4.14 SOILS

This section describes potential impacts on soils resulting from each project component for all alternatives and variants. Mitigation and control measures would incorporate structural and non-structural best management practices (BMPs) to address erosion and stormwater runoff. The evaluation also assumes that activities would be performed in accordance with prepared water management and sediment control plans, and necessary Alaska Department of Environmental Conservation (ADEC) permits (if issued) and stormwater pollution prevention plans (SWPPPs). This includes typical or standard practice activities and BMPs when none are specified in project documents (see Chapter 5, Mitigation).

The Environmental Impact Statement (EIS) analysis area for soils includes all areas that would be disturbed as a result of the project, and addresses all alternatives, components, and variants. Disturbed areas would include locations of removal or subsequent placement of soil.

The impact analysis considered the following factors: magnitude, duration, geographic extent, and potential:

- Magnitude – impacts are assessed based on the magnitude of the impact, as indicated by the quantified amount of soil resources expected to be affected (e.g., cubic feet or tons affected).
- Duration – impacts are assessed based on the duration of effects on soil resources (e.g., short-term, long-term, or permanent). Short-term effects are considered to be those impacts occurring only during construction and operations phases; long-term effects are considered to be those impacts extending into closure; and permanent effects are considered to be those impacts extending indefinitely into post-closure, with no restorative actions planned.
- Geographic extent – impacts are assessed on the location and distribution of occurrence of the expected effects on soil resources (e.g., mine site footprint).
- Potential – impacts are assessed based on the potential likelihood of an effect to soil resources occurring as a result of the proposed alternatives.

All three alternatives would result in a similar magnitude and duration of and potential for impacts related to soils. The primary difference between the alternatives would be the amount of soils that would be affected.

There were no scoping comments that addressed specific concerns regarding the impact of the project on soils.

4.14.1 No Action Alternative

Under the No Action Alternative, the Pebble Project would not be undertaken. No construction, operations, or closure activities would occur. Therefore, no additional future direct or indirect effects on soils would be expected. Though no resource development would occur under the No Action Alternative, permitted resource exploration activities currently associated with the project may continue (ADNR 2018-RFI 073). Pebble Limited Partnership (PLP) would have the same options for exploration activities that currently exist. In addition, there are many valid mining claims in the area and these lands would remain open to mineral entry and exploration. It is possible for permitted exploration to continue under this alternative (ADNR 2018-RFI 073), which could include borehole drilling and sampling.

PLP would be required to reclaim any remaining sites at the conclusion of their exploration program. If reclamation approval is not granted immediately after the cessation of reclamation activities, the State may require continued authorization for ongoing monitoring and reclamation work as deemed necessary by the State of Alaska. Soils along the transportation corridor, natural gas pipeline corridor, and at the port sites would remain in the current state. There would be no effects on existing soils in the areas of these components. In summary, there would be no direct or indirect impacts on baseline soil conditions from implementation of the No Action Alternative.

4.14.2 Alternative 1 – Applicant's Proposed Alternative

Impacts to soil resources from Alternative 1 would include those related to soil disturbance and erosion. Soil quality is also evaluated for the mine site due to potential fugitive dust impacts from sources of concern. Factors used to evaluate soil impacts include soil type and area of disturbance; erosion based on BMPs and foreseeable control measures using common industry practices; planned reclamation and objectives; and anticipated effects on soil quality based on planned project activities. Chapter 5 discusses PLP's proposed mitigation measures that have been incorporated into the project.

Evaluation of soil impacts assumes that sediment control measures, BMPs, and adaptive control strategies would be established in a water management and sediment control plan prepared prior to construction and operations; and that proposed earthwork would sufficiently meet necessary conditions required under the Alaska Pollutant Discharge Elimination System program (APDES) for approval of an ADEC Clean Water Act (CWA) Section 402 Stormwater Construction and Operation Permit, and a Stormwater Discharge Pollution Prevention Plan prior to construction. Discharge of pollutants from construction would be addressed under an APDES Construction General Permit (CGP) for disturbances of at least 1 acre of land. The CGP requires establishing authorized stormwater and non-stormwater discharges, including those that are not authorized. A permittee is required to contain runoff from exposed soils to minimize erosion and sediment transport. The CGP also requires established conditions that meet water quality standards through operator control measures. The CGP would be required prior to project start, and would include filing a signed Notice of Intent and SWPPP to ADEC. The SWPPP would be prepared by an ADEC-qualified person, and would establish sources of pollutants and how control measures would be implemented to meet permit standards. The SWPPP also requires establishing inspection-related criteria; how corrective actions are addressed; and permit eligibility related to endangered species. Additional information and reference to applicable requirements are provided in the ADEC APDES CGP-Final, Permit No. AKR100000 (ADEC 2016); Alaska Storm Water Guide (ADEC 2011); and Alaska Department of Transportation and Public Facilities (ADOT&PF) Best Management Practices for Erosion and Sediment Control (ADOT&PF 2016). To be issued, the requirements of all of these permits must be met.

Other agencies that may require additional considerations related to upland soils include the Alaska Department of Natural Resources (ADNR) for an Approved Pipeline Right-of-Way (ROW) Permit; the ADOT&PF for a Utility Permit on ROW; Kenai Peninsula Borough; and US Army Corps of Engineers (USACE) Section 404/10 Permit.

4.14.2.1 Mine Site

This section describes potential effects on soils at the mine site from construction through closure and post-closure management.

Soil Disturbance

The magnitude and extent of impact would be the disturbance of approximately 8,086 acres of soil at the mine site. The majority of the extent of the impact would be soils associated with soil map unit IA9 (5,755 acres), with the remaining disturbance associated with soil map unit IA7. The total acreage of soil disturbances includes major earthworks and the duration of the impact would occur be long term over the 4-year construction period, and mine site operations up to closure. The total acreage estimate does not include reclamation of various mine site infrastructure that would be partially restored, or reduced soil disturbances during the closure period. These impacts to soil at the mine site would be certain to occur if the project is permitted and built as described for Alternative 1.

Mine site facilities not required for post-closure activities would be reclaimed in accordance with an ADNR-approved reclamation plan per Alaska Reclamation Act requirements; and mining reclamation regulations per Alaska Statute (AS) 27.19 and 11 Alaska Administrative Code (AAC) 97. The reclamation performance standard is the adequate reclamation of disturbed areas from mining operations, and to leave the site in a stable condition; or reestablishment of renewable resources on the site within a reasonable period of time by natural processes.

Facilities that would be reclaimed include the pyritic tailings storage facility (TSF), bulk TSF, overburden stockpiles, milling and processing facilities, and non-essential roads. Progressive reclamation of the seepage recovery systems, main water management pond, and water treatment plants would be performed in post-closure. With the exception of overburden stockpiles, all reclamation would occur after operations have ceased. Mine site infrastructure that would not undergo reclamation includes the open pit (approximately 608 acres); mine water treatment plants (approximately 27 acres); power generation facilities (approximately 22 acres); inert monofill (approximately 9 acres) in the disturbed footprint; quarry sites (approximately 873 acres); and limited camp, storage facilities, and access roads. The magnitude and duration of post-closure impacts would be that a total of approximately 1,500 acres would not be reclaimed, and would result in permanent disturbances to existing soil conditions.

Although soil conditions underlying the TSF footprints would result in permanent soil disturbances, each would be reclaimed to conform to designated post-mining land use, as administered by the ADNR. The liner below the pyritic TSF would be removed, and bermed structures would be recontoured. This would be followed by application of salvaged growth media and surface restoration. The bulk TSF would remain in place after controlled dewatering and dry closure, resulting in a permanent landform. The bulk TSF surface would be graded and contoured as needed for drainage control. Growth media would be added for seeding and revegetation, including the embankments.

Summary of Soil Disturbance Impacts

Indirect soil disturbance impacts are most likely to be associated with erosion and stormwater sediment transport processes, and are evaluated under erosion.

Soil Quality

The magnitude and extent of project effects on soil quality would be the wet and dry deposition of fugitive dust derived from mine site sources, including mining operations in the pit (e.g., drilling and blasting); material transport, storage, processing, and handling (including ore, waste rock, concentrate, and aggregate); and wind erosion of exposed bulk tailings. This deposition would be long-term, lasting from construction through the life of the project, and would be certain to occur if the project is permitted and built. The cumulative deposition (i.e., loading) of dust throughout construction and operation were evaluated for the potential to impart an adverse change to surface soil chemistry. Dust deposition effects on water quality are discussed in Section 4.18, Water and Sediment Quality.

Fugitive Dust Constituents of Concern

Total potential criteria pollutant and hazardous air pollutant (HAP) emissions were calculated for the mine site and other project components assuming that each emission unit was operated continuously unless otherwise noted (PLP 2018-RFI 007). Annual fugitive particulate matter (PM) emissions were calculated based on conservative scenarios that assumed worst-case conditions for each activity or source component, such as peak ore crushing capacity, maximum ore hauling distance from final pit, and maximum waste rock hauling.

Of the 189 HAPs listed in the 1990 Clean Air Act Amendment and 40 Code of Federal Regulations (CFR) Part 63, applicable metals from fugitive sources were further evaluated for incremental increase over the 20-year operations period (Table 4.14-1). Hydrocarbons, anions, and cations are not considered compounds of concern from fugitive dust emissions.

Table 4.14-1: Calculated Mine Site Post-Dust Deposition Metal Concentrations in Soil

Analyte	Baseline Mean[1] (mg/kg)	Post-Dust Deposition			Comparative Action Levels	
		Incremental Increase over 20 Years (mg/kg)[2,3]	Baseline + 20 Years of Dust Deposition	Percent Increase after 20 Years	Human Health[4] (mg/kg)	Migration to Groundwater[4] (mg/kg)
Antimony	0.24	0.0075	0.25	3.04%	33	4.6
Arsenic	**10.2**	0.0589	**10.3**	0.57%	7.2 (inorganic)	0.2
Beryllium	0.41	0.00213	0.412	0.52%	170	260
Cadmium	0.24	0.00173	0.242	0.72%	76 (diet)	9.1
Chromium (total)	17.7	0.0733	17.77	0.41%	1.0×10^5 (Cr^3)	1.0×10^5 (Cr^3)
Cobalt	6.55	0.0195	6.57	0.30%	--	--
Lead	8.74	0.0205	8.76	0.23%	400	--
Manganese	388.0	0.693	388.69	0.18%	--	--
Mercury	0.120	0.00013	0.120	0.11%	3.1 (elemental)	0.36
Nickel	9.16	0.0176	9.18	0.19%	1,700 (soluble salts)	340
Selenium	2.76	0.00753	2.77	0.27%	410	6.9

Notes:
[1] 3PPI 2011a
[2] Based on PLP 2018-RFI 009 total HAPs concentration in dust and EPA 2005.
[3] Assumptions include life of mine (20 years) deposition period, soil mixing zone of 2 centimeters, and bulk soil density of 1.5 grams per cubic centimeter based on USGS estimate for silty soils (NRCS 2018; EPA 2005).
[4] ADEC 18 AAC 75, Oil and Other Hazardous Substances Pollution Control, September 29, 2018, Table B1. Method Two – Soil Cleanup levels, Human Health, Over 40 Inch Zone, and Migration to Groundwater (ADEC 2017a).
mg/kg = milligrams per kilogram-- No available reference value per ADEC 18 AAC 75. Additional human health evaluation of all HAP metals is provided in Section 4.10 (Health and Safety) based on published EPA Regional Screening Levels (RSLs).

Dust Deposition on Soils

Figure 4.14-1 depicts result of modeling dust deposition at the mine site during operations.

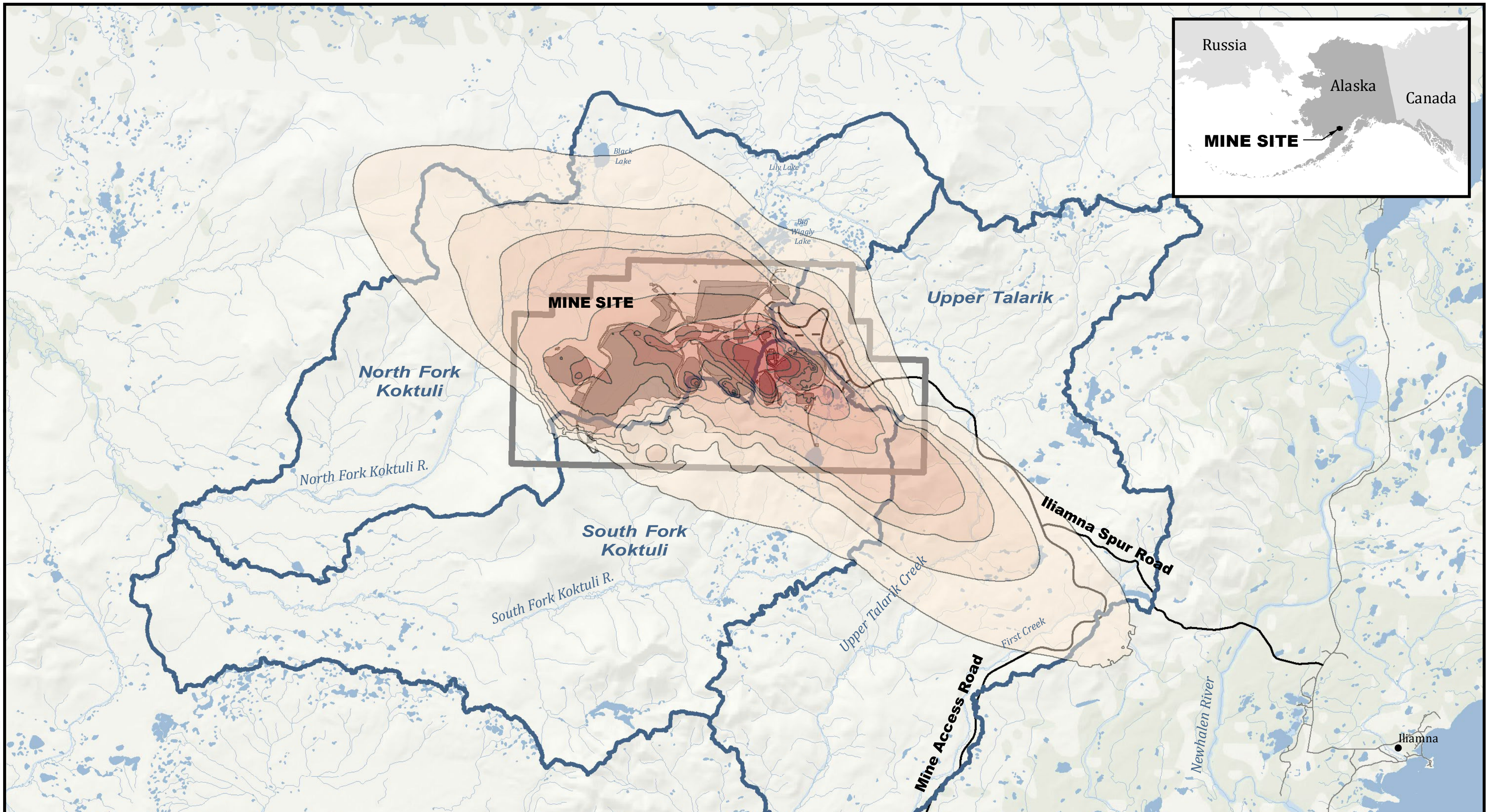
Potential increase in metal concentration in the top 1 inch of soil at the mine site was estimated using AERMOD modeling data for airborne metals concentrations and dust deposition (PLP 2018-RFI 009). The EPA defines ambient air as the portion of the atmosphere, external to buildings, to which the general public has access (40 CFR Part 50.1 [e]). Airborne metal concentration was modeled along the mine site ambient air boundary to determine the maximum cumulative concentration of metals bordering the ambient environment. Extrapolating from the upper-bound airborne concentration, dust deposition was modeled by calculating deposition values for metals (PLP 2018-RFI 009). The incremental increase in metals concentration in mine site soil over the 20-year mine life was calculated using the following formula (EPA 2005):

$$Cs = 100t_D * \left(\frac{D}{Z_S * B_D}\right)$$

Where: C_s is the average soil concentration over the exposure duration (milligrams [mg] constituents of potential concern [COPC] per kilograms [kg] of soil); D is the yearly dry deposition rate (in grams COPC per square meter per year [g COPC/m^2-yr]); t_D is the time period over which deposition occurs (in years); Z_S is the soil mixing zone depth (in centimeters [cm]), B_D is the soil bulk density (grams per cubic meter [g/cm^3]), and 100 is a unit conversion factor. The expected constituent soil concentration after the 20-year mile life due to operational dust deposition was calculated by adding the incremental increase to baseline soil concentrations provided in Appendix K3.14. Calculated results are summarized in Table 4.14-1.

The calculated percent increase in HAP metals from 20 years of dust deposition at the mine site would not be considered of sufficient magnitude to have an adverse impact on surface soils relative to baseline conditions and ADEC action levels used for purposes of comparative evaluation. The greatest percent increase in baseline metals concentration (3.04 percent) is associated with antimony, although the concentrations with dust are still below ADEC levels. All calculated percent increase of other HAP metals were all below 1 percent. With the exception of arsenic, all evaluated metals were well below ADEC levels. The presence of naturally occurring arsenic above the ADEC level is readily apparent, with a reported mean of 10.2 milligrams per kilogram (mg/kg). For these reasons, the incremental arsenic increase of 0.57 percent from fugitive dust in surface soils is considered negligible relative to baseline conditions and documented presence of elevated concentrations in soils throughout the state. The natural occurrence of elevated chromium and arsenic concentrations in soil is acknowledged in ADEC Technical Memorandum, Arsenic in Soil, dated March 2009; and notes 11 and 12 of Table B1 (ADEC 2013d).

Similar to arsenic, elevated baseline concentrations of total chromium are present at the mine site, but well below the ADEC action level for trivalent chromium. Because there are no anthropogenic sources of hexavalent chromium (Cr^{6+}), nor are mineral assemblages considered favorable for Cr^{6+} genesis (e.g., chromite), no further evaluation was conducted. Additional human health evaluation of all HAP metals based on published EPA Regional Screening Levels (RSLs) is provided in Section 4.10, Health and Safety, and includes metals for which no ADEC reference value is shown in Table 4.14-1.



Sources: PLP 2018-RFI009a

Average annual PM_{10} deposition ($g/m^2/yr$)

0.3 - 0.5
0.5 - 0.7
0.7 - 0.9
0.9 - 2.0
2.0 - 4.0
4.0 - 6.0
6.0 - 8.0
8.0 - 10.0
10.0 - 20.0
> 20.0

Alternative 1

Natural Gas Pipeline
Transportation Corridor
Mine Site
Ambient Air Quality Boundary

Other Features

Local Roads
Major Drainage Boundary

US Army Corps of Engineers

2 0 2 4
Miles

DUST DEPOSITION DURING MINE SITE OPERATIONS

PEBBLE PROJECT EIS

FIGURE 4.14-1

Dust Control

The project design incorporates a number of measures to minimize fugitive dust. Coarse ore would be stockpiled in a covered steel-frame building to minimize dust emissions. Baghouse-type dust collectors would be present at each conveyor-fed ore transfer point between the coarse ore stockpile and semi-autogenous grinding (SAG) ("ball") mills. Water would be added during operations at the SAG mill to suppress dust. Specialized bulk cargo containers equipped with removable locking lids would contain thickened concentrates for transport to Amakdedori port.

The pyritic tailings and potentially acid-generating (PAG) waste would be stored sub-aqueously during operations, removing the potential for wind erosion and dust dispersion from sources with elevated metals concentrations. The bulk TSF would have tailings beaches, which would be susceptible to wind erosion and fugitive dust emissions throughout operations. The bulk TSF would eventually be reclaimed through contouring of surfaces and application of growth media for revegetation and surface stabilization, eliminating the beaches as a dust source following closure activities.

Erosion

The duration and extent of impacts from hydraulic erosion under planned conditions at the mine site would be during the year-round construction phase, coinciding with the longest period of soil disturbances. The magnitude of the impact of removing vegetative matting would be the exposure of fine-grained silty loam—volcanic ash mixtures in shallow surface soils (less than 30 inches deep) that are susceptible to water and wind erosion. Deeper soils consisting of coarser-grained glacial till and colluvium mixtures would be comparatively less susceptible to erosion. Much of the finer-grained (i.e., shallow) soil mixtures exposed during construction would be removed due to undesirable engineering properties (e.g., loading and compaction) required for infrastructure construction, and placed in salvaged growth media stockpiles.

Wind and hydraulic erosion is not anticipated to occur when soils are frozen during winter. Frozen soil conditions generally occur between 4 and 5 months per year (Hoefler 2010a). The greatest potential for hydraulic erosion would be during rainfall events that typically occur during the fall. Soil susceptibility to wind erosion is influenced by moisture and particle size. Wind-induced erosion would be comparatively less than hydraulically driven processes in the construction phase, due to seasonal meteorological conditions and cohesive forces associated with soil moisture. A soil matrix composed of larger grains is less capable of retaining moisture, but less susceptible to wind transport. Although finer-grained soils are generally less tolerant to wind erosion, they are more capable of retaining cohesive moisture. Moisture is anticipated to minimize wind erosion of finer-grained surface soils for most of the year; however, the potential for erosion would be greatest during drier periods lasting 1 to 2 months during the summer.

All runoff water that comes in contact with mine site facilities, or is derived from the open pit, would be captured, including any entrained sediment in runoff from erosion. A Water Management Plan has been developed, and includes water treatment options and strategic discharges of treated water (PLP 2018-RFI 019). A sediment control plan would address construction runoff and associated sediment control measures, BMPs, and adaptive control strategies.

Water management structures (e.g., berms, channels, collection ditches) would be designed to accommodate a 100-year, 24-hour rainfall event. Sediment control ponds would be designed to treat a 10-year, 24-hour rain event, and safely accommodate a 200-year, 24-hour rainfall event. Mine site water management infrastructure would include freshwater diversion channels, an open pit water management pond (WMP), the main WMP, the bulk and pyritic TSFs, the bulk

TSF main embankment seepage collection pond (SCP), seepage collection and recycle ponds, sediment ponds, and two water treatment plants. Water management design criteria and structure configurations are further discussed in Section 4.16, Surface Water Hydrology; and in the Operations Water Management Plan (Knight Piésold 2018a).

During construction, runoff upgradient of the TSFs would be intercepted by a cofferdam and released at a discharge point downgradient of all construction activities in the same watershed. Runoff from the TSF embankments during construction would also be captured. Similarly, runoff from larger excavations associated with the construction of long-term infrastructure (e.g., process plant, camps, power plant, and storage areas) would be routed to settling ponds prior to discharge. During operations, comparatively less soil erosion from water would occur because of diminished need for soil removal. Non-contact runoff would be captured in engineered diversion channels and discharged downgradient. In addition, completed construction of most long-term infrastructure would coincide with established water management and sediment control plan measures. Stormwater runoff from mine facilities that only requires sediment removal would be captured in sediment ponds, treated, and discharged under general APDES stormwater permits. Mine site drainage surface water that comes in contact with infrastructure would be diverted to water treatment plants for processing prior to discharge. Although water and sediment control during the operations phase would emphasize contact water minimization and management, runoff and sediment control measures would continue to be managed through BMPs and adaptive control strategies per the SWPPP(s). Reduction in water management during operations would be limited to concurrent reclamation of overburden stockpiles.

The magnitude, extent and duration of impacts from planned management of slurried tailings delivered to the bulk TSF would be the transport of dried, fine-grained tailings materials through wind erosion during operations. Bulk tailings would be pumped and discharged through spigots along the interior of the perimeter cell, with the slurry preferentially discharged to maintain an exposed tailings beach between the TSF embankment and supernatant pond. Although this approach minimizes potential risks associated with seepage effects on embankment stability, the fine tailings (e.g., beaches) would be susceptible to wind erosion when dried. Additional information regarding fugitive dust derived from the bulk TSF is presented in the Soil Quality discussion for the mine site.

The mine site would be reclaimed per an ADNR-approved reclamation plan that establishes requirements for designated post-mining land use. The reclamation plan would supplement or describe measures to control and mitigate erosion at the mine site through the post-closure period. Erosion during closure would be less than during construction, primarily because of comparatively less surface disturbances. Erosion would be greater during closure than operations because of reclamation earthwork required during closure. The magnitude of the impacts from reclamation would be the destabilization of large soil surface areas from decommissioning activities. Earthwork associated with the preparation and application of growth media would likely result in erosion until surface stabilization is achieved. At a minimum, similar measures established for construction in the sediment control plan would address runoff through sediment controls and BMPs. Additional measures may include future developments in available technologies or practices, and refined adaptive control strategies acquired throughout operations. Removal and reclamation of long-term water management infrastructure would progressively coincide with surface stabilization objectives established in the ADNR-approved reclamation plan.

The duration of impacts from erosion during reclamation from destabilized surfaces would likely continue for several years beyond closure. Prescribed design standards for reclaimed infrastructure and monitoring requirements would be established in the reclamation plan.

Continued monitoring would be required to implement any erosional control maintenance or adaptive control measures. Prescribed monitoring would likely occur annually until surface conditions are stabilized, and meet land use objectives. Although reclaimed infrastructure would be designed to withstand anomalous storm events (e.g., 100-year, 24-hour rain event), monitoring would be necessary immediately after any occurrence.

4.14.2.2 Amakdedori Port

This section describes potential effects on shore-based, upland soils at the Amakdedori port site during construction through closure. Offshore sediment impacts resulting from intertidal and open-water construction, operations, and closure of marine facilities are discussed in Section 4.18, Water and Sediment Quality.

Soil Disturbance

No current development exists at the Amakdedori port site. Shore-based soil disturbances would mostly be attributed to construction of the terminal and airstrip. The magnitude and extent of impact would be the disturbance of approximately 20 acres of soil at the Amakdedori port site. This magnitude of soil disturbances at the port would include the complete removal of soil cover at the terminal during construction and placement of engineered fill at the terminal. The duration of these disturbances would be long term to permanent and the impact would be certain to occur if the project is permit and the port is built. Because no construction would be required during operations, subsequent disturbances to soil would likely be limited. With the exception of necessary infrastructure to support shallow-draft tug and barge access to the dock, onshore port facilities would be removed during closure. No additional soil disturbances are anticipated during closure, and restoration of post-disturbance soil conditions would occur through reclamation activities (e.g., scarification, growth media, contouring, and seeding).

Soil Quality

Materials sites for engineered fill are well outside the Pebble deposit, and field review has not identified PAG rock at any of the road material sites. If PAG material were to be identified at a site evaluation prior to use, the material site would be moved (PLP 2018-RFI 035). Furthermore, coarse-grained, engineered fill textures would be less susceptible to erosion or fugitive dust generation, which would be suppressed through watering (PLP 2018-RFI 007). Therefore, engineered fill or locally sourced materials at the port site are not expected to introduce chemical impairments to soils.

The most probable source/activity of soil quality impairment would be concentrate handling. Sealed bulk containers would be emptied offshore in the hold of bulk carriers (i.e., ship), at a depth of no less than 20 feet below the hatch (PLP 2018-RFI 007). The calculated magnitude of total fugitive particulate matter generated on a yearly basis during offshore transfers is 0.002 ton per year (4 pounds). For these reasons, the magnitude and potential of soil quality impact from project activities at the port are considered negligible, and unlikely to impact soil quality in upland conditions. The geographic extent of soil quality impacts (if any) would be confined to the immediate port footprint, of which the duration would be predominantly limited to the construction and operations phases.

Erosion

Water- and wind-induced erosion would occur at the port site throughout construction, and to a limited extent during operation and closure. The potential for soil erosion would be greatest during the initial construction phase.

Earthwork during construction would incorporate erosion control measures specified in an approved SWPPP. Typical measures may include silt fences, hay bales, temporary sedimentation basins; and repurposed brush for berms and watering for dust suppression. BMPs may include crowning or in-sloping of running surfaces; and temporary drainage channels, berms, and catchment basins.

Hydraulic erosion during operations would be comparatively less than during construction due to little additional soil removal and effects of established SWPPP design features (e.g., culverts, swales). Erosion during closure would be less than during construction, but likely greater than during operations. Exposed ground surfaces at sites of removed infrastructure not required for post-closure would be susceptible to wind and water erosion for an interim period until reclamation and restoration activities are completed. The potential for erosion would be mitigated using measures similar to those described for construction.

4.14.2.3 Transportation Corridor

This section describes potential effects on soils along the transportation corridor. Impacts associated with the natural gas pipeline are also included in this section, because the pipeline would be buried in the road prism.

Soil Disturbance

Approximate soil disturbance acreages associated with the proposed transportation corridor include the following:

- Port Access Road – 408 acres
- Mine Access Road – 346 acres
- Kokhanok Airport Spur Road – 15 acres
- Iliamna Spur Road – 119 acres
- Water extraction site access roads – 4 acres (approximate)
- Ferry Terminals – 27 acres
- Material Sites – 241 acres total

Material Sites

The magnitude of disturbances would include the complete removal and segregation of surface soils and overburden materials considered unsuitable for construction purposes. The duration of the disturbance would be long term lasting through the life of the project, but these materials would be salvaged for future reclamation as a growth medium. These impacts on surface soils at material sites would be certain to occur if the project is permitted and constructed as described for Alternative 1. However, mitigation measures described in the following sections and in Chapter 5, Mitigation, would be expected to reduce impacts. Portions of sites no longer used for material extraction would be progressively reclaimed. This would mainly occur after the construction phase, once the bulk demand for materials has been met with infrastructure completion (e.g., roads). Material sites and access roads would continue to be used throughout operations for maintenance of project infrastructure, as needed. Less soil disturbance would occur during operations than during construction, but soil disturbance during operations would be caused by excavation or blasting on an as-needed basis. A need for materials would also persist throughout the post-closure period for continued road maintenance and other limited post-closure needs. Incremental reclamation of disturbance at materials sites would be required. Typical reclamation at gravel material sites would likely include grading and contouring of sidewall slopes; scarification or ripping to promote surface water infiltration and vegetation growth; application of salvaged growth media; and seeding with proposed mixtures as needed. No sidewall reclamation would be conducted at shot-rock material sites with 20-foot bench heights on exposed rock walls.

Soil Quality

Dust from truck traffic and wind erosion of road bed aggregate sourced from materials sites would not be expected to impact chemical concentrations in soils along the access roads. This is because material sites along the access roads are well outside the Pebble deposit; and surface soil conditions associated with the transportation corridor are chemically consistent with those described above and shown in Table 4.14-1 for the mine site study area (SLR et al. 2011a). Metal concentrations in mine site dust were considered to be of insufficient magnitude to have an adverse impact on surface soils. Field review has not identified PAG rock at any of the road material sites. If PAG material were to be identified at a site evaluation prior to use, the material site would be moved (PLP 2018-RFI 035). Therefore, the material sources are not expected to introduce chemical impairments to soil. Transportation of concentrates from the mine site would be in sealed containers with locking lids, and therefore are not expected to be a source of fugitive dust along the roads.

Erosion

Similar to all other project components, stormwater and erosion mitigation and control measures would incorporate structural and non-structural BMPs (PLP 2018d). Wind-induced erosion would be comparatively less than hydraulically driven processes throughout all phases of the project along the transportation corridor, due to seasonal meteorological conditions; physical attributes associated with soil types; infrastructure configuration and construction methods; and planned mitigation. Soils capable of retaining moisture in the project area are generally considered to have a low susceptibility to wind erosion, due to inherent moisture content from periodic precipitation or snowmelt throughout the year. For this reason, the potential for wind erosion would be greatest during drier periods lasting 1 to 2 months during the summer. If necessary, wind erosion can be mitigated through dust-control watering as needed during the summer.

The duration and extent of impacts from hydraulic erosion would be throughout the entire project lifecycle along the transportation corridor; this is evident based on erosion assessments conducted on the existing Williamsport-Pile Bay Road, approximately 30 miles northeast of the port access road. Precipitation events resulting in the greatest erosional losses from surface runoff and flooding generally occur from late September through November. Gently sloping or level transportation infrastructure would be less susceptible to erosional processes. These would include the ferry terminal sites and access roads constructed over glacial fluvial and moraine soil types (Table 4.14-2). Physical conditions more susceptible to hydraulic erosion along the transportation corridor include poorly drained, fine-grained loess or colluvium on sloped topography, waterbody crossings, road prism drainages (e.g., swales), higher-gradient slopes, and sidehill cuts. Approximate access road lengths traversing moderate and rough terrain requiring rock cuts are detailed in Table 4.14-2.

Table 4.14-2: Alternative 1 Road Lengths, Terrain, and Soil Types

Road Segment	Gentle Terrain	Moderate Terrain	Rough Terrain	Approximate Percent Soil Map Unit
Port Access Road	3.9 miles (10%)	9.8 miles (26%)	23.6 miles (63%)	20% (IA72), 80% (IA173)
Mine Access Road	26.7 miles (92%)	2.3 miles (8%)	None (0%)	59% (IA7), 37% (IA94), 4% (HY4)
Iliamna Spur Road	2.9 miles (41%)	4.1 miles (59%)	None (0%)	47% (IA7), 53% (IA9)
Percent Total Access Roads Terrain Type1	46%	22%	32%	

Notes:
[1] Kokhanok airport spur road is not included in the evaluation due to the comparatively short road length and similar conditions to other project access roads.
[2] IA7: Typic Cryandepts – Very gravelly, nearly level to rolling association.
[3] IA17: Dystric Lithic Crandepts – Loamy, hilly to steep association.
[4] IA9: Typic Cryandepts – Very gravelly, hilly to steep association.
[5] HY4: Pergelic Cryofibrists – Nearly level association.
Source: Rieger et al. 1979; PLP 2018

Construction-phase activities that would potentially cause or contribute to erosion include:

- Removal and clearing of vegetation for access roads, material sites, and terminal facilities.
- Overburden clearing and vegetative mat removal for cut and/or fill placement of engineered materials (e.g., aggregate, substrates).
- Overburden management that would include stockpiles or windrows of organic-rich materials and vegetation, or excavated substrates considered unsuitable for infrastructure construction.
- Development of material sites and material site access roads.
- Blasting of bedrock to support roadbed construction.

The magnitude of effects from erosion during construction would vary along project road segments depending on soil types and physical conditions present, seasonal conditions, and construction requirements. The extent of impacts from erosion may be localized at susceptible locations, such as waterbody drainages and crossings (e.g., culverts, bridges, and swales), wetlands, or intermittent sloped topography. Impacts of erosion, though generally expect to only occur during the construction phase, would be long term in that the results of the erosion would be evident until the sites are reclaimed. Broader areas considered more susceptible to runoff and erosion would include continuous segments of road through rough terrain; and to a lesser extent, moderate terrain. These conditions would require steeper roadbed grades and side-hill cuts that could result in greater erosion potential from runoff (i.e., greater energy) and slope failure.

Terrain and substrates along the port access road correspond with conditions that are considered most susceptible to erosion along the corridor. About 63 percent of the port access road would be predominantly constructed over rough, variable terrain (Table 4.14-1), where fine-grained soil types reportedly overlie shallow bedrock. Although conditions along the port access road appear most vulnerable to hydraulic erosion processes, the evaluation is based on generalized soil descriptions provided in the Exploratory Soil Survey of Alaska (ESS), (Rieger et al. 1979), and does not account for local variations in soil conditions or bedrock outcrops where no soil horizon may exist. With the exception of the northernmost 4- to 6-mile portion of the port access road route, blasting will be required for most roadbed construction, supporting the prevalence of shallow bedrock and moderate to rough terrain conditions (PLP 2018-RFI 084).

No rough terrain requiring rock cuts is present along the Iliamna spur road or the mine access road; however, each traverses approximately 59 percent and 8 percent of moderate terrain, respectively. The mine access road would be least susceptible to hydraulic erosion, based on terrain types traversed and soil conditions. Construction methods along the mine access road would require less backslope cuts (i.e., layback), foreslope contouring, and variation in roadbed grade, compared to other access roads. In addition, surficial glacial deposits and gravel fractions in existing soils along the mine access road and Iliamna spur road would be less susceptible to hydraulic erosion, compared to the port access road.

Similar to access roads, the magnitude of effects of hydraulic erosion at material sites would also vary based on source material competency (e.g., shot bedrock or aggregate) and conditions unique to each borrow site location. Construction of material sites and transportation corridor infrastructure would use structural and non-structural BMPs, and employ erosion control measures adequate to satisfy appropriate ADEC discharge permit requirements and coverage under an SWPPP (PLP 2018d).

Ground disturbances would be progressively restored throughout construction until stabilization and restoration are achieved. Most disturbances would likely be stabilized during construction, or several years thereafter, at locations considered less susceptible.

The least erosion would likely occur during operations, when stabilization of disturbed surfaces would be achieved through natural recovery, applied restoration measures, and long-term or permanent stabilization measures. Material sites and access roads would be progressively reclaimed. Typical reclamation BMPs at material sites include benching or sloping of sidewalls to suitable grades, based on material types (e.g., aggregate or bedrock); distribution of salvaged overburden growth media on pit floors and slopes; and tracking and seeding.

Continuous feedback from truck traffic during operations and/or prescribed follow-up inspections would identify areas of acute or persistent erosion. Areas of concern would be identified, and additional or more robust measures applied to meet local site-specific conditions. This would most likely be required along rough terrain associated with the port access road, and/or areas requiring permanent drainage controls (e.g., culverts, bridges, swales).

The magnitude of erosion during closure and post-closure would likely be greater than during operations. Some erosion may be cause by the removal and reclamation of long-term facilities (e.g., ferry terminals) before complete restoration and surface stabilization objectives are met. However, most erosion would likely be associated with permanent roads to the mine site. Monitoring frequencies in post-closure would typically be less than during operations, and there would be reduced access to equipment and resources. Required permanent transportation corridor access would result in an indefinite potential for erosion monitoring and maintenance.

4.14.2.4 Natural Gas Pipeline Corridor

This section describes potential effects on shore-based upland soils from pipeline infrastructure on the eastern side of Cook Inlet. Pipeline impacts for segments of the pipeline coincident with the transportation corridor are addressed above. The magnitude and extent of impact would be the disturbance of approximately 35 acres of soil associated with onshore stand-alone segments of pipeline under this alternative (i.e., western side of Cook Inlet); these soil types are common to the transportation corridor. Impacts would be short term during construction and would be expected to occur if the project is permitted and the gas pipeline is built. Pipeline activities resulting in disturbances to wetlands and submerged ocean and lake sediment are detailed in Section 4.22, Wetlands and Other Waters/Special Aquatic Sites, and Section 4.18, Water and Sediment Quality, respectively.

Soil Disturbance

The magnitude of acreage of shore-based soil disturbances from pipeline infrastructure on the eastern side of Cook Inlet is approximately 5 acres. This would include the compressor station, laydown area, access road, metering pad, and horizontal directional drilling (HDD) work area.

Erosion

Similar to other project components, mitigation and control measures would incorporate structural and non-structural BMPs to address erosion and stormwater runoff (PLP 2018d). The topography associated with the pipeline infrastructure on the eastern side of Cook Inlet is gently sloping or nearly level. Silty loam soils associated with these conditions are considered not be susceptible to erosion by water, but are vulnerable to erosion by wind, assuming the top cover is removed. Use of HDD would provide a sufficiently wide setback distance between the project footprint and Cook Inlet bluff (about 200 feet); project activities are not expected to contribute to ongoing natural erosion in this area (Section 3.15, Geohazards).

4.14.2.5 Alternative 1 – Summer-Only Ferry Operations Variant

This variant would require an increase in soil disturbances associated with the construction of designated concentrate container storage areas at the mine site and Amakdedori port. The magnitude and extent of impacts on soil would be the disturbance of approximately 37.5 acres of additional storage area at the mine site, and approximately 27.5 acres at Amakdedori port. The duration of these impacts would be long term, remaining throughout the mine operations, but not permanent, because they would be reclaimed during closure. These disturbances to soil would be certain to occur if the project is permitted and the Summer-Only Ferry Operations Variant is chosen and built.

This variant would also temporally compress road traffic during ice-free months, which could result in a greater potential for hydraulic and wind erosion along the transportation corridor.

4.14.2.6 Alternative 1 – Kokhanok East Ferry Terminal Variant

Despite a shorter transportation route and reduced ferry terminal footprint, the total acreage of soil disturbance under this variant would be greater than Alternative 1. This is attributed to greater material quantities required for road construction. The magnitude of the impact is 125 additional acres of disturbances from material sites. The total acreage of soil disturbance associated with the Kokhanok East Ferry Terminal Variant is approximately 60 acres greater than Alternative 1. These impacts on soils would be long term and would be expected to occur if the project is permitted and the east ferry terminal is built.

Although soil disturbance acreage is greater under this variant, the potential for erosion is likely to be less. A greater potential for erosion is associated with roads relative to material sites. Roads traverse a broader expanse of terrain and soil types (e.g., waterbodies, cross slopes, inclines) that have a greater point source potential for erosion. Roads typically require a greater diversity of erosion control measures. Engineered fill material sites inherently consist of coarser-grained materials (or bedrock) that are less susceptible to hydraulic and wind erosion. Furthermore, sediment runoff is often retained in the footprint of disturbance (e.g., depressions).

4.14.2.7 Alternative 1 – Pile-Supported Dock Variant

A pile-supported dock constructed at Amakdedori port would reduce the volume of fill material needed for dock access/construction; therefore, less surface disturbance is anticipated at material sites. The magnitude of surface disturbance impacts would be less under this Alternative 1 variant; the duration, extent, and potential would be comparable to Alternative 1.

4.14.3 Alternative 2 – North Road and Ferry with Downstream Dams

The following section describes impacts to soil resources under Alternative 2. Infrastructure descriptions, usage, physical reclamation, and closure would be the same as Alternative 1, but would occur at the locations described under this alternative.

4.14.3.1 Mine Site

The bulk TSF dam at the mine site would be constructed using different methods under this alternative (i.e., downstream method with buttress). The magnitude of the impact of this construction method on soils would be an increased impoundment footprint of 162 acres compared to Alternative 1; however, the total increase in additional acreage would be 155 acres. Overall, the duration and extent of impacts to soil from ground disturbances would be comparable to Alternative 1; however, there would be greater impact magnitude based on the increased acreage of disturbance. Erosion impacts would be the same as Alternative 1; however, there would be an increased potential for erosion based on infrastructure build-out.

4.14.3.2 Transportation Corridor

Soil Disturbance

Transportation corridor components under Alternative 2 would also incorporate two ferry terminals on Iliamna Lake, and road access to either the mine or port (i.e., Diamond Point port). The road would bypass all but 5 miles of the existing Williamsport-Pile Bay Road; however, these sections would require upgrades to accommodate larger vehicles. The magnitude and extent of soil disturbance acreages associated with Alternative 2 transportation infrastructure (including the co-located portion of roadbed pipeline) include:

- Mine site access road: mine site to Eagle Bay ferry terminal site – 505 acres / 36 miles
- Port access road: Pile Bay ferry terminal to Diamond Point port site – 209 acres / 18 miles
- Ferry terminal sites – 25 acres
- Material sites and access roads – 422 acres

Although disturbance mechanisms, nature of impacts, and erosion mitigation and control measures during construction, operations, and closure of transportation corridor infrastructure would be comparable to those described under Alternative 1, the overall magnitude of soil disturbance would be less. This is based on a comparatively smaller transportation corridor soil disturbance acreage required under this alternative. The total road length under this alternative would require approximately 37 fewer miles of road compared to Alternative 1. The total footprint of both ferry terminals would also be approximately 1 acre less. The duration and potential of impacts would be comparable to Alternative 1.

Soil Quality

Impacts to soil quality along the transportation corridor under Alternative 2 would be the same as described for the corridor under Alternative 1.

Erosion

Soil types and general terrain descriptors present along the Alternative 2 transportation corridor are summarized in Table 4.14-3. Terrain descriptors are based on the presence of shallow bedrock or terrain requiring blasting to accommodate road construction.

Table 4.14-3: Alternative 2 Approximate Road Terrain and Soil Types

ESS Soil Type	Gentle to Moderate Terrain	Moderate to Rough Terrain
IA7[1]	51% (~27 miles)	6% (~3 miles)
IA9[2]	9% (~4.8 miles)	< 1% (0.36 miles)
RM1[3]	15% (~8 miles)	9% (~4.5 miles)
SO11[4]	8% (~4.3 miles)	2% (~1 mile)
Percent Total Terrain Type[5]	83% (~44.1 miles)	17% (~9 miles)

Notes:
ESS = Exploratory Soil Survey of Alaska (Rieger et al. 1979)
< = less than
[1] IA7: Typic Cryandepts – Very gravelly, nearly level to rolling association.
[2] IA9: Typic Cryandepts – Very gravelly, hilly to steep association.
[3] RM1: Rough Mountainous Land – Steep rocky slopes.
[4] SO11: Humic Cryorthods – Silty volcanic ash over gravelly till, hilly to steep association.
[5] Terrain type classification associated with planned blasting requirements (segments) for road construction.
Source: Rieger et al. 1979; PLP 2018d

A greater proportion of coarse-grained materials is present along the transportation corridor route based on generalized soil descriptions provided in the ESS, whereas the occurrence of finer-grained silt/sand loam mixtures are reportedly less prevalent than Alternative 1 (Table 4.14-3). Therefore, less wind erosion is anticipated under this alternative, based on the prevalence of coarser-grained substrates along the transportation corridor; a comparatively smaller acreage of soil disturbance that would reduce the potential for wind shear on disturbed surfaces; and a reduced vehicle travel distance for dust dispersion. Because the proposed route under this alternative is also lower in elevation than Alternative 1, overall wind-driven forces (e.g., velocity) are also likely to be less. However, this would not preclude occurrence of episodic high wind processes that are commonly associated with valley features present along the port access road.

Most hydraulic erosion mechanisms, nature of impacts, and mitigation and control measures during construction, operations, and closure of transportation corridor infrastructure would be comparable to those described under Alternative 1. Similar to Alternative 1, hydraulic erosion susceptibility under this alternative would be greatest along the southernmost port access road segment.

Heavy precipitation and flooding during fall months have previously resulted in significant hydraulic erosion losses along the Williamsport-Pile Bay Road (USACE 2007a; KPB 2014). Specific conditions that resulted in impassable erosion washout at multiple points along the Williamsport-Pile Bay Road in the fall of 2003 included culvert and bridge crossings, and surface water erosion in drainages aligned adjacent (e.g., swale or ditch) to the road (USACE 2007a).

Although the proposed route is commonly aligned with 5 miles of the existing Williamsport-Pile Bay Road, the remaining roadway would be newly constructed roadway to minimize conditions historically susceptible to erosional processes along the current Williamsport-Pile Bay Road alignment. The southernmost uplands road segment has comparatively fewer cross cuts along toe-slopes in areas of greater vertical relief, and traversed terrain is considered to be more gentle and moderate in character (Table 4.14-3). Rock cuts along the southernmost uplands segment and other discrete segments would require blasting; however, it would be comparatively less than the port access road under Alternative 1. Furthermore, roadway commonly shared with the existing Williamsport-Pile Bay Road would be improved to accommodate large trucks. These improvements would foreseeably account for historical erosion occurrence through road design and condition-specific mitigation and control measures.

Approximately 2.5 to 3 miles of road extending from the Diamond Point port site would follow the coastline of Iliamna Bay. This coastline road segment is considered most susceptible to erosion under all alternatives. The coastal road is situated along the toe-slopes of mountainous terrain, and would likely be subjected to marine-driven processes. The topographic relief immediately adjacent to the road from the port is characteristic of a high-energy environment, where natural hydraulic erosion and slope failure processes are likely to be more prevalent. Portions of roadway along this coastline segment could also be more susceptible to tidal action: ice scour/rafting, storm surge, and wave action. Additional discussion regarding slope failure processes and occurrence are presented in Section 4.15, Geohazards.

In summary, the greatest magnitude of corridor erosion under Alternatives 1 and 2 would occur along the port access routes. Erosion along the port access route under Alternative 2 would likely be less, based on a smaller acreage of soil disturbance and presence of terrain types that are associated with a reduced erosion potential. However, the initial 2 miles of road extending from the port under Alternative 2 could be the most erosion-susceptible segment of road. This nearshore segment of road is unique to Alternatives 2 and 3, and would require enhanced design and mitigation measures to account for the high-energy environment. The duration of these impacts would be long term and they would be expected to occur if Alternative 2 is chosen, and the project is permitted and transportation corridor is built.

4.14.3.3 Diamond Point Port

<u>Soil Disturbance</u>

Soils in the port footprint are reportedly associated with rough mountainous land (RM1) consisting of sparsely vegetated soil over shallow bedrock or stones/boulders. The port terminal facility and dredge material stockpile would result in the soil disturbances. The magnitude of shore-based soil disturbances at Diamond Point port would be approximately 41 acres. The estimated acreage of disturbance includes the footprints of the port terminal facility and uplands disposal of dredged materials (e.g., stockpile). The magnitude of dredge material stockpile footprints would total approximately 16 acres, and would be managed similarly to overburden stockpiles. Dredge stockpiles would include berms to contain sediments, collection of seepage, and stormwater runoff, as well as treatment in settling ponds prior to discharge (PLP 2018-RFI 099). These effects on soils would be long term and certain to occur if Alternative 2 is chosen and the Diamond Point port is permitted and built.

Most soil disturbance mechanisms and impacts during construction, operations, and closure at the port would be similar in magnitude, duration, and extent to those described under Alternative 1; however, disturbances unique to this alternative include the following:

- Blasting of shallow bedrock at discrete locations to accommodate port infrastructure
- Uplands disposal of dredge material

Soil disturbances during construction would involve grading and contouring of ground surfaces, and extensive blasting of shallow bedrock to accommodate port construction. Removal of soil considered unsuitable for construction purposes would be limited due to prevalent shallow bedrock and coarse alluvium outwash. The bermed dredge material stockpile would be built immediately adjacent to the port terminal to receive spoils from dredge channel clearance.

Because no additional construction would be required during operations, soil disturbances during port operations would primarily be limited to dredge material stockpile expansion from maintenance dredging. The magnitude of dredged materials to be stockpiled would be, at a minimum, half of the material dredged for channel construction and maintenance (approximately 325,000 cubic yards). This material would be disposed of on-shore in a bermed facility. Soil disturbance impacts associated with the dredge material stockpile could range from the direct burial of existing soils, to potential acute or obvious changes associated with any stockpiled marine sediment in an upland environment. These impacts would be long term, lasting for the duration of the project and would be expected to occur if Alternative 2 is chosen and permitted, and the Diamond Point port is constructed.

Soil Quality

Impacts to soil quality along the transportation corridor under Alternative 3 would be the same as described for the corridor under Alternative 1.

Erosion

Most hydraulic erosion mechanisms, nature of impacts, and mitigation and control measures during construction, operations, and closure of port facilities would be comparable to those described under Alternative 1. The magnitude, extent, duration, and potential of impacts due to erosion would also be comparable to Alternative 1. Because coarse alluvium outwash and shallow bedrock conditions at the port site are less susceptible to erosion, the period of greatest ground disturbance during port facility construction would generally result in less erosion than Alternative 1. However, unique conditions specific to this alternative that could potentially increase erosional susceptibility or require additional design and mitigation measures throughout construction, operations, and post-closure include the following:

- Uplands disposal of dredge material
- Topographic relief and slope stability

Hydraulic erosion of stockpiled dredge materials would be mitigated through proper impoundment and drainage design. Stockpiled materials could be susceptible to wind erosion, depending on the physical attributes of dredge materials (particle size distribution and cohesion); interim surface stabilization measures; constructed dimensions; and frequency and magnitude of coastal and seasonal winds. Physical conditions that are considered less susceptible to wind erosion include high moisture contents or frozen conditions; larger particle sizes; presence of surface cover, and lower slope angles to reduce wind shear. Mitigation measures that may reduce the potential for wind erosion include wind breaks, snow fencing, reduced slope angles, or watering during increased periods of susceptibility. Final closure of the stockpile would include drainage and surface stabilization. Typical measures that could facilitate stockpile surface stabilization include slope and top-cover engineering, tracking (rolling), seeding, and repurposing of material as growth media.

The topographic relief immediately inland of the eastern port footprint (to the jetty/causeway) is characteristic of an environment where natural hydraulic erosion and slope failure processes are likely to be more prevalent. Sloped ground conditions bordering the port footprint have a greater potential for increased surface water runoff, which could result in greater rates of scouring or aggradation. This could potentially include slope failure processes that indirectly impact port infrastructure. Recent slope failure occurrence (e.g., landslide) is present along the access road extending from the port to the jetty. These conditions would require additional design and mitigation measures; however, the potential for slope failure to compromise discrete portions of port infrastructure would likely persist. This would also include infrastructure at the base of headwall cuts in bedrock. Additional discussion regarding slope failure processes and occurrence are presented in Section 4.15, Geohazards.

4.14.3.4 Natural Gas Pipeline Corridor

The pipeline under Alternative 2 would come ashore at Ursus Cove. The pipeline would be constructed below grade along a valley floor, and eventually resurface at the Diamond Point port site after a short marine crossing of Cottonwood Bay. The magnitude of effects would be disturbance to 5.5 miles of uplands that coincide with shallow bedrock and coarse soil textures (e.g., boulder and cobble) in rough mountainous terrain; however, it is likely that an appreciable gravelly sand colluvium is present along the valley floor. The pipeline from the port would follow a shared road corridor towards the Pile Bay ferry terminal. The stand-alone pipeline (no road) between the Pile Bay and Eagle Bay road off-takes would be 36 miles in length.

Soil Disturbance

The magnitude and extent of upland ground disturbance associated with stand-alone pipeline components under Alternative 2 include:

- Stand-alone pipeline construction ROW – 516 acres
- Material sites and access roads – 306 acres
- Operation infrastructure (Compressor Station) – 5 acres
- Temporary construction access – 29 acres

Although the pipeline construction corridor would be 100 feet wide during construction to accommodate trench spoils and heavy equipment traffic, complete removal of the overlying vegetative mat would be limited to an 8-foot span directly above the trench. The total acreage of vegetative mat that would be completely removed during construction is approximately 40 acres. Shallow soil on the spoils and working sides of the trench would mostly be limited to disturbances from working equipment resulting in ground compaction, rutting, or tearing of ground surfaces. The duration and potential of impacts would be comparable to Alternative 1.

Construction would occur year-round along simultaneous or overlapping construction efforts on segments; construction would include preliminary ROW clearing and preparation, followed by pipeline installation, and rehabilitation/commissioning. Temporary pipeline camps and material sites would be required.

Soils that are more susceptible to surface disturbances (e.g., wetlands) would incorporate additional mitigation measures and BMPs. Working pads constructed of swamp mats along the working ROW would be used to minimize surface disturbances during summer months, and frost-packing of the entire construction ROW during winter months. Frost-packing would involve clearing the snow from the ROW to achieve a frost depth of 2 feet below ground surface. Although no other mitigation and restoration activities have been specified, common practices that could be used during construction include salvaging of timber for corduroy matting or ice-pad construction. To the extent practicable, backfilling would occur as soon as possible to minimize additional equipment efforts or soil disturbances. Temporary impoundment of saturated spoils and/or drainage control measures for water accumulation in the trench may be required for construction in wetlands.

Most mitigation and restoration measures would be conducted during and immediately after construction; however, follow-up measures may be required on a case-by-case basis, particularly after winter construction activities. Surface disturbances are expected to recover within the first few years following construction. Soil disturbances during operations would be less than during the construction period. The permanent pipeline ROW may require periodic brush-clearing to accommodate routine and non-routine pipeline monitoring and maintenance over the operational period. Disturbances may result from intermittent corrective maintenance activities or additional surface stabilization measures on a case-by-case basis.

Erosion

Similar to other project components, mitigation and control measures would incorporate structural and non-structural BMPs to address erosion and stormwater runoff. ESS soils corresponding to stand-alone segments of pipeline are summarized in Table 4.14-4:

Table 4.14-4: Alternative 2 Standalone Pipeline Soil Types

ESS Soil Type	Percent Total Alignment (Acreage)	Acres (Miles)
IA7[1]	31%	162 (~13 miles)
RM1[2]	14%	75 (~6 miles)
SO1[3]	<1%	1 (~0.5 mile)
SO11[4]	55%	290 (~24 miles)

Notes:
ESS = Exploratory Soil Survey of Alaska, Rieger et al. 1979
< = less than
[1] IA7: Typic Cryandepts – Very gravelly, nearly level to rolling association.
[2] RM1: Rough Mountainous Land – Steep rocky slopes.
[3] SO1: Typic Cryorthods – Silty loess to fibrous organic soils over gravelly till, nearly level to hilly.
[4] SO11: Humic Cryorthods – Silty volcanic ash over gravelly till, hilly to steep association.
Source: Rieger et al. 1979; PLP 2018d

The magnitude and extent of hydraulic and wind erosion impacts would be largest along pipeline segments in moderate to rough terrain, where finer-grained silty loess or volcanic ash materials are present at shallow depth. The duration and potential of these impacts would be similar to Alternative 1. The segment of stand-alone pipeline from the port road to Canyon Creek west of Pedro Bay generally coincides with finer-grained silty volcanic ash soils (shallow) overlying glacial till (SO11, Table 4.14-4). Slopes range from hilly to steep, and slightly less than half of this segment (12.3 miles) may require some blasting. Based on the presence of rougher terrain (e.g., blasting), steeper slopes, and finer-grained shallow soils, this segment is considered more susceptible to erosion relative to other sections of the pipeline route to the mine site.

Effective erosional management during and immediately after construction is anticipated through applied erosional control measures and BMPs; however, post-construction or operations phase, inspections may identify localized conditions requiring installation of long-term surface stabilization controls. Areas considered more susceptible to erosion, where longer-term surface stabilization controls may be required to promote recovery include, sloped topography, wetlands, and waterbody crossings.

The least amount of anticipated erosion would occur during closure and post-closure. The pipeline would be abandoned in place, and areas requiring more intensive surface stabilization measures would likely be addressed over the period of operation. Surface facilities associated with the pipeline would be removed and reclaimed.

4.14.3.5 Alternative 2 – Summer-Only Ferry Operations Variant

The Alternative 2 Summer-Only Ferry Operations Variant would have the same impact at the mine site as Alternative 1. However, the magnitude of impacts from the Alternative 2 Summer-Only Ferry Operations Variant would be approximately 28.8 additional acres of disturbance at the port, as compared to the Alternative 1 Summer-Only Ferry Operations Variant. The duration of the additional disturbances would remain throughout the period of mine operations, and be reclaimed during closure. It is certain that the impact on soil would occur if Alternative 2 with the Summer-Only Ferry Operations Variant is chosen and the project is permitted and built. No other pipeline, transportation corridor, or mine site infrastructure would change under this variant.

4.14.3.6 Alternative 2 – Pile-Supported Dock Variant

Impacts to soil resources under this variant would be the same as those described for Alternative 1.

4.14.4 Alternative 3 – North Road Only

A continuous overland access road would connect the Diamond Point port to the mine site. The magnitude, extent, duration and potential of impacts to soil resources at the mine site would be the same as Alternative 1, and those at the port would be the same as those described under Alternative 2.

Because the natural gas pipeline would predominantly be aligned with the transportation corridor under this alternative, both are collectively evaluated together for soil disturbance and erosion impacts. However, the magnitude of impacts from construction of the pipeline under Alternative 3 approximately 81 acres of disturbance to soils within the onshore, stand-alone pipeline footprint, in addition to 10 acres of material sites specific to the pipeline. The following section describes impacts for the transportation corridor that would be appreciably different under Alternative 3.

4.14.4.1 Transportation Corridor

<u>**Soil Disturbance**</u>

The gas pipeline trench would be adjacent to the road (road-bed prism) to facilitate construction, maintenance, and inspection. The pipeline(s) would use vehicle bridges to span major stream crossing, and HDD drilling or trenching across smaller drainages as appropriate. No Iliamna Lake ferry infrastructure would be required under this alternative, based on the continuous overland route to the mine site. The magnitude of estimated acreages of transportation corridor (and pipeline) ground disturbances under this alternative include:

- Shared road corridor/pipeline(s) – 1,036 acres (does not include stand-alone pipeline)
- Shared transportation and pipeline material sites – 717 acres (does not include stand-alone pipeline)

The total magnitude of acreage of ground disturbance from material sites and shared road and pipeline under this alternative is approximately 66 percent greater than Alternatives 1 and 2. The permanent need for transportation corridor access throughout post-closure would create a permanent ground disturbance in the footprint, unlike the approximately 500 acres of stand-alone pipeline corridor ground disturbance associated with Alternative 2 that would be expected to recover to pre-disturbance conditions during the operations phase. This impact would occur if Alternative 3 is chosen, and if the project is permitted and the transportation corridor as described for Alternative 3 is built.

Erosion

ESS soil types corresponding to transportation corridor terrain under Alternative 3 are summarized in Table 4.14-5.

Table 4.14-5: Alternative 3 Approximate Road/Pipeline(s) Terrain and Soil Types

ESS Soil Type	Gentle to Moderate Terrain	Moderate to Rough Terrain
IA7[1]	42% (~34.7 miles)	4% (~3.5 miles)
IA9[2]	6% (~5 miles)	<1% (0.36 mile)
RM1[3]	11% (~8.7 miles)	6% (~4.5 miles)
SO11[4]	15% (~12.3 miles)	16% (~13.5 miles)
Percent Total Terrain Type[5]	74% (~60.7 miles)	26% (~22 miles)

Notes:
ESS = Exploratory Soil Survey of Alaska, Rieger et al. 1979)
< = less than
[1] IA7: Typic Cryandepts – Very gravelly, nearly level to rolling association.
[2] IA9: Typic Cryandepts – Very gravelly, hilly to steep association.
[3] RM1: Rough Mountainous Land – Steep rocky slopes.
[4] SO11: Humic Cryorthods – Silty volcanic ash over gravelly till, hilly to steep association.
[5] Terrain type classification associated with planned blasting requirements (segments) for road construction.
Source: Rieger et al. 1979; PLP 2018

Mitigation and control measures for erosion and stormwater runoff would incorporate structural and non-structural BMPs common to transportation and pipeline construction practices described under Alternatives 1 and 2. The greatest potential for hydraulic and wind erosion impacts would correspond with invasive ground disturbance during construction. Disturbed surfaces would remain susceptible to erosion until concurrent or follow-up stabilization is achieved. Permit required mitigation measures and BMPs are anticipated to alleviate most conditions throughout or immediately after construction.

More robust mitigation and follow-up stabilization measures during and after construction are likely to be required in areas of moderate to rough terrain, where fine-grained soil conditions exist. This coincides with the segment of stand-alone pipeline from the port road to Canyon Creek west of Pedro Bay under Alternative 2 (SO11 soils). The least amount of erosion would likely occur during operations, when stabilization of disturbed surfaces would be achieved through natural or applied restoration and stabilization measures, and continued (i.e., real-time) monitoring along the corridor. Erosion throughout post-closure would likely be greater than the operations phase, based on an indefinite need for transportation corridor access; a reduced erosion monitoring frequency; and reduced access to equipment and resources.

Summary of Erosion Impacts

Enhanced design and mitigation measures would be required along discrete segments; in particular, the segment of coastline road through rugged terrain from Diamond Point port (2.5 miles) under Alternatives 2 and 3. More robust mitigation and restoration measures may be needed in moderate to rough terrain with finer-grained soil conditions (iSO11 soils). The duration of erosion would vary from completion of the activity (e.g., construction or reclamation), to an indefinite period in post-closure. The extent of erosion effects would be mostly limited to the immediate vicinity of disturbance or footprint.

The overall magnitude, extent, and potential for erosion under this alternative are considered to be greater than the transportation corridor for Alternative 2, based on total footprint acreage, presence of fine-grained soils in moderate to rough terrain, and increased frequency of waterbody crossings. The duration would be comparable to Alternative 2, because both alternatives indefinitely retain transportation corridor infrastructure.

4.14.4.2 Alternative 3 – Concentrate Pipeline Variant

This variant includes an HDPE[1]-lined steel pipeline that would convey slurried copper and gold concentrates from the mine site to the port facility (PLP 2018-RFI 066). The pipeline would be predominantly buried sub-grade in the same trench as the gas pipeline, with approximately 36 inches of top cover. Impacts to soil resources at the mine site and port would be the same as those described under Alternative 2; however, a small soil disturbance increase would be anticipated due to a concentrate pipeline pump house (e.g., 1 acre), and pipeline booster station (0.7 acre).

The shared transportation and concentrate pipeline corridor would increase the road corridor width by less than 10 percent, resulting in a proportional soil disturbance increase. The duration and geographic extent of soil disturbance and erosion would be the same as Alternative 3; however, there would be an appreciable increase in erosion magnitude and potential, based on the additional acreage of disturbance associated with transportation corridor widening.

4.14.5 Summary of Key Issues

Table 4.14-6 provides summary statements of key issues and impacts from the project on soil resources.

Table 4.14-6: Summary of Key Issues for Soil Resource

Impact Causing Project Component	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variants
		Mine Site	
Soil disturbance	*Alternative 1* ~8,086 acres (total) *Summer-Only Ferry Operations Variant* ~8,124 acres (total)	*Alternative 2* ~155 additional acres (downstream TSF construction) *Summer-Only Ferry Operations Variant* No change	*Alternative 3* No change from Alternative 1 *Concentrate Pipeline Variant* ~1.7 additional acres
Soil quality	*Alternative 1* Magnitude and potential: With	*Alternative 2* No change	*Alternative 3* No change

[1] HDPE = high-density polyethylene

Table 4.14-6: Summary of Key Issues for Soil Resource

Impact Causing Project Component	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variants
	the exception of antimony (+3.04%), the percent increase in baseline concentrations for all HAP metals from dust deposition in surface soils would be less than 1 percent; therefore, no adverse change to surface soil chemistry from fugitive dust deposition exists relative to baseline conditions. Extent: mine site (ambient air) boundary. Duration: Throughout post-closure. *Summer-Only Variant* No change	*Summer-Only Ferry Operations Variant* No change	*Concentrate Pipeline Variant* No change
Erosion	*Alternative 1* Magnitude: Within project design and permit requirements. Duration: Pre-activity levels within 100 years. Extent: Project boundaries. Potential: Inherent *Summer-Only Ferry Operations Variant* No change	*Alternative 2* Potential erosion increase from TSF build out. *Summer-Only Ferry Operations Variant* No change	*Alternative 3* No change from Alternative 1 *Concentrate Pipeline Variant* No change from Alternative 1
Transportation Corridor			
Soil disturbance	*Alternative 1* ~1,161 acres (includes shared pipeline) *Summer-Only Ferry Operations Variant* No change *East Ferry Variant* ~60-acre total increase due to material site acreage, but less wetland disturbance	*Alternative 2* Comparable acreage footprint but ~20 fewer miles of roadway (more material sites under Alternative 2). *Summer-Only Ferry Operations Variant* No change	*Alternative 3* ~1,753 acres (total) 66% greater than Alternative 1 and 2 *Concentrate Pipeline Variant* Increased Transportation Corridor but likely less than or equal to10%
Soil quality	*Alternative 1* Magnitude and Potential: No adverse change to surface soil chemistry from fugitive dust deposition. No PAG material from locally sourced material sites, seasonal emission mitigation/suppression through watering, and concentrate transport in sealed containers.	*Alternative 2* No change *Summer-Only Ferry Operations Variant* No change	*Alternative 3* No change *Concentrate Pipeline Variant* No change

Table 4.14-6: Summary of Key Issues for Soil Resource

Impact Causing Project Component	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variants
	Duration: Indefinite, based on continued post-closure transportation corridor access. Potential: Inherent; but low due to mitigation measures and fill source (material site) geo-chemistry assessment. *Summer-Only Ferry Operations Variant* No change		
Erosion	*Alternative 1* Magnitude: Approximately 30 miles of port road corridor in moderate to rough terrain (~33.4 miles total) that is associated with the presence of shallow fine-grained soils. May require some enhanced design and mitigation measures. Duration: Temporary to indefinite Extent: Project footprint Potential: Inherent; but greatest potential along port access road, with a low potential for other transportation components. *Summer-Only Ferry Operations Variant* Potential erosion increase due to greater road usage during ice-free months. *East Ferry Variant* Comparable but potentially less erosion based on shorter road length.	*Alternative 2* Magnitude and extent: Reduced based on smaller acreage of ground disturbance and increased presence of coarser soil types and gentler terrain. Duration: No change (temporary to indefinite) Potential: Increased along 2.5-mile coastline segment of port access road, where unique road design and mitigation measures would be required to minimize erosion potential; however, erosion potential will likely persist (e.g., topography and maritime conditions). *Summer-Only Ferry Operations Variant* Potential erosion increase due to greater road usage during ice-free months, but less than Alternative 1 variant based on shorter road length.	*Alternative 3* Magnitude, extent, potential: Greater than Alternatives 1 and 2 based on greatest footprint acreage and waterbody crossing frequency. However, magnitude and potential may be comparable to Alternative 1 (at a minimum) based on less-moderate to rough terrain that coincides with shallow fine-grained soil types. Duration: No change (temporary to indefinite) *Concentrate Pipeline Variant* Magnitude and potential: Greatest amongst all alternatives and variants due to less than 10% increase in transportation corridor width (i.e., Alternative 3). Duration: No change (temporary to indefinite) Extent: Comparable to Alternative 3.
Port Site			
Soil disturbance	*Alternative 1* ~20 acres (total) *Summer-Only Ferry Operations Variant* ~47.5 acres (total) *Pile-Supported Dock Variant* Reduced fill material demand and acreage.	*Alternative 2* ~41 acres (total) (~11 additional acres) *Summer-Only Ferry Operations Variant* Additional 28.8 acres	*Alternative 3* Same as Alternative 2 *Concentrate Pipeline Variant* Same as Alternative 2
Soil quality	*Alternative 1*	*Alternative 2*	*Alternative 3*

Table 4.14-6: Summary of Key Issues for Soil Resource

Impact Causing Project Component	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variants
	Magnitude: No adverse change to surface soil chemistry from fugitive dust deposition. No PAG material from locally sourced material sites; seasonal emission mitigation/suppression through watering. Concentrate transfer from sealed bins to bulk carriers conducted off-shore below deck. Calculated concentrate total emissions is approximately 4 pounds per year. Duration: Indefinite, based on continued post-closure port needs Potential: Low; however, greatest during the operational period during concentrate storage and handling. *Summer-Only Ferry Operations Variant* No change	No change *Summer-Only Ferry Operations Variant* No change	No change *Concentrate Pipeline Variant* No change
Erosion	*Alternative 1* Magnitude: Low and within project design and permit requirements. Duration: Indefinite and up to several years into post-closure Extent: Project footprint Potential: Inherent – low *Summer-Only Ferry Operations Variant* Increased erosion potential *Pile-Supported Dock Variant* Reduced erosion potential	*Alternative 2* Magnitude and Extent: Increased, based on larger acreage of ground disturbance/infrastructure, terrain, and dredge material stockpile. Duration: No change Potential: Increased, based on larger acreage of ground disturbance, terrain, and dredge material stockpile. *Summer-Only Ferry Operations Variant* Increased erosion magnitude and potential *Pile-Supported Dock Variant* Same as Alternative 1 Variant	*Alternative 3* Same as Alternative 2 *Concentrate Pipeline Variant* Same as Alternative 2
Natural Gas Pipeline (Stand-alone)			
Soil disturbance	*Alternative 1* ~40 acres (stand-alone total) *East Ferry Variant*	*Alternative 2* ~827 additional acres (includes pipeline material sites).	*Alternative 3* With the exception of 97 acres of stand-alone pipeline and material sites,

Table 4.14-6: Summary of Key Issues for Soil Resource

Impact Causing Project Component	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variants
	Shorter 3-mile pipeline length (change) based on shared Transportation Corridor.		the pipeline under this alternative is considered part of the commonly aligned/shared Transportation Corridor. See Alternative 3, Transportation Corridor key issues for soil disturbance. *Concentrate Pipeline Variant* Same as above
Erosion	*Alternative 1* Magnitude: Low and within project design and permit requirements based on limited ground disturbance and shared transportation corridor. Duration: Indefinite Extent: Project footprint Potential: Inherent, but low *East Ferry Variant* Decreased erosion potential	*Alternative 2* Magnitude, extent, and potential: Increased during construction and operations based on larger acreage of ground disturbance, length, and reduced accessibility. Magnitude and extent are considered comparable to Alternative 1 during post-closure based on stabilization, ground surface restoration, and in-place abandonment. Potential: Increased during post-closure. Duration: Comparable, based on shared transportation corridor segments.	*Alternative 3* Although the pipeline under this alternative is considered part of the commonly aligned transportation corridor for evaluation, the following key issue is considered: The potential for increased erosion susceptibility of shallow fine-grained soils in moderate to rough terrain from the port road to Canyon Creek west of Pedro Bay under Alternative 2 (stand-alone pipeline) would be reduced under Alternative 3 immediately after construction and throughout operation. This is due to continuous road access for monitoring and maintenance of surface stabilization and restoration measures. *Concentrate Pipeline Variant* Same as above

4.14.6 Cumulative Effects

The cumulative effects analysis area for soils encompasses the footprint of the proposed project, including alternatives and variants. In this area, a nexus may exist between the project and other past, present, and reasonably foreseeable future actions (RFFAs) that could contribute to a cumulative effect on soils. Section 4.1, Introduction to Environmental Consequences, details the comprehensive set of past, present, and RFFAs considered for evaluation as applicable. A number of the actions identified in Section 4.1, Introduction to Environmental Consequences, are considered to have no potential of contributing to cumulative effects on soils in the analysis area. These include offshore-based developments; activities that may occur in the analysis area, but are unlikely to result in any appreciable impact on soil resources (such as tourism, recreation, fishing, and hunting); or actions outside of the cumulative effects analysis area (e.g., Donlin Gold, Alaska LNG).

Past, present, and RFFAs that could contribute cumulatively to geologic resource impacts, and are therefore considered in this analysis, include:

- Pebble project buildout – develop 55 percent of the resource over 78-year period
- Pebble South/PEB*
- Big Chunk South*
- Big Chunk North*
- Fog Lake*
- Groundhog*
- Diamond Point Rock Quarry
- Lake and Peninsula Transportation and Infrastructure

**Indicates exploration activities only.*

4.14.6.1 Past and Present Actions

Past and present actions that have impacted soils in the analysis area are limited, and include transportation development where existing roads intersect the project footprint, and mineral exploration in locations where past or current activities have impacted soils (e.g., work pads or camp areas). Although these actions affect localized areas, they are additive to other actions that may occur, slightly increasing the total cumulative effect on geologic resources. Overall, the cumulative effects on soils from past and present actions are minimal in extent and minor in magnitude for all alternatives.

4.14.6.2 Reasonably Foreseeable Future Actions

<u>No Action Alternative</u>

The No Action Alternative would not contribute to cumulative effects on soils.

<u>Alternative 1 – Applicant's Proposed Alternative</u>

Pebble Mine Expanded Development Scenario – An expanded development scenario for this project, as detailed in Table 4.1-2 (Section 4.1, Introduction to Environmental Consequences), would include an additional 58 years of mining (for a total of 78 years) over a substantially larger mine site footprint, and would include increases in port and transportation corridor infrastructure. The mine site footprint would have a larger open pit and new facilities to store tailings and waste rock (Section 4.1, Introduction to Environmental Consequences, Figure 4.1-1), which would contribute to cumulative effects on geologic resources through removal of overburden, waste rock, and ore.

The Pebble mine expanded development scenario project footprint would impact approximately 34,790 acres, compared to 9,317 acres under Alternative 1. The magnitude of cumulative impacts to soil would vary from temporary soil disturbance to permanent soil removal. Similarly, erosion would vary from minimal surface stabilization efforts to indefinite erosion maintenance (e.g., roads, mine site infrastructure).

Other Mineral Exploration Projects – Mineral exploration is likely to continue in the analysis area for the mining projects listed previously in this section. Exploration activities, including additional borehole drilling, road and pad construction, and development of temporary camp and other support facilities would contribute to the cumulative effects on soils, although impacts would be expected to be limited in extent and low in magnitude.

Road Improvement and Community Development Projects – Road improvement projects would have impacts on soils through grading, filling, and potential increased erosion, and would contribute to cumulative effects in the analysis area. The most likely road improvements in the area would be in the development footprint of existing communities, with only Iliamna and Newhalen being considered to be in the analysis area for soils cumulative effects. Some limited road upgrades could also occur in the vicinity of the natural gas pipeline starting point near Stariski Creek, or in support of mineral exploration previously discussed. None of the anticipated transportation development in the analysis area would contribute greatly to cumulative effects on soils.

Additional RFFAs that have the potential to affect soils in the analysis area are limited to the Diamond Point rock quarry. That RFFA would include the excavation of rock, which would require removal of soil overburden materials, and result in a direct and cumulative effect on soils in the analysis area. Upland soil disturbances and erosion impacts would be limited to coarse soils occurring in rocky mountainous terrain. The estimated area that would be affected is approximately 140 acres (ADNR 2014a).

Alternative 2 – North Road and Ferry with Downstream Dams

Pebble Mine Expanded Development Scenario – Expanded mine site development and associated contributions to cumulative effects on soils would be similar for all alternatives. Under Alternative 2, project expansion would use the existing Diamond Point port facility; would use the same natural gas pipeline; and would use portions of the constructed portion of the North Road. A concentrate pipeline and a diesel pipeline from the mine site to Iniskin Bay would be constructed; both having potentially limited impacts on soils due to trenching activities. Cumulative effects on soils would be similar to those discussed under Alternative 1.

Other Mineral Exploration Projects, Road Improvement, and Community Development Projects – Cumulative effects of these activities on soils would be similar to those discussed under Alternative 1. Under Alternative 1, the proposed Diamond Point rock quarry has the potential to affect soils in the analysis area. The footprint of the Diamond Point rock quarry coincides with the Diamond Point port footprint under Alternatives 2 and 3. The increase in soil disturbance and erosion impacts (e.g., magnitude and geographic extent) would be the same as identified under Alternative 1. Cumulative impacts would likely be less under Alternative 2 due to commonly shared project footprints with the quarry site.

Alternative 3 – North Road Only

Pebble Mine Expanded Development Scenario – Expanded mine site development and associated contributions to cumulative effects on soils would be similar for all alternatives. Under Alternative 3, project expansion would use the Diamond Point port facility; would use the same natural gas pipeline and diesel pipeline; and would use the same north road and concentrate pipeline variant, but would extend the concentrate pipeline with a service road to Iniskin Bay.

Other Mineral Exploration Projects, Road Improvement, and Community Development Projects – Cumulative effects of these activities on soils would be similar to those discussed under Alternative 2.

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