sites

Special Aquatic Sites—Special aquatic sites are a subset of WOUS that are large or small areas possessing special ecological characteristics of productivity, habitat, wildlife protection, or other important and easily disrupted ecological values (40 CFR Part 230.3). Special aquatic sites include wetlands, sanctuaries and refuges, mudflats, vegetated shallows, coral reefs, and riffle and pool complexes (40 CFR Part 230.41). These sites influence or positively contribute to the overall environmental health of the entire ecosystem, and therefore receive special attention under EPA's Section 404(b)(1) guidelines.

Although no sanctuaries or refuges occur in the project area, several protected areas are nearby. The Alaska Maritime National Wildlife Refuge is managed by the USFWS, and was established to conserve marine mammals, seabirds and other migratory birds, and the marine resources on which they rely. The natural gas pipeline corridor in Cottonwood Bay would be 250 feet from the nearest refuge island, and would pass approximately 7 miles from a portion of the Alaska Maritime National Wildlife Refuge. Refuge islands are within 3,200 feet of Diamond Point and 900 feet from the nearest dredge area. The primary lightering station would be 2,800 feet from the nearest refuge island, and the proposed alternative lightering station would be 2.25 miles from Augustine Island, which is also included in the refuge. The National Estuarine Research Reserve System is a network of 29 coastal sites cooperatively managed by the National Oceanic and Atmospheric Administration and the member state, and designated to protect and study estuarine systems; Kachemak Bay is included in this network as representative of a high-latitude, fjord estuary type. The natural gas pipeline corridor would pass within 4 miles of the boundary of the Research Reserve. The McNeil River State Game Sanctuary and Refuge is managed for the preservation of wildlife habitat and its unique concentration of brown bears. Coral reefs are not present in the analysis area.

Wetlands—As a special aquatic site, wetlands are defined in accordance with 33 CFR Part 328.3[b]. In Alaska, wetlands generally include wet and moist tundra, bogs, fresh and salt marshes, fens and muskegs. Wetland types occurring in the analysis area are described throughout this section.

Mudflats—Mudflats are broad, flat areas along the coast; coastal rivers to the head of tidal influence; and in inland lakes, ponds, and riverine systems. The substrate of mud flats contains organic material and particles smaller in size than sand. They are either unvegetated or vegetated only by algal mats. When mud flats are inundated, wind and wave action may resuspend bottom sediments. Coastal mud flats are exposed at extremely low tides and inundated at high tides with the water table at or near the surface of the substrate. For calculating impact acres in Section 4.22, Wetlands and Other Waters/Special Aquatic Sites, mudflats are defined as any jurisdictional wetland classified in the NWI system as having an unconsolidated shore with mud substrate. This special aquatic site includes estuarine intertidal habitat, described above as a regionally important wetland type.

Vegetated Shallows—Vegetated shallows are permanently inundated areas that under normal circumstances support rooted aquatic vegetation; vegetated shallows may be found in the estuarine, marine, riverine, and lacustrine systems; only palustrine and lacustrine vegetated shallows are documented in the analysis area. The submerged aquatic vegetation characteristic of vegetated shallows provides food and habitat for species, as well as maintaining water quality by absorbing nutrients, trapping sediments, reducing erosion, and producing oxygen. Algal subsidy provides food for a variety of grazing invertebrates, especially crustaceans, which in turn, become prey for numerous species of fish, mammals, and birds.

Although vegetated shallows are not documented in the port analysis areas at Diamond Point or Amakdedori, rocky reefs are present in outlying intertidal to subtidal portions of Iliamna Bay, Cottonwood Bay, Ursus Cove, and Kamishak Bay. These reef habitats support dense macro-algal communities exhibiting strong vertical zonation. Upper intertidal zones are dominated by rockweed (*Fucus distichus*) and the reds (*Mastocarpus* spp., *Mazzaella* spp.) transitioning to red algae, especially red ribbon species (*Palmaria* spp.) and sea sac (*Halosaccion glandiforme)* with depth. The lower intertidal zone is dominated by larger kelps such as *Alaria* and *Saccharina* species. Eelgrass (*Zostera marina*) is found predominantly south of Amakdedori around reefs associated with Nordyke Island and Chenik Head, north of Amakdedori near Contact Point, and in patchy beds in Iliamna and Cottonwood bays (GeoEngineers 2018c).

In the freshwater environment of the analysis area, vegetated shallows are largely associated with pond, lake, and stream margins. In the analysis area, vegetated shallows develop along pond margins at the mine site and along the Iliamna Lake shoreline at all three ferry terminal locations. For calculating impact acres in Section 4.22, Wetlands and Other Waters/Special Aquatic Sites, vegetated shallows are defined as any jurisdictional wetland classified as aquatic bed under the NWI group classification.

Riffle and Pool Complexes—Riffle and pool complexes are most likely to develop in steep- to moderate-gradient sections of streams where the rapid movement of water over a coarse substrate in riffles results in rough flow, a turbulent surface, and high levels of dissolved oxygen in the water. Pools are deeper areas associated with riffles and characterized by a slower stream velocity, smooth surface, and finer substrate. Riffle and pool complexes are particularly valuable habitat for fish and wildlife.

Baseline mapping of streams did not explicitly identify riffle and pool complexes in the 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 et al. 2011a). These streams are low-gradient, meandering watercourses that are bordered by open to closed low-shrub communities, often dominated by willow species. Habitat typing discussed in Section 3.24, Fish Values, indicates that the mainstem NFK (Reaches A through C) below the mine site is dominated by riffle habitat (56 to 65 percent) with few pools (1 to 2 percent). Upstream of the mine site, the NFK (Reach D) is similarly dominated by riffle habitat (46 percent), with increasing frequency of pools (9 percent) due in part to a greater incidence of beaver-dammed pools in its headwaters. The presence of riffle habitat in reaches of the SFK (Reaches A through D) ranges from 27 to 65 percent, with pools relatively rare (2 to 5 percent). Reaches of the UTC (A through F) show a more even ratio of riffle and pool habitat, with percent riffle habitat ranging from 16 to 54, and percent pool habitat ranging from 1 to 22. Although the riffle-to-pool ratio among reaches of the SFK varies with downstream position, reaches of both the NFK and UTC show decreasing presence of pools with downstream position (see Table 3.24-1).

All riverine habitat was 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 zone where gradients are steeper and stream beds are predominantly gravel or coarser substrates. The area and length of upper perennial stream habitats are used as a proxy for riffle and pool presence. By this definition, the perennial reaches of the NFK, SFK, and UTC shown in Figure 3.24-1 are included as riffle and pool complexes. Stream morphology and associated fish habitat in the analysis area is described in detail in Section 3.24, Fish Values; surface water quality is addressed in Section 3.18, Water and Sediment Quality.

3.22.7 Wetland and Other Waters Functions and Values

Functions can be defined as the processes necessary for the maintenance of an ecosystem, whereas values are associated with society's perception of those ecosystem functions. The value of a wetland is therefore based on human judgment of the worth, merit, quality, or importance attributed to the functions of that wetland (Hall et al. 2003). High-value wetlands often include those providing habitat for threatened or endangered species, regionally scarce or rare and high-quality wetlands in a given region, and undisturbed wetlands whose ecological functions are difficult or impossible to replace within a human lifetime. Because the USACE evaluates environmental, economic, and social concerns before deciding whether to grant a permit, the impact to wetland function and associated values is an important component of their decision process.

Functions and values considered by the regulatory branch for CWA Section 404(b)(1) wetland permits (USACE 2015) include the modification of groundwater recharge and discharge, storm- and floodwater storage, modification of flow and water quality, production and export of organic matter, as well as contribution to the abundance and diversity of wetland flora and fauna. Values ascribed to these functions include opportunities for recreational and subsistence use; aesthetic values relating to an intact viewshed, education, and scientific research, as well as the uniqueness and heritage values of a wetland. Recreational use is considered non-consumptive, whereas subsistence use is considered consumptive and includes hunting, fishing, trapping, and gathering. The following description of HGM classes and associated functions and values (Table 3.22-2 and Table 3.22-3) are modified from Hall and others (2003), Lee and others (1999), and Natural Resources Conservation Service (NRCS) (2008). Although functional overlap among types of wetlands and other waters exists, functions are likely to be performed at different levels and intensities by ecologically distinct wetlands and waters. Similarly, because the identification of wetland values is subjective, all values may be applied to any wetland type; the emphasis (bold "X") given in Table 3.22-3 indicates primary values associated with a given wetland type, and is based on professional judgement. The following section summarizes the functions and values generally associated with recognized classes of wetland hydrogeomorphology and vegetation. This qualitative description does not constitute a formal wetland assessment.

Slope Wetlands are found where there is a discharge of groundwater to the land surface. They typically occur on sloping land where elevation gradients may range from steep hillsides to nearly level terrain. Slope wetlands are usually incapable of depressional storage. Principal water sources are usually groundwater return flow and interflow from surrounding uplands, as well as precipitation. Hydrodynamics are dominated by downslope, unidirectional water flow. Slope wetlands lose water by overland and surface flows and by evapotranspiration.[1] Channels may develop, but they serve only to convey water out of the system.

<u>Slope wetland vegetation</u>—Slope wetlands are the most common HGM wetland type in the analysis area and are predominately represented by the broad-leaved deciduous shrub and herbaceous NWI group types, and to a lesser extent by the open low shrub, wet herbaceous,

[1] The process where water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces.

dwarf shrub, closed tall shrub, open/closed forest, closed low shrub, open tall shrub, and dry to moist herbaceous project vegetation types (listed in decreasing order of representation).

Slope wetlands occur in the analysis area as seeps on footslopes and toeslopes, and as headwaters and drainages in steep to rolling terrain where stream channels have not yet formed. Herbaceous slope wetlands may occur as fens, whereas forested and shrub slope wetlands often develop on toeslopes adjacent to, yet above flood-prone areas of streams.

Table 3.22-2 Summary of Wetland Functions by Hydrogeomorphic Class for Analysis Area

HGM Class	Hydrologic			Biogeochemical					Biotic			
	Storm Surge and Floodwater Storage	Streamflow Modification	Groundwater Recharge	Groundwater Discharge	Organic Carbon Sequestration	Nutrient and Compound Cycling	Detritus Export	Water Quality Modification	Waterfowl Habitat Maintenance	Aquatic Organism Habitat Maintenance	Terrestrial Species Habitat Maintenance	Plant Community Maintenance
Slope		X		X	X	X		X		X	X	X
Depressional			X	X	X	X		X	X	X	X	
Flat				X	X			X		X	X	X
Lacustrine Fringe	X				X	X	X		X	X	X	
Riverine	X	X		X		X	X		X	X	X	X
Coastal Fringe	X				X	X	X		X	X	X	

Note:
HGM = hydrogeomorphic

Table 3.22-3: Summary of Wetland Values by Hydrogeomorphic Class for Analysis Area

HGM Class	Recreation (non-consumptive use)	Subsistence (consumptive use)	Aesthetic	Education/ Scientific	Uniqueness/ Heritage
Slope	**X**	**X**	x	**X**	**X**
Depressional	x	**X**	x	**X**	**X**
Flat	x	**X**	**X**	**X**	**X**
Lacustrine Fringe	**X**	**X**	x	x	**X**
Riverine	**X**	**X**	x	x	X
Coastal Fringe	**X**	**X**	**X**	**X**	**X**

Note:
HGM = hydrogeomorphic

Slope wetland functions—Because slope wetlands develop from the one-way discharge of groundwater and only occur only on surfaces where a change in slope gradient or an aquiclude[2] forces water to the surface, they seldom have any significant surface water. Their maintenance of wildlife habitat is instead provided to resident species that rely on surface saturation (e.g., amphibians). As groundwater is discharged to the surface, it is maintained in temporary storage in the soil, and slowly released as spring flow, which maintains downstream baseflows. Discharges tend to be steady, long-term, and in some cases, can be continuous even through dry years. The deposition of organic material to a saturated surface under anaerobic conditions promotes the accumulation of peat and the sequestration of organic carbon in the soil. Furthermore, groundwater discharge through organic carbon under anaerobic conditions provides good conditions for cycling of dissolved nitrogen (NRCS 2008). The organic matter produced, and nutrients mobilized in slope wetlands contribute to the maintenance of plant, aquatic organism, and terrestrial animal habitat in downstream reaches.

Slope wetland values—As the most common HGM class in the analysis area and broader region, slope wetlands are widely used for subsistence and recreation. Nutrient-rich slope wetlands (i.e., fens) are rare in Alaska; this type of slope wetland is attributed both uniqueness and education value.

Riverine Wetlands occur in association with active floodplains, riparian corridors, and stream channels. The distinguishing characteristic of riverine wetlands is that they are flooded by overbank flow from the stream or river at least every other year; perennial flow in the channel is not a requirement. Dominant water sources are often overbank flow from the channel or subsurface hydraulic connections between the channel and wetlands. Additional sources may include groundwater discharge from shallow aquifers, overland flow from adjacent uplands, tributary inflow, and precipitation. Riverine wetlands lose surface water by flow returning to the channel after flooding, and overland flow to the channel during precipitation events. They lose subsurface water by discharge to the channel, movement to deeper groundwater, and evapotranspiration.

Riverine wetland vegetation—Riverine wetlands are the second most common HGM wetland type in the analysis area and are predominately represented by the broad-leaved deciduous shrub and herbaceous NWI group types—and to a lesser extent—the open low shrub, wet herbaceous, closed and open tall shrub, dry to moist herbaceous, and open/closed forest project vegetation types (listed in decreasing order of representation). Riverine wetlands in the analysis area occur primarily as narrow riparian corridors along higher-gradient streams, and occasionally as broad floodplains along lower perennial streams. At their headwaters, Riverine wetlands are often replaced by slope or depressional wetlands where the channel morphology may disappear. They may intergrade with poorly-drained flats or uplands.

Riverine wetland functions—Riverine wetlands provide dynamic floodwater storage, which affects downstream peak discharges. This function is related to the stream's ability to move water between the channel and the adjacent floodplain. In high-functioning riparian wetlands (i.e., not degraded), floodplain storage capacity is related to microtopographic features and vegetative structure. Where floodplain storage capacity is high, riparian wetlands function to maintain downstream base flows. Riverine wetlands provide a high level of sediment cycling due to alternating accretion and scour. Surface flooding provides the water source for maintenance of surface ponding in macrotopographic features. The maintenance of plant and wildlife communities also relies heavily on the system's hydrograph and sediment dynamics. Dominant woody species are either adventitiously rooting (e.g., willows) and propagated by stems and branches carried by high flow; or grow from seeds dispersed on fresh deposits of sediment (e.g., cottonwoods). Fresh

[2] An impermeable barrier to the flow of water.

stands are initiated during high flow events, and the presence of multi-age stands is indicative of a system that maintains regular flood frequencies. Although fish species often depend on the maintenance of stream processes provided by the active channel, other species rely on the opportunities for off-channel feeding, rearing, and refugia provided by access to the floodplain during high flow. The presence of beaver can further enhance plant and wildlife habitat by increasing the types and abundance of wetland habitat; specifically, snags and downed wood for wildlife, cold-water refugia for fish, and different age classes of vegetation. Waterfowl rely on surface water in riverine systems, and other aquatic and terrestrial animals move readily among riverine landscape elements (NRCS 2008).

Riverine wetland values—Rivers and their associated wetlands are highly valued by residents of and visitors to the Bristol Bay region. In a largely roadless area, rivers provide transportation and critical habitat for subsistence and commercial resources. Therefore, rivers and riverine wetlands are often the focal point of communities with high recreational, economic, subsistence, and heritage value.

Flats Wetlands occur in topographically flat or very gently sloping areas that are hydrologically isolated from surrounding ground or surface water; they can be underlain by mineral or organic soil. Both types develop on interfluves, extensive relic lake bottoms, or large, inactive floodplain terraces. Different from mineral soil flats, organic soil flats develop only in climatic zones where precipitation is well in excess of evapotranspiration, thereby allowing the accretion of organic matter. Through the accumulation of peat, mineral soil flats and depressional wetlands can transition to organic soil flat wetlands. For both mineral and organic types, water source is dominated by precipitation; therefore, these systems are relatively nutrient-poor. Different from slope wetlands, flats wetlands receive no inputs of groundwater. Water loss is by evaporation, overland flow, and seepage to underlying groundwater.

Flats wetland vegetation—Flats wetlands are the third most common HGM wetland class in the analysis area and are predominately represented by the broad-leaved deciduous shrub and herbaceous NWI groups, and the wet herbaceous, open low shrub and open/closed forest project vegetation types. Both mineral and organic soil flats are found in the analysis area; however, they were not differentiated in the field, and are therefore treated collectively as “flats wetlands.” In the analysis area, flats wetlands develop on broad ridgetops, glacial outwash terraces, and remnant glacial lake beds. They may transition to slope wetlands at topographic breaks associated with groundwater discharge.

Flats wetland functions—Because no landscape is truly flat, shallow ponding in microtopographic lows of mineral flat wetlands provide some maintenance of waterfowl habitat. These depressions are shallow, with ephemeral to temporary surface water; but can provide ice-free water and wetland habitat earlier than deeper-depression wetlands. Maintenance of the plant community is often codependent with surface saturation, because together, surface microtopography and vegetation community structure can be an important mechanism for the storage and infiltration of water. Flats wetlands may provide critical amphibian breeding, egg-laying, and larval/juvenile habitat (NRCS 2008).

Peat aggradation in organic flat wetlands eventually creates a domed deposit so that surface and groundwater gradients move water to adjacent landscapes at the rate of precipitation. Such ombrotrophic peatlands are nutrient-poor and acidic, which supports the growth of characteristic plant communities. Extensive peat deposition acts also to sequester carbon and store water; the slow release of this water contributes to the maintenance of downstream baseflows. Due to the lack of open water, organic flat wetlands do not typically support waterfowl, but can provide cover and plant and invertebrate food sources for wildlife. Where ambient moisture is high, surface saturation is maintained; consequently, surface runoff can be high. However, the dense vegetation and flat slopes lessen the effect relative to other wetland systems. Organic wetland flats have less potential for cycling of nutrients and compounds due to the lack of groundwater inputs (NRCS 2008).

Flats wetlands values—Flats wetlands provide habitat for prey species, and therefore have hunting value. Expansive wetland flats can be a defining characteristic of the landscape with aesthetic value. The considerable sequestration of carbon in large organic flats wetlands provides opportunity for scientific research, especially related to climate change.

Depressional Wetlands occur in topographic depressions on a variety of geomorphic surfaces. Dominant water sources are precipitation, groundwater discharge, and surface flow and interflow from adjacent uplands. The direction of flow is normally from the surrounding uplands towards the center of the depression, which allows for the accumulation of surface water. Depressional wetlands may have any combination of inlets and outlets; or lack them completely. Dominant hydrodynamics are vertical fluctuations, primarily seasonal. Depressional wetlands may lose water through intermittent or perennial drainage from an outlet, by evapotranspiration, and if they are not receiving groundwater discharge, may slowly contribute to groundwater.

Depressional wetland vegetation—Depressional wetlands are the fourth most common HGM wetland type in the analysis area, and are predominantly represented by the herbaceous and broad-leaved deciduous shrub NWI groups and the wet herbaceous and open low shrub project vegetation types. In the analysis area, depressional wetlands occur as abandoned river features on terraces (e.g., oxbows) above active floodplains, or as kettles on moraine landforms. Depressional wetlands are often embedded in other HGM wetland classes.

Depressional wetland functions—Depressional wetlands may function to provide groundwater recharge or discharge. Recharge depressions receive most of their water as surface runoff and have a soil substrate with low-conductivity soils capable of ponding water. Ponded water provides waterfowl habitat, as well as other wildlife habitat functions. Discharge depressions receive more groundwater inflow than they deliver to receiving landscapes. Because groundwater usually contains dissolved minerals, these wetlands often have soils that feature accumulations of minerals such as calcium. Due to storage capacity, discharge depressions can maintain downstream baseflow functions. Similar to slope wetlands, the discharge rate increases with increasing precipitation and infiltration. Depressional wetlands with no surface water connection usually provide habitat for amphibians that is free from fish predation. Depressional wetlands can cycle dissolved nitrogen, serve as a sink for phosphorous, and provide for other cycling of nutrients and compounds functions (NRCS 2008).

Depressional wetland values—Due to the provision of habitat for waterfowl, depressional wetlands are attributed hunting and subsistence use values.

Lacustrine Fringe Wetlands occur adjacent to lakes where the water elevation of the lake maintains the water table in the wetland. In some cases, they develop as a mat of floating vegetation attached to land. Additional sources of water are precipitation and groundwater discharge, the latter dominating where lacustrine fringe wetlands intergrade with uplands or slope wetlands. Surface water flow is bidirectional, usually controlled by water level fluctuations such as seiches (i.e., the building of water on the downwind shoreline during high wind events), in the adjoining lake. Lacustrine fringe wetlands may be indistinguishable from depressional wetlands, where the size of the lake becomes so small relative to fringe wetlands that the lake is incapable of stabilizing water tables. Lacustrine fringe wetlands lose water by flow returning to the lake after flooding, by overland flow, and by evapotranspiration. Organic matter normally accumulates in areas sufficiently protected from shoreline wave erosion.

Lacustrine fringe wetland vegetation—These wetlands are of limited extent in the analysis area. They are predominantly represented by the herbaceous NWI groups and the wet herbaceous and open low-shrub project vegetation types. In the analysis area, lacustrine fringe wetlands occur as freshwater marshes and peatlands bordering lakes.

Lacustrine fringe wetland functions—Functionally, lacustrine fringe wetlands are similar to estuarine fringe wetlands, except that they are freshwater, and their water level fluctuations are longer term and can be more extreme. Lacustrine fringe wetlands adjacent to lakes with relative stable water levels sequester organic carbon in the soil. During storm and flood events, lacustrine wetlands can provide attenuation of high flow, and can cycle nutrients and compounds delivered to the systems by floodwaters. Because lacustrine fringe wetlands provide a diverse array of hydrologic regimes, from deep water to surface saturation, they maintain habitat for a variety of wildlife species, including fish, waterfowl, and freshwater shellfish. In many cases, the maintenance of lake fisheries is dependent on lacustrine fringe wetlands for habitat during critical life-cycle periods (NRCS 2008).

Lacustrine fringe wetland values—Lakes and their associated wetlands are highly valued by residents of and visitors to the Bristol Bay region. In a largely roadless area, Iliamna Lake provides transportation and critical habitat for subsistence and commercial resources. Therefore, lakes and lacustrine wetlands are often the focal point of communities with high recreational, economic, subsistence, and heritage value.

Coastal Fringe Wetlands occur along protected coastlines, lagoons, and estuaries under tidal influence. The most extensive systems develop at the outlets of large rivers, where the unidirectional flow of freshwater gives way to the ebb and flow of tides. Here, river channel flow and tidal exchange are common water sources, with additional inputs from groundwater discharge and precipitation. Because coastal fringe wetlands frequently flood, and water table elevations are controlled mainly by sea level, they are seldom dry for significant periods. Coastal fringe wetlands lose water by tidal exchange, by overland flow to tidal creek channels, and by evapotranspiration. Organic matter normally accumulates in higher-elevation marsh areas where flooding is less frequent, and the wetlands are isolated from shoreline wave erosion by intervening areas of low marsh.

Coastal fringe wetland vegetation—Coastal fringe wetlands are an uncommon HGM wetland type in the analysis area and are exclusively represented by the herbaceous NWI group type and the halophytic wet graminoid meadow and halophytic dry graminoid project vegetation types (listed in decreasing order of representation). Occurrence of coastal fringe wetlands in the analysis area is limited to the coastline at Diamond Point.

Coastal fringe wetland functions—Because of the continuous maintenance of water levels provided by tides, sheltered coastal fringe wetlands are able to sequester organic carbon in their soils. Nutrients and compounds carried in river and stream water are cycled in coastal wetlands as flow slows before entering the ocean. Tidal and storm surge attenuation is provided as water enters and leaves through stable tidal channels. Coastal fringe wetlands provide a diverse array of hydrologic regimes, from deeper open water to surface saturation, which provides diverse habitat for a variety of wildlife species, including fish, waterfowl, and shellfish (NRCS 2008).

Coastal fringe wetland values—Coastal wetlands are dynamic and productive habitats that support a variety of subsistence resources. As an uncommon component of the broader coastal landscape, they are attributed high aesthetic, recreational, and uniqueness value. Due to the increased variability of coastal processes in the context of a changing climate, coastal fringe wetlands are ascribed additional value for the opportunities for education and scientific research they provide.

Other waters in the 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 function to mitigate and retain storm and floodwater flows are additionally valued for recreation, hunting, fishing, and navigation opportunities.

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. Nearshore and estuarine habitats have been investigated at the Amakdedori and Diamond Point port analysis areas (GeoEngineers 2018a; Pentec Environmental/Hart Crowser 2011a, b). Several habitat types were identified, including mudflats and vegetated shallows. Mudflats, a special aquatic site described in the preceding subsection, 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 (*Clupea pallasii*), and Pacific razor clam (*Siliqua patula*), Alaska surf clam (*Spisula solidissima*), and cockle species (*Clinocardium* spp.) (Ellanna and Wheeler 1989). Vegetated shallows, a special aquatic site supporting submerged aquatic vegetation, provide food and habitat for species, as well as maintaining water quality by absorbing nutrients, trapping sediments, reducing erosion, and producing oxygen.

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 important to subsistence, commercial, and sport harvests.

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 (*Cygnus columbianus*), long-tailed duck (*Clangula hyemalis*), common loon (*Gavia immer*), arctic tern (*Sterna paradisaea*), river otter (*Lontra canadensis*), and moose (*Alces alces*). Iliamna Lake provides habitat to a population of freshwater seals, which are believed to be harbor seals (*Phoca vitulina*), although the exact species identification remains uncertain. These seals are unique in that freshwater seal populations are very rare in the northern hemisphere (VanLanen 2012). The wood frog (*Lithobates sylvaticus*) is the only amphibian that occurs in the 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 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 correspondingly 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).

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 importance to 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 (*Histrionicus histrionicus*), bald eagle (*Haliaeetus leucocephalus*), arctic tern, river otter, brown bear (*Ursus arctos)*, and beaver (*Castor canadensis*). 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.

3.22.8 Alternative 1a

The Alternative 1a analysis area is 20,553 acres, and includes the direct and indirect footprints for all project components; no variants are considered under this alternative (Table 3.22-4). Wetlands, a special aquatic site, compose 17 percent of this area; an additional 6 percent of the analysis area is other waters, including 184.7 miles of streams. Quantifiable types of wetlands identified as regionally important and other special aquatic sites individually represent 1 percent or less of the Alternative 1a analysis area; slope wetlands are the dominant HGM class. The types and areas of wetlands and other waters in the Alternative 1a analysis area are presented by project component in the following subsections.

3.22.8.1 Mine Site

The Alternative 1a analysis area for the mine site is predominantly in the Headwaters Koktuli River watershed, with a smaller portion in the Upper Talarik Creek watershed.[3] The Headwaters Koktuli River watershed drains the NFK and SFK rivers, which flow into Bristol Bay via the Mulchatna and Nushagak rivers (Figure 3.22-2). The landscape is composed of glaciated, volcanic-ash–influenced hills and valleys that are free of permafrost. Human-caused disturbance at the mine site is minimal and appears to be limited to all-terrain vehicle (ATV) trails, campsites, and exploration activity. Drill pads and other temporary disturbance from project exploration were not observed to alter wetland status or characteristics (Three Parameters Plus and HDR 2011b).

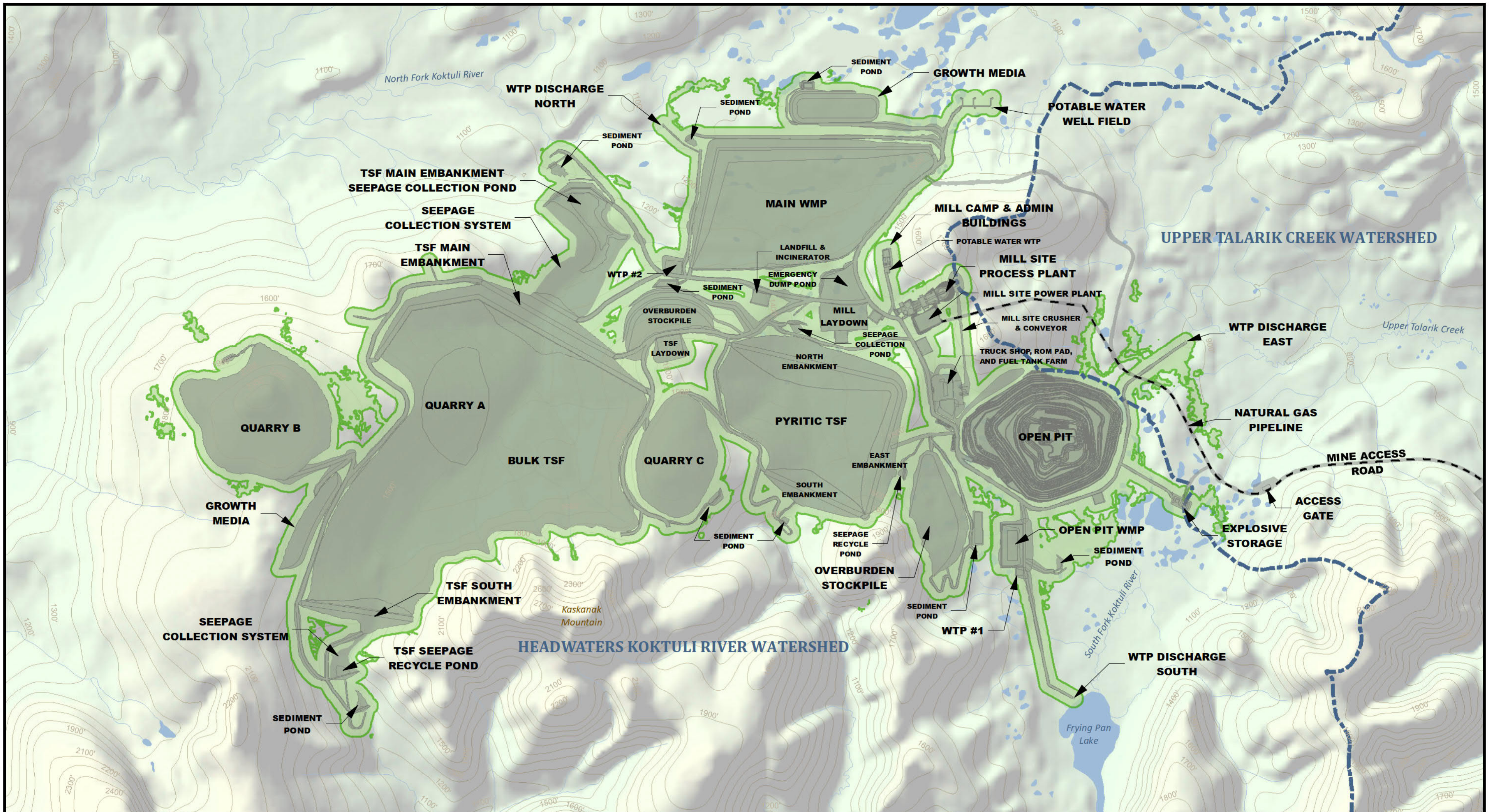
The mine site analysis area under Alternative 1a is 11,937 acres. Uplands represent 73 percent of the mine site, with the remaining 27 percent of the area composed of wetlands and other waters (Table 3.22-5). Of the wetland types present, the broad-leaved deciduous shrub type is dominant at 17 percent, with herbaceous wetlands subdominant at 8 percent. Both wetland types occur primarily as the slope HGM class, and secondarily as the riverine HGM class. Due to elevation and exposure, forested wetlands are absent at the mine site. Of the other water types present, ponds are the most abundant type at 1 percent of the mine site analysis area. A total of 132.9 miles of streams is present in the mine site analysis area. Community-level descriptions of wetland types, and the functions and values associated with HGM classes, are presented in the preceding sections.

[3]Watersheds are presented at the hydrologic unit code (HUC) 10 scale.

Table 3.22-4: Summary of Wetlands, Other Waters, Regionally Important Wetlands, Special Aquatic Sites, and HGM Classes by Area for Alternative 1a

Alternative 1a	Area (Acres)	Length (Miles)	Area (%)
Wetlands	3,588		17
Other Waters	1,293	184.7	6
Uplands	15,672		76
Total Wetlands and Other Waters	4,881		24
Alternative Analysis Area	20,553		100
Special Aquatic Sites			
Wetlands	3,588		17
Mudflats	40		<1
Vegetated Shallows	4		<1
Riffle and Pool Complexes	101	149.7	<1
Regionally Important Wetlands			
Fens	141		1
Forested Wetlands	13		<1
Riverine Wetlands	226		1
Estuarine Wetlands	-		-
Hydrogeomorphic Classes			
Slope	3,445		17
Depressional	174		1
Flat	37		<1
Lacustrine	246		1
Lacustrine Fringe	9		<1
Riverine Channel	115	184.7	1
Riverine	227		1
Coastal Fringe	-		-
Marine	646		3

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019a, i



Sources: PLP 2019-RFI153

US Army Corps of Engineers

0.5 0 0.5 1

Miles

Mine Site Analysis Area

Alternative 1a

Natural Gas Pipeline

Mine Site/Transportation

Other Features

River/Stream

Lake/Pond

Watershed

100' Contour (Existing)

MINE SITE WETLANDS ANALYSIS AREA

PEBBLE PROJECT EIS

FIGURE 3.22-2

Table 3.22-5: Alternative 1a Analysis Area—Mine Site Wetland and Other Water Types

NWI Wetland Group	HGM Wetland Type								Total Area (Acres)	Total Length (Miles)	Total Area (%)
	Slope	Depressional	Flat	Lacustrine	Lacustrine Fringe	Riverine Channel	Riverine	Upland			
Herbaceous	833	14	4	—	8	—	77	—	937	—	**8**
Deciduous Shrub	1,902	12	11	—	1	—	112	—	2,038	—	**17**
Evergreen Shrub	13	—	—	—	—	—	—	—	13	—	**<1**
Aquatic Bed	2	—	—	—	—	—	—	—	2	—	**<1**
Ponds	30	86	—	—	—	<1	16	—	132	—	**1**
Lakes	—	—	—	15	—	—	—	—	15	—	**<1**
Streams (Intermittent)	—	—	—	—	—	5	<1	—	5	21.1	**<1**
Streams (Perennial)	—	—	—	—	—	57	—	—	57	111.8	**<1**
Upland	—	—	—	—	—	—	—	8,738	8,738	—	**73**
Total Wetlands and Other Waters (Acres)	**2,780**	**112**	**15**	**15**	**9**	**62**	**206**	**—**	**3,199**	**132.9**	**27**
Total Area (Acres)	**2,780**	**112**	**15**	**15**	**9**	**62**	**206**	**8,738**	**11,937**	**—**	**100**
Total Area (%)	**23**	**1**	**<1**	**<1**	**<1**	**1**	**2**	**73**	**100**		

Notes:
HGM = Hydrogeomorphic
NWI = National Wetland Inventory
Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019a, i

3.22.8.2 Transportation Corridor

The Alternative 1a analysis area for the transportation corridor includes the 35 miles of the mine site access road from the mine site to the Eagle Bay ferry terminal, with a connection to the existing Iliamna/Newhalen road system, a 28-mile crossing of Iliamna Lake to the south ferry terminal, and a 37-mile port access road between the lake and Amakdedori port. It also includes the Kokhanok spur road connecting the transportation corridor to the community of Kokhanok and the explosives storage spur road connecting the mine site access road to a storage pad near the mine site. The transportation corridor includes the segments of the natural gas pipeline that are co-located with road alignments. This alternative includes a southern crossing of the Newhalen River and a crossing of the Gibraltar River.

The transportation corridor is dominated by glaciated, volcanic ash-influenced mountains, hills, plains, and valleys that are free from permafrost. Human-caused disturbance in the transportation corridor is minimal, and appears to be limited to 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 (Three Parameters Plus and HDR 2011b).

The transportation corridor crosses the Bristol Bay and Cook Inlet drainage basins; in the Cook Inlet drainage basin, the Amakdedori Creek-Kamishak Bay watershed[4] is the only watershed crossed by the transportation corridor. The watersheds intersected by the transportation corridor in the Bristol Bay drainage basin include the UTC, Newhalen River, Iliamna Lake, and Gibraltar Lake watersheds.

The Alternative 1a transportation corridor analysis area is 7,494 acres. Uplands represent 89 percent of the transportation corridor, with the remaining 11 percent of the area composed of wetlands and other waters (Table 3.22-6). Of the wetland types present, the broad-leaved deciduous shrub type is dominant at 5 percent, and herbaceous wetlands are subdominant at 2 percent. Both wetland types occur primarily as the slope HGM class, with broad-leaved deciduous shrub wetlands also occurring as the riverine HGM class. Forested wetlands account for less than 1 percent of the Alternative 1a transportation corridor. Of the other water types present, ponds are dominant at 2 percent of the transportation corridor; the remaining other water types represent less than 1 percent each of the analysis area. A total of 51.1 miles of streams is present in the transportation corridor analysis area. Community-level descriptions of wetland types, and the functions and values associated with HGM classes, are presented in the preceding sections.

3.22.8.3 Amakdedori Port

The Alternative 1a analysis area for the Amakdedori port comprises 118 acres of undisturbed habitat on the shore of Kamishak Bay near Amakdedori Creek. The port is in the Amakdedori Creek-Kamishak Bay watershed in the Cook Inlet drainage. Topography is generally flat, with dunes located closer to the gravel beach shoreline of Cook Inlet; eelgrass beds are not present in the Alternative 1a analysis area (see Section 3.24, Fish Values).

Uplands represent 82 percent of the port site, with the remaining 18 percent of the area composed of wetlands and other waters (Table 3.22-7). Herbaceous wetlands are the only wetland type represented, and are associated primarily with riverine, and secondarily with slope HGM classes. Of the other water types present, marine waters (both intertidal and subtidal) are dominant at 15 percent combined. Community-level descriptions of wetland types, and the functions and values associated with HGM classes, are presented in the preceding sections.

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[4] Watersheds are presented at the hydrologic unit code (HUC) 10 scale.

Table 3.22-6: Alternative 1a Analysis Area—Transportation Corridor Wetland and Other Water Types

NWI Wetland Group	HGM Wetland Type								Total Area (Acres)	Total Length (Miles)	Total Area (%)
	Slope	Depressional	Flat	Lacustrine	Lacustrine Fringe	Riverine Channel	Riverine	Upland			
Herbaceous	156	9	8	—	<1	—	3	—	176	—	**2**
Deciduous Shrub	316	1	6	—	<1	—	15	—	339	—	**5**
Evergreen Shrub	48	2	—	—	—	—	—	—	50	—	**1**
Deciduous Forest	11	—	—	—	—	—	1	—	12	—	**<1**
Evergreen Forest	<1	—	—	—	—	—	—	—	<1	—	**<1**
Aquatic Bed	<1	1	—	—	<1	—	<1	—	1	—	**<1**
Ponds	102	47	—	—	—	—	1	—	150	—	**2**
Lakes	—	—	—	74	—	—	—	—	74	—	**1**
Streams (Intermittent)	—	—	—	—	—	2		—	2	13.8	**<1**
Streams (Perennial)	<1	—	—	—	—	48	<1	—	48	37.2	**1**
Upland	—	—	—	—	—	—	—	6,642	6,642	—	**89**
Total Wetlands and Other Waters (Acres)	**634**	**60**	**15**	**74**	**<1**	**50**	**20**	**—**	**852**	**51.1**	**11**
Total Area (Acres)	**634**	**60**	**15**	**74**	**<1**	**50**	**20**	**6,642**	**7,494**	—	**100**
Total Area (%)	**8**	**1**	**<1**	**1**	**<1**	**1**	**<1**	**89**	**100**		

Notes:
-- = not applicable
HGM = Hydrogeomorphic
NWI = National Wetland Inventory
Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019a, i

Table 3.22-7: Alternative 1a Analysis Area—Amakdedori Port Wetland and Other Water Types

NWI Wetland Group	HGM Wetland Type					Total Area (Acres)	Total Length (Miles)	Total Area (%)
	Slope	Riverine Channel	Riverine	Marine	Upland			
Herbaceous	1		<1	—	—	1	—	**1**
Streams (Perennial)	—	3	—	—	—	3	0.1	**2**
Marine (Intertidal)	—	—	—	9	—	9	—	**7**
Marine (Subtidal)	—	—	—	9	—	9	—	**8**
Upland	—	—	—	—	97	97	—	**82**
Total Wetlands and Other Waters (Acres)	**1**	**3**	**<1**	**18**	**—**	**22**	**0.1**	**18**
Total Area (Acres)	**1**	**3**	**<1**	**18**	**97**	**118**	**—**	**100**
Total Area (%)	**1**	**2**	**<1**	**15**	**82**	**100**		

Notes:
— = not applicable
HGM = Hydrogeomorphic
NWI = National Wetland Inventory
Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019a, ii

3.22.8.4 Natural Gas Pipeline Corridor

Under Alternative 1a, the natural gas pipeline corridor includes five main segments: 1) Cook Inlet crossing to the Amakdedori port; 2) along the port access road to Iliamna Lake; 3) across Iliamna Lake to Newhalen; 4) overland to connect with the mine access road east of the Newhalen River crossing; and 5) along the mine access road to the mine site.

Segments of the natural gas pipeline corridor adjacent to access roads are addressed under the transportation corridor analysis area. Stand-alone segments of the natural gas pipeline (i.e., those that are not co-located with road corridors) are addressed here, and include overland stand-alone segments to tie-in to project facilities (13 miles), the Cook Inlet crossing (104 miles), and the Iliamna Lake crossing (21 miles). Cook Inlet is characterized by nearshore and deepwater 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. Iliamna Lake is almost entirely deepwater habitat with an unconsolidated bottom.

The Alternative 1a analysis area for the natural gas pipeline corridor is 1,007 acres. Uplands represent 20 percent of the analysis area, with the remaining 80 percent of the area composed of wetlands and other waters (Table 3.22-8). Of the wetland types present, the broad-leaved deciduous shrub and herbaceous types are codominant at 1 percent each. Both wetland types occur primarily as slope, and secondarily as flat HGM classes. Of the other water types present, subtidal marine waters are dominant at 62 percent; lakes are subdominant at 16 percent. Community-level descriptions of wetland types, and the functions and values associated with HGM classes, are presented in the preceding sections.

3.22.9 Alternative 1

The Alternative 1 analysis area is 21,860 acres, and includes the direct and indirect footprints for all project components, as well as the Summer-Only Ferry Operations, Kokhanok East Ferry Terminal, and Pile-Supported Dock variants (Table 3.22-9). Wetlands, a special aquatic site, comprise 17 percent of this area; an additional 6 percent of the analysis area is other waters, including 189.0 miles of streams. Quantifiable types of wetlands, identified as regionally important, and other special aquatic sites represent 1 percent or less of the Alternative 1 analysis area; slope wetlands are the dominant HGM class. The types and areas of wetlands and other waters in the Alternative 1 analysis area are presented by project component in the following subsections.

Table 3.22-8: Alternative 1a Analysis Area—Natural Gas Pipeline Corridor Wetland and Other Water Types

NWI Wetland Group	HGM Wetland Type								Total Area (Acres)	Total Length (Miles)	Total Area (%)
	Slope	Depressional	Flat	Lacustrine	Riverine Channel	Riverine	Marine	Upland			
Herbaceous	3	1	2	—	—	<1	—	—	6	—	**1**
Deciduous Shrubs	5	<1	4	—	—	1	—	—	10	—	**1**
Evergreen Shrubs	3		2	—	—	—	—	—	5	—	**<1**
Evergreen Forest	—	—	—	—	—	<1	—	—	<1	—	**<1**
Aquatic Bed	—	<1	—	—	—	—	—	—	<1	—	**<1**
Ponds	—	<1	—	—	—	—	—	—	<1	—	**<1**
Lakes	—	—	—	157	—	—	—	—	157	—	**16**
Streams (Intermittent)	—	—	—	—	<1	—	—	—	<1	0.1	**<1**
Streams (Perennial)	—	—	—	—	<1	—	—	—	<1	0.5	**<1**
Marine (Intertidal)	—	—	—	—	—	—	1	—	1	—	**<1**
Marine (Subtidal)	—	—	—	—	—	—	628	—	628	—	**62**
Upland	—	—	—	—	—	—	—	200	200	—	**20**
Total Wetlands and Other Waters (Acres)	**11**	**2**	**8**	**157**	**<1**	**2**	**628**	**—**	**808**	**0.6**	**80**
Total Area (Acres)	**11**	**2**	**8**	**157**	**<1**	**2**	**628**	**200**	**1,007**	**—**	**100**
Total Area (%)	**1**	**<1**	**1**	**16**	**<1**	**<1**	**62**	**20**	**100**		

Notes:
— = not applicable
HGM = Hydrogeomorphic
NWI = National Wetland Inventory
Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019a, i

Table 3.22-9: Summary of Wetlands, Other Waters, Regionally Important Wetlands, Special Aquatic Sites, and HGM Classes by Area for the Alternative 1 Analysis Area

Alternative 1	Area (Acres)	Length (Miles)	Area (%)
Wetlands	3,623	—	17
Other Waters	1,392	189.0	6
Uplands	16,845	—	77
Total Wetlands and Other Waters	5,015	—	23
Total Alternative Analysis Area	21,860	—	100
Special Aquatic Sites			
Wetlands	3,623	—	17
Mudflats	52	—	<1
Vegetated Shallows	3	—	<1
Riffle and Pool Complexes	91	150.9	<1
Regionally Important Wetlands			
Fens	142	—	1
Forested Wetlands	3	—	<1
Riverine Wetlands	242	—	1
Estuarine Wetlands	—	—	—
Hydrogeomorphic Classes			
Slope	3,458	—	16
Depressional	196	—	1
Flat	53	—	<1
Lacustrine	286	—	1
Lacustrine Fringe	9	—	<1
Riverine Channel	109	189.0	<1
Riverine	242	—	1
Coastal Fringe	—	—	—
Marine	683	—	3

Notes:
— = not applicable
HGM = Hydrogeomorphic
Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019a, i

3.22.9.1 Mine Site

The mine site analysis area under Alternative 1 is 11,955 acres. Uplands represent 73 percent of the mine site, with the remaining 27 percent of the area composed of wetlands and other waters (Table 3.22-10). Of the wetland types present, the broad-leaved deciduous shrub type is dominant at 17 percent; herbaceous wetlands are subdominant at 8 percent. Both wetland types occur primarily as the slope HGM class, and secondarily as the riverine HGM class. Due to elevation and exposure, forested wetlands are absent at the mine site. Of the other water types present, ponds are the most abundant type at 1 percent of the mine site analysis area. A total of 132.9 miles of streams is present in the mine site analysis area. Community-level descriptions of wetland types, and the functions and values associated with HGM classes, are presented in the preceding sections.

Summer-Only Ferry Operations Variant

This variant would restrict operation of the ferry across Iliamna Lake to the open water season. Instead of daily transportation to the Amakdedori port, concentrate would be stored in a container-based system that would be stockpiled at the mine site during the period when the lake is frozen. The containers would be stored in a laydown area at the mine site, requiring relocation of the sewage tank pad. This change in configuration would increase the area of direct disturbance at the mine site by 33 acres, thereby increasing the area of the affected environment for wetlands and other waters. This increase is included in the Alternative 1 analysis area for the mine site, presented in Table 3.22-10.

3.22.9.2 Transportation Corridor

The Alternative 1 transportation corridor includes 28 miles of the mine access road from the mine site to a ferry terminal on the north shore of Iliamna Lake; a 18-mile ferry crossing of Iliamna Lake from the north ferry terminal to the south ferry terminal west of Kokhanok; and the port access road considered under Alternative 1a. Separate spur roads included under Alternative 1 are the 9-mile Iliamna spur road from the mine access road to the existing road system supporting the communities of Iliamna and Newhalen, and the Kokhanok spur road and explosives storage spur road described under Alternative 1a. The transportation corridor includes the segments of the natural gas pipeline that are co-located with road alignments. This alternative includes a crossing of the Gibraltar River.

The transportation corridor analysis area under Alternative 1 is 8,820 acres. Uplands represent 89 percent of the area, with the remaining 11 percent of the area composed of wetlands and other waters (Table 3.22-11). Of the wetland types present, the broad-leaved deciduous shrub type is dominant at 4 percent, herbaceous wetlands are subdominant at 2 percent, and the evergreen shrub type represents an additional 1 percent. All three wetland types occur primarily as the slope HGM class. Forested wetlands account for less than 1 percent of the transportation corridor analysis area. No additional wetland types are represented. Of the other water types present, ponds are dominant at 2 percent, with lakes subdominant at 1 percent. A total of 55.7 miles of streams is present in the transportation corridor analysis area. Community-level descriptions of wetland types, and the functions and values associated with HGM classes, are presented in the preceding sections.

Table 3.22-10: Alternative 1 Analysis Area—Mine Site Wetland and Other Water Types

NWI Wetland Group	HGM Wetland Type								Total Area (Acres)	Total Length (Miles)	Total Area (%)
	Slope	Depressional	Flat	Lacustrine	Lacustrine Fringe	Riverine Channel	Riverine	Upland			
Herbaceous	833	14	4	—	8	—	77	—	937	—	**8**
Deciduous Shrub	1,902	12	11	—	1	—	112	—	2,038	—	**17**
Evergreen Shrub	13	—	—	—	—	—	—	—	13	—	**<1**
Aquatic Bed	2	—	—	—	—	—	—	—	2	—	**<1**
Ponds	30	86	—	—	—	<1	16	—	132	—	**1**
Lakes	—	—	—	15	—	—	—	—	15	—	**<1**
Streams (Intermittent)	—	—	—	—	—	5	<1	—	5	21.1	**<1**
Streams (Perennial)	—	—	—	—	—	57	—	—	57	111.8	**<1**
Upland	—	—	—	—	—		—	8,756	8,756	—	**73**
Total Wetlands and Other Waters (Acres)	**2,780**	**112**	**15**	**15**	**9**	**62**	**206**	**—**	**3,199**	**132.9**	**27**
Total Area (Acres)	**2,780**	**112**	**15**	**15**	**9**	**62**	**206**	**8,756**	**11,955**	**—**	**100**
Total Area (%)	**23**	**1**	**<1**	**<1**	**<1**	**1**	**2**	**73**	**100**		

Notes:
— = not applicable
HGM = Hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019a, i

Table 3.22-11: Alternative 1 Analysis Area—Transportation Corridor Wetland and Other Water Types

NWI Wetland Group	HGM Wetland Type								Total Area (Acres)	Total Length (Miles)	Total Area (%)
	Slope	Depressional	Flat	Lacustrine	Lacustrine Fringe	Riverine Channel	Riverine	Upland			
Herbaceous	164	16	13	—	<1	—	5	—	199		**2**
Deciduous Shrub	322	3	18	—	—	—	27	—	370		**4**
Evergreen Shrub	48	1	6	—	—	—	—	—	55		**1**
Deciduous Forest	2	—	—	—	—	—	<1	—	2		**<1**
Evergreen Forest	—	—	1	—	—	—	—	—	1		**<1**
Aquatic Bed	1	<1	—	—	<1	—	<1	—	1		**<1**
Ponds	116	63	—	—	—	—	1	—	179		**2**
Lakes	—	—	—	93	—	—	—	—	93		**1**
Streams (Intermittent)	—	—	—	—	—	3	—	—	3	17.0	**<1**
Streams (Perennial)	—	—	—	—	—	38	—	—	38	38.7	**<1**
Upland	—	—	—	—	—	—	—	7,880	7,880		**89**
Total Wetlands and Other Waters (Acres)	**652**	**82**	**38**	**93**	**<1**	**40**	**34**	**—**	**940**	**55.7**	**11**
Total Area (Acres)	**652**	**82**	**38**	**93**	**<1**	**40**	**34**	**7,880**	**8,820**	**—**	**100**
Total Area (%)	**7**	**1**	**<1**	**1**	**<1**	**<1**	**<1**	**89**	**100**		

Notes:
— = not applicable
HGM = Hydrogeomorphic
NWI = National Wetland Inventory
Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019a, i

Kokhanok East Ferry Terminal Variant

This variant considers an alternate south ferry terminal site east of Kokhanok, thereby avoiding a crossing of the Gibraltar River and reducing the overall number of stream crossings. It includes a 27-mile-long crossing of Iliamna Lake and a 27-mile port access road from the Kokhanok East ferry terminal to Amakdedori port on Cook Inlet. Spur roads included under this variant are the 5-mile Kokhanok spur road connecting the port access road to the community of Kokhanok, and the Iliamna and explosives storage spur roads described under Alternative 1a. Increase to the extent of the affected environment for wetlands and other waters is captured in the Alternative 1 analysis area for the transportation corridor, presented in Table 3.22-11.

3.22.9.3 Amakdedori Port

Uplands represent 65 percent of the port site, with the remaining 35 percent of the area composed of wetlands and other waters (Table 3.22-12). Herbaceous wetlands are the dominant wetland type represented (2 percent), and are associated primarily with riverine, and secondarily with slope HGM classes. Of the other water types present, marine waters (both intertidal and subtidal) are dominant at 30 percent combined. Community-level descriptions of wetland types, and the functions and values associated with HGM classes, are presented in the preceding sections.

3.22.9.4 Summer-Only Ferry Operations Variant

Under this variant, concentrate would be transported to the port site during the operating months and stored in an expanded container storage yard. Construction of this storage yard would increase the area of direct disturbance at the port by approximately 28 acres. Increase to the affected environment for wetlands and other waters is captured in the Alternative 1 analysis area for the Amakdedori port, presented in Table 3.22-12.

Pile-Supported Dock Variant

This variant proposes an alternate pile-supported dock design at Amakdedori port, which would reduce the footprint of direct disturbance by 11 acres. The area of the affected environment for wetlands and other waters is captured in the Alternative 1 analysis area for the Amakdedori port, presented in Table 3.22-12.

3.22.9.5 Natural Gas Pipeline Corridor

The Alternative 1 natural gas pipeline corridor includes four main segments: 1) Cook Inlet crossing to the Amakdedori port; 2) along the port access road to the south ferry terminal; 3) across Iliamna Lake to the north ferry terminal; and 4) along the mine access road to the mine site.

Segments of the natural gas pipeline corridor adjacent to access roads are addressed under the transportation corridor for Alternative 1. Stand-alone segments of the natural gas pipeline (i.e., those that are not co-located with road corridors) are addressed here, and include overland stand-alone segments to tie-in to project facilities (5 miles), the Cook Inlet crossing (104 miles), and the Iliamna Lake crossing (19 miles).

The natural gas pipeline corridor analysis area under Alternative 1 is 900 acres. Uplands represent 10 percent of the analysis area, with the remaining 90 percent of the area composed of wetlands and other waters (Table 3.22-13). Broad-leaved deciduous shrub and herbaceous are the only wetland types present, and are co-dominant at less than 1 percent each. Both wetland types occur primarily as slope, and secondarily as riverine HGM classes. Of the other water types present, subtidal marine waters are dominant at 70 percent, lakes are subdominant at 20 percent. The natural gas pipeline analysis area contains 0.2 mile of streams. Community-level descriptions of wetland types, and the functions and values associated with HGM classes, are presented in the preceding sections.

Table 3.22-12: Alternative 1 Analysis Area—Amakdedori Port Wetland and Other Water Types

NWI Wetland Group	HGM Wetland Type					Total Area (Acres)	Total Length (Miles)	Total Area (%)
	Slope	Riverine Channel	Riverine	Marine	Upland			
Herbaceous	1		2	—	—	3		**2**
Deciduous Shrubs	<1		<1	—	—	<1		**<1**
Streams (Perennial)	—	7	—	—	—	7	0.2	**4**
Marine (Intertidal)	—	—	—	9	—	9		**5**
Marine (Subtidal)	—	—	—	45	—	45		**25**
Upland	—	—	—	—	120	120		**65**
Total Wetlands and Other Waters (Acres)	**1**	**7**	**2**	**54**	**—**	**65**	**0.2**	**35**
Total Area (Acres)	**1**	**7**	**2**	**54**	**120**	**185**		**100**
Total Area (%)	**1**	**4**	**1**	**29**	**65**	**100**		

Notes:
— = not applicable
HGM = Hydrogeomorphic
NWI = National Wetland Inventory
Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019a, i

Table 3.22-13: Alternative 1 Analysis Area—Natural Gas Pipeline Corridor Wetland and Other Water Types

NWI Wetland Group	HGM Wetland Type							Total Area (Acres)	Total Length (Miles)	Total Area (%)
	Slope	Depressional	Lacustrine	Riverine Channel	Riverine	Marine	Upland			
Herbaceous	2	—	—	—	<1	—	—	2		**<1**
Deciduous Shrubs	2	—	—	—	<1	—	—	2		**<1**
Ponds	—	<1	—	—	—	—	—	<1		**<1**
Lakes	—	—	178		—	—	—	178		**20**
Streams (Intermittent)	—	—	—	<1	—	—	—	<1	0.1	**<1**
Streams (Perennial)	—	—	—	<1	—	—	—	<1	0.1	**<1**
Marine (Intertidal)	—	—	—	—	—	1	—	1		**<1**
Marine (Subtidal)	—	—	—	—	—	628	—	628		**70**
Upland	—	—	—	—	—	—	90	90		**10**
Total Wetlands and Other Waters (Acres)	**4**	**<1**	**178**	**<1**	**<1**	**628**	**—**	**810**	**0.2**	**90**
Total Area (Acres)	**4**	**<1**	**178**	**<1**	**<1**	**628**	**90**	**900**		**100**
Total Area (%)	**0**	**<1**	**20**	**<1**	**<1**	**70**	**10**	**100**		

Note:
Less than 0.1 acre of Streams and less than 1 acre of Ponds are present in the analysis area for this alternative
— = not applicable
HGM = Hydrogeomorphic
NWI = National Wetland Inventory
Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019a, i

Kokhanok East Ferry Terminal Variant

Under the Kokhanok East Ferry Terminal Variant, the natural gas pipeline alignment from the Amakdedori port would follow the port access road towards the Kokhanok East ferry terminal and the spur road into Kokhanok. From Kokhanok, it would follow an existing road alignment to the point where it departs the shoreline to tie into the route from the Kokhanok west ferry terminal site. The total pipeline length with this variant would be approximately 2 miles less than the Alternative 1 base case but would increase the crossing of Iliamna Lake by 1 mile. Change to the affected environment for wetlands and other waters is captured in the Alternative 1 analysis area for the natural gas pipeline, presented in Table 3.22-13.

3.22.10 Alternative 2—North Road and Ferry with Downstream Dams

The Alternative 2 analysis area is 20,515 acres, and includes the direct and indirect footprints for all project components, as well as the Summer-Only Ferry Operations, Newhalen River North Crossing, and Pile-Supported Dock variants (Table 3.22-14). Wetlands, a special aquatic site, comprise 17 percent of this area; an additional 7 percent of the analysis area is other waters, including 180.0 miles of streams. Quantifiable wetland types identified as regionally important and other special aquatic sites represent 1 percent or less of the Alternative 2 analysis area. The types and HGM classes of wetlands and other waters are summarized by area and presented by project component below.

3.22.10.1Mine Site

The downstream dam construction method proposed for the Alternative 2 mine site increases direct disturbance footprint by 107 acres relative to Alternative 1a, Alternative 1, and Alternative 3, thereby increasing the affected environment for wetlands and other waters. The mine site analysis area under Alternative 2 is 12,052 acres. Uplands represent 73 percent of the mine site, with the remaining 27 percent of the area made up of wetlands and other waters (Table 3.22-15). Of the wetland types present, the broad-leaved deciduous shrub type is dominant at 17 percent; herbaceous wetlands are subdominant at 8 percent. Both wetland types occur primarily as the slope HGM class, and secondarily as the riverine HGM class. Due to elevation and exposure, forested wetlands are absent at the mine site. Of the other water types present, ponds are the most abundant type at 1 percent of the mine site analysis area. A total of 133.4 miles of streams is present in the mine site analysis area. Community-level descriptions of wetland types, and the functions and values associated with HGM classes, are presented in the preceding sections.

Summer-Only Ferry Operations Variant

The Summer-Only Ferry Variant would increase the area of direct disturbance at the mine site by 33 acres associated with a container storage yard and relocation of a sewage tank pad, thereby increasing the extent of the affected environment for wetlands and other waters. This increased size is included in the Alternative 2 analysis area for the mine site presented in Table 3.22-15.

3.22.10.2Transportation Corridor

The Alternative 2 transportation corridor includes 35 miles of the mine access road from the mine site to the Eagle Bay ferry terminal on the northern shore of Iliamna Lake, a 29-mile crossing of the lake to the Pile Bay ferry terminal, and an 18-mile port access road connecting the Pile Bay terminal to the Diamond Point port on Cook Inlet. This alternative includes a southern crossing of the Newhalen River. The transportation corridor includes the segments of the natural gas pipeline that are co-located with road alignments.

Table 3.22-14: Summary of Wetlands, Other Waters, Regionally Important Wetlands, Special Aquatic Sites, and HGM Classes by Area for the Alternative 2 Analysis Area

Alternative 2	Area (Acres)	Length (Miles)	Area (%)
Wetlands	3,407	—	17
Other Waters	1,370	180.0	7
Uplands	15,738	—	77
Total Wetlands and Other Waters	4,776	—	23
Total Alternative Analysis Area	20,515	—	100
Special Aquatic Sites			
Wetlands	3,406	—	17
Mudflats	136	—	1
Vegetated Shallows	3	—	<1
Riffle and Pool Complexes	147	147.5	1
Regionally Important Wetlands			
Fens	140	—	1
Forested Wetlands	28	—	<1
Riverine Wetlands	259	—	1
Estuarine Wetlands	4	—	<1
Hydrogeomorphic Classes			
Slope	3,131	—	15
Depressional	161	—	1
Flat	30	—	<1
Lacustrine	67	—	<1
Lacustrine Fringe	11	—	<1
Riverine Channel	181	180.0	1
Riverine	263	—	1
Coastal Fringe	331	—	2
Marine	618	—	3

Notes:
— = not applicable
HGM = Hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019a, i

Table 3.22-15: Alternative 2 Analysis Area—Mine Site Wetland and Other Water Types

NWI Wetland Group	HGM Wetland Type								Total Area (Acres)	Total Length (Miles)	Total Area (%)
	Slope	Depressional	Flat	Lacustrine	Lacustrine Fringe	Riverine Channel	Riverine	Upland			
Herbaceous	845	14	4	—	8	—	77	—	948		**8**
Deciduous Shrub	1,909	12	11	—	1	—	112	—	2,044		**17**
Evergreen Shrub	13	—	—	—	—	—	—	—	13		**<1**
Aquatic Bed	2	—	—	—	—	—	—	—	2		**<1**
Ponds	30	86	—	—	—	<1	16	—	132		**1**
Lakes	—	—	—	15	—	—	—	—	15		**<1**
Streams (Intermittent)	—	—	—	—	—	5	<1	—	5	21.1	**<1**
Streams (Perennial)	—	—	—	—	—	58	—	—	58	112.2	**<1**
Upland	—	—	—	—	—	—	—	8,835	8,835		**73**
Total Wetlands and Other Waters (Acres)	**2,799**	**112**	**15**	**15**	**9**	**62**	**206**	**—**	**3,217**	**133.4**	**27**
Total Area (Acres)	**2,799**	**112**	**15**	**15**	**9**	**62**	**206**	**8,835**	**12,052**	**—**	**100**
Total Area (%)	**23**	**1**	**<1**	**<1**	**<1**	**1**	**2**	**73**	**100**		

Notes:
— = not applicable
HGM = Hydrogeomorphic
NWI = National Wetland Inventory
Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019a, i

The transportation corridor analysis area under Alternative 2 is 5,788 acres. Uplands represent 88 percent of the analysis area, with the remaining 12 percent of the area made up of wetlands and other waters (Table 3.22-16). Of the wetland types present, the broad-leaved deciduous shrub type is dominant at 4 percent; herbaceous wetlands are subdominant at 2 percent. Both wetland types occur primarily as the slope HGM class, and to a lesser extent as the riverine HGM class. Of the other water types present, subtidal estuarine waters and perennial streams are codominant at 2 percent each. A total of 34.1 miles of streams is present in the transportation corridor analysis area, including 0.2 mile of tidally influenced river. Community-level descriptions of wetland types, and the functions and values associated with HGM classes, are presented in the preceding sections.

Summer-Only Ferry Operations Variant

Under this variant, concentrate shipping at the Diamond Point port would continue per the year-round schedule even though the Iliamna Lake ferry operations would be restricted to the open water season. To support shipping from Diamond Point port, a 22-acre container storage area would be located along the Williamsport-Pile Bay Road; the remote location is due to limited space at Diamond Point port. The increase in the extent of the affected environment for wetlands and other waters related to the storage area is included in the Alternative 2 analysis area for the transportation corridor, presented in Table 3.22-16.

Newhalen River North Variant

This variant includes an alternative crossing of the Newhalen River north of the proposed location and would increase the direct disturbance footprint by 20 acres; mainly attributed to material sites. This increase in the affected environment for wetlands and other waters is included in the analysis area for the Alternative 2 transportation corridor, presented in Table 3.22-16.

3.22.10.3 Diamond Point Port

The Diamond Point port analysis area under Alternative 2 is composed of 255 acres of relatively undisturbed habitat at the juncture of Iliamna and Cottonwood bays. The Diamond Point Quarry is adjacent to the proposed port location, and the Williamsport-Pile Bay Road terminates at the head of Iliamna Bay. Coastal habitats in the Alternative 2 Diamond Point port analysis area include sand and pebble substrates interspersed by rocky reefs and mudflats. Eelgrass beds are not known to occur in the Alternative 2 Diamond Point port analysis area (see Section 3.24, Fish Values). The nearshore environment at Diamond Point is shallow, and would therefore require initial and maintenance dredging of 58 acres for access to the dock. Dredged material would be disposed of onshore in two bermed storage facilities. Both the area of dredging and the areas of storage facilities are included in the port analysis area. Dredging activities are more fully described in Chapter 2, Alternatives; locations of the proposed dredge area and storage areas for dredged materials are shown in Figure 2-71. Uplands represent 46 percent of the Diamond Point port analysis area, with the remaining 54 percent of the area composed of wetlands and other waters (Table 3.22-17). Estuarine intertidal wetlands are the dominant wetland type at 3 percent; herbaceous wetlands represent an additional 1 percent. These wetland types are exclusively associated with the coastal fringe HGM class. Of the other water types present, subtidal estuarine waters are overwhelmingly dominant at 50 percent. A total of 0.8 mile of streams is present in the port analysis area; 0.7 mile of this total is intermittent, and the remaining 0.2 mile is perennial. Community-level descriptions of wetland types, and the functions and values associated with HGM classes, are presented in the preceding sections.

Table 3.22-16: Alternative 2 Analysis Area—Transportation Corridor Wetland and Other Water Types

NWI Wetland Group	HGM Wetland Type									Total Area (Acres)	Total Length (Miles)	Total Area (%)
	Slope	Depressional	Flat	Lacustrine	Lacustrine Fringe	Riverine Channel	Riverine	Coastal Fringe	Upland			
Herbaceous	57	15	8	—	<1	—	18	3	—	100		**2**
Deciduous Shrub	170	4	6	—	<1	—	23	—	—	204		**4**
Evergreen Shrub	19	2	—	—	—	—	—	—	—	21		**<1**
Deciduous Forest	11	<1	—	—	—	—	3	—	—	14		**<1**
Evergreen Forest	5		—	—	—	—	1	—	—	7		**<1**
Aquatic Bed	<1	1	—	—	—	—	<1	—	—	1		**<1**
Ponds	9	26	—	—	—	—	5	—	—	39		**1**
Lakes	—	—	—	38	—	—	—	—	—	38		**1**
Streams (Intermittent)	—	—	—	—	—	9		—	—	9	**8.4**	**<1**
Streams (Perennial)	<1	—	—	—	—	94	<1	—	—	94	**25.4**	**2**
Rivers/Streams (Tidal)	—	—	—	—	—	<1		1	—	1	**0.2**	**<1**
Estuarine (Intertidal)	—	—	—	—	—	—	—	69	—	69		**1**
Estuarine (Subtidal)	—	—	—	—	—	—	—	89	—	89		**2**
Upland	—	—	—	—	—	—	—	—	5,102	5,102		**88**
Total Wetlands and Other Waters (Acres)	**271**	**47**	**15**	**38**	**<1**	**104**	**49**	**162**	**—**	**686**	**34.1**	**12**
Total Area (Acres)	**271**	**47**	**15**	**38**	**<1**	**104**	**49**	**162**	**5,102**	**5,788**		**100**
Total Area (%)	**5**	**1**	**<1**	**1**	**<1**	**2**	**1**	**3**	**88**	**100**		

Notes:
— = not applicable
HGM = Hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019a, i; stream miles included parenthetically.

Table 3.22-17: Alternative 2 Analysis Area—Diamond Point Port Wetland and Other Water Types

NWI Wetland Group	HGM Wetland Type			Total Area (Acres)	Total Length (Miles)	Total Area (%)
	Riverine Channel	Coastal Fringe	Upland			
Herbaceous	—	1	—	1		**1**
Streams (Intermittent)	2	—	—	2	0.7	**1**
Streams (Perennial)	<1	—	—	<1	0.2	**<1**
Estuarine (Intertidal)	—	8	—	8		**3**
Estuarine (Subtidal)	—	127	—	127		**50**
Upland	—	—	116	116		**46**
Total Wetlands and Other Waters (Acres)	**2**	**137**	**—**	**139**	**0.8**	**54**
Total Area (Acres)	**2**	**137**	**116**	**255**		**100**
Total Area (%)	**1**	**54**	**46**	**100**		

Notes:
— = not applicable
HGM = Hydrogeomorphic
NWI = National Wetland Inventory
Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019a, i

Pile-Supported Dock Variant

This variant would reduce the direct disturbance footprint by 11 acres. The extent of the affected environment for wetlands and other waters is captured in the Alternative 2 analysis area for the Diamond Point port, presented in Table 3.22-17.

3.22.10.4Natural Gas Pipeline Corridor

The Alternative 2 natural gas pipeline corridor includes three main segments: 1) Cook Inlet crossing coming ashore at Ursus Cove; 2) northward to Diamond Point port; and 3) overland to the mine site, following along the port and mine access roads with a stand-alone segment between.

Segments of the natural gas pipeline corridor adjacent to access roads are addressed under the transportation corridor. Stand-alone segments of the natural gas pipeline (i.e., those that are not co-located with road corridors) are addressed here, and include overland stand-alone segments to tie-in to project facilities (44 miles), the Cook Inlet crossing (75 miles), and the Cottonwood Bay crossing (3 miles). The area also encompasses construction access roads to the natural gas pipeline corridor on the northern side of Iliamna Lake.

The natural gas pipeline corridor analysis area under Alternative 2 is 2,419 acres. Uplands represent 70 percent of the analysis area, with the remaining 30 percent of the area comprising wetlands and other waters (Table 3.22-18). Of the wetland types present, the broad-leaved deciduous shrub and herbaceous types are co-dominant at 1 percent each. Both wetland types occur primarily as slope, and secondarily as riverine HGM classes. Of the other water types present, subtidal marine waters are overwhelmingly dominant at 26 percent. A total of 11.6 miles of streams is present in the natural gas pipeline analysis area. Community-level descriptions of wetland types, and the functions and values associated with HGM classes, are presented in the preceding sections.

Table 3.22-18: Alternative 2 Analysis Area—Natural Gas Pipeline Corridor Wetland and Other Water Types

NWI Wetland Group	HGM Wetland Type									Total Area (Acres)	Total Length (Miles)	Total Area (%)
	Slope	Depressional	Lacustrine	Lacustrine Fringe	Riverine Channel	Riverine	Coastal Fringe	Marine	Upland			
Herbaceous	10	1	—	<1	—	4	—	—	—	15		**1**
Deciduous Shrubs	27	<1	—	1	—	3	—	—	—	32		**1**
Evergreen Shrubs	1	—	—	—	—	—	—	—	—	1		**<1**
Deciduous Forest	6	—	—	—	—	<1	—	—	—	6		**<1**
Evergreen Forest	1	—	—	—	—	<1	—	—	—	1		**<1**
Aquatic Bed	—	—	—	—	—	<1	—	—	—	<1		**<1**
Ponds	<1	<1	—	—	—	<1	—	—	—	1		**<1**
Lakes	—	—	14	—	—	—	—	—	—	14		**1**
Streams (Intermittent)	—	—	—	—	1	—	—	—	—	1	2.0	**<1**
Streams (Perennial)	—	—	—	—	13	—	—	—	—	13	9.6	**1**
Estuarine (Intertidal)	—	—	—	—	—	—	7	—	—	7		**<1**
Estuarine (Subtidal)	—	—	—	—	—	—	25	—	—	25		**1**
Marine (Intertidal)	—	—	—	—	—	—	—	1	—	1		**<1**
Marine (Subtidal)	—	—	—	—	—	—	—	618	—	618		**26**
Upland	—	—	—	—	—	—	—	—	1,685	1,685		**70**
Total Wetlands and Other Waters (Acres)	**45**	**2**	**14**	**2**	**14**	**8**	**32**	**618**	**—**	**734**	**11.6**	**30**
Total Area (Acres)	**45**	**2**	**14**	**2**	**14**	**8**	**32**	**618**	**1,685**	**2,419**		**100**
Total Area (%)	**2**	**<1**	**1**	**<1**	**1**	**<1**	**1**	**26**	**70**	**100**		

Notes:
— = not applicable
HGM = Hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019a, i

3.22.11 Alternative 3—North Road Only

The Alternative 3 analysis area is 21,684 acres and includes the direct and indirect footprints for all project components and the Concentrate Pipeline Variant (Table 3.22-19). Wetlands, a special aquatic site, comprise 16 percent of this area; an additional 6 percent of the analysis area is other waters, including 190.4 miles of streams. Quantifiable types of wetlands identified as regionally important and other special aquatic sites represent 1 percent or less of the Alternative 3 analysis area; slope wetlands are the dominant HGM class. The types and HGM classes of wetlands and other waters are summarized by area and presented by project component below.

Table 3.22-19: Summary of Wetlands, Other Waters, Regionally Important Wetlands, Special Aquatic Sites, and HGM Classes by Area for the Alternative 3 Analysis Area

Alternative 3	Area (Acres)	Length (Miles)	Area (%)
Wetlands	3,454	—	16
Other Waters	1,300	190.4	6
Uplands	16,929	—	78
Total Wetlands and Other Waters	4,754	—	22
Total Alternative Analysis Area	21,684	—	100
Special Aquatic Sites			
Wetlands	3,454	—	16
Mudflats	115	—	1
Vegetated Shallows	3	—	<1
Riffle and Pool Complexes	160	156.7	1
Regionally Important Wetlands			
Fens	140	—	1
Forested Wetlands	34	—	<1
Riverine Wetlands	274	—	1
Estuarine Wetlands	3	—	<1
Hydrogeomorphic Classes			
Slope	3,158	—	15
Depressional	167	—	1
Flat	33	—	<1
Lacustrine	64	—	<1
Lacustrine Fringe	11	—	<1
Riverine Channel	193	190.4	1
Riverine	279	—	1
Coastal Fringe	297	—	1
Marine	569	—	3

Notes:
— = not applicable
HGM = Hydrogeomorphic
Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019a, i

3.22.11.1 Mine Site

The mine site analysis area under Alternative 3 is the same as Alternative 1a, a summary of which is presented in Table 3.22-5.

3.22.11.2 Concentrate Pipeline Variant

This variant considers delivery of concentrate to Diamond Point port via a pipeline, and includes an option to construct an additional pipeline to return filtrate to the mine site for reuse. This variant would increase the direct disturbance footprint at the mine site by 1 acre for an electric pump station. Due to the configuration of facilities, this increase does not result in an increase to the Alternative 3 mine site analysis area.

3.22.11.3Transportation Corridor

The Alternative 3 transportation corridor includes the 82-mile north access road from the mine site to a port location north of Diamond Point in Iliamna Bay. This alternative includes a realignment from the Alternative 2 natural gas pipeline corridor around Knutson Bay on Iliamna Lake and a southern crossing of the Newhalen River. The transportation corridor analysis area includes the sections of the natural gas pipeline that are co-located with roads.

The transportation corridor analysis area under Alternative 3 is 8,757 acres. Uplands represent 91 percent of the transportation corridor, with the remaining 9 percent of the area composed of wetlands and other waters (Table 3.22-20). Of the wetland types present, the broad-leaved deciduous shrub type is dominant at 3 percent; herbaceous wetlands are subdominant at 2 percent, and estuarine intertidal habitat represent an additional 1 percent. The broad-leaved deciduous shrub and herbaceous wetland types occur primarily as the slope HGM class, and secondarily as the riverine HGM class, while estuarine intertidal wetlands are exclusively associated with the coastal fringe HGM class. Of the other water types present, estuarine subtidal, lakes, ponds, and perennial streams each represent 1 percent of the analysis area. A total of 54.2 miles of streams is present in the transportation corridor analysis area. Community-level descriptions of wetland types, and the functions and values associated with HGM classes, are presented in the preceding sections.

Concentrate Pipeline Variant

This variant would slightly increase the road corridor width due to the co-location of the concentrate pipeline and the optional return water pipeline in a single trench with the natural gas pipeline. Construction of the concentrate pipeline would increase the average width of the road corridor by less than 10 percent; construction of both the concentrate and water return pipelines would increase the average width of the road corridor by less than 3 feet. The length would be the same as the overland portion of the natural gas pipeline. An intermediate booster station would be sited in a material site along the road alignment. The increase in road alignment width associated with this variant does not result in an increase in the transportation corridor analysis area for Alternative 3, presented in Table 3.22-20.

3.22.11.4Port

Alternative 3 proposes a caisson dock design at a port site north of Diamond Point in Iliamna Bay. Due to the shallowness of Iliamna Bay, dredging would be required at this port location. Bulk concentrate would be lightered by barges out to Handysize bulk carriers at a mooring point in Iniskin Bay. There would not be an alternate lightering location under Alternative 3.

Table 3.22-20: Alternative 3 Analysis Area—Transportation Corridor Wetland and Other Water Types

NWI Wetland Group	HGM Wetland Type									Total Area (Acres)	Total Length (Miles)	Total Area (%)
	Slope	Depressional	Flat	Lacustrine	Lacustrine Fringe	Riverine Channel	Riverine	Coastal Fringe	Upland			
Herbaceous	85	12	11	—	2	—	27	3	—	139		**2**
Deciduous Shrub	229	3	7	—	<1	—	36	—	—	275		**3**
Evergreen Shrub	13	<1	—	—	—	—	—	—	—	13		**<1**
Deciduous Forest	21	—	—	—	—	—	4	—	—	25		**<1**
Evergreen Forest	8	—	—	—	—	—	<1	—	—	8		**<1**
Aquatic Bed	—	1	—	—	—	—	<1	—	—	1		**<1**
Ponds	2	39	—	—	—	<1	5	—	—	46		**1**
Lakes	—	—	—	49	—	—	—	—	—	49		**1**
Streams (Intermittent)	—	—	—	—	—	10	—	—	—	10	11.5	**<1**
Streams (Perennial)	<1	—	—	—	—	117	—	—	—	117	42.5	**1**
Streams (Tidal)	—	—	—	—	—	<1	—	1	—	1	0.2	**<1**
Estuarine (Intertidal)	—	—	—	—	—	—	—	63	—	63		**1**
Estuarine (Subtidal)	—	—	—	—	—	—	—	65	—	65		**1**
Upland	—	—	—	—	—	—	—	—	7,945	7,945		**91**
Total Wetlands and Other Waters (Acres)	**357**	**54**	**18**	**49**	**2**	**128**	**72**	**131**	**—**	**811**	**54.2**	**9**
Total Area (Acres)	**357**	**55**	**18**	**49**	**3**	**128**	**72**	**131**	**7,945**	**8,757**		**100**
Total Area (%)	**4**	**1**	**<1**	**1**	**<1**	**1**	**1**	**1**	**91**	**100**		

Notes:
— = not applicable
HGM = Hydrogeomorphic
NWI = National Wetland Inventory
Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019a, i

The port analysis area under Alternative 3 comprises 160 acres of relatively undisturbed habitat in Iliamna Bay. There is a quarry at Diamond Point, and the Williamsport-Pile Bay Road terminates at the head of Iliamna Bay. Coastal habitats in the Alternative 3 port analysis area include sand and pebble substrates interspersed by rocky reefs and mudflats. Eelgrass beds are not known to occur in the Alternative 3 port analysis area (see Section 3.24, Fish Values). Initial and maintenance dredging would be required over 76 acres of estuarine habitat; dredged material would be stored in one of two facilities in uplands along the port access road. Both the areas of dredging and dredged material storage facilities are included in the port analysis area.

Uplands represent 42 percent of the port analysis area, with the remaining 58 percent of the area composed of wetlands and other waters (Table 3.22-21). Estuarine waters are the dominant habitat type at 57 percent, and are exclusively associated with the coastal fringe HGM class. A total of 0.4 mile of streams is present in the port analysis area. Community-level descriptions of wetland types, and the functions and values associated with HGM classes, are presented in the preceding sections.

Concentrate Pipeline Variant

This variant would require concentrate handling, dewatering, and treatment facilities at Diamond Point port. Port operations would change due to the requirements of dewatering the concentrate, storing water and concentrate, and treating and discharging the filtrate water; however, the overall footprint of the port is only expected to increase by less than 1 acre (approximately 0.3 acre); attributed to the placement of three caissons in the dredge basin to provide mooring and loading for concentrate lightering barges. This increase in the marine facility footprint does not result in an increase in the port analysis area for Alternative 3, as presented in Table 3.22-21.

3.22.11.5Natural Gas Pipeline Corridor

The Alternative 3 natural gas pipeline corridor analysis area would follow the entire north road access route from the port to the mine site. Relative to Alternative 2, this co-location with the road places much of the natural gas pipeline in the transportation corridor analysis area. Stand-alone segments of the natural gas pipeline (i.e., those that are not co-located with road alignments) are addressed here and include overland stand-alone segments to tie-in to project facilities (8 miles), the Cook Inlet crossing (75 miles), and the Cottonwood Bay crossing (3 miles). The Alternative 3 natural gas pipeline corridor analysis area includes intertidal estuarine habitat in Cottonwood Bay, the unvegetated portions of which are considered mudflats, a special aquatic site.

The natural gas pipeline corridor analysis area under Alternative 3 is 830 acres. Uplands represent 22 percent of the analysis area, with the remaining 78 percent of the area consisting of wetlands and other waters (Table 3.22-22). Of the wetland types present, the broad-leaved deciduous shrub and intertidal estuarine habitat are co-dominant at 1 percent each. Of the other water types present, subtidal marine waters are overwhelmingly dominant at 69 percent. A total of 2.9 miles of streams is present in the natural gas pipeline analysis area. Community-level descriptions of wetland types, and the functions and values associated with HGM classes, are presented in the preceding sections.

Table 3.22-21: Alternative 3 Analysis Area—Port Wetland and Other Water Types

NWI Wetland Group	HGM Wetland Type					Total Area (Acres)	Total Length (Miles)	Total Area (%)
	Flat	Riverine Channel	Riverine	Coastal Fringe	Upland			
Deciduous Shrubs	<1	—	<1	—	—	1		**<1**
Streams (Intermittent)	—	1	—	—	—	1	0.3	**<1**
Streams (Perennial)	—	<1	—	—	—	<1	0.1	**<1**
Estuarine (Intertidal)	—	—	—	<1	—	<1		**<1**
Estuarine (Subtidal)	—	—	—	92	—	92		**57**
Upland	—	—	—	—	67	67		**42**
Total Wetlands and Other Waters (Acres)	**<1**	**1**	**<1**	**92**		**93**	**0.4**	**58**
Total Area (Acres)	**<1**	**1**	**<1**	**92**	**67**	**160**		**100**
Total Area (%)	**<1**	**1**	**<1**	**57**	**42**	**100**		

Notes:
— = not applicable
HGM = Hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019a, i

Table 3.22-22: Alternative 3 Analysis Area—Natural Gas Pipeline Corridor Wetland and Other Water Types

NWI Wetland Group	HGM Wetland Type							Total Area (Acres)	Total Length (Miles)	Total Area (%)
	Slope	Depressional	Riverine Channel	Riverine	Coastal Fringe	Marine	Upland			
Herbaceous	1	—	—	<1	—	—	—	1		**<1**
Deciduous Shrubs	4	—	—	<1	—	—	—	4		**1**
Ponds	<1	<1		—	—	—	—	<1		**<1**
Rivers/Streams (Intermittent)	—	—	<1	—	—	—	—	<1	0.5	**<1**
Rivers/Streams (Perennial)	—	—	2	—	—	—	—	2	2.4	**<1**
Estuarine (Intertidal)	—	—	—	—	6	—	—	6		**1**
Estuarine (Subtidal)	—	—	—	—	67	—	—	67		**8**
Marine (Intertidal)	—	—	—	—	—	1	—	1		**<1**
Marine (Subtidal)	—	—	—	—	—	569	—	569		**69**
Upland	—	—	—	—	—	—	180	180		**22**
Total Wetlands and Other Waters (Acres)	**5**	**<1**	**2**	**1**	**74**	**569**		**650**	**2.9**	**78**
Total Area (Acres)	**5**	**<1**	**2**	**1**	**74**	**569**	**180**	**830**		**100**
Total Area (%)	**1**	**<1**	**<1**	**<1**	**9**	**69**	**22**	**100**		

Notes:
— = not applicable
HGM = Hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019a, i

3.22.12 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. Wetland trends observed in the Bristol Bay region are attributed in recent publications to warmer and wetter conditions, including rapid tree growth and expansion, new coastal wetlands, and changes in phenology (i.e., the 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 low ericaceous shrub environment in the vicinity of the project area have been replaced by alder and willow shrub (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 et al. 2014). However, in some places, lakes are becoming larger as a result of lateral permafrost degradation (Roach et al. 2011). Future permafrost thaw would 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). Wildland fires with burn intensities and depths capable of consuming vegetation and peat have the potential to significantly alter wetland function and hydrology.

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, because it seems unlikely that the projected increased precipitation would exceed evapotranspiration over the longer thawed periods (Hassol 2004). Overall, Alaska is likely to experience lower overall land coverage in wetlands and likely an increase in forested wetlands relative to more herbaceous types (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.