4.17 GROUNDWATER HYDROLOGY

This section describes the effects of the project on the distribution and movement of groundwater in the subsurface. Potential direct and indirect effects from the project may include:

- Drawdown of groundwater around the open pit from dewatering activities, and consequent reduction of groundwater available to surrounding surface water and wetlands.
- Reduction in natural recharge to groundwater from filling drainage areas beneath large project facilities such as water management ponds (WMPs) and tailings storage facilities (TSFs).
- Changes in groundwater flow patterns from shallow groundwater interception or surface water withdrawals during road and pipeline construction.
- Drawdown of groundwater around potable wells from water supply use.
- Changes to groundwater flow from horizontal directional drilling (HDD) activities.

The Environmental Impact Statement (EIS) analysis area includes the mine site, transportation corridor, pipeline corridor, and port for all alternatives and variants, and includes the watersheds most likely to be affected by the project (see Section 3.17, Groundwater Hydrology, Figure 3.17-1). The geographic area considered in the analysis of groundwater hydrology is the near vicinity of all project components (i.e., within 0.5 mile to several miles) where project effects could be expected to occur on groundwater flow patterns. The duration of impacts would either be short-term, lasting only though construction; or long-term, lasting though the life of the mine. Long-term impacts to groundwater may not be permanent if they would be resolved post-closure.

Scoping comments were received on impacts to groundwater systems and aquifers, and the transportation of groundwater, and how it moves underground. Commenters requested that existing groundwater within the area of both the project and alternatives, including groundwater levels and flow, be characterized; and that a thorough understanding of the groundwater and surface water hydrology and how they relate to each other should be demonstrated. Impacts to groundwater and surface water quality are addressed in Section 4.18, Water and Sediment Quality.

4.17.1 Methodology for the Analysis of Groundwater Impacts

Impacts to groundwater hydrology were evaluated based on baseline data, water management plans, and groundwater modeling. The methodology applied to analyze and predict direct or indirect impacts is based on the range of effects for each of following factors:

- Magnitude – Effects on groundwater flow systems are estimated by predicting changes in water table elevation, flow direction, or distance of impact from project activity. Effects could be maintained within historic seasonal variation; could exceed baseline variations, but nearby uses and conditions would be maintained; or there could be groundwater flow changes that affect nearby uses or environment.
- Duration – The duration of effects depends on project phase, length of construction activities, and aquifer characteristics. Groundwater flow effects could last no longer than construction, then return to baseline conditions; they could remain after construction throughout life of mine, and decades afterward; or they could not return to baseline conditions for more than 100 years.
- Geographic Extent – Groundwater flow effects are described in terms of area. Effects might be limited to portions of the project footprint or component area and not

hydraulically connected to waters outside the component area; they could occur beyond local project component areas, potentially throughout the EIS analysis area; or flow effects could be hydraulically connected to areas beyond the EIS analysis area.

- Potential – Most effects on groundwater flow at the mine site are considered likely to occur. The likelihood of occurrence for other project components is correlated to the distribution of shallow groundwater-bearing deposits, which varies across the project area; and the likelihood that the water table would be intercepted during specific construction activities.

4.17.2 No Action Alternative

Under the No Action Alternative, the project would not be undertaken; there would be no mine site, transportation corridor, port development, or natural gas pipeline corridor. Under the No Action Alternative, Pebble Limited Partnership (PLP) would have the same options for exploration activities that currently exist. 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 and environmental baseline data collection to continue under this alternative (ADNR 2018-RFI 073), which could include groundwater extraction from pump tests. These tests temporarily lower groundwater elevations in the immediate area surrounding a well, which typically recover to natural conditions within a matter of hours to days.

Groundwater along the transportation corridor, pipeline corridor, and at the port sites would remain in its current state. There would be no effects on existing private wells. In summary, there would little to no direct or indirect impacts on baseline groundwater conditions from implementation of the No Action Alternative.

4.17.3 Alternative 1 – Applicant's Proposed Alternative

4.17.3.1 Mine Site

Groundwater conditions resulting from mine site activities were modeled by Piteau Associates (2018a) using an updated version of the groundwater flow model originally developed by Schlumberger (2011a). Model development and calibration to baseline groundwater and streamflow conditions are described in Section 3.17, Groundwater Hydrology, and Appendix K3.17. The results of using the model to predict project effects on groundwater are described below, with additional details provided in Appendix K4.17. Model uncertainty and reliability are also summarized in this section, and additional details are provided in Appendix K4.17.

The analysis of project impacts using the model addressed two general areas: 1) the open pit; and 2) the bulk and pyritic TSFs and main WMP. Analysis of groundwater conditions was conducted for the groundwater capture zone[1] around the pit, and the zone of influence[2] for a wider area of the mine site. For the operations phase, the model estimated the effect of open pit dewatering on groundwater flow conditions at end of mining, the groundwater inflow rate to the pit, the related reduction of groundwater discharge to Upper Talarik Creek (UTC), South Fork Koktuli (SFK), and North Fork Koktuli (NFK) drainages, impacts to wetlands, and groundwater

[1] The **capture zone** is the area in which all groundwater flow is towards a groundwater "sink" and all groundwater recharge is captured by the sink. The outer boundary of the capture zone is a groundwater divide.

[2] The **zone of influence** is the area in which man-made hydraulic stress (such as dewatering) lowers groundwater elevations. The zone of influence is typically larger than the capture zone, because groundwater elevations can be affected outside the groundwater divide that defines the capture zone.

and seepage flow from the TSFs and the WMPs. The model was also used to assess groundwater flows after mining ceases, including the time to form an open pit lake and the lake level elevation needed to maintain it as a hydraulic sink. Post-closure was defined as the time at which the pit lake reached its maximum managed level after Closure Year 20.

Pit Dewatering

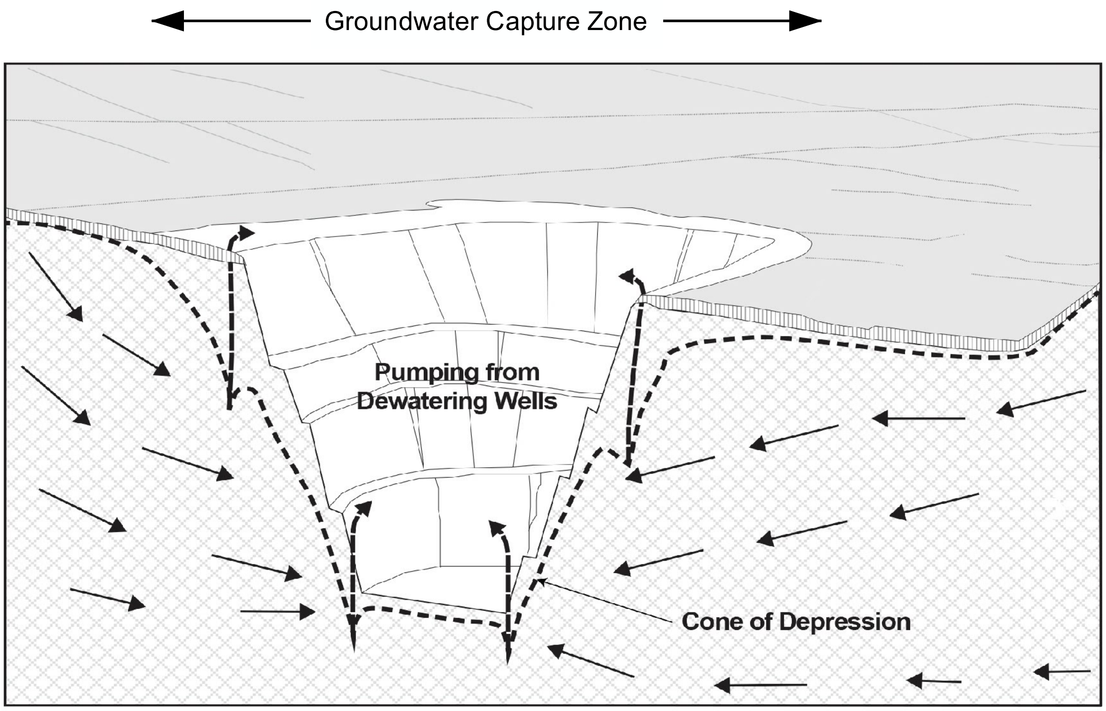
Construction and Operations. Dewatering of the open pit would be required to facilitate mining. Construction of the open pit would require lowering groundwater levels in the pit area through dewatering to establish stable pit walls and provide dry working conditions. Although a specific dewatering design has not been developed at this point, the ultimate pit dewatering design would be based on a series of interim pit phases that successively expand and deepen the pit. This phased approach would allow the pit dewatering program to be adjusted, based on the operational performance of each preceding phase (Knight Piésold 2018e).

Dewatering is typically accomplished by placement of dewatering wells around the proposed pit perimeter, wells in the pit bottom as mining progresses, and ditches and horizontal drains along the pit walls (Figure 4.17-1). Dewatering results in a groundwater "cone of depression[3]" because the water table is lowered in the pit, and the effect extends laterally beyond the pit area into the adjacent bedrock and overburden aquifers (see Appendix K3.17, Table K3.17-1 for aquifer descriptions). The cone of depression would deepen and widen as pit excavation progresses and dewatering expands, and would last as long as the dewatering system is operated during construction, operation, and closure of the mine. The magnitude and extent of impacts would be that groundwater levels would ultimately need to be lowered below the bottom of the final mine pit, which is estimated to be up to 2,200 feet below grade. Effects of groundwater drawdown on other resources such as wetlands and vegetation are described in Section 4.22, Wetlands and Other Waters/Special Aquatic Sites, and Section 4.26, Vegetation, respectively.

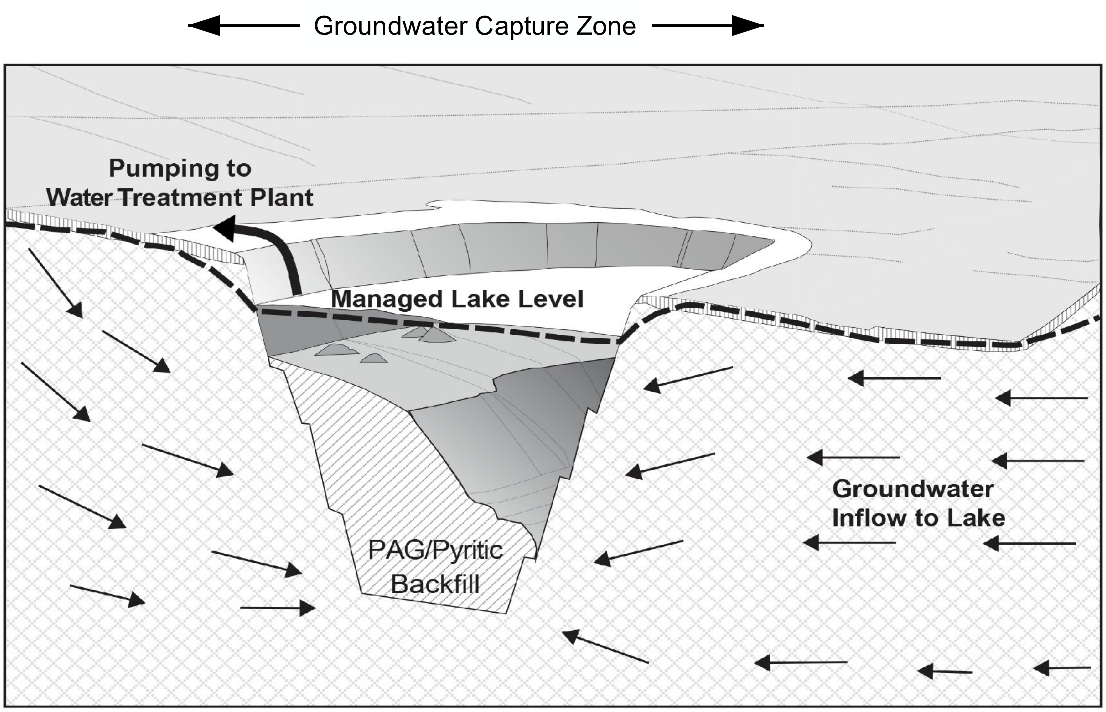
The initial dewatering well field during construction is conceptualized to consist of approximately 30 operating wells installed to a depth of 150 feet, and spaced about 200 feet apart around the starter pit perimeter (Knight Piésold 2018e). The wells would initially be pumped at a rate of 50 gallons per minute (gpm), with a total rate of approximately 1,500 gpm. The estimated groundwater inflow to the pit at the end of operations is estimated to be about 2,200 to 2,400 gpm (Piteau Associates 2018a). The well field at the end of mining is expected to include approximately 30 wells at 500-foot spacing around the pit perimeter. Sumps in the pit would capture precipitation and groundwater not captured by the dewatering system.

The rates of estimated groundwater inflow to the pit described above are based, in part, on a wide range of climate scenarios using a historical 40-year record of data (Section 3.16, Surface Water Hydrology). Potential changes in future precipitation due to climate change that result in more rain and less snow would tend to even out swings in seasonal recharge to the groundwater system, and lie within the scenarios estimated by the watershed module (AECOM 2018o). To estimate the effects of potential higher meteoric recharge on the groundwater model results, the model was run using double the amount of recharge. This would result in roughly twice the amount of inflow to the pit needing to be dewatered and treated (Piteau Associates 2018a). As described in Appendix K4.17, flexibility is built into the water management strategy in such a manner that the additional water could be stored within the capacity of the main WMP and treated at the water treatment plants (WTPs) (Knight Piésold 2018a, 2018f).

[3] **Cone of depression** refers to the geometry of the water table that develops in aquifers surrounding the pit when water is pumped from the pit or formation, creating an actual depression of groundwater levels. The surface created by connecting the water levels of many wells that penetrate the water table is shaped like an inverted cone (wider at the top).



Late Operations



Post-Closure

Sources: Modified from BGC 2014

US Army Corps of Engineers

CONCEPTUAL GROUNDWATER SYSTEM AROUND PIT IN LATE OPERATIONS AND POST-CLOSURE

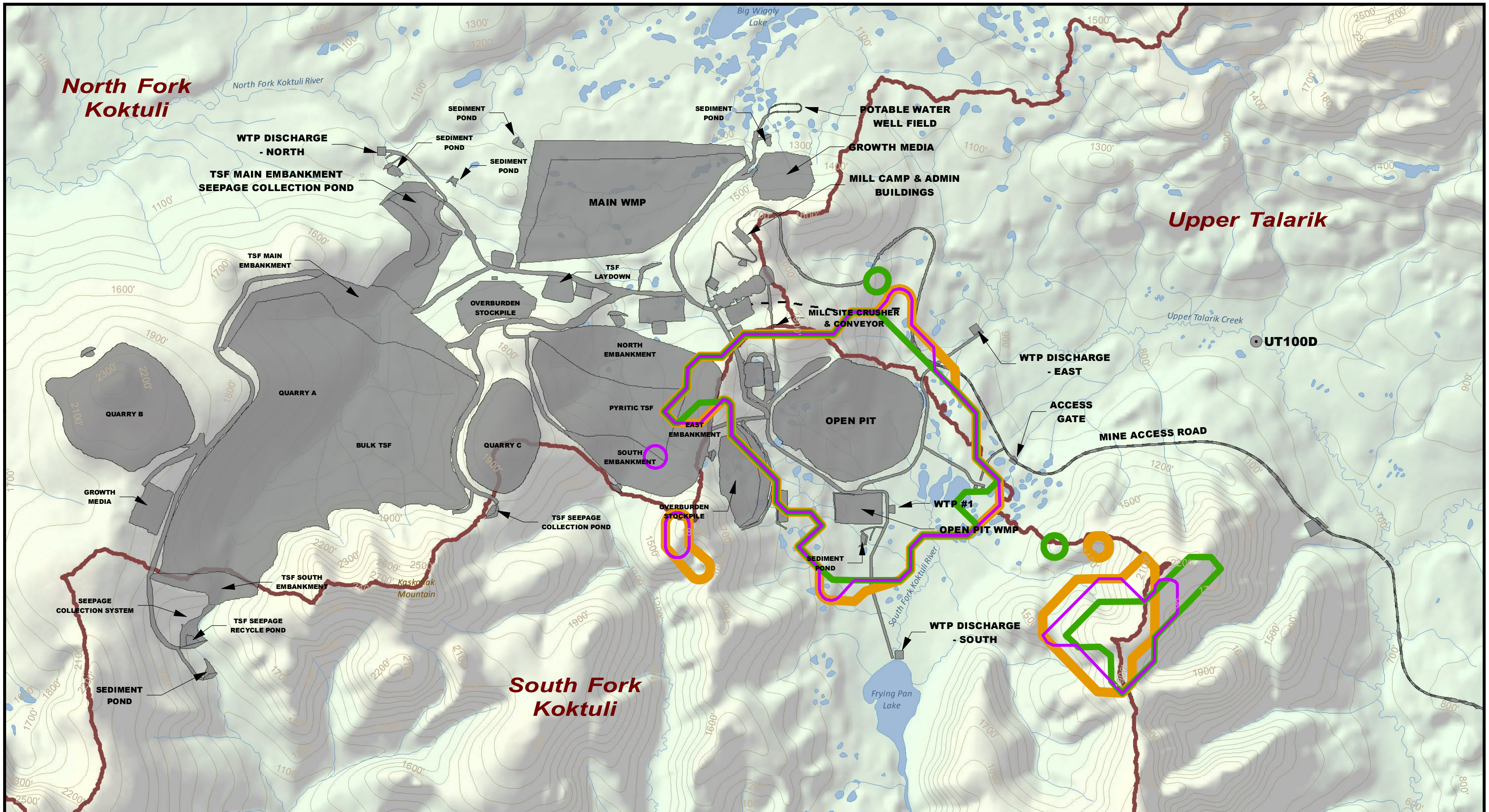
Water in the open pit would be managed using a storage pond and runoff controls. Groundwater inflows to the open pit would be pumped to the open pit WMP for storage and treatment prior to discharge from the WTPs (see Section 4.18, Water and Sediment Quality). Runoff from areas upslope of active mining would be intercepted and diverted around the open pit to the extent possible (see Section 4.16, Surface Water Hydrology). Direct rainfall, snowmelt, and runoff from the open pit walls would be collected and pumped using in-pit pumps to the open pit WMP for storage and treatment prior to discharge. WTP discharge locations would be located outside of the pit cone of depression.

Creation of a cone of depression around the pit would locally change groundwater flow patterns such that groundwater flows radially inwards and vertically upwards towards the pit. Groundwater/surface water interactions and surface water flows would also be impacted by pit dewatering. Natural groundwater discharge to seeps, wetlands, streams, ponds, or lakes in or adjacent to the proposed pit may cease or be reduced, resulting in lower surface water base flows, or pond or lake levels. In terms of magnitude and extent, some wetlands, stream segments, ponds, or lakes in the immediate pit area may be eliminated as the water table is lowered, and water leaks out of these waterbodies during construction and mining operation. The duration of this impact would be long term, lasting for the life of the project, and certain to occur if the project is permitted and built. Indirect impacts to wetlands from the lowered water table around the pit were evaluated by PLP (2018-RFI 082) by comparing the hydrogeomorphic wetlands classification codes to the permeability and recharge potential of surficial geologic units in the groundwater model to determine their susceptibility to dewatering impacts. Areas with highly permeable layers such as glacial outwash would be most affected by drawdown, whereas areas underlain by glacial lake deposits are relatively isolated from groundwater and less impacted by drawdown. Areas of drawdown that coincide with susceptible wetlands are shown on Figure 4.22-2, and acreages are provided in Section 4.22, Wetlands and Other Waters/Special Aquatic Sites.

The proposed pit would be located entirely within the headwaters of the SFK River watershed. Groundwater dewatering impacts related to the proposed project are expected to be confined to the upper reaches of the SFK watershed and the nearest portions of the UTC and NFK watersheds. In terms of magnitude, groundwater discharge from the SK100C sub-basin is estimated to be reduced by 2.9 cubic feet per second (cfs) at the end of operations without the addition of WTP flows to the basin, and is expected to be unchanged with addition of WTP discharges back into the basin (Knight Piésold 2018i). Groundwater discharge from the SK100C sub-basin is estimated to be reduced by 2 cfs during post-closure without the addition of WTP discharges, and reduced by 0.6 cfs with addition of WTP discharges. Impacts to wetlands, ponds, and small streams located upstream of the WTP discharge location would not be mitigated by WTP discharges. The extent of impacts is that pit dewatering may locally impact groundwater flow across the groundwater divide, drawing groundwater from the headwaters of the UTC watershed depending on the extent of the cone of depression around the pit (Piteau Associates 2018a). Without the addition of WTP outflows, groundwater discharge to the upper UTC drainage (above gage UT100D) is predicted to decline at a magnitude of 14 to 19 percent (Appendix K4.17, Figure K4.17-1). However, this reduction is expected to be mitigated by releases from the east WTP discharge location, so that groundwater flow would not change relative to natural conditions, and surface flows would increase slightly for both end of operations and post-closure periods on a mean annual basis, as observed at station UT100D (Knight Piésold 2018i, 2018j, 2018n). Impacts to wetlands, ponds and small streams located upstream of the WTP discharge location would not be mitigated by the WTP discharges. Pit dewatering is not expected to have any effects on groundwater flow in the NFK watershed (Knight Piésold 2018i, 2018j) Streamflow reduction during operations and closure is further addressed in Section 4.16, Surface Water Hydrology, and related effects on wetlands and fish are addressed in Section 4.22, Wetlands and Other Waters/Special Aquatic Sites and 4.24, Fish Values, respectively.

The extent of primary impacts to groundwater flow would be in the overburden and bedrock aquifers in the open pit footprint and cone of depression. Local, intermediate, and regional groundwater flow in these aquifers would radially flow towards the pit and be captured by the dewatering system. Groundwater located beneath the pit would also flow upwards towards the pit. The magnitude of impact to groundwater flow patterns would grow as mining proceeds to depth, and the cone of depression surrounding the pit becomes wider and extends to the full depth of the pit. Piteau Associates (2018a) estimates that the cone of depression at its widest extent at the end of operations would range from a distance of approximately 1,500 feet from the pit crest along its northeastern side, to as much as 14,000 feet along the ridge southeast of the pit, depending on the hydraulic character of the affected aquifers (Figure 4.17-2). The capture zone in the immediate area around the pit represents relatively shallow flowpaths, and the outlying areas represent deeper flowpaths with very low groundwater velocities. Groundwater outside of the capture zones is predicted to discharge to local streams or seeps as they do currently, and not be affected by the capture zone (Piteau Associates 2018a; Knight Piésold 2018n). The maximum area of the capture zone at the end of operations would be about 2,700 acres.

As further described in Appendix K4.17, the range of capture zones shown on Figure 4.17-2 are based on evaluating a modest range of variability in hydrogeologic properties assigned to the different layers and zones in the model to estimate the effect of uncertainty in these parameters. Although the model is a suitable tool for evaluating the effects of pit dewatering, other viable simulations of the model using different input parameters are possible. Considering the model uncertainties, the actual results of dewatering the pit may differ from projections described above. It is expected that the amount of water produced during pit dewatering could be larger than simulated, and the capture zone and zone of influence could be larger. Additional details regarding model uncertainty are provided in the Appendix K4.17.



Sources: Piteau Associates 2018a, Fig. 3

Groundwater Capture Zones
- 5th percentile
- 50th percentile
- 95th percentile

Alternative 1
- Natural Gas Pipeline
- Project Features

Other Features
- 100' Contour (Existing)
- River/Stream
- Lake/Pond
- Major Drainage Boundary

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0.5 0 0.5 1
Miles

ESTIMATED RANGE OF GROUNDWATER CAPTURE ZONES AT END OF OPERATIONS

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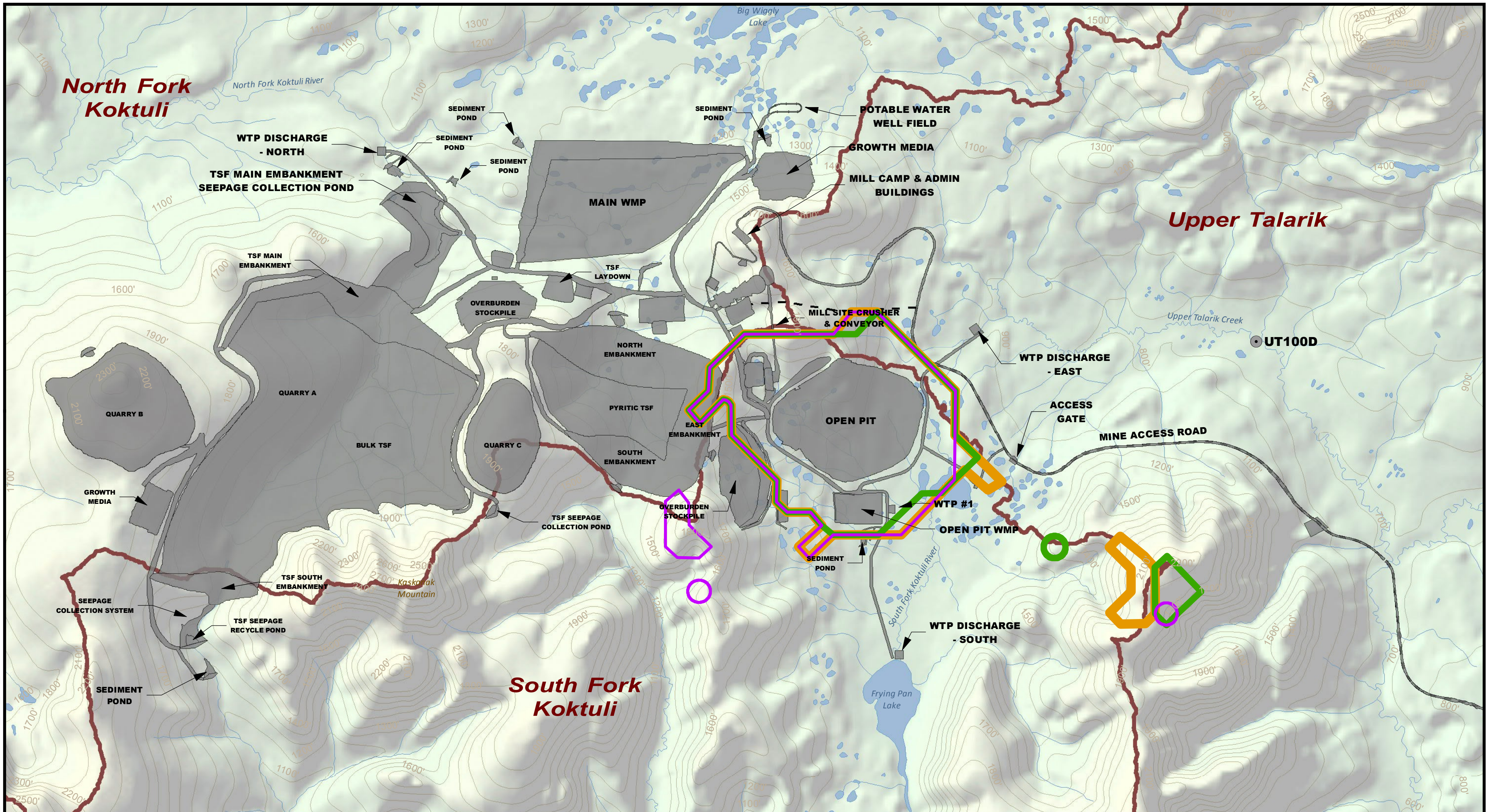
FIGURE 4.17-2

Closure and Post-Closure. Once mining ceases, dewatering activities would be reduced while potentially acid-generating (PAG) waste rock and pyritic tailings are returned to the pit, and groundwater in the open pit would be allowed to rise. It is estimated it would take 19 to 21 years for the groundwater in the pit to reach the maximum management (MM) level (890 feet above mean sea level [amsl]) (not-to-exceed level would be 900 feet amsl) (Knight Piésold 2018n). The model was used to select the not-to-exceed level to prevent flow reversal and lake water seepage away from the pit, based on the elevation below which the model predicts all flow directions are towards the pit. Groundwater levels surrounding the pit would be monitored throughout closure to determine whether this control elevation would need to be adjusted to prevent groundwater outflow from the pit (Knight Piésold 2018n).

The groundwater level in the pit would be maintained to create a permanent groundwater sink to prevent pit lake water from discharging to the environment. Knight Piésold (2018d) estimates an average annual pit water surplus of 3 cfs, which would be managed by pumping and treating groundwater to maintain the MM level in the pit lake and prevent lake water from discharging into the environment. This would result in a permanent pit lake that would be pumped to maintain the MM level indefinitely (allowing for 10 feet of freeboard to accommodate the probable maximum flood and still not breach the not-to-exceed level of 900 feet). The current closure water balance and water quality models are based on monthly flows (Knight Piésold 2018g); therefore, it is assumed that the pit lake would be pumped year-round.

The presence of a permanent groundwater sink at the pit would continue to influence groundwater flow in the immediate vicinity of the pit throughout post-closure. However, the influence on groundwater flow would be smaller than in its fully dewatered state during active mining operations. Piteau Associates (2018a) estimates that the extent of the post-closure cone of depression would range from a distance of about 1,500 feet from the pit crest along its northeastern side, to as much as 13,500 feet from the pit crest to the southeast, depending on the actual hydraulic characteristics of the affected aquifer (Figure 4.17-3). Similar to operations, the post-closure model results show a capture zone in an immediate area around the pit representing relatively shallow flowpaths; several outlying zones along upland ridges east and west of the pit representing deeper flowpaths; and intermediate areas where groundwater recharge is expected to discharge to local streams and seeps and not be affected by the capture zone. The input parameters and assumptions used to estimate the range of capture zones shown on Figure 4.17-3 are described in greater detail in Appendix K4.17, Groundwater Hydrology.



Sources: Piteau Associates 2018a, Fig. 8

Groundwater Capture Zones
- 5th percentile
- 50th percentile
- 95th percentile

Alternative 1
- Natural Gas Pipeline
- Project Features

Other Features
- 100' Contour (Existing)
- River/Stream
- Lake/Pond
- Major Drainage Boundary

US Army Corps of Engineers®

0.5 0 0.5 1
Miles

N

ESTIMATED RANGE OF GROUNDWATER CAPTURE ZONES IN POST-CLOSURE

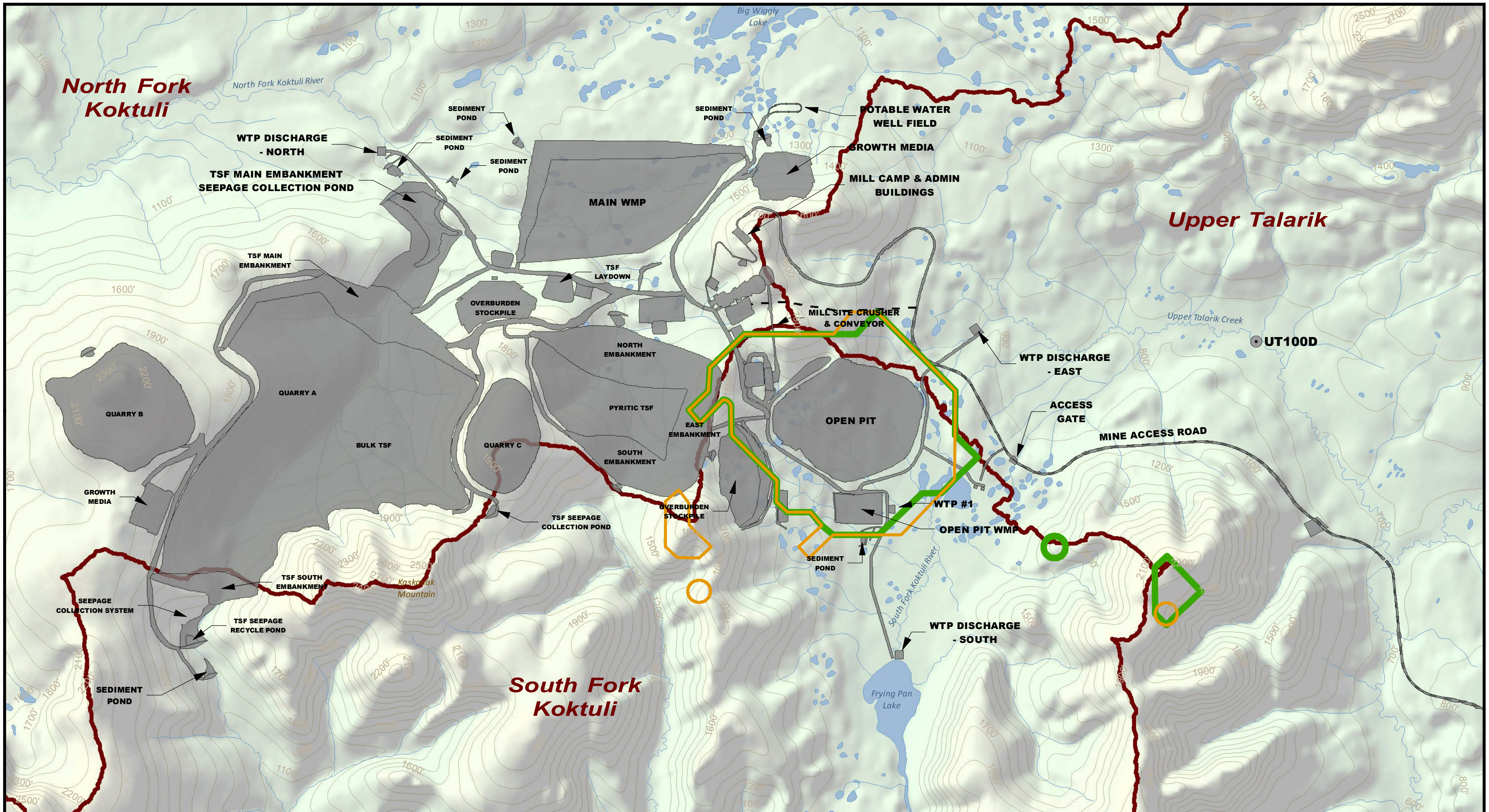
PEBBLE PROJECT EIS

FIGURE 4.17-3

A comparison between the estimated capture zones at the end of operations and post-closure is shown on Figure 4.17-4. The extent of the pit capture zone is expected to be roughly the same as during operations around the northern and southwestern sides of the pit; and in terms of magnitude, would shrink by about 1,000 to 3,000 feet elsewhere around the pit. The estimated extent of the capture zone in post-closure would be about 1,800 acres. The post-closure capture zone along the northeastern side of the pit is not much smaller than that at the end of operations, because the pit lake at its maximum elevation is below the lowest part of the bedrock ridge separating the pit from the UTC drainage, which causes shallow groundwater around the pit to continue discharging to the pit, similar to the end of operations. In contrast, the distal zone along the ridge east-southeast of the pit is predicted to be considerably smaller in post-closure, because this zone represents deeper flow paths in bedrock, where gradients would be reduced as the pit lake rises (Piteau Associates 2018a).

In terms of magnitude and extent, areas of wetlands indirectly affected by drawdown in post-closure would also shrink from those affected in operations, as shown on Figure 4.22-2 (acreages are provided in Section 4.22, Wetlands and Other Waters/Special Aquatic Sites). Duration of impacts would be long term, because impacted wetlands in the operations drawdown area outside of the post-closure area would be expected to recover after the final pit lake level is reached (PLP 2018-RFI 082). Uncertainty associated with these model projections is similar to those described as pertaining to the pit dewatering at the end of operations, as described in more detail in Appendix K4.17.

Impacts to groundwater from pit dewatering would occur if the project is permitted and constructed, and could include groundwater flow changes that affect the nearby environment. The duration of impacts would be more than 100 years, and the geographic extent could occur beyond local project component areas within the EIS analysis area.



Sources: Piteau Associates 2018a, Fig. 9

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0.5 0 0.5 1

Miles

Groundwater Capture Zones

- Post-closure
- End of Operations

Alternative 1

- Natural Gas Pipeline
- Project Features

Other Features

- 100' Contour (Existing)
- River/Stream
- Lake/Pond
- Major Drainage Boundary

COMPARISON OF GROUNDWATER CAPTURE ZONES IN OPERATIONS AND POST-CLOSURE

Water Management Ponds

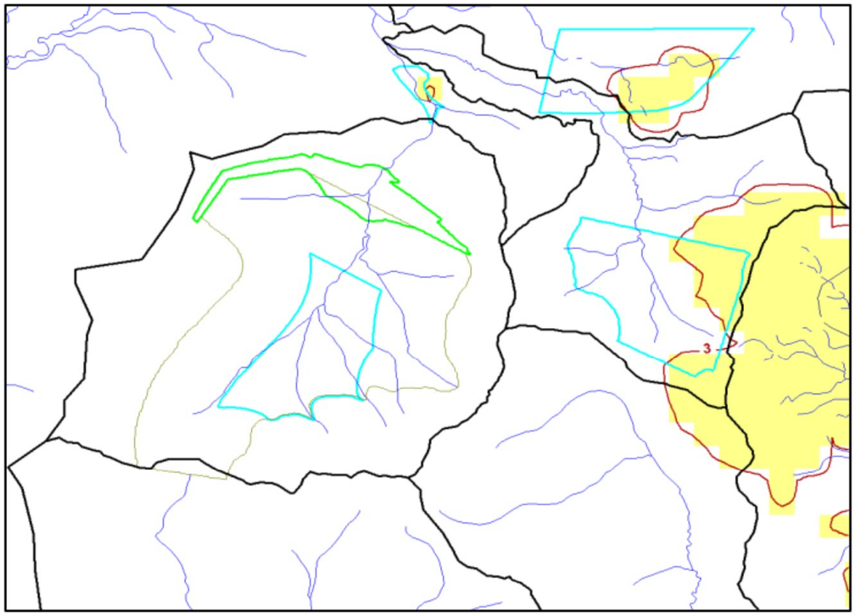
The main and open pit WMPs would be constructed at the mine site to manage water removed during pit dewatering, manage water from the milling and concentrating operations, and manage surface water runoff collected in the mine site. These ponds would be lined with high-density polyethylene (HDPE) and equipped with underdrains to minimize leakage of water with potentially elevated particulate and constituent concentrations to the underlying groundwater (PLP 2018-RFI 006). Water in the WMPs would be treated as needed, and used in the milling operations. The water may also be used in tailings disposal operations (to create a tailings slurry). Surplus water would be treated to discharge standards and released downstream of the mine site at specified discharge areas (see Section 4.16, Surface Water Hydrology, Figure 4.16-1) to mitigate surface water flow water balances downstream of the mine site (Section 4.16, Surface Water Hydrology). Surplus WMP water that is treated and discharged downstream of the mine site would help restore downgradient groundwater flow as it infiltrates into the subsurface to help maintain existing flow conditions.

Groundwater flow would be impacted by the construction of the WMPs, and local reduction in recharge caused by the presence of the liner. The groundwater model results indicate that groundwater levels would be lowered by several feet in the area of the main WMP (Figure 4.17-5). Modeling also indicates that the predicted change in groundwater levels would not change the estimated pre-mining groundwater discharge from sub-basin NF100C from 10.9 cfs compared to the end of operations scenario without treated water discharge (Knight Piésold 2018i). Removing the main WMP after closure would allow natural recharge to be re-established and groundwater elevations to recover.

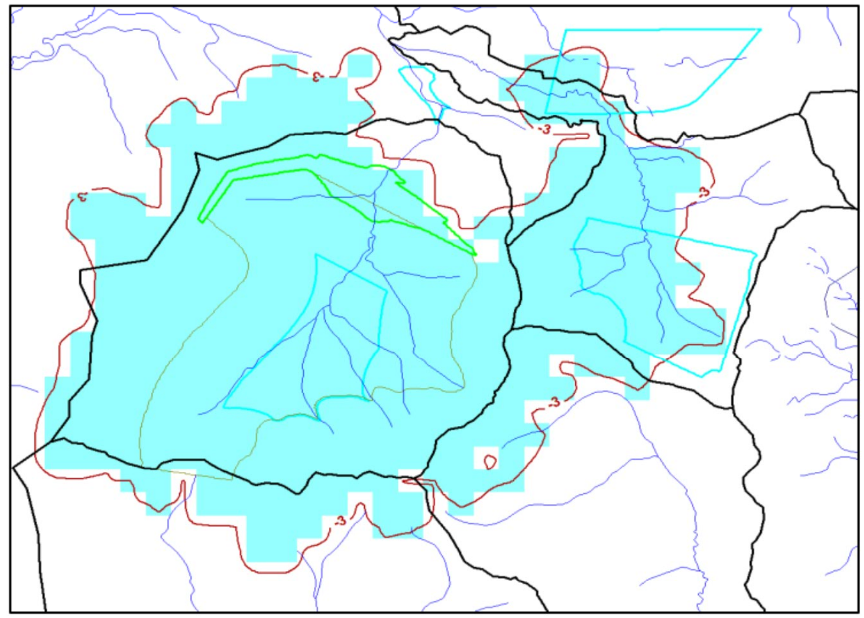
As described in Appendix K4.17, contact water that leaks through the main WMP liner to shallow groundwater would be mitigated by the monitoring/pumpback wells, which would continue to operate as long as required to intercept potential leakage. The wells would primarily be operated as monitoring wells unless leakage is detected; therefore, their impact on groundwater levels is expected to be intermittent, and limited to the immediate vicinity of the mine site. Based on data collected during construction and operations, the monitoring well network would be expanded or filled in as required (Knight Piésold 2018n).

The open pit WMP lies within the pit capture zone for all scenarios during operations (Figure 4.17-2). Therefore, any leakage from this pond is expected to report to the pit (Piteau Associates 2018a). The open pit WMP would be removed in early closure (Knight Piésold 2018d); any previously affected groundwater beneath this facility would lie within the post-closure pit capture zone (Figure 4.17-3), and continue to flow towards the pit.

Impacts to groundwater from the main WMP and open pit WMP would occur. The duration of impacts would be long term, lasting until the facilities are removed during closure. Effects could slightly exceed historic seasonal variation, but would not extend beyond project component areas.



3ft Drawdown



3ft Mounding

Sources: PLP (2019-RFI 109b)

Legend

Lower water table (Drawdown)

Higher water table (Mounding)

3 ft Drawdown/Mounding Contour

Notes:
1. Drawdown calculated as Pre-Mine Water Table minus End of Mine Water Table. Negative numbers indicate higher water levels, whereas positive numbers indicate lower water levels.
2. The Zone of Influence is defined by the 3 ft contour.

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SIMULATED ZONE OF INFLUENCE AT END OF OPERATIONS FOR TSFs AND MAIN WMP

PEBBLE PROJECT EIS

FIGURE 4.17-5

Tailings Storage Facilities

Bulk TSF

Bulk flotation tailings primarily composed of non-acid generating finely ground rock material generated during milling operations would be stored in a bulk tailings storage facility (bulk TSF) at the mine site. With the exception of the upstream face of the bulk TSF south embankment, which would be lined with HDPE, the bulk TSF would be unlined, and the bulk TSF main embankment would operate as a flow-through structure draining towards the north (see Section 4.15, Geohazards). The bulk TSF would be constructed in the NFK watershed, with a series of embankments to impound the tailings and entrained and ponded water. A drain system at the main embankment and a grout curtain at the south TSF embankment would manage seepage water draining through the main embankment from the tailings. The thickened bulk flotation tailings discharged to the TSF would settle, and water would collect in a pond on top of the tailings.

Seepage water draining through the main embankment from the tailings would be collected by a drain system and routed to a lined seepage collection pond (SCP) north of the TSF. Piteau Associates (2018a) estimates the bulk TSF would discharge approximately 0.1 cfs to shallow groundwater beneath the TSF at the end of operations. A larger component of flow (about 9 cfs) would go through the main TSF embankment. A basin underdrain system would be constructed at various locations throughout the main TSF basin to provide preferred drainage pathways for seepage flows (PLP 2018d). Seepage through the embankment would be collected in the bulk TSF main SCP (see Section 4.16, Surface Water Hydrology, Figure 4.16-1). The SCPs would be constructed with low-permeability cores and grout curtains to block groundwater flow. Any leakage through the bulk TSF south embankment would report to the bulk TSF south SCP, and be routed to the main WMP. Water collected in the SCPs would be used for tailings dust control, or transferred to the main WMP for subsequent use in ore processing. Surplus water in the main WMP would be treated to discharge standards, and released downstream of the mine site outside of the pit cone of depression.

As described in Appendix K4.17, because tailings along the northwestern ridge of the bulk TSF would be built up higher than the two saddles along this ridge, it is possible that there would be a potential for groundwater flow paths through these saddles in late operations. Groundwater levels would be monitored during operations in piezometers along the ridge and downstream of the embankment, and operational rules established to maintain hydraulic containment. If seepage through the ridge is detected, contingencies such as relief wells and/or seepage recovery wells would be implemented (Knight Piésold 2018n).

Some of the seepage from the bulk TSF tailings that enters shallow groundwater beneath the tailings would be expected to flow laterally and report to the SCP. Seepage water could also flow vertically downwards into deeper bedrock fractures.

Construction of the bulk TSF would locally impact surface water features at the site, and potentially impact groundwater/surface water interactions; this impact is expected to be modest in extent (e.g., approximately 8,000 acres [PLP 2019-RFI109b] near the vicinity of the bulk TSF), but permanent. The extent of the higher water table resulting from the TSF is shown on Figure 4.17-5. Grout curtains installed at the south TSF embankment and SCPs would locally impact groundwater flow in the overburden and shallow bedrock, but would not affect regional flow patterns. Tailings seepage from the bulk TSF could create local groundwater mounds[4] within and beneath the TSF basin, and in the valley between the main embankment and the

[4] Groundwater mounding refers to areas of locally higher water table elevation caused by infiltration or vertical seepage of surface water.

SCP. Mounding could cause a small portion of flow to be directed towards the sides of the valley, or become entrained in groundwater flow systems that extend beyond the mine component area. The seepage collection system associated with the bulk TSF is further described in Section 4.18, Water and Sediment Quality, along with potential impacts to groundwater quality as a result of seepage.

Pyritic TSF

The PAG pyritic tailings and PAG waste rock would be stored in a separate impoundment that is fully lined with HDPE and equipped with underdrains. Tailings would be placed on top of the liner and covered with water to minimize oxidation and the potential release of acidic contact waters to the environment. Groundwater levels would be reduced several feet by the construction of this impoundment due to local reduction in recharge caused by presence of the liner, and groundwater flow exiting sub-basin NK119A would be reduced from 0.8 cfs to 0, both without return of water from the WTP (Piteau Associates 2018a; Knight Piésold 2018i) (see Appendix K4.17, Figure K4.17-5). Like the main WMP, removing the pyritic TSF after closure would allow natural recharge to be re-established and groundwater elevations to recover, with the exception that groundwater elevations in the northeastern corner of the pyritic TSF footprint would continue to be influenced by the open pit capture zone in post-closure (Figure 4.17-3).

As described in Appendix K4.17, any liner leakage that reaches groundwater beneath the pyritic TSF is expected to flow north, with a small component migrating east, both of which would be captured by SCPs backed up by monitoring/pumpback wells that would continue to operate as long as necessary following decommissioning to intercept potential leakage (Knight Piésold 2018n).

The pyritic tailings would be moved to the bottom of the open pit at the end of mining, and submerged in the pit lake to prevent oxidation. The pyritic TSF liner and embankments would be removed at closure, and the site reclaimed by removing impacted materials, regrading, and capping with growth media (Section 4.16, Surface Water Hydrology describes closure in greater detail) (Knight Piésold 2018d). Therefore, groundwater flow in this tributary drainage is expected to essentially return to pre-mining conditions post-closure (Section 4.16, Surface Water Hydrology).

Impacts to groundwater from the pyritic TSF facility would occur if the project is permitted and constructed, and would be long term, lasting until the facilities are removed during closure. The magnitude and extent of effects could slightly exceed historic seasonal variation, but would not extend beyond project component areas.

Potable Well Supply

There would be no effects on any community groundwater or surface water supplies from the changes in groundwater flows at the mine site. The closest such water systems are located about 15 to 20 miles east and southeast of—and on the opposite side of the UTC-Newhalen River watershed divide from—the pit groundwater capture zone (see Section 3.16, Surface Water Hydrology, Figure 3.16-15; and Section 3.17, Groundwater Hydrology, Figure 3.17-12).

Potable water at the mine site would be supplied by a series of groundwater wells located north of the mine site (in the Big Wiggly Lakes area), outside of the estimated cone of depression around the proposed open pit. The wells would be located upgradient or side-gradient of the main WMP (see Section 3.17, Groundwater Hydrology, Figure 3.17-9 and Figure 3.17-10, and Section 4.16, Surface Water Hydrology, Figure 4.16-1), which is the closest potential source of groundwater contamination. The wells would be pumped at rates described below to provide sufficient potable water for mine site personnel living and working at the site. The potable water supply wells would also be used for fire-fighting, if needed.

As indicated in the project description (PLP 2018d) and Knight Piésold (2018e), a 250-person camp would initially be built to support early site construction activities. This camp would then be supplemented by the main camp, which would accommodate about 1,700 workers during construction. The main camp would be converted at the end of construction into a permanent facility expected to house 850 workers. Assuming an average water requirement of 50 gallons per day (gpd) per person to support the camps (ADNR 2018f), and an additional 10 gpd per person for the other facilities, the magnitude of impacts from camp water requirements would be a maximum daily volume of 102,000 gallons. In terms of magnitude, the total average water flow requirement rate during construction for the camps is estimated to be about 80 gpm, which is near the upper end of the range of pumping rates achieved during the pumping tests. This average demand is expected to be met by the installation of a single pumping well with two backup wells to allow for regular downtime and maintenance. During operations, the potable water requirement would be reduced to about 35 gpm. The potable water would be distributed through a pump-and-piping network to supply fresh water to holding tanks at the camps and other facilities. The holding tank capacity would be sufficient for a 24-hour supply. Impacts from pumping at the potable water supply well have not been modeled; but based on borehole and well testing results, expected aquifer conditions (Section 3.17, Groundwater Hydrology), and assuming the well would be pumped intermittently to maintain holding tank capacity, the well is expected to have negligible impact on local groundwater flow. Water-level fluctuations caused by pumping are expected to be approximately of the same magnitude as natural seasonal fluctuations of water levels.

4.17.3.2 Transportation Corridor

Shallow Groundwater Interception. The transportation corridor is designed to avoid wetlands and stream crossings where feasible, and its alignment would be optimized for the most amenable soil and geotechnical conditions. Road beds are typically constructed well above the water surface elevation in adjacent ditches, and are typically of suitable materials to avoid groundwater retention in the road prism. Therefore, road construction would not have an areal effect on groundwater/surface water interactions, other than the possible need to temporarily dewater some stream or lowland crossings as construction proceeds. Local groundwater flow impacts may occur along the corridor, where the roadway is constructed across wetlands that may be supported by groundwater inflow.

Some road segments would require road cuts to maintain proper road grade. These are represented by wide areas of the road footprint on hillslopes (PLP 2017: Figures T-001 through T-046), which are prevalent throughout much of the mine and port access and spur road corridors. Because shallow groundwater is expected to be present across the mine and port access road corridors, it is possible that road cuts could intersect groundwater in some areas, and cause a local diversion of groundwater flow, as drainage controls (construction BMPs as described in Chapter 5, Mitigation) direct potential seepage away from the road. In addition, benched cuts at material sites would likely intercept groundwater. These diversions would generally not move water to a different drainage, or cause dewatering of wetlands or waterbodies extending more than a few feet from the road corridor or material sites.

Ferry Terminals. At the ferry terminals, there could be a deviation of groundwater flow on a facility footprint scale as a result of foundation materials that differ in hydraulic properties from native soil. These effects are expected to be limited to the footprint of these facilities. The lake portion of ferry terminal construction is not expected to impact groundwater.

Water Extractions. Surface water/groundwater interaction is expected to occur at locations used for surface water extraction where shallow groundwater is present. Groundwater occurrence in glacial and alluvial deposits along the mine access road is similar to that of the mine site. Shallow groundwater occurrence is limited along the port access road due to the presence of shallow bedrock. In terms of magnitude and extent, approximately 50 million gallons of surface water would be extracted from 21 water extraction sites along the port and access road corridors, mostly for use in road construction activities (PLP 2018-RFI 022) (see Figure 4.16-7). This water would be extracted at specific permitted locations along the mine and port access road corridors over months to years of construction (see Section 4.16, Surface Water Hydrology). The extraction would draw connected shallow groundwater toward extraction sites. Temporary construction camps located at Amakdedori port, Kokhanok, Iliamna, Newhalen, the mine site, and the north and south ferry terminals may be supplied by local groundwater sources, and would be authorized by Temporary Water Use Authorizations from ADNR. The extent of impacts would be limited to the immediate area of the camps, and duration would be long term, lasting throughout the mine life, but would be temporary; because once water drawdown ceases, groundwater would no longer be drawn towards the extraction facilities.

4.17.3.3 Amakdedori Port

Shallow Groundwater Interception. The port site is designed to avoid wetlands where feasible, and its footprint would be optimized for the most amenable soil and geotechnical conditions. Excavations across the port footprint may be required during port and dock construction. The elevation of the terminal area is about 15 to 20 feet above that of the Amakdedori Creek floodplain, which has a high water table in alluvial deposits that are hydraulically connected to Amakdedori Creek. The closest distance of the terminal to the floodplain would be about 700 feet (see Figure 2-28). Because of the elevation difference and distance to the floodplain, excavations are not expected to intercept shallow groundwater in this area. Mounding of groundwater is not expected to occur due to infiltration of fill placed for terminal construction, because the terminal would be paved and runoff controlled.

The marine portion of the port construction would have no effect on groundwater. Impacts to groundwater would be limited to within the footprint of material sites used for dock construction, and would occur only during construction.

Groundwater Use. Based on limited hydrogeologic information at the port site, shallow glacial and fluvial sediments in the area are likely to host groundwater (Glass 2001; Detterman and Reed 1973; Zonge 2017). A groundwater well is planned to supply potable water for port personnel and/or fresh water for operations. The precise location for the well would be identified during detailed design. The well would be sited on uplands far enough from the shore to avoid any potential for saltwater intrusion, and water would be piped to the site from the wellhead (PLP 2018-RFI 022a). It is anticipated that such a well would have a local (i.e., a few feet to a few tens of feet radius) impact on groundwater flow and quantity, depending on rate and frequency of drawdown caused by pumping. The duration of impacts would be long-term, lasting through the life of the project. Water rights authorization for water production from the well would be acquired, and the design of the well production activities would be reviewed and approved by ADEC.

4.17.3.4 Natural Gas Pipeline Corridor

Shallow Groundwater Interception. Like the transportation corridor, the water table is expected to be close to the surface along much of the pipeline corridor, as evidenced by abundant wetlands, kettle ponds, and exposed bedrock. Groundwater along the pipeline corridor coincident with the northern mine access road is expected to be held in shallow aquifers of glacial sediment, as demonstrated in similar geologic terrain at the mine site (see Section 3.13, Geology). Much of the buried pipeline in this area could intersect shallow groundwater, as shown by the distribution of wetlands on Figure K4.22-1. Shallow groundwater occurrence along the pipeline adjacent to the southern part of the mine access road is expected to be more limited, because much of this route appears to be sited on a well-drained terrace of surficial deposits several tens of feet above First Creek floodplain. Shallow groundwater along the route south of Iliamna Lake is expected to be sparse and intermittent due to lengthy segments through exposed bedrock.

Potential impacts to groundwater would involve interception of shallow groundwater during trenching activities, which could be captured and locally routed along the trench backfill. Modifications to groundwater flow would occur mostly in the immediate vicinity of the trench. Impacts could extend beyond the life of the project, because the pipeline may be abandoned in place. Low-permeability trench plugs, considered a typical best management practices (BMP) for pipeline installation (e.g., USACE 2018c), could be installed to minimize movement of groundwater along the trench; reduce erosion along the trench backfill; and minimize alteration of the natural groundwater flow path.

Horizontal Directional Drilling. On the Kenai Peninsula, the pipeline would be trenched for a short distance west of the compressor station, and then installed by HDD at the shoreline and into Cook Inlet from an elevation of about 200 feet to -12 feet mean lower low water (PLP 2018-RFI 011). Groundwater is present in this area in aquifers in glacial and alluvial deposits, and Tertiary-age (approximately 66 to 2.6 million years ago) sedimentary bedrock. Although the exact depth to groundwater is unknown at the HDD location, nearby wells drilled at similar elevations to the HDD work area encountered shallow water-bearing glacial deposits at depths between 8 and 30 feet below ground surface, as well as deeper aquifers in both glacial deposits and sedimentary bedrock units between 50 and 120 feet deep (USGS 1967; Nelson and Johnson 1981; ADNR 2018). Therefore, the HDD-installed pipeline segment would be expected to intersect these aquifers, which are used near the project footprint by private wells (see Figure 3.17-13).

Dewatering would not be required for HDD drilling (PLP 2018-RFI 051). Other effects on groundwater might include pressurization of the hole, forcing drilling fluids into aquifers (e.g., TRCA 2010). In terms of extent, it is possible for drill fluid to travel short distances from the borehole due to this pressure, and have an effect on groundwater flow patterns in the immediate vicinity of the drill-site. Drilling fluid returns would be monitored during drilling, and drilling specifications and a mud plan developed during detailed engineering to avoid the potential for injection of drill fluid into the aquifer. Typical mitigation procedures (see Chapter 5) may include lowering drill fluid pressure, temporary rig shutdown, adjusting fluid viscosity, and adding solids to the fluid to reduce loss into the formation (PLP 2018-RFI 051). These effects are expected to be temporary, recovering days or weeks after construction. Potential effects on groundwater quality from drill fluid loss are discussed in Section 4.18, Water and Sediment Quality.

4.17.3.5 Alternative 1 – Summer-Only Ferry Operations Variant

The expected magnitude, extent, duration and likelihood of effects of this alternative variant are similar to those described under Alternative 1. The main difference between Alternative 1 and this variant relates to the need to construct concentrate and fuel storage facilities at the mine site or at the Amakdedori port site (Ausenco 2018). There would be no effects on groundwater from the seasonal-only use of Iliamna Lake. The extent of the expanded container yard at the port site would reach the edge of the Amakdedori floodplain. Therefore, excavations during construction in this area are more likely to intercept shallow groundwater than under Alternative 1 without this variant.

The expanded facilities at both the mine and port sites could have a short-term impact on shallow groundwater during construction from drainage controls or fill; and longer-term impacts on surface water/groundwater interactions and groundwater recharge from the installation of liners to control leaks or spills, which would be disturbed during construction, and continue throughout the life of the project. The extent of these effects would be limited to the immediate vicinity of the mine or port. Although long term, lasting though the life of the project, they would be reasonably restored once mining ends and the port site is reclaimed (PLP 2018-RFI 024).

4.17.3.6 Alternative 1 – Kokhanok East Ferry Terminal Variant

The expected magnitude, extent, duration, and likelihood of effects of this alternative are similar to those described under Alternative 1. The main difference between Alternative 1 and this variant is that the extent of the Kokhanok east route is approximately 15 percent shorter, which would reduce potential shallow groundwater and water extraction impacts (if any) associated with access road and pipeline construction. It is also anticipated that fewer streams and wetlands would be impacted (see Section 4.16, Surface Water Hydrology, and Section 4.22, Wetlands and Other Waters/Special Aquatic Sites), because the Kokhanok east route is shorter, and the Kokhanok east spur and port access roads are located along ridge tops once they separate from the proposed route in Alternative 1. However, the footprint of material sites associated with this variant are larger than Alternative 1 (Table 2-2), and would therefore have a slightly greater impact on shallow groundwater in the immediate vicinity of the materials sites during construction. Shallow groundwater impacts from construction of the Kokhanok east ferry terminal would be short term, and similar to those of the proposed south ferry terminal, and would only occur during construction.

4.17.3.7 Alternative 1 – Pile-Supported Dock Variant

The expected magnitude, extent, duration, and likelihood of effects of this alternative are similar to those described under Alternative 1 for the onshore parts of the Amakdedori port site. Because there would be no need for fill by the dock structure, the effects of borrow material extraction on shallow groundwater interaction would be slightly less under this variant. Therefore, a pile-supported dock would have less impact than the earthfill dock proposed under this alternative.

4.17.4 Alternative 2 – North Road and Ferry with Downstream Dams

4.17.4.1 Mine Site

The expected magnitude, extent, duration, and likelihood of effects of this alternative are similar to those described under Alternative 1 for the mine site. The downstream dam (and bulk TSF south embankment) would be about 15 feet higher in elevation at its maximum height (see Table K4.15-1), and therefore would have a higher water table and be more likely to experience seepage through the topographic saddles on the eastern and western sides of the impoundment. This is expected to be mitigated by piezometer monitoring and relief wells and/or seepage recovery wells as necessary (PLP 2018-RFI 019c). The predicted seepage rates through the embankment and vertically through the tailings to shallow groundwater would be essentially the same as those predicted by the groundwater model under Alternative 1.

4.17.4.2 Transportation Corridor

The expected magnitude, extent, duration, and likelihood of effects of Alternative 2 on shallow groundwater are similar or slightly greater than those described under Alternative 1. This is because although the extent of the total access road lengths would be shorter under Alternative 2 than Alternative 1 by about 20 miles, and would have three fewer material sites, Alternative 2 is expected to intersect more shallow groundwater overall than under Alternative 1 due to the nature and distribution of surficial deposits and terrain. The eastern part of the mine access road has an abundance of surficial deposits that are more likely to contain shallow groundwater and wetlands (see Figure 3.13-4 and Figure K4.11-1). Also, the Alternative 2 port access road has steep terrain and more side-hill cut requirements, while the port access road under Alternative 1 has sparse surficial deposits and fewer cut-slope requirements.

4.17.4.3 Diamond Point Port

In terms of magnitude and extent, the onshore footprint of the Diamond Point port is larger than at Amakdedori due to the need for a dredge materials storage area. The terminal is located in an area of alluvial fan deposits at the mouth of the small drainage (see Figure 2-58), which are expected to have a shallow water table. In terms of extent and duration, construction excavations could intercept groundwater and temporarily alter natural flow patterns within this immediate area of the port. The duration of impacts would be short term, lasting only through construction. Placement of fill in this area could also result in groundwater mounding in the fill, which would likely be mitigated through drainage controls (see Chapter 5). The expected effects of Alternative 2 from groundwater use are similar to those described under Alternative 1 for Amakdedori port.

4.17.4.4 Natural Gas Pipeline Corridor

The types of effects of Alternative 2, and their magnitude, extent, duration, and likelihood on shallow groundwater along the natural gas pipeline corridor are similar to those described under Alternative 1, because the natural gas pipeline would be mostly buried in a trench along the transportation corridor roadside. The extent and duration of impacts would be an effect on shallow groundwater flow in the vicinity of the pipeline right-of-way (ROW) during construction; however, the use of trench plugs, as is typical of pipeline construction BMPs in wet areas, would reduce the alteration of the natural groundwater flow patterns and minimize erosion along the trench backfill. The extent of effects would be greater under Alternative 2 than Alternative 1 due to the greater pipeline length through areas with shallow groundwater. The extent of the onshore part of the pipeline trench under Alternative 2 is about 24 miles longer than Alternative 1, and includes a greater distance through surficial deposits that are expected to contain shallow groundwater.

4.17.4.4 Alternative 2 – Summer-Only Ferry Operations Variant

The expected magnitude, extent, duration, and likelihood of effects of Alternative 2 on shallow groundwater for the Summer-Only Ferry Operations Variant would be similar to those described for the Summer-Only Ferry Operations Variant under Alternative 1. Impacts to groundwater from the additional container storage at Williamsport would be similar to those described for the transportation corridor for this variant. The footprint at this location is slightly wider than the mine and port access road corridors under Alternative 2. Therefore, there would likely be additional groundwater intersection and diversion on the 2,500-foot-long cut-slope side of the storage area, which would last throughout operations.

4.17.4.5. Alternative 2 – Pile-Supported Dock Variant

The magnitude, extent, duration, and likelihood of expected effects of this variant on shallow groundwater for the onshore part of the Diamond Point port site are similar to those described for Alternative 2. There would be no effects on groundwater for the onshore part of this dock variant.

4.17.5 Alternative 3 – North Road Only

4.17.5.1 Mine Site

The magnitude, extent, duration, and likelihood of expected effects of Alternative 3 on shallow groundwater at the mine site are the same as those described under Alternative 1.

4.17.5.2 Transportation Corridor

The magnitude and duration of the effects of Alternative 3 on shallow groundwater in the transportation corridor are similar to those described under Alternative 1. The magnitude and extent of affected groundwater resources would be slightly greater than both Alternatives 1 and 2. This is because the north access road under Alternative 3 would be about 6 miles longer than Alternative 1, and 38 miles longer than Alternative 2. It would cross a greater distance of groundwater-bearing surficial deposits along its western part, and require a greater distance of side-hill cuts in steep terrain that could intersect groundwater.

4.17.5.3 Diamond Point Port

The expected magnitude, extent, duration, and likelihood of effects of Alternative 3 on shallow groundwater at the Diamond Point port are similar to those described under Alternative 2 for the Diamond Point port.

4.17.5.4 Natural Gas Pipeline Corridor

The magnitude and duration of the effects of Alternative 3 on shallow groundwater along the natural gas pipeline corridor are similar to those described under Alternative 2. There would be a slightly increased magnitude and extent of impacts due to the 1-mile-longer pipeline route length. The extent of affected groundwater resources under both Alternatives 2 and 3 would be greater than Alternative 1 due to the greater pipeline length through areas of groundwater-bearing deposits north of Iliamna Lake.

4.17.5.5 Alternative 3 – Concentrate Pipeline Variant

The magnitude, extent, duration, and likelihood of expected effects of this variant on shallow groundwater are similar to those described under Alternative 3 for the transportation corridor and gas pipeline, given that the concentrate pipeline would be placed in the same excavation as the natural gas pipeline along the north access road. The primary difference in water use between this variant of Alternative 3 and other alternatives is the loss of 1 to 2 percent of the water used to slurry the concentrate that would otherwise be available for discharge at the mine site to drainages affected by embankment blockage and pit dewatering. Reduced flow to surface water at the NFK, SFK, and UTC discharge sites by a similar percentage would result in slightly decreased recharge to groundwater in the upper portions of these drainages.

The magnitude, extent, duration, and likelihood of impacts to groundwater at the Diamond Point port site under this variant would be the same as Alternatives 2 and 3, because there would be no change in total footprint, and no impacts to groundwater from treatment and offshore discharge of slurry water.

4.17.6 Summary of Key Issues

See Table 4.17-1 for a summary of key issues related to groundwater hydrology.

Table 4.17-1: Summary of Key Issues for Groundwater Hydrology Resource

Impact Causing Project Component	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
Mine Site			
Groundwater diversion and reduction in recharge during construction and operations at pyritic TSF, WMPs, and other mine facilities Water-table mounding in, below, and in vicinity of bulk TSF	**Alternative 1:** Diverted groundwater at TSFs and WMPs would be largely captured, treated, and discharged to the affected drainages during construction and operations to approximately restore natural flow conditions, as described in more detail in Section 4.16, Surface Water Hydrology. Small reduction (several feet) in groundwater elevation expected beneath lined facilities during operations due to blocked recharge. Water-table mounding under and in non-lined bulk TSF and increased flow to bedrock aquifer. **Summer-Only Ferry Operations Variant:** Additional facilities at mine site and Amakdedori port for storage of materials would cause additional changes in groundwater recharge through operations phase.	**Alternative 2:** The downstream dam would have a higher maximum crest and water table elevation is more likely to create potential seepage through topographic saddles on eastern and western sides.	**Alternative 3:** Same as Alternative 1 **Concentrate Pipeline Variant:** Slightly decreased groundwater recharge at mine site due to diversion of 1 to 2% of mine site groundwater to slurry concentrate.
Groundwater use for potable water supply during construction and operations	Groundwater use would be highest during construction and operations, and is expected to largely recover to pre-mining levels once reclamation occurs in closure.	Same as Alternative 1	Same as Alternative 1
Open pit dewatering	Groundwater-level change up to 2,200 feet below baseline condition during operations, recovering to 90 to 350 feet below original level in post-closure. The large range is because of the high pre-mining water table slope across the open pit footprint (see Section 3.17, Groundwater Hydrology, Figure 3.17-9b). Groundwater flow direction	Same as Alternative 1	Same as Alternative 1

Table 4.17-1: Summary of Key Issues for Groundwater Hydrology Resource

Impact Causing Project Component	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
	change caused by flow towards open pit, which acts as hydraulic sink and would remain so in perpetuity. The areal extent of the cone of depression surrounding the open pit would increase as mining proceeds and the open pit becomes deeper. The estimated maximum area of the capture zone at end of mining would be about 2,700 acres. The areal extent of the cone of depression would decrease as the pit fills with groundwater to form a pit lake; however, a cone of depression would exist around the pit in perpetuity. The estimated area of the capture zone at post-closure and beyond would be about 1,800 acres.		
Transportation Corridor			
Groundwater diversion during construction	**Alternative 1:** Groundwater flow systems are maintained; temporary flow interruptions during construction. **Summer-Only Ferry Operations Variant:** No impacts to groundwater from seasonal lake crossings. **Kokhanok East Ferry Terminal Variant:** Similar to Alternative 1; slightly less impact during road construction due to 15% shorter route and slightly more during material extraction due to larger footprint.	**Alternative 2:** Similar to Alternative 1, although slightly more impacts due to greater route length through areas of shallow groundwater-bearing deposits and steep cut slopes. **Summer-Only Ferry Operations Variant:** Slightly more groundwater diversion at Williamsport container storage along cut slope.	**Alternative 3:** Similar to Alternative 1, although impacts slightly more than Alternatives 1 and 2 due to greater route length through areas of shallow groundwater-bearing deposits and steep cut slopes. **Concentrate Pipeline Variant:** Similar to Alternative 3. Buried in same trench as natural gas pipeline; trench is slightly larger than gas pipeline-only installation, and may slightly increase temporary groundwater impacts; groundwater flow systems are maintained; temporary flow interruptions during construction.
Water extraction and groundwater use during construction and operations	Impacts to groundwater from surface water extraction and groundwater use at the construction camps would be short term, and the aquifer would return	Same as Alternative 1	Same as Alternative 1

Table 4.17-1: Summary of Key Issues for Groundwater Hydrology Resource

Impact Causing Project Component	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
	to historical levels once operations end.		
Port Sites			
Groundwater diversion during construction	**Alternative 1:** Groundwater flow systems are maintained; temporary flow interruptions during construction. **Summer-Only Ferry Operations Variant:** Similar to Alternative 1; increased likelihood of intersecting shallow groundwater along Amakdedori Creek floodplain due to larger footprint. **Pile-Supported Dock Variant:** Slightly less impact to groundwater at borrow sites due to less fill needs.	**Alternative 2:** Types of impacts similar to Alternative 1, although construction excavations at Diamond Point terminal more likely to intersect shallow groundwater-bearing deposits than at Amakdedori. **Pile-Supported Dock Variant:** Same as Alternative 1	**Alternative 3:** Same as Alternative 2 **Concentrate Pipeline Variant:** Same as Alternatives 2 and 3
Groundwater use at port during operations	Changes in groundwater quantity from water supply well would be within historical seasonal variability.	Same as Alternative 1	Same as Alternative 2
Natural Gas Pipeline			
Groundwater diversion during construction	**Alternative 1:** Groundwater flow systems are maintained; temporary flow interruptions during construction. **Kokhanok East Ferry Terminal Variant:** similar to Alternative 1; slightly less impact due to shorter pipeline route.	Similar to Alternative 1; temporary groundwater impacts would be slightly more due to greater route length through areas of shallow groundwater-bearing deposits and steep cut slopes.	Similar to Alternative 2; trench footprint is 10% longer than Alternative 2, slightly increasing temporary groundwater impacts. Impacts slightly more than Alternative 1 due to greater route length through areas of shallow groundwater-bearing deposits and steep cut slopes.
Groundwater use during construction	Groundwater use at the construction camps would be short term, and aquifer would return to historical levels once construction ends.	Same as Alternative 1	Same as Alternative 1

4.17.7 Cumulative Effects

The geographic area considered in the cumulative effects analysis for groundwater hydrology is the near vicinity (i.e., within 0.5 mile to several miles) of all project components where project-related effects on groundwater flow patterns and use could overlap with other past, present, and reasonably foreseeable future surface and groundwater uses.

Past, present, and reasonably foreseeable future actions (RFFAs) within the cumulative impact study area have the potential to contribute cumulatively to impacts on groundwater. Section 4.1, Introduction to Environmental Consequences, details the past, present, and RFFAs considered for evaluation. Several of these are considered to have no potential for cumulative impacts on groundwater flow and quantity in the EIS analysis area. These include non-industrialized point source activities that are unlikely to result in any appreciable impact beyond a temporary basis (e.g., subsistence, tourism, recreation, hunting and fishing). Other RFFAs removed from further consideration include those sufficiently distant from the study area to eliminate groundwater co-use by other parties (e.g., Donlin, Shotgun), or those RFFAs that occur in the marine environment of Cook Inlet (e.g., lease sales or proposed pipeline crossings).

The most important potential future actions in this analysis are those that are likely to contribute to impacts on groundwater flow and quantity in close vicinity to aquifers affected by the project. RFFAs that could contribute cumulatively to groundwater quantity and flow impacts, and that are therefore considered in this analysis, are limited to those activities that would occur in the mine site vicinity, or immediately within or adjacent to the transportation corridor. These include:

- Pebble Project buildout—development of 55 percent of resource over a 78-year period.
- Exploration activities at nearby Big Chunk South and Groundhog prospects.
- Diamond Point rock quarry
- Lake and Peninsula Borough (LPB) transportation projects along Williamsport-Pile Bay, Nondalton-Iliamna, and Kaskanak-Igiugig roads.

4.17.1.1 Past and Present Actions

Past and present activities that have affected groundwater hydrology in the EIS analysis area include development of water supply wells in communities around Iliamna Lake, small-scale wells or seeps associated with cabins and camps along the pipeline route, or mining exploration near the project area (e.g., pump tests, camp water use). Impacts associated with these activities include localized changes in groundwater flow patterns, reductions in groundwater in aquifers, and use of streams that are hydraulically connected with groundwater. These past and present actions are expected to continue throughout the project area, primarily in and around Iliamna Lake villages. Other parts of the project would be located in more remote areas, characterized as having very little development, and past and present activities are seasonal in nature and do not substantially draw from groundwater resources during mining exploration (see Section 3.17, Groundwater Hydrology). Mining exploration activities on State lands are subject to exploration permits, with requirements for inspections and appropriate reclamation.

4.17.7.2 Reasonably Foreseeable Future Actions

No Action Alternative

Under the No Action Alternative, exploration activities would continue to occur at the mine site and other exploration prospects in the vicinity. During these activities, there could be limited groundwater extraction from pump tests that result in a temporary localized lowering of the water table, which would be expected to recover to natural conditions within hours or days after the tests.

Alternative 1 – Applicant's Proposed Alternative

Pebble Mine Expanded Development Scenario. An expanded development scenario for this project, as detailed in Table 4.1-2, would include an additional 58 years of mining and 20 years of additional milling over a substantially larger mine site footprint, and would include increases in port and transportation corridor infrastructure under Alternative 1. The Pebble Project expansion would result in additional development not included under the other alternatives:

- Increased pit footprint and depth.
- Increased TSF and PAG storage footprints with additional SCPs.
- new waste rock storage and footprints with additional SCPs.
- Additional processing infrastructure.
- Construction of a new port site with additional access road and pipelines extending to the mine site.

The buildout would correspond to about a six-fold increase in the footprint of the pit, an increase in pit depth to about 3,500 feet (PLP 2018-RFI 094), and a duration increase of up to 78 years for the operations capture zone. Assuming the expanded pit encounters similar units with a similar range of hydrogeologic parameters as those around the Alternative 1 pit (Piteau Associates 2018a; Knight Piésold 2018n), the magnitude and extent of the expanded pit capture zone would be larger to account for the deeper and wider pit. Assuming a similar slope for the cone of depression (based on similar hydrogeology), the estimated capture zone for the expanded dewatered pit during operations would be an irregular circle about 5 miles across (about 20 square miles) straddling the SFK and UTC drainages, although it could extend 1 to 2 miles further south along the ridge between these watersheds, if similar to the modeled capture zone under Alternative 1 (Figure 4.17-2).

Based on the position of the expanded pit relative to watershed divides, the expanded capture zone would likely draw roughly equal amounts of inflow from the SFK and UTC watersheds. This would include vertical seepage that reaches shallow groundwater from approximately the western quarter of the north waste rock facility (WRF) and the northern half of the south WRF (see Section 4.1, Introduction to Environmental Consequences, Figure 4.1-1).

The surface area of the expanded pit capture zone (estimated to be 20 miles) is roughly five times greater than that of the proposed pit capture zone (about 4 square miles). Assuming the volume of groundwater inflow to the pit is roughly proportional to the surface area of the capture zones, it is estimated that the expanded pit would draw about five times more groundwater than under Alternative 1; or about 12,000 gpm (27 cfs) near the end of operations and 6,500 gpm (15 cfs) in post-closure. About half of this inflow would come from the SFK watershed and half from UTC. It is assumed that there would be WTP discharge locations similar to Alternative 1 in operations and closure, with discharge locations downstream of major facilities in each of the main watersheds: NFK in approximately the same location as under Alternative 1, SFK downstream of the south WRF collection pond, and UTC downstream of the north WRF collection pond. Streamflow reductions in SFK and UTC due to the pit capture zone would be somewhat mitigated by treated water being returned to these watersheds. Effects on streamflow reduction from the expanded mine scenario are further discussed in Section 4.16, Surface Water Hydrology.

The extent of the pit capture zone would not affect existing drinking water supply wells in Newhalen or Iliamna, or the community surface water system in Nondalton (Section 3.16, Surface Water Hydrology), which are located about 10 to 12 miles east and southeast of the expanded pit capture zone, and in a different drainage on the other side of the UTC-Newhalen River watershed divide.

The estimated footprint of the lined pyritic TSF would be about 2.5 times greater than under Alternative 1 (Section 4.1, Introduction to Environmental Consequences, Figure 4.1-1). This would reduce the amount of natural recharge to groundwater and lower the water table elevation beneath the expanded facility in a fashion similar to that described under Alternative 1 (Appendix K4.17, Figure K4.17-5), but in an area about 2.5 times greater. The area of lowered water table beneath the main WMP would remain the same under the expanded mine scenario. Diverted runoff and collected seepage from unlined project facilities, such as the expanded bulk TSF and WRFs, would alter local groundwater flow patterns and natural discharge to streams over a wider area than under Alternative 1 as the flow is captured in downstream SCPs and treated and discharged to downstream areas.

The effects of the project on groundwater would be limited to the near vicinity of the mine site, and would be reduced in post-closure as the site is reclaimed and groundwater returns to pre-mining conditions in all areas except the bulk TSF, WRFs, and open pit, where groundwater impacts would remain. The post-closure pit capture zone would likely be reduced compared to the operations capture zone by an amount similar to that of Alternative 1; that is, the capture would be about one-third smaller in extent than during operations, and would remain in perpetuity to maintain a hydraulic sink towards the pit.

The potential for impacts on shallow groundwater interception along the transportation and pipeline corridors would increase under the expanded mine scenario, because both the north and south access corridors would be used, and the north corridor would eventually be wider and longer to accommodate a diesel pipeline. In addition, the development of a port at Iniskin Bay would increase the potential for localized shallow groundwater interaction effects during construction. The cumulative effects of the non-mine site components under the expanded mine scenario would be similar to the combined impacts of both Alternatives 1 and 3.

Other Mineral Exploration and Road Development Projects. Nearby RFFAs associated with mineral exploration activities (e.g., Big Chunk South and Groundhog) could have some limited impacts on groundwater in common watersheds to the Pebble project—for example, from pump tests or camp groundwater use; however, they would be seasonally sporadic, temporary, and localized, based on their remoteness.

The potential exists for greater impacts on groundwater hydrology during construction and maintenance of LPB transportation infrastructure that is co-located or close to the Pebble Project. For example, the Nondalton-Iliamna and Kaskanak-Igiugig road projects could intercept shallow groundwater during construction that is co-located with shallow aquifers intercepted during Alternative 1 road construction. Increased local groundwater flow impacts could occur where roadways are constructed across wetlands supported by groundwater inflow, or in steep areas where road cuts cause a local effect on groundwater flow as drainage controls direct it away from the road.

<u>**Alternative 2 – North Road and Ferry with Downstream Dams**</u>

Pebble Mine Expanded Development Scenario. The expanded mine site development and associated contributions to cumulative impacts would be the same for the mine site component of Alternative 2.

The potential for shallow groundwater interception impacts along the Alternative 2 transportation and pipeline corridors would increase under the expanded mine scenario, because the north corridor would be wider and longer to accommodate the concentrate/diesel pipelines, associated access road, and port at Iniskin Bay. These could include localized flow changes in wetland areas supported by groundwater flow, or rerouting of groundwater flow around road cuts. However, overall cumulative effects under Alternative 2 with expanded mine development would be less than that of Alternative 1 with expanded mine development, because the expanded mine scenario under Alternative 2 would not use the south access corridor or Amakdedori port site.

Other Mineral Exploration and Road Development Projects. The contribution of other mine exploration RFFAs to cumulative effects under Alternative 2 would be the same as Alternative 1. The footprint of the Diamond Point rock quarry partially coincides with the Diamond Point port footprint under Alternative 2. Cumulative impacts would be limited to a potential increase in temporary localized impacts on groundwater flow during construction, material extraction, and groundwater supply from commonly shared project footprints and infrastructure with the quarry site under Alternative 2.

The contribution of LPB transportation infrastructure projects to cumulative effects under Alternative 2 would be slightly greater than under Alternative 1, due to a greater potential for co-location with these RFFAs. In addition to the Nondalton-Iliamna and Kaskanak-Igiugig projects—portions of which could be co-located with shallow aquifers along the mine access roads under both Alternatives 1 and 2—the Williamsport-Pile Bay Road upgrade could increase local groundwater flow impacts across wetlands or steep road cuts along the eastern portion of the north access road under Alternative 2.

Alternative 3 – North Road Only

Pebble Mine Expanded Development Scenario. The expanded mine site development and associated contributions to cumulative impacts would be the same for the mine site component of Alternative 3.

The potential for localized shallow groundwater interception impacts for the Alternative 3 non-mine components would increase under the expanded mine RFFA, because the north access road corridor would be slightly wider and longer to accommodate diesel and concentrate pipelines and the Iniskin Bay port. However, overall cumulative effects under Alternative 3 with expanded mine development would be less than that of Alternative 1 with expanded mine development, because the Alternative 3 expanded mine scenario would not use the south access corridor or Amakdedori port site.

Other Mineral Exploration and Road Development Projects. The contribution of other mine exploration, quarry, and road development RFFAs to cumulative effects under Alternative 3 would be the same as Alternative 2.

4.18 WATER AND SEDIMENT QUALITY

This section describes potential impacts of the project on surface water, groundwater, and sediment quality within the Environmental Impact Statement (EIS) analysis area, which includes the project footprint and outside of the project footprint where direct or indirect impacts to downstream or downgradient surface water, groundwater, and substrate or sediment quality may occur. The following potential impacts were evaluated to meet applicable Clean Water Act (CWA) Section 404(b)(1) guidelines:

- Effects of ground disturbance and potential erosion on surface water and sediment quality.
- Effects of geochemical weathering of mined rock and tailings on the water quality of human-made waterbodies at the mine site.
- Effects of treated water discharge on water and sediment downstream of mine site facilities.
- Effects of dust deposition on water quality.
- Effects of tailings, waste rock, and contact water storage on groundwater quality and downstream resources.
- Effects of groundwater migration adjacent to the pit at closure.
- Effects of fill placement and erosion on substrate and sediment quality.
- Effects of marine construction and dredging on substrate and water quality.
- Effects on drinking water sources.

Information regarding impacts to surface water and groundwater occurrence and flow is provided in Section 4.16, Surface Water Hydrology and Section 4.17, Groundwater Hydrology.

4.18.1 Methodology for Impact Analysis

Impacts to surface water and sediment quality were evaluated based on baseline data, water management plans, and predictive water quality modeling. The methodology applied to analyze and predict direct or indirect impacts is based on the range of effects for each of following factors:

- Magnitude – Effects are assessed based on the magnitude of the impact, as indicated by the degree to which water or sediment quality may be altered from documented baseline conditions, with potential changes to chemical or physical condition (e.g., changes in chemistry, temperature, or turbidity).
- Duration – The duration of effects depends on project phase, length of construction activities, and the nature of activities. Water and sediment quality effects could be temporary during construction (e.g., turbidity from construction); or they could remain after construction throughout life of mine and into closure (e.g., impacts from treated water discharge).
- Geographic Extent – Effects could be localized, or could extend to downstream areas within the same watersheds.
- Potential – Most effects on water and sediment quality at and near the mine site are predictable, and considered likely to occur. The likelihood of occurrence for other project components would be determined by the nature of activity and proximity to water and sediment resources.

Clean Water Act 404(b)(1) Evaluation Factors. Evaluation factors considered by the US Army Corps of Engineers (USACE) in making determinations under CWA Section 404(b)(1), Subpart C, include impacts on the following physical and chemical characteristics of the aquatic ecosystem. Impacts related to these characteristics are addressed in this section of the EIS as noted below:

- **Substrate.** Substrate includes sediment at the bottom of waterbodies, as well as wetlands soils. Impacts on waterbody substrate (sediment) are summarized under Substrate/Sediment Quality in each of the four project component sections. Impacts on wetlands substrate are addressed in Section 4.22, Wetlands and Other Waters/Special Aquatic Sites.
- **Suspended Particulates/Turbidity.** Effects on turbidity and levels of suspended sediment are summarized under the "Surface Water Quality" heading in each of the four project component sections below.
- **Water.** Direct effects on surface water quality and potential effects on surface water quality from migration of contaminants in groundwater are summarized under the "Surface Water Quality" and "Groundwater Quality" headings in each of the four project component sections below. Additional details are provided in Appendix K4.18.
- **Salinity Gradients.** Effects on salinity gradients are described under Surface Water Quality.

4.18.2 No Action Alternative

Under the No Action Alternative, the Pebble Project would not be undertaken. No construction, operations, or closure activities would occur. Although 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. No project-related geochemical processes or impacts on surface water, groundwater, or sediment quality would occur under this alternative.

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 of Alaska may require continued authorization for ongoing monitoring and reclamation work as deemed necessary by the State. Although these activities would also cause some disturbance, reclamation would benefit water and sediment quality.

The geologic material at the mine site would continue to naturally weather in place. Background water and sediment quality in the mine site vicinity would not change; certain constituents would still be present in amounts exceeding regulatory levels because of natural mineralization and geochemical weathering processes. Water quality along the transportation and pipeline corridors would continue to reflect the presence of elevated levels of some constituents, as described in Section 3.18, Water and Sediment Quality. Natural levels of sediment transport, deposition, and substrate modification would continue, and sediment would continue to contain certain constituents (e.g., metals) at elevated levels. No project-related geochemical processes or impacts on surface water, groundwater, or sediment quality would occur under this alternative.

4.18.3 Alternative 1 – Applicant's Proposed Alternative

This section describes the impacts of the project on surface water, groundwater, and substrate/sediment quality for each of the four project components under Alternative 1.

4.18.3.1 Mine Site

Surface Water Quality

Water originating in the mine site area would be managed in an environmentally responsible manner while providing an adequate water supply for operations. A primary design consideration would be to ensure the effective management of all contact water that would require treatment before release to the environment. This would include carefully assessing the layout of project facilities, process requirements, the topography, hydrometeorology, aquatic habitat and resources, and regulatory discharge requirements for managing surplus water. Water management strategies at the mine site are discussed in Section 4.16, Surface Water Hydrology. A map of the mine site layout showing water storage facilities, diversion channels, collection ponds, and flowlines is provided in Chapter 2, Alternatives, Figure 2-4 and Figure 4.16-1. Water balance model schematics showing estimated recycle flows between mine facilities are shown in Appendix K4.16.

All runoff water contacting the facilities at the mine site and water pumped from the open pit would be captured to protect overall downstream water quality. Prior to discharge to the environment, any water not meeting applicable discharge requirements would be treated. For example, contact water that may infiltrate into the groundwater system at the mine site would be collected at the mine site by the open pit groundwater wells or by pumpback wells located around the mine site. This water would be treated at a water treatment plant (WTP) and discharged as wastewater (i.e., surplus water). Non-acid-generating quarry or waste rock would be selected and used in construction of mine site roads and embankments, through techniques commonly used for grade control in open pit mines (PLP 2018-RFI 021c), such as testing for acid rock drainage (ARD) and leachable metals at specified intervals or block sizes. The project design incorporates an analysis of water collection and management, including quantity and quality estimates, water treatment options, design of water management facilities, and strategic discharge of treated water. Implementation of the water management plan would enable the process plant to operate without additional water from off-site sources. Additional details on surface water and groundwater hydrology are provided in Section 4.16, Surface Water Hydrology, and Section 4.17, Groundwater Hydrology, respectively.

The impact on surface water quality would be the discharge of treated process and runoff water that has come into direct contact with mining infrastructure. The duration and likelihood of treated discharge would be long term and certain, if the mine is permitted and built. The following subsections describe how contact and runoff water would be treated prior to discharge.

Water Treatment during Construction – Minimal water storage capacity would be available at the mine site until the completion of initial construction activities. Therefore, before completion of the bulk tailings storage facility (TSF) embankments and water management structures, all contact water not meeting water quality standards would be treated in modular WTPs and released. Contact water from the following sources and activities in construction would be expected to require treatment before release:

- Dewatering of the overburden aquifer above and near the pit deposit

- Water, primarily from precipitation, that accumulates in the open pit during construction
- Runoff from construction of TSF embankments.

Non-contact runoff water from excavation for site infrastructure such as the process plant, camps, power plant, or storage areas would be routed to sediment settling ponds before release. Non-contact runoff water that does not come into direct contact with mining infrastructure (open pit, waste rock and tailings stockpiles, etc.) is considered stormwater, as defined in 40 Code of Federal Regulations (CFR) Part 122.26(b)(13). Some or all of the stormwater discharge may require authorization from the Alaska Department of Environmental Conservation (ADEC) under the Alaska Pollutant Discharge Elimination System (APDES) Mine Site General Permit for stormwater, and would only require treatment for sediments prior to discharge into the environment. ADEC administers the APDES Program, in compliance with the CWA, 33 US Code (USC) Section 1251 et seq., as amended by the Water Quality Act of 1987, Public Law 100-4, Alaska Statute 46.03, and the Alaska Administrative Code (AAC), as amended, and other applicable state laws and regulations, to authorize and set conditions on discharges of pollutants from facility to waters of the US (WOUS)[1]. To ensure protection of water quality and human health, APDES permits place limits on the types and amounts of pollutants that can be discharged from a facility, and outlines best management practices (BMPs) to which a facility must adhere.

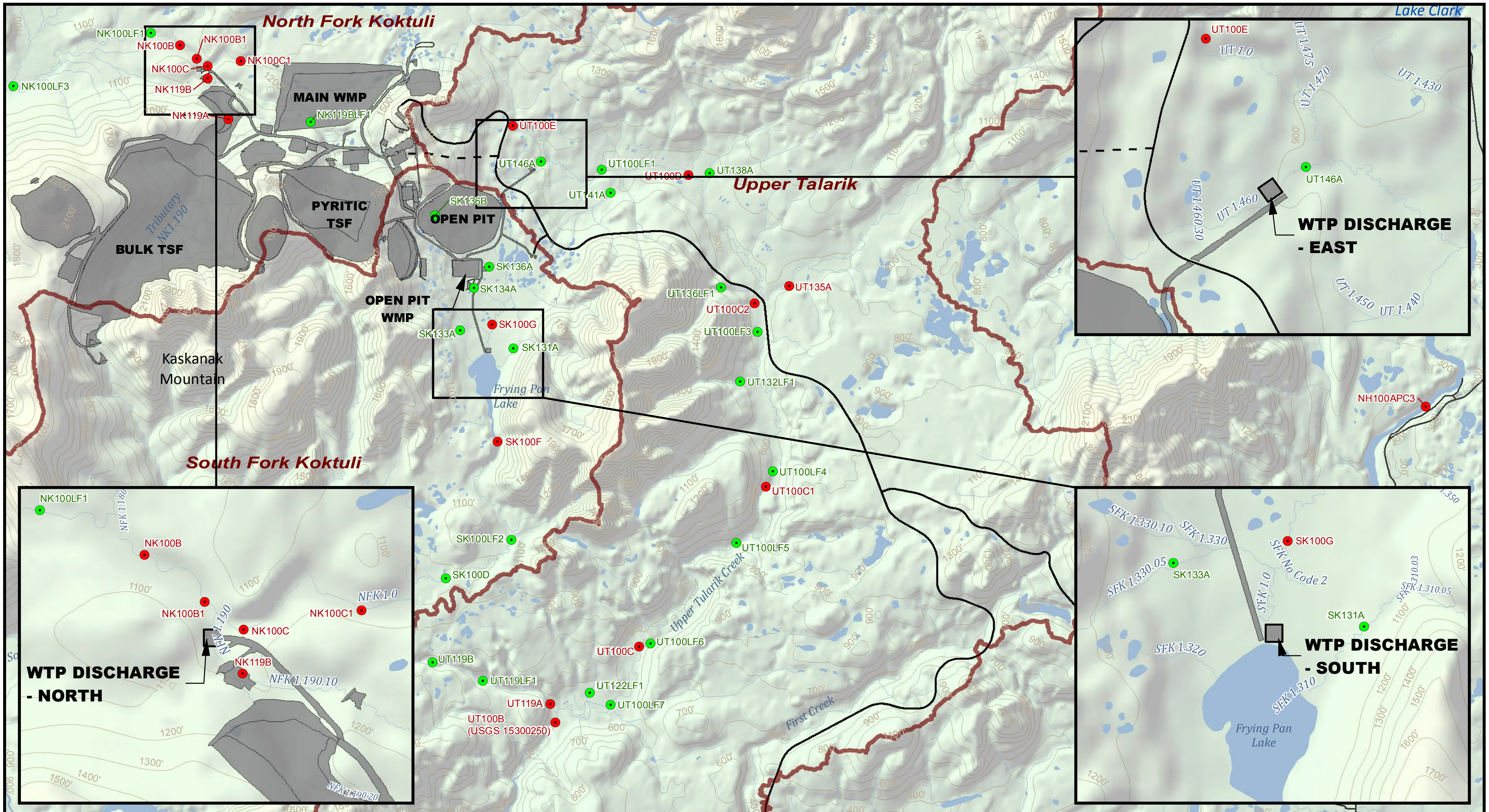
Water Treatment during Operations – During operations, the mine site would have two WTPs: the open pit WTP (WTP#1) and the main WTP (WTP#2). Both would be constructed with multiple, independent treatment trains, which would enable ongoing water treatment during mechanical interruption of any one train. Figure 4.18-1 provides a detailed view of WTP discharge locations and relevant nearby surface water monitoring stations and tributaries. Details of the WTP systems are provided in Appendix K4.18, and summarized below.

WTP#2 would treat water from the main water management pond (WMP), which would receive water from the bulk and pyritic TSFs and the TSF main embankment seepage collection pond (SCP). WTP#1 would treat water from the open pit WMP, which would be composed primarily of pit dewatering water. As described in Appendix K4.18, both facilities would employ treatment plant processes commonly used in mining and other industries around the world. Key treatment steps for both WTPs would include dissolved metals oxidization, co-precipitation, clarification, ultrafiltration, and reverse osmosis (see Chapter 2, Alternatives, Figure 2-11 and Figure 2-12). The open pit WTP would also include biological selenium removal, and the main WTP would include nanofiltration through high-pressure membranes (expected to remove selenium and other salts) and multiple-stage calcium sulfate precipitation with a lime softening process. Clarifier solids-filter backwash from both WTPs would be thickened/evaporated, and transferred to the pyritic TSF (HDR 2018a; PLP 2018d; PLP 2018-RFI 021d). Supplemental heating could be necessary during cooler periods to achieve minimum temperature levels for biological selenium removal to be effective. If hydraulic capacity of the WTPs is not adequate to meet the influent flow, additional trains would be installed as needed (PLP 2019-RFI 106).

Based on an independent review of the WTP source terms and processes (Appendix K4.18; AECOM 2018i), discharge water from both WTPs is currently expected to meet ADEC criteria. However, there is some concern that salt and selenium could build up over time in the pyritic

[1] The regulatory definition of WOUS is given in 40 CFR 230.3(s). Locations within the project area in which wetlands and other waters of the US have been identified as jurisdictionally under the authority of the USACE are described in the Preliminary Jurisdictional Report in Appendix J. The project area is defined in Section 3.1, Introduction to Affected Environment, as “the exact project footprint for each action alternative.”

TSF, which has the potential to lead to increased total dissolved solids (TDS) concentrations that would require treatment in the main WTP (AECOM 2018i). This may require further investigation as design progresses, and/or as a long-term adaptive management strategy. Assuming these protections are adopted, direct and indirect impacts of treated contact waters to off-site surface water are not expected to occur. However, over the life of the mine, it is possible that APDES permit conditions may be exceeded for various reasons (e.g., treatment process upset, record-keeping errors) as has happened at other Alaska mines. In these types of events, corrective action is typically applied in response to ADEC oversight to bring the WTP discharges into compliance.



Sources: HDR 2012; PLP 2013

US Army Corps of Engineers

0.5 0 0.5 1

Miles

- Continuous Monitoring Gage Stations
- Early Spring Low-Flow Measurement Sites

Alternative 1

- Transportation Corridor
- Natural Gas Pipeline
- Mine Site

Other Features

- 100' Contour (Existing)
- River/Stream
- Lake/Pond
- Major Drainage Boundary

WATER TREATMENT PLANT DISCHARGE LOCATIONS IN OPERATIONS

PEBBLE MINE EIS

FIGURE 4.18-1

In terms of magnitude and extent, all WTP#1 treated water and most WTP#2 treated water would be discharged to the environment downstream of the mine site. A small portion of the WTP#2 treated water would be used for process and power plant needs. Water discharge points would be located in the North Fork Koktuli (NFK) River, South Fork Koktuli (SFK) River, and Upper Talarik Creek (UTC) drainages (see Figure 4.16-1). Water from both treatment plants would be strategically discharged in a manner that would optimize downstream aquatic habitat, based on modeling and monitoring during discharge (PLP 2018d). WTP discharges as mitigation for streamflow reduction are further discussed in Section 4.16, Surface Water Hydrology and Section 4.24, Fish Values. The duration and likelihood of impacts would be long term, lasting for the life of the project and into closure.

ADEC regulates wastewater discharges from hard-rock mining facilities through various permits:

- APDES Individual Permit for point source discharge into wetlands and other waters
- Integrated Waste Management Permit for solid waste disposal and wastewater discharge not into wetlands and other waters
- APDES Multi-sector General Permit for stormwater discharge
- Domestic Wastewater Discharge Permit.

An APDES permit is necessary and would be issued unless discharge is not to wetlands and other waters, in which case a domestic wastewater discharge permit would be required. State of Alaska regulations require that the conditions of these permits comply with state water quality standards that are based on the use classification for the waterbody receiving discharge, and on the state's anti-degradation policy. For constituents that exceed criteria in background surface water and groundwater (see Section 3.18, Water and Sediment Quality, and Appendix K3.18), there are currently no plans to incorporate site-specific background levels of constituents into discharge limits (ADEC 2018-RFI 064a).

Water Treatment during Closure – Water treatment during closure/post-closure would use the operations WTPs #1 and WTP#2 as needed, with WTP#1 upstream of Frying Pan Lake reconfigured as WTP#3 (Knight Piésold 2018d), and separate WTP systems developed in later closure phases to treat SCP and pit water. Closure water treatment would occur as follows (HDR 2019b):

- Closure Phase 1 (years 0 to 15) – WTP#2 would treat water from the main WMP, and WTP#3 would treat water from the open pit during placement of pyritic tailings prior to filling of the pit lake.
- Closure Phase 2 (years 16 to 20) – No water treatment is anticipated during closure phase 2 as the pit lake fills, and WTP#2 would be decommissioned.
- Closure Phases 3 and 4 (years 21 to 50, and beyond year 50) – Water from the open pit would be pumped and treated to maintain the pit lake level at or below the maximum management level of 890 feet above mean sea level (amsl). Surplus water from the open pit, as well as the bulk TSF main SCP, would be treated as two stand-alone water treatment streams based on anticipated treatment needs, both of which would be housed in the same WTP building (HDR 2019b).

In terms of magnitude and extent, treated water would be discharged within the NFK, SFK, and UTC drainages at the locations shown on Figure 4.16-1 (Knight Piésold 2018d). Details of the WTP processes in closure phases are described in Appendix K4.18. Water quality would be monitored and treatment processes adjusted as needed. If hydraulic capacity of the WTPs is not adequate to meet the influent flow, additional trains would be installed as needed (PLP 2019-RFI 106). Table K4.18-14 provides an estimate of treated discharge water quality from the SCP, which is predicted to be within water quality standards. Water quality of discharge from the open pit WTP is the subject of ongoing engineering analysis (PLP 2019-RFI 106). Reclamation and closure plan and financial assurance mechanisms required by the State of Alaska would include financial provisions for operating water treatment facilities and conducting ongoing monitoring indefinitely in the post-closure period.

Effects of Ground Disturbance and Erosion – Ground disturbance during construction has the potential to lead to erosion and introduce suspended sediment and increased turbidity into waterbodies downstream of the mine site, potentially resulting in direct and indirect impacts to water quality. These effects are likely to occur, and the magnitude and extent of direct impacts would include increased turbidity, temperature changes, or changes in water chemistry in downstream waterbodies. Indirect impacts would also be expected to occur. The magnitude and extent of indirect impacts could include changes to dissolved oxygen (DO) content, or an increase or decrease in biologic activity within waterbodies resulting from the mine project. The duration and likelihood of impacts would be long term, and certain to occur if the mine is permitted and constructed. Implementation of the water management plan during the construction phase would include the following features:

- Water diversion, collection, and treatment systems would be installed to address the effects of ground disturbance and erosion on water quality during construction. The locations of these features would be determined based on minimizing sedimentation effects. Major features currently planned are shown on Figure 2-3 and Figure 4.16-1.
- BMPs for water management and sediment control structures, including temporary settling basins and silt fences, would be installed to accommodate initial construction at the mine site.
- Among the first facilities to be constructed would be water management structures that would be maintained for use in adaptive management during operations. These structures would include diversion and runoff collection ditches to minimize water contact with disturbed surfaces, and sediment control measures such as settling ponds to prevent sediment from reaching downstream waterbodies.
- Stormwater runoff from facilities that does not come in direct contact with mining infrastructure would be treated for sediment and discharged under general APDES stormwater permits (Knight Piésold 2018a).

During the operations phase, implementation of the water management and sediment control plan would focus on reducing the accumulation of contact water through diversion structures. Runoff and associated sediment control measures would be managed with BMPs and adaptive management control strategies. BMPs are described further in Section 4.14, Soils. Where water could not be diverted, it would be collected for use in the mining process, or treated and discharged.

Effects of Dewatering Water Discharge in Construction – Dewatering of the open pit is likely to have both direct and indirect impacts on surface water quality, resulting from changes to hydrologic flow regimes between groundwater and surface water, and discharge of pumped groundwater to surface waterbodies.

The construction phase would involve dewatering of the pit area beginning approximately 1 year before the start of operations. During construction, water collected from pit dewatering wells would be discharged to the open pit WMP, which is expected to be in place before preproduction (e.g., removal of overburden in the pit area) mining commences in Year 1. In the event that the open pit WMP is not available, water from dewatering wells would be treated prior to discharge by WTP#1 if it is in place; or by a modular WTP if WTP#1 is not in place. WTP processes for construction wastewater would include modules for the following processes as necessary: a temporary sedimentation pond; a sedimentation tank and/or sand separator; chemical addition and rapid mix module; a filtration module; and associated modules containing water feed/transfer pumps, chemical storage/feed systems, electricity generation, a workshop, and parts storage (PLP 2018-RFI 021b). WTP discharge locations are depicted on Figure 4.18-1. In terms of magnitude and extent, following module WTP processing, water from pit dewatering wells would be discharged to the SFK catchment (PLP 2018-RFI 021b). The duration of impact would be until the open pit WMP is in place. Under either the WTP#1 scenario or the modular WTP scenario, discharge would require an APDES permit, and must meet prescribed discharge limits and monitoring and reporting requirements.

Effects of Waste Rock/Tailings Storage and Water Management Ponds. Waste rock, TSFs, and WMPs would impact surface water or groundwater quality if not properly managed. Contact water that accumulates in on-site tailings and waste rock storage facilities and WMPs would be managed through containment and recycling/reuse so that it would not be released to surface water downstream of these facilities until intended for treatment and discharge. Water in these containments would not be considered WOUS prior to discharge; therefore, such water would not be subject to regulation under the CWA, or subject to APDES permitting requirements while retained within on-site water management facilities.

Bulk and pyritic tailings slurries from the mill would be directed to the bulk TSF and the pyritic TSF, respectively. Potentially acid-generating (PAG) waste rock from the pit would also be stored in the pyritic TSF. Section 3.18, Water and Sediment Quality, provides a description of these materials. Precipitation and runoff water would also collect in these facilities. The bulk TSF would maintain a small operating (supernatant) pond, while the pyritic tailings would remain fully submerged in the lined pyritic TSF to minimize ARD and Metal Leaching (ML), with sufficient coverage to prevent resuspension of tailings by wind-induced waves or oxidation of the tailings. Excess water from the pyritic TSF would be pumped to the main WMP (see Section 4.16, Surface Water Hydrology, Figure 4.16-2).

The main embankment at the bulk TSF would operate as an unlined flow-through facility. Water collecting in the bulk TSF would flow through the embankment to the main embankment's SCP. From there, water would be directed either to the main WMP for use in the mill, or to the WTP#2 for treatment and discharge. Excess surface water in the pyritic TSF would be similarly managed. Water treatment byproduct sludge and reject water (water resulting from the treatment process) would be directed to the process plant and added to the pyritic TSF via the pyritic tailings slurry line. A portion of the treated water from the WTP#2 would be returned for use in the process plant and power plant cooling towers. The magnitude and extent of impacts to surface waters would be that treated water from WTP#2 that is not needed for mine operations would be discharged downstream of the mine. The magnitude and extent of effects on shallow groundwater would be expected to be limited to the area between the bulk TSF and the SCP, with collection systems capturing and directing water. The magnitude and extent of effects could extend to deeper fracture-flow groundwater, depending on geologic and hydrogeologic conditions beneath the bulk TSF. The duration of effects would be long term, lasting for the life of the project, and certain to occur if the mine is permitted and constructed.

The predicted chemistry of geochemical sources contributing to the main and pyritic TSF ponds, the main SCP, and main WMP is discussed in Appendix K4.18 and shown in Table K4.18-2. Table K4.18-4 shows the predicted water quality in the ponds. Water in these ponds is predicted to contain levels of TDS, sulfate, and a number of metals in excess of water quality criteria (Appendix K3.18, Table K3.18-1). These data have been used in the development of WTP processes described in Appendix K4.18.

The size of the ponds and the design criteria intended to prevent overtopping of pond water are described in Section 4.16, Surface Water Hydrology. Upset conditions that could lead to unexpected release of pond water to the environment are addressed in Section 4.27, Spill Risk.

A water surplus is anticipated during operations under normal and wetter than normal climatic conditions (Knight Piésold 2018a). The magnitude, extent, and duration of impacts to surface water would be that treated surplus water would be discharged throughout the year. Section 4.16, Surface Water Hydrology, provides further details on the volume of water available for discharge, compared to baseline (i.e., pre-mine) flows in surrounding drainages.

Effects from Embankment Rockfill Runoff – Runoff from rockfill would impact surface water quality if not properly managed. Based on the geochemical analysis of source rock, the chemistry of runoff from rockfill in embankments is expected to be comparable to that of natural surface water and groundwater, with two possible exceptions (SRK 2018d):

- *Hydrothermally altered, sulfide-bearing PAG rock.* This rock would be managed separately based on PAG classification, and would be used only at limited locations on the northern embankment of the pyritic TSF where runoff would be directed to the main WMP. All other embankments would be constructed of non-PAG rock (PLP 2018-RFI 021c).
- *Rock containing explosive residues*. Explosives used during mining would consist of ammonium nitrate/fuel oil (ANFO) mixtures manufactured on site (PLP 2018d). A small amount of these materials may not be fully consumed, and residue may remain on rock used in embankment construction. In terms of magnitude of impact, these materials would impact surface waters through runoff. Runoff from embankments quarried with explosives would be contained and monitored until explosive residues have been leached (PLP 2018-RFI 021c). Explosives residue is considered in the prediction of surface water quality from mine site sources in Table K4.18-2 (SRK 2018a).

Effects from Small Hydrocarbon Spills – Inadvertent release of hydrocarbons would result in a direct impact to surface water quality if spilled materials come into contact with surface water. The likelihood of small hydrocarbon spills from mine-related sources (e.g., mine machinery, product or waste storage facilities, or transfer operations) would be reduced through the application of BMPs, including the use of certified containers to transfer and store fuels and lubricants; secondary lined containment around bulk storage facilities; and managed storage, reuse, and/or disposal of used fuel products. Should a small spill occur, controls would be implemented, including automatic shutoff devices, and in-place spill response equipment and procedures (PLP 2018d). Section 4.27, Spill Risk, describes the potential for and effects of a large hydrocarbon spill, which would have the potential for greater magnitude and extent of direct effects on surface water and sediment quality.

Effects of Discharge Water Temperature – Modeling of temperature impacts using documented baseline temperatures and flow data, and predicted WTP discharge temperature and flow rates, indicates the magnitude of expected effects on temperature (PLP 2018-RFI 047). In terms of extent of impacts to surface waters, the modeled temperature effects are based on a limited set of measured water temperatures and flow scenarios collected at specific locations; the calculated discharge impacts reflect those conditions and locations. The duration and likelihood of impacts would be long term, and certain to occur if the mine is permitted and constructed as designed. The calculated temperature effects provide a reasonable estimate of typical temperature effects from operational WTP discharges, summarized as follows:

- Temperature changes in the NFK watershed approximately 0.5 mile downstream of the WTP discharge point would be expected to be in the range of about -0.2 to +2.4 degrees Celsius (^{o}C); (average of about +1.2^{o}C) in summer months, and from about +1.7 to +3.6^{o}C (average of about +2.8^{o}C) in winter months.
- Temperature changes in the SFK watershed approximately 1 mile downstream of the WTP discharge point at the outfall of Frying Pan Lake would be expected to be in the range of about -1 to +1^{o}C (average of about -0.15^{o}C) in summer months.
- Temperature changes in the UTC watershed approximately 3 miles downstream of the WTP discharge point would be expected to be in the range of about 0 to +0.3^{o}C (average of about 0.12^{o}C) in summer months, and from about +0.3 to +0.7^{o}C (average of about +0.54^{o}C) in winter months.

Effects of Treated Water Discharge on Spatial Trends – Discharge of treated water from WTPs during operations would also have an effect on water conditions other than temperature within receiving waters (e.g., DO levels, turbidity, nutrient levels). As with temperature in terms of extent, these effects would be expected to be spatially limited to the area at and immediately downstream of discharge points, and would be managed by the planned strategic discharge of treated water between the three planned discharge points (PLP 2018d). The magnitude of changes in water condition that occur at each discharge point would also be expected to be diluted through natural flow over a relatively short distance, and to return to background or near-background conditions. The magnitude, extent, and duration of the effects of discharges on natural stream conditions would vary by location and seasonally, depending on background flow and other variable factors (e.g., fluctuations in water clarity, nutrient levels, or DO content). Streams in the area are naturally nutrient rich (PLP 2018d). Additionally, installing engineered discharge chambers at discharge points would reduce effects on certain water conditions such as turbidity and DO by baffling the discharge and allowing for more equilibration of water condition at the discharge point (Knight Piésold 2018f).

Effects from Deposition of Fugitive Dust – Fugitive dust from various mine site sources with elevated levels of certain metals would be deposited on soils surrounding the mine site. Impacts on surface water would be the leaching of these metals into runoff leading to downgradient waterbodies, or be deposited directly on waterbodies. In terms of impact extent, the modeled areal extent of dust deposition in construction and operation phases of the mine site is depicted in PLP 2018-RFI 065. Section 4.14, Soils, presents the incremental concentrations of metals that would be expected in the top inch of soil at the end of operations. Appendix K4.18 provides the methodology used to calculate the incremental increase in surface water, and Table K4.18-17 shows the results. In terms of impact magnitude, the calculations indicate an expected increase in the concentration of metals in surface water as a result of dust deposition, ranging from 0.1 to 0.7 percent, which would not result in exceedances of the most stringent water quality criteria (Appendix K3.18, Table K3.18-1) in background conditions or WTP outflow conditions. PLP is developing a fugitive dust control plan for mitigation and control of fugitive dust and wind erosion related to project activities. The anticipated plan would use BMPs and best available control technology (PLP 2018-RFI 071a). Dust suppression water would be used at the mine site and along the transportation corridor as described below (PLP 2018-RFI 021c). These impacts would be long term, lasting for the life of the mine, and would be expected to occur if the project is permitted and constructed.

Effects from Dust Suppression Water – During operations, dust suppression at the mine site would use untreated contact water from the open pit WMP. This water source would be applied only to areas of the mine site where runoff is collected and treated. The impact on surface waters would be that this water is discharged as described above for treated water discharge.

Outside of these areas, dust suppression would use non-contact water from other unaffected water sources outside of the mine site footprint (PLP 2018-RFI 021c).

Effects during Closure/Post-Closure – Once mining ceases, partial dewatering would be maintained within the open pit to allow the PAG waste rock to be moved from the pyritic TSF to the pit, and to maintain pit wall stability until the PAG waste rock buttresses the potentially unstable lower walls of the open pit (see Section 4.15, Geohazards, and Appendix K4.15). An initial layer of PAG waste rock would be placed 1 year prior to deposition of pyritic tailings (Knight Piésold 2018d). The remaining PAG waste rock would be deposited in the open pit concurrently with the pyritic tailings as it is exposed during reclamation of the pyritic TSF (Knight Piésold 2018b, 2018d). The pyritic tailings would be re-slurried using water in the pyritic tailings, and the tailings slurry pumped to the open pit for subaqueous disposal. The water level in the open pit would be maintained to allow controlled placement and management of the PAG waste rock in dry areas of the pit, while keeping a water cover over the submerged pyritic tailings. Backhauling of the PAG waste rock would end approximately 14 years into closure, and the transfer of pyritic tailings would end about 15 years into closure. Dewatering of the open pit would cease at the end of Closure Phase 1 once the transfer of these materials is complete. PAG waste rock would be submerged within 2 years of placement as the water level in the pit rises (PLP 2018-RFI 092). Once dewatering ceases, groundwater behind the pit walls would begin to rise to create a pit lake. The open pit would then be allowed to fill with direct precipitation, surface water runoff, and groundwater, but would be kept at a maximum management level so that groundwater would continue to flow into the open pit from all directions; and it would remain as a hydraulic sink to minimize the potential for subsurface releases to the environment (see Section 4.17, Groundwater Hydrology). The maximum elevation of the pit lake in closure is expected to be 890 feet amsl (Appendix K4.18, Figure K4.18-6). Additional general details of the pit lake are included in Table K4.18-12.

Surface runoff from reclaimed areas would be collected, and either treated in the WTPs, or directed to the open pit lake. The bulk TSF would be graded and revegetated to direct surface runoff toward the closure spillway at approximately Closure Year 10. This would reduce infiltration and direct runoff water to the eastern end of the bulk TSF, where it would be collected in seepage collection and recycle ponds. In terms of magnitude, duration, and extent of impacts, surplus free water on the surface of the bulk TSF would be pumped to the main WMP through approximately Year 15 post-closure, then to the open pit through approximately Year 50 post-closure. Seepage water from the embankment seepage collection systems would be collected, and either treated in the WTPs, or directed to the pit lake until determined to be suitable for discharge, anticipated after approximately Closure Year 50 (Knight Piésold 2018d).

Surface runoff into the pit lake would carry any metals leached from the pit walls. In addition, contaminated groundwater would flow into the pit as described below under Groundwater Quality. The resultant groundwater capture zone, in which all groundwater would flow into the pit in closure, would primarily be located in the SFK watershed, with parts extending under the pyritic TSF. The corresponding zone of influence of the pit lake would extend marginally farther out than the capture zone (Piteau Associates 2018a). The extent of the groundwater capture zones in operations and closure are discussed in Section 4.17, Groundwater Hydrology, and depicted on Figure 4.17-2 through Figure 4.17-4.

Water quality in the pit lake would be expected to be initially acidic, becoming slightly alkaline over time, with elevated concentrations of TDS, hardness, sulfate, and some metals (aluminum, antimony, arsenic, cadmium, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, and zinc) exceeding water quality standards as a result of the oxidation of sulfide minerals in the pit walls, and the natural concentrations of metals found in the unmined mineralized rock. Appendix K4.18 describes pit lake water quality modeling further.

Table K4.18-7 through Table K4.18-10 summarize predicted lake water quality for a fully mixed pit lake during the four closure phases. The evolution of pit lake water quality during closure was further evaluated using a one-dimensional hydrodynamic model to determine if thermal and/or chemical stratification is expected to develop within the pit lake. The hydrodynamic pit lake model approach and water quality results are also summarized in Appendix K4.18, and Figure K4.18-10 through Figure K4.18-15.

Once the level of the pit lake has risen to about 890 feet amsl, anticipated to occur at approximately Year 20 post-closure, water would be pumped from the pit to maintain the lake level at the maximum management level, and treated as required at WTP#3 (redesigned for post-closure from WTP#1). In terms of magnitude and extent, the treated water would be discharged to the environment downstream of the mine site in Frying Pan Lake in the SFK drainage. The duration of impact would be permanent, and it would be expected to occur only if mine closure is approved as described.

Summary of Mine Site Effects on Surface Water Quality. As described above, direct and indirect impacts to water quality are likely to occur as a result of permitted discharges of treated water to drainages downstream of the mine site. The duration of these discharges would range from long term, lasting from construction throughout the life of the mine; and in some cases, throughout post-closure. Process-related (contact) water would not be considered WOUS or subject to APDES permitting while such water is retained in on-site water management facilities and recycled/reused on site. Contact water collected in mine facilities (e.g., bulk TSF, pyritic TSF) is not expected to meet Alaska water quality criteria for discharge (AAC Title 18, Section 70, ADEC 2018b) and would not be released directly to the environment without prior treatment to meet specific discharge requirements. WTP processes are expected to be effective in treating water to meet discharge criteria, although concerns regarding potential long-term increased TDS levels may require further investigation as design progresses, and/or adaptive management strategies are implemented during operations (see Chapter 5, Mitigation). The discharge limits described in this section and Appendices K3.18 and K4.18 would become part of an APDES permit, which would have monitoring requirements to ensure that discharged water meets applicable water quality criteria. The geographic extent of impacts on surface water chemical quality attributable to contact water would be limited to areas used for on-site storage of contact water before treatment. The magnitude of temperature effects ranging from about -1 to 3.6^{o}C would occur up to 0.5 to 3 miles downstream of the mine site.

Groundwater Quality

Section 3.17, Groundwater Hydrology, and Section 3.18, Water and Sediment Quality, address the affected environment with respect to groundwater flow and quality, respectively. The principal mechanisms responsible for potential effects on groundwater quality at the mine site are summarized below.

Effects from TSF Seepage – The main embankment of the bulk TSF would be designed to promote seepage to the bulk TSF main SCP, thereby minimizing the volume of water contained within the tailings impoundment, and promoting embankment stability (see Section 4.15, Geohazards,). In terms of magnitude and extent, groundwater that would be affected by vertical seepage from the unlined bulk TSF would flow north down the NFK west drainage and be captured by the main SCP. The primary design criterion for management of this and other seepage collection systems at the mine site is defined as “no detectable seepage downgradient of the collection and pumpback systems” (PLP 2018j). Hydraulic containment of seepage flow from the bulk TSF would be achieved and maintained using a series of control measures, including:

- North-flowing underdrains beneath the bulk TSF.
- Tailings beaches that would promote a north-sloping phreatic surface in the bulk tails.
- Upstream liners, low-permeability core zones, and grout cutoff walls at the south embankment of the bulk TSF; and the main, south, and east embankments of the SCP.
- Seepage pumpback wells downgradient of the three SCPs (Knight Piésold 2018a; PLP 2018d; PLP 2018-RFIs 006, 006a, 008f).

The above drainage and hydraulic containment systems are currently conceptual only, and would be further developed in final design. Drainage materials that would be placed beneath the bulk TSF impoundment and embankment would help minimize the amount of vertical seepage to groundwater (e.g., PLP 2018-RFI 006: Figure 1).

In terms of magnitude and extent of impacts, groundwater modeling estimates that the bulk TSF would contribute about 0.2 cubic feet per second (cfs) of seepage to the underlying groundwater system during and at the end of mining (assumed to be accurate to within a factor of 5), as compared to about 9 cfs that are expected to flow through the bulk TSF main embankment (Knight Piésold 2018a; Piteau Associates 2018a). In terms of magnitude and duration of impacts, the seepage rate would decrease over time after closure as the tailings consolidate and pore waters are squeezed out. Affected groundwater migrating beneath the bulk TSF and downgradient to the main SCP would flow through the overburden and underlying weathered bedrock units shown on cross-section M-1 in Section 3.17, Groundwater Hydrology, Figure 3.17-8, and described in Appendix K3.17, Table K3.17-1. Additional discussion of the potential for contaminated groundwater to migrate in units beneath the bulk TSF and SCP, and uncertainties in the groundwater model, is provided in Section 4.17, Groundwater Hydrology.

The results of groundwater modeling performed by Piteau Associates (2018a) indicate that a sump or pumping wells with an operating elevation of 1,250 feet at the main SCP and a grout curtain with an effective hydraulic conductivity of $1x10^{-5}$ cm/s would be effective in capturing seepage. Containment of affected groundwater would be monitored using monitoring/pumpback wells to assess groundwater levels and quality (Knight Piésold 2018a). Any impacted groundwater that bypasses the SCP capture system is expected to be detected in these wells. Additional seepage collection, cutoff walls, and/or pumpback systems may be installed downstream if necessary, as determined by monitored water quality (PLP 2018-RFI 006a).

The predicted concentration of constituents in groundwater beneath the bulk TSF, and between the TSF and the main SCP, would be similar to those listed in Appendix K4.18, Table K4.18-4 for the main SCP. In terms of magnitude, several metals (aluminum, antimony, arsenic, cadmium, copper, lead, manganese, mercury, molybdenum, nickel, selenium, silver, and zinc), TDS, and sulfate in the main SCP are predicted to exceed baseline concentrations and regulatory criteria at the end of mining and the end of Closure Phase 3, and therefore would require continued treatment at WTP#3 in post-closure to meet discharge criteria (Knight Piésold 2018d).

The pyritic TSF would be fully lined. The potential for liner damage (e.g., from ice or placement of waste rock) leading to leakage of tailings porewater was evaluated in the EIS-Phase Failure Modes Effects Analysis (FMEA), and the likelihood of occurrence was considered to be low to moderate (AECOM 2018l). In terms of magnitude and extent of impact, potential leakage through the liner would be diluted by unaffected groundwater flowing north down the NFK east drainage, and would be intercepted by the main WMP and its downgradient seepage pumpback wells.

Based on the proposed seepage collection systems and contingencies, the vertical extent of impacts on downgradient groundwater quality outside of the mine would be expected to be limited to shallow groundwater in overburden deposits, and the bedrock contact zone between the TSFs and seepage collection facilities. The magnitude and duration of impacts on local groundwater within the mine site are expected to exceed water quality regulatory criteria, and those effects would persist through the life of the mine, and well into post-closure Phase 4. Should monitoring at seepage collection systems in post-closure indicate that water quality meets approved criteria for discharge without treatment, direct discharge would occur. In terms of duration, groundwater impacted by limited seepage from the TSFs would meet regulatory discharge criteria at approximately Closure Year 50 (see Appendix K4.18, Figure K4.18-9) (Knight Piésold 2018d), although collection and treatment of SCP water would continue as long as required.

Effects from WMP Leakage – Appendix K4.18, Table K4.18-4 shows the predicted concentration of mine-related constituents in water in the main and open pit WMPs. Water in these ponds is anticipated to contain TDS, sulfate, and a number of metals at levels exceeding discharge water quality criteria. Pond water leaking through the pond liners would be intercepted by underdrain systems included in the design of those facilities, and subsequently pumped back to the respective WMP (PLP 2018-RFI 019a); however, in terms of impacts, some water could bypass the underdrain system and seep into underlying shallow groundwater. In the case of the open pit WMP, all underlying shallow groundwater would be completely within the capture zone of the dewatered open pit during operations and post-closure; therefore, any impacted groundwater would be recycled through the dewatering and treatment process, or contained in the pit lake.

In the case of the main WMP, in terms of magnitude of impacts to groundwater, the estimated maximum leakage rate through the liner of 1 liter per second (Piteau 2018; PLP 2018-RFI 019c) or 0.035 cfs would potentially impact underlying shallow groundwater. In terms of extent of impacts, without intervention, this water would be expected to mix with shallow groundwater and discharge into the NFK watershed. To prevent this, a line of monitoring/pumpback wells would be installed along the northern side and at the northwestern corner of the main WMP. Should monitoring of these wells show impacts from liner leakage, the wells would be used to intercept and recycle shallow groundwater back to the main WMP. Based on the current mine plan, it is possible that gaps exist along the main WMP embankment that would allow potentially affected groundwater to flow through areas where wells are limited (e.g., along the southwestern side of the embankment; see Section 4.16, Surface Water Hydrology, Figure 4.16-1). As discussed in the EIS-Phase FMEA, the final location and spacing of pump-back wells would be determined based on additional hydrogeologic investigation as design progresses, to minimize the likelihood of this occurrence. Because the main WMP would be removed at the end of mining Closure Phase 2 (Knight Piésold 2018d), the duration of this potential effect would be through this closure phase; it would not occur during subsequent post-closure periods (Piteau 2018).

Effects from Pit Overburden Stockpile Seepage – Seepage from pit overburden materials that would be excavated and stockpiled would be expected to affect surface water or groundwater quality. Potential effects would be limited by segregating mineralized overburden from non-mineralized overburden, and stockpiling mineralized materials that exhibit a high potential for leaching in the pyritic TSF. Prior to excavation, overburden materials would be characterized by drilling and sampling, thereby allowing materials to be segregated visually during excavation. This technique is common in open pit mining for grade control (PLP 2018-RFI 021c). As a secondary control to address placement of potential PAG material in the non-mineralized overburden stockpile, multiple lines of monitoring wells would be installed downgradient from the stockpile and monitored for exceedances of applicable water quality standards. If exceedances were observed, the wells would be converted to pumping wells to intercept and redirect impacted water to the open pit WMP for treatment and permitted discharge (PLP 2018-RFI 021c).

Effects on Seeps – Most overburden with seeps overlying the open pit would be removed, and seeps present in the footprints of the TSFs and mine facilities would be covered. Although seeps could impact groundwater, any impacted groundwater would be captured by the seepage collection systems or contained within the open pit cone of depression, and would not be expected to surface as seeps within the mine site. However, should seeps occur downgradient of mine facilities, surface water runoff controls would be used to capture and route it to the appropriate collection ponds for treatment and subsequent discharge. Monitoring would also be conducted to recognize new seeps that may form, measure their water quality, and ensure that the seepage is captured and routed to the appropriate seepage control pond; or if water quality is satisfactory, discharged to the environment.

Dust Leaching to Groundwater – Fugitive dust deposited on soils surrounding the mine site has the potential to leach into groundwater. Section 4.14, Soils, presents the baseline and incremental concentrations of metals in soil at the end of operations. These results are compared to ADEC migration-to-groundwater levels to estimate the magnitude of this effect on groundwater. Appendix K4.18, Table K4.18-18 presents the metals concentrations in soil after dust deposition, as well as ADEC comparative action levels for the migration to groundwater criteria for soils. In terms of magnitude, the predicted percent increase in metals concentration in groundwater attributable to dust deposition was less than 0.8 percent for all metals, with the exception of antimony, which is predicted to increase in concentration by approximately 3 percent. Modeling and calculations of dust deposition do not indicate that any new exceedances of the ADEC levels would result from the dust effects. Arsenic was the only metal that would be expected to exceed these criteria; however, that exceedance would result from baseline soil conditions, and dust deposition would be expected to increase arsenic concentrations in soil by only about 0.6 percent. The duration of impact to groundwater would be long term, lasting though the life of the mine, and would be expected to occur at this magnitude if the mine is permitted and built.

Effects from Pit Lake in Closure – Surface water in the pit would continue to be pumped out during the first 15 years of closure while pyritic tailings and PAG waste rock are being placed in it. Pumping of groundwater may initially be maintained in an area of the open pit at the end of mining to facilitate safe placement of the waste while maintaining pit wall stability in the lower portion of the pit where faults are present (see Section 4.15, Geohazards) (PLP 2018-RFI 023a). In terms of magnitude and extent, pumping of water from the pit during early closure, and cessation of most groundwater pumping while waste is being placed would result in the groundwater level adjacent to the pit rising faster than the pit lake level rise, so that contact water in the pit is not likely to extend beyond the pit walls, except in the localized area of temporary wall stability depressurization. Hydraulic containment would be maintained during all closure phases because overall flow gradients would be toward the pit lake radially from all directions, thereby limiting the extent of migration and capturing any pit-contaminated groundwater (PLP 2018-RFI 019d).

In terms of duration of the impacts, all pit dewatering would cease once placement of the PAG waste rock and pyritic tailings is complete to allow the pit lake to rise and cover the waste. Inputs of contaminated water into the pit lake from the waste and walls are predicted to exceed regulatory limits for water quality for a number of constituents, including TDS, sulfate, and metals (see Table K4.18-7 through Table K4.18-10).

After lake level rise, groundwater gradients toward the pit would be maintained by managing the pit lake level through pumping and treating the lake water in perpetuity. With the pit water level maintained at the maximum management level of 890 feet amsl, groundwater flow is expected to be directed radially toward the pit from all directions, although there are uncertainties in the groundwater model, as described in Section 4.17, Groundwater Hydrology. At the maximum managed level, the pit water would be expected to be retained in the pit, and would not contribute (flow out) to affect the quality of groundwater outside of the radius of influence of the pit. In terms of impact extent, modeling indicates that the open pit hydraulic capture zone would extend 1,000 feet or more from the crest of the pit in post-closure (Piteau and Associates 2018a). To maintain the 890 feet amsl management level, the maximum anticipated flow through the WTP is estimated to be approximately 1,300 gallons per minute, or 2.9 cfs (Piteau and Associates 2018a), although this rate could be higher than predicted under the current groundwater model based on model uncertainties. At 2.9 cfs, this rate is well below the expected treatment rates during operations and early closure phases of up to 45 cfs (Knight Piésold 2018a) and 58 cfs (Knight Piésold 2018d), respectively. Section 4.17, Groundwater Hydrology and Appendix K4.17 provide additional information on the analysis of groundwater flow in closure.

Modeling of post-closure pit water quality indicates that the open pit water would need to be treated in perpetuity (Knight Piésold 2018d). To ensure that impacted groundwater is contained as planned, groundwater monitoring would be conducted at selected wells surrounding the pit lake to confirm that groundwater flow is toward the pit, and that impacted groundwater is not migrating outside of the pit. Should the monitoring find that groundwater does not flow toward the pit, or that groundwater quality outside the pit is degraded during the post-closure period, the maximum management level (890 feet amsl) currently proposed would be reconsidered, and the pit lake level would be lowered to maintain hydraulic containment.

Pit lake modeling indicates that the lake would become thermally and chemically stratified (Lorax Environmental 2018), as discussed in Appendix K4.18. In terms of magnitude and extent, pit lake water quality predictions for various closure and post-closure time periods indicate that hardness and trace metals (aluminum, antimony, arsenic, cadmium, copper, iron, mercury, manganese, molybdenum, nickel, lead, selenium, and zinc) in near surface (upper 30 feet) pit lake water would exceed discharge limits. Pit lake pH values are predicted to be slightly alkaline (7.6 to 8.2). At these pH values, the concentrations of some of the metals (aluminum, cadmium, copper, iron, mercury, manganese, nickel, lead, and zinc) may be reduced via precipitation, adsorption, or complexation (which was not accounted for in the model). However, several metals form oxyanions (arsenic, molybdenum, antimony, and selenium) are likely mobile at these pH values. Therefore, it would be important to continue to maintain the pit lake as a hydraulic sink in perpetuity to control releases of these (and possibly other) metals to the environment.

Effects on Drinking Water Wells – Groundwater is abundant in the project area, and would be used as a source of potable water for the mine facilities. The proposed water supply wells would be sited on a groundwater high located upgradient—and on the northern (opposite) side of—the NFK east and north drainages that contain seepage collection systems for the pyritic TSF and main WMP (Figure 4.16-1). Therefore, groundwater that would be potentially affected by mine site facilities would not be expected to affect drinking water sources used by on-site workers. Similarly, no effect would be expected on drinking water wells outside of the mine site area.

Effects of Wetlands Reduction – Disruption, in-filling, and removal of wetlands would be likely to influence groundwater recharge and discharge patterns, which would affect groundwater quality in the vicinity of the mine site. Currently, although sulfides appear to be naturally oxidizing in the deposit area, the groundwater is not acidic (see Section 3.18, Water and

Sediment Quality). Reducing conditions are prevalent, partly because of deposition of organic carbon from wetlands and infiltration of organic carbon during spring thaw. The redox (reduction-oxidation reaction) state of the overburden may change during mine operations as the water table is lowered, and previously saturated soils and sediments are exposed to oxygen. In terms of magnitude of impact, this change in redox conditions would be expected to result in the release of metals to groundwater as oxidation occurs, and possibly precipitate reduced metals within sediment pores. Concentrations of metals in shallow groundwater may also increase because of the disruption of wetlands and increased sedimentation, resulting in an increase in suspended particulates with adsorbed metals. If these effects on groundwater conditions were to occur, the effects would be within the groundwater capture zone of the open pit, and all impacted water would be treated prior to discharge to the environment.

Summary of Effects on Mine Site Groundwater Quality – The geographic extent of impacts on groundwater quality from mine site activities under Alternative 1 would be limited to effects on local groundwater in the near vicinity of mine facilities, within the footprint of the mine site. Section 4.17, Groundwater Hydrology, describes uncertainties in the groundwater model that could have implications as to the extent of affected groundwater. The magnitude of these impacts would be such that groundwater would not meet regulatory criteria at certain discrete locations within the mine site (e.g., shallow groundwater beneath the bulk TSF and groundwater in the open pit as the lake level rises). Groundwater entering the pit, where it would mix with pit lake water, would be pumped and treated in perpetuity to maintain the open pit as a hydraulic sink. In terms of duration, groundwater quality beneath the NFK west and NFK east drainages in the immediate vicinity of the mine site would be impacted during operations, but would be expected to improve in the decades after mine closure. Monitoring would be conducted at the SCPs after the end of mining and during the closure and post-closure periods, to determine whether water quality in these localized areas improves after mining ceases. If monitoring shows that water quality is not improving during the post-closure period, additional remedies would be implemented to treat the impacted groundwater, as needed. These impacts are expected to occur through post-closure if the mine is permitted and constructed.

Substrate/Sediment Quality

This section describes impacts on waterbody substrates. Impacts on wetlands substrates are addressed in Section 4.22, Wetlands and Other Waters/Special Aquatic Sites.

Effects of Fill Placement on Physical Substrate – The magnitude and extent of impacts of physical substrate would be that placement of fill for construction of TSFs, WMPs, stockpiles, seepage and sediment ponds, and other facilities at the mine site would bury substrate in a number of streams and ponds. Section 4.22, Wetlands and Other Waters/Special Aquatic Sites, lists the acreages of fill placement in both waterbodies and wetlands.

Another impact of placement of fill would be changes in sediment supply to downgradient streams. In terms of extent of the impact, at mine site locations where streams would be filled, such as at the bulk TSF and associated seepage and sediment ponds, the downstream sediment supply to the NFK River would be cut off, depleting the natural supply of sediment to downstream gravels, and potentially affecting aquatic habitats (see Section 4.24, Fish Values). A decrease in water flow from fill placement would also lower the natural level of coarse sediment transport, potentially allowing more fine particles to accumulate within the streambed. These impacts of placement of fill would be permanent, and certain to occur if the project is permitted and constructed.

Summer-Only Ferry Operations Variant – The magnitude of impact of potential operational scenarios under the Summer-Only Ferry Operations Variant would be an additional effect on substrate because of the increased operational footprint at the mine site (Ausenco Engineering 2018). In terms of extent, ore concentrates and additional diesel fuel would be stockpiled at the mine site, requiring additional container and fuel storage areas that would total approximately 38 acres. These storage areas would be constructed partially or wholly on wetland areas, thereby directly affecting substrate. The impacts would be long term, and would occur if the Summer-Only Ferry Operations Variant is chosen, and the mine is permitted and built.

Effects of Erosion on Physical Substrate – Sediment release from erosion during construction and operations would be likely to impact water quality. BMPs (described above under Surface Water Quality) would be followed, and sediment control measures would be applied during construction, including the use of temporary settling basins and silt fences. Sediment control measures during operations through closure would include a number of diversion channels that would direct surface runoff away from project facilities, and sediment ponds that would allow material to settle out of the water column, inhibiting the extent of downstream sediment transport. Surface runoff and seepage from stockpiles would be captured by drainage ditches and routed into sedimentation ponds to allow settling before water is released downstream. The potential exists for erosion during periods of high precipitation and runoff to overwhelm the BMPs, resulting in an influx of fine sediment and increased turbidity into gravel-dominated streambeds. In terms of magnitude and extent of impacts, suspended fine particles would be expected to settle, and fill in interstitial spaces among the gravel, potentially affecting the streambed ecosystem (see Section 4.24, Fish Values).

Construction of the mine site facilities would block some streamflow, reducing natural erosion during high-precipitation events. However, in terms of magnitude and extent of impacts, increased streamflow where WTP effluent is discharged would increase the quantity of sediment that would be eroded, transported, and deposited downstream, thereby modifying substrate. Current designs for WTP discharge indicate that each outfall pipeline would be equipped with a discharge chamber to mitigate the potential for erosion at discharge points. Discharge chambers would be buried at sufficient depth for thermal insulation against freezing. Each outfall pipeline would be designed first to drain into the discharge chambers to reduce the energy of water outflow, then to release the water into the drainage (Knight Piésold 2018f). The duration of impacts would be long term and possible if control measures are inadequate or fail.

Impacts on Sediment Quality during Construction and Operations – Mining and exposing rock to chemical and physical weathering and erosion may increase the natural (pre-mine) rates of these processes and release constituents into surrounding surface water and substrate, thereby resulting in direct impacts to sediment quality. The magnitude of impact would be that substrate may be inundated with newly eroded materials, or undergo changes in chemistry due to the presence of weathering by-products. The evaluation of impacts on sediment quality depends largely on water quality and the other direct sedimentation impacts described above (e.g., erosion, dust). In terms of magnitude and extent, the chemical quality of sediment in some sections of streams at the mine site would be altered by fill placement, sediment accumulation upstream of embankments, and migration of contact water to downstream collection facilities. For example, contact water from the flow-through bulk TSF main embankment would introduce contaminants into native sediment between the TSF and the downstream SCP. Chemical components in water (such as metals and sulfate) would be absorbed by sediment or adsorbed onto sediment surfaces. Conversely, sediment would be expected to retain chemical constituents and slowly release them into water.

In terms of the extent of impacts on sediment quality, containment structures, and implementation of BMPs would limit impacts on sediment quality from surface disturbances to the project footprint. Water would be treated before discharge, and the potentially affected sediment would be contained by seepage and sediment ponds upstream of the discharge points. Likewise, although sediment in fully lined or contained facilities such as the pyritic TSF, WMPs, and pit lake would contain PAG materials and metals from the mining process, these would not affect native sediment in downstream waterbodies if properly managed.

Impacts on Sediment Quality from Fugitive Dust – Fugitive dust from various mine site sources and activities has the potential to affect sediment chemistry, particularly the concentration of metals. Appendix K4.18 provides the methodology used to calculate the predicted incremental increase in metals concentrations in sediment, and Table K4.18-16 shows the results. In terms of magnitude, total increases in metals concentration in sediment due to dust deposition are predicted to be less than 1 percent for all metals except antimony, which would be expected to increase by about 3 percent. Dust deposition would not be expected to result in any exceedances of the most stringent sediment quality criteria (Table K3.18-1).

Effects on Sediment Quality during Closure – Residual impacts from mine operations could remain beneath operational facilities. During closure and reclamation, soil and sediment beneath the facilities slated for removal (such as the pyritic TSF and WMPs) would be tested for contaminants, and any impacted materials exceeding applicable regulatory levels would be either treated or removed, and placed in the open pit (Knight Piésold 2018b). Surface runoff and groundwater that may be hydraulically connected to on-site sediment would be monitored downstream of the TSFs and WMPs at selected locations during post-closure to verify that potentially contaminated sediment is not affecting downstream water quality.

It is possible that mine-impacted sediment would remain between the reclaimed pyritic TSF and WMP footprints that are tested at closure. In these locations, the duration of impacts would be such that sediment can retain chemical constituents and slowly release them into overlying water, for decades or longer. Contaminants can be flushed out of coarse sediments such as gravels relatively quickly; by contrast, fine sediments like silts, muds, and clays found in some of the glacial lake deposits at the mine site could retain contaminants in porewater, and could store them for long periods of time because of their higher surface area. Even in areas where downstream water quality would be monitored; contaminants held in sediment would be expected to continue to be slowly released into waterbodies over the long term through runoff.

4.18.3.2 Transportation Corridor

Surface Water Quality

Road Corridor – In terms of magnitude, extent, duration, and likelihood, long-term impacts on surface water quality along the road corridor resulting from erosion at construction sites, material sites, and stream crossings would be expected, potentially causing increased suspended solids and turbidity in downstream waterbodies. Erosion and sedimentation would be managed by implementing BMPs as described in Section 4.14, Soils.

Based on a field review of geology at material sites, PAG material has not been identified at any site along the transportation corridor, and the rock types present are not typical of PAG rock. Rock types would be investigated further during site evaluation before construction. If PAG material is identified, it would not be used for construction, and the material site would be relocated to an alternate location with non-PAG rock (PLP 2018-RFI 035).

The potential for small amounts of vehicle- or ferry-related pollutants to affect streams along the transportation corridor is discussed below under “Substrate/Sediment Quality.” Section 4.27, Spill Risk, discusses the potential for containers containing concentrate to affect water quality.

Ferry Construction and Operations – In terms of duration and magnitude, short-term but recurring impacts on surface water quality would result if ferry-induced suspended sediment in

Iliamna Lake near the terminals were to exceed background levels (see Appendix K3.18, Table K3.18-13). However, because the ferry would approach the dock perpendicularly at low power, and the propeller base plane would be 4 feet above the keel, the potential for propeller-induced erosion of the lakebed would be limited (PLP 2018-RFI 013). In terms of magnitude and duration, if fine bottom sediments were resuspended by ferry operations, it is expected that TSS concentrations would be expected to return to background levels within a short distance (less than 100 feet) from the ferry.

Stormwater runoff at the ferry terminals would be a potential source of impacts on surface water quality, potentially carrying suspended material and contributing to increased turbidity. Releases from ferry terminal facilities (e.g., generators, maintenance shops, or parking areas) would have the potential to affect surface water quality through stormwater runoff. Releases at the ferry terminals would be reduced through implementation of engineering controls (e.g., secondary containment, planned material management, and the presence of spill response equipment). In addition, stormwater capture and treatment systems would be in place at both ferry terminal locations to capture potential contaminants (PLP 2018-RFI 093). The duration and likelihood of impacts from construction and operation of ferry terminals would be long term and possible if control measures are inadequate or fail.

Groundwater Quality

Road construction, material site development, and ferry operations are not expected to affect groundwater quality.

Substrate/Sediment Quality

Erosion Effects – Project-induced erosion and increased sedimentation on waterbody substrates would be expected to occur during construction activities such as vegetation removal, excavation, and grading of road beds and material sites. In terms of duration and magnitude, long-term impacts ranging from direct inundation of substrate to minor changes to substrate characteristics and chemistry would result. Withdrawal of water from permitted waterbodies during construction and operations also has the potential to disturb fine sediment on streambeds and lakebeds. BMPs such as dust control and erosion and sedimentation control measures and compliance with permit stipulations for water extraction methods would be followed to reduce potential impacts. The extent of effects during road construction would likely be limited to stream crossing locations within the construction right-of-way (ROW). The duration and potential for erosion and sedimentation is expected to be seasonal (reduced in winter by frozen conditions), and to continue for the life of the unpaved roads, which would be permanent, because they would be needed to support water treatment at the mine site post-closure.

Should BMPs be inadequate or overwhelmed by high-precipitation events, eroded soils and sediments would be transported by water and wind, potentially causing sedimentation into nearby waterbodies. Section 4.24, Fish Values, describe effects on fish habitat and aquatic resources. Streams intersecting the transportation corridor vary in grain size and substrate composition, with some crossings composed mainly of sand, silt, and organic material; and others having a higher concentration of gravel, cobbles, and boulders (Section 3.18, Water and Sediment Quality) (PLP 2018-RFI 036). The Gibraltar River bridge crossing location is largely dominated by gravel and cobbles. Stream crossings in areas where substrate is predominantly fine-grained would likely be subject to greater erosional effects and impacts on substrate than those with predominantly coarser substrates (see Section 4.16, Surface Water Hydrology, for discussion of erosion and sedimentation at stream crossings)

Placement of Fill Material – Road construction would include the placement of fill onto waterbody substrates at stream crossings, lakes, and ponds along the transportation corridor, resulting in a direct long-term to permanent impact to sediment. Gravel fill would be placed at certain bridge abutments and at the ends of culverts larger than 3 feet in diameter to protect the bridge structures and substrate from erosion. Fill would also be placed inside larger culverts requiring fish passage to simulate streambed material for aquatic habitat. The areas and lengths of streams affected are quantified in Section 4.22, Wetlands and Other Waters/Special Aquatic Sites, Table 4.22-2, and shown on Appendix K4.22, Figure K4.22-1. The magnitude of the direct effect of fill placement would be to permanently bury existing sediment, because the road would remain during post-closure. In terms of extent and duration, fill placement at the ferry landings would extend about 105 to 155 feet onto the nearshore lake sediment (PLP 2018-RFI 093), and would remain in place at closure. Potential indirect effects under CWA Section 404(b)(1) include temporary localized sediment suspension and redeposition downstream during construction.

Sediment Contamination – Fuel, oil, and lubricants would be used during the normal course of operations; and if not properly managed, these materials could be inadvertently released onto the roadbed, and run off to stream or pond substrates, or could be released into Iliamna Lake and incorporated into lakebed substrate, resulting in direct impacts to sediment quality. These potential impacts related to sediment contamination would be reduced by following BMPs and fuel handling requirements, and would extend throughout the life of the mine and into post-closure. Section 4.27, Spill Risk, addresses impacts from potential major spills along the transportation corridor.

Summer-Only Ferry Operations Variant – Under the Summer-Only Ferry Operations Variant, the magnitude and duration of impacts from activities at the ferry terminals would be reduced for approximately 6 months per year, during the winter (Ausenco Engineering 2018). As a result, roadway use would also be greatly reduced, particularly on the southern side of Iliamna Lake. During the period of no use, the potential for impacts on substrate and sediment quality would also be reduced because of the lower activity levels. However, the potential for impacts would not be eliminated entirely, because fuel, lubricants, or other potential contaminants would still be stored at local ferry terminal facilities, and because some roadway use would still be expected. During the periods of ferry operation, the magnitude of activity would approximately double to account for the reduced length of the operational season. Overall, the magnitude, extent, duration, and likelihood of impacts of this variant on substrate would be essentially the same as the effects of Alternative 1.

4.18.3.3 Amakdedori Port

Surface Water Quality

Surface Water Runoff – Amakdedori port would be the shoreline hub for shipping, receiving, and storage of concentrate containers, fuel, reagents, and other freight for the project; and as a result, would experience impacts from those activities. In terms of magnitude and extent, the primary potential direct impact from surface water runoff would be the transport of contaminants from the port facilities into adjacent marine waters. These direct impacts would be reduced through engineering controls. For example, the outside of concentrate containers would be vacuumed or spray-washed at the port site (PLP 2018-RFI 45). In addition, the secondary containment (container barrier wall) built around the fuel tanks, and a perimeter containment curb constructed around the terminal would prevent surface water runoff from these facilities and activities from reaching off-site surface water.

The WTP at Amakdedori port would treat surface runoff from the port facilities, which could potentially contain constituents from the above sources. In terms of magnitude and extent of impact to water quality, runoff water from the port facilities would have some similarities to mine contact water in terms of solids, but would not be expected to have the same levels of TDS, given the lack of material processing. Prior to discharge, the treatment process would include dissolved metal oxidation using potassium permanganate, followed by co-precipitation with ferric chloride. Water from the co-precipitated solids would flow into flocculators/clarifiers to separate out the solids. The clarified water would then be treated with sodium hydrogen sulfide, sodium hydroxide, and ferrous sulfate to further co-precipitate the remaining metals under reducing conditions. The solids removed would be thickened and disposed of appropriately, either at the mine site in the pyritic TSF, or at an approved offsite disposal facility via barge. Water treatment would also address any hydrocarbons (petroleum, oil, lubricants [POL]) in the runoff (PLP 2018-RFI 087). The treated water would be suitable for discharge, with a discharge point in marine waters at the end of the dock structure. A potable WTP and a sewage treatment plant would also be located at the port site. The duration of potential impacts would be for the life of the project, if the mine is permitted and the Amakdedori port is constructed and operated.

Dust Impacts on Marine Water Quality – In terms of impact potential, dust generation during bulk carrier loading operations would be mitigated by implementing BMPs to prevent the dust from entering the water. The copper and gold concentrate containers would be lowered into the hold of the bulk carrier prior to being emptied, deep enough to prevent crosswinds from generating dust. The containers would be emptied within 10 feet of the concentrate pile, minimizing dust generation, and the hold would be filled to only approximately 50 percent of capacity. Based on the typical dimensions of a bulk carrier, the inverting and discharge of containers would occur at least 20 feet below the hatch. The concentrate is expected to still be moist from processing, but a water fog system could be installed to minimize dust if required (PLP 2018-RFI 099; PLP 2018-RFI 045). Section 4.27, Spill Risk, addresses impacts on water quality under potential upset conditions.

Impacts on Salinity Gradients – Salinity gradients that might occur naturally at the locations of freshwater discharges into the port areas would assimilate quickly into adjacent marine waters due to natural mixing by wind-driven currents and waves, and therefore would not be affected by port operations.

Suspended Particulates/Turbidity from Causeway Fill – In terms of magnitude and duration of potential impacts on marine waters, increased concentrations of suspended sediment and redeposition would occur in Kamishak Bay during the placement of fill material for causeway construction and the installation of sheet pile for the wharf structure. Such conditions could persist for up to several days after the completion of construction. The duration and extent of the increase in suspended sediment concentrations would depend on the amount of fine sediment in the fill material and disturbed seafloor material, as well as weather conditions (i.e., tides and wind-driven currents and waves would disperse suspended sediment even as it settles to the seabed). Section 4.16, Surface Water Hydrology, also describes impact of in-water structures. Fill material would consist of either blasted granitic bedrock trucked along the road from the closest material site, MS-A08, or imported by barge from existing commercial sources (PLP 2018-RFI 005; PLP 2018-RFI 035) such as the granite quarry at Diamond Point (ADNR 2014a). The existing marine substrate at the port site consists of subtidal gravels (GeoEngineers 2018a). Although sediments in the area are generally coarse-grained (Section 3.18, Water and Sediment Quality), project-related activity would contribute to the magnitude, extent, duration, and potential of increased suspended sediment levels in marine water around the proposed port site.

Pile-Supported Dock Variant – Compared to the causeway alternative, this dock variant would essentially be transparent to water movements in the port area; that is, a pile-supported dock would not be capable of deflecting alongshore currents from the shore in the same manner as a solid-fill causeway. In terms of magnitude and extent, wake effects would be limited to a few pile diameters' distance from each pile (on the lee side). No alteration of water movements or sedimentation processes would occur. Vibrations caused by pile driving during construction could affect sediment substrate; however, these effects would be limited in duration to the actual pile-driving period.

Groundwater Quality

Impacts on groundwater quality at the port site are not expected. No excavation or placement of fill would occur at depths that intersect the water table. Using groundwater for drinking water supplies at the port would not adversely affect groundwater quality. A single groundwater well is planned for the port site for potable water supply (location to be identified during detailed design). The well would be sited on uplands far enough from shore to mitigate the risk of potential saltwater intrusion, and water would be piped to the port site from the wellhead (PLP 2018-RFI 022a).

Substrate/Sediment Quality

Effects on Freshwater Substrate – In terms of magnitude, extent, and duration, direct impacts to sediment in Amakdedori Creek on the southwestern side of the terminal and in ponds to the north may occur as a result of erosion and overland runoff, especially during construction. However, BMPs would be in place to avoid or reduce erosion and runoff. The port terminal would be built at an elevation of 35 feet, about 15 feet above the floodplain of Amakdedori Creek. As described above, runoff from the terminal would be contained and treated before discharge to Amakdedori Creek. Section 4.14, Soils, and Section 4.16, Surface Water Hydrology, provide further descriptions of BMPs and potential flooding effects, respectively.

Summer-Only Ferry Operations Variant – In terms of magnitude and extent, the Summer-Only Ferry Operations Variant would result in an increased operational footprint at the port site, which would cause increased effects on substrate (Ausenco Engineering 2018). The additional concentrate storage under this variant would require placement of fill along the eastern bank of Amakdedori Creek (PLP 2018-RFI 065). Section 4.22, Wetlands and Other Waters/Special Aquatic Sites, provides the acreage of wetland substrate loss under this variant. The impact of additional fill placement would be permanent and certain to occur if the Summer-Only Ferry Operations Variant is chosen, the project is permitted, and the port is built.

Effects on Marine Substrate – In terms of magnitude and extent of impacts on marine substrate, the causeway would be approximately 1,200 feet long with an average base width of 250 feet, and the wharf would extend another 700 feet, with a width of 120 feet (PLP 2018-RFI 093); the footprint on the floor of Kamishak Bay would be approximately 11 acres (see Chapter 2, Alternatives, Table 2-2). The duration and likelihood of effects would be permanent and certain to occur if the project is permitted and the causeway is constructed. Placement of fill and riprap on top of the seabed during causeway construction and installation of sheet pile for wharf construction would result in direct impacts, including the burial of substrate beneath the footprint, disturbance of seafloor sediment during fill placement and sheet pile driving, and settling of suspended solids away from the footprint, as described above under Surface Water Quality. Dredging of offshore sediment would not be required at the Amakdedori port site.

Section 4.24, Fish Values, discusses impacts on the primarily soft sediment habitat types in this area.

Fuel, oil, and lubricants may leak from vessels into Kamishak Bay and Cook Inlet waters, and potentially become incorporated into seafloor sediments. However, strong currents, shallow water, and high tidal exchange in Cook Inlet create an ongoing flushing of seawater in the inlet (USACE 2013). Potential contaminants from marine vessels accessing Amakdedori port would be diluted and flushed into the North Pacific Ocean, and would not be expected to contribute a negligible amount of contamination to existing low background levels (contaminate marine sediments (Section 3.18, Water and Sediment Quality). Section 4.27, Spill Risk, discusses impacts from upset conditions.

4.18.3.4 Natural Gas Pipeline Corridor

Surface Water Quality

The magnitude, extent, duration, and likelihood of impacts to surface water quality within the natural gas pipeline corridor would be associated with installation of the pipeline at water crossings and the use of local water sources for hydrostatic testing. Impacts at material sites and stream crossings would be the same as those described above for the transportation corridor.

In terms of magnitude of effects, surface water quality at pipeline stream crossings is expected to be within water quality standards for turbidity during construction. Natural turbidity measurements at stream crossings along the transportation corridor were mostly below the instrument's minimum detection level of 7 to 11 nephelometric turbidity units (NTU) during 2018 field studies (see Section 3.18, Water and Sediment Quality) (PLP 2018-RFI 036). ADEC water quality standards specify that turbidity levels may not exceed 5 NTU above these conditions (when the natural turbidity level is 50 NTU or less). It is possible that isolated occurrences of impacts above this standard could occur temporarily during construction (e.g., during high-precipitation periods along summer construction segments); planned redundancies in BMPs, erosion and sediment control measures, and reclamation/cleanup crew functions would reduce potential impacts. Exceedances of turbidity standards would not be expected during operations if appropriate pipeline cover material is applied, consistent with the US Department of Transportation Pipeline and Hazardous Materials Safety Administration code and BMPs, including water bars and diversion features. Impacts to surface water quality in excess of allowable standards from erosion of horizontal directional drilling (HDD) sites during and after construction would not be anticipated if proper procedures and BMPs are applied (PLP 2018-RFI011).

The removal of water from rivers and small lakes along the route for hydrostatic pipeline pressure testing would be required. However, the water volume removed for testing purposes would be small; therefore, impacts on surface water quality from hydrostatic testing are not expected. Discharges of hydrostatic test water would meet the requirements of the applicable APDES general permit, or other state-issued permit as applicable, depending on whether discharges are to land or water.

Groundwater Quality

Trenching Effects – The pipeline trench would likely intersect shallow groundwater intermittently along the overland portion of the route, causing potential impacts on groundwater quality similar to those of the transportation corridor. In areas of shallow groundwater, there would be local alterations to groundwater flow patterns (Section 4.17, Groundwater Hydrology), and small changes in the composition of groundwater that would likely not exceed applicable regulatory criteria. The extent of groundwater impacts would be limited to particular areas, primarily in the vicinity of stream crossings.

Horizontal Directional Drilling Effects on Drinking Water Wells – HDD operations would be required for the natural gas pipeline at the Kenai shore approach near Anchor Point, and potentially at other locations as permits require. Impacts of HDD operations on groundwater and potential drinking water sources would be expected to be minimal and localized, relative to baseline groundwater supply wells (see Section 3.18, Water and Sediment Quality). Dewatering would not be required for HDD operations, precluding the risk of changes in local groundwater flow patterns (see Section 4.17, Hydrogeology). Drilling fluid would likely be composed of bentonite and water. The potential risk exists for drilling fluids, injected under pressure, to propagate away from the borehole and escape into the local aquifer (PLP 2018-RFI 051). Drilling fluid returns would be closely monitored during operations to ensure no excessive fluid loss. Drilling fluid returns would be treated via a separation system, and the cleaned fluid would be reinjected into the borehole for use during drilling, or stored in tanks at the surface for later disposal off site (PLP 2018-RFI 051).

Substrate/Sediment Quality

Potential impacts on waterbody substrate from erosion and sedimentation, fill placement, and contamination would be similar to those described above for the transportation corridor. No waterbody substrates would be crossed by the pipeline segment east of Cook Inlet. West of Cook Inlet, trench excavation and placement of cover material at stream crossings would be within the acreages documented for the road fill prism in Section 4.22, Wetlands and Other Waters/Special Aquatic Sites. BMPs would be in place to control runoff and erosion during trenching, backfilling, and other ground-disturbing activities; therefore, impacts would be avoided or minimized.

Placement of fill at pipeline landfalls in Cook Inlet and Iliamna Lake would entail trenching into the existing bottom sediment and covering the pipeline with at least 3 feet of fill to a water depth of 12 feet (PLP 2018-RFI 013). Section 4.16, Surface Water Hydrology, addresses the potential for sediment suspension, plume transport, and redeposition to occur during construction in the marine environment.

4.18.4 Alternative 2 – North Road and Ferry with Downstream Dams

4.18.4.1 Mine Site

Buttressed Downstream Bulk TSF Main Embankment – Due to similar seepage design and downstream capture under Alternatives 1 and 2 , the downstream dam alternative for the bulk TSF main embankment would likely have similar impacts on surface water and groundwater quality as centerline construction. However, impacts to substrate (freshwater sediment) would be greater than Alternative 1, because construction of the downstream dam alternatives would require a 45 to 60 percent increase in fill over the centerline constructed dam due to the larger embankment footprint, and would cover approximately 23 more acres (PLP 2018-RFI 075). This would result in a corresponding increase in direct impacts on substrate in the NFK west drainage through permanent burial by fill, and a potential increase in erosion and redeposition impacts (described under Alternative 1).

4.18.4.2 Transportation Corridor

Mine Site to Eagle Bay, and Pile Bay to Diamond Point Roads – Under Alternative 2, two road segments would cross approximately half as many waterbodies requiring bridges or culverts as the transportation corridor under Alternative 1. Water quality and substrate impacts associated with the road segments and material sites would therefore be expected to be incrementally less than Alternative 1. As in Alternative 1, the impacts that would be expected would be potential direct and temporary effects on water quality due to sedimentation and turbidity generated through construction activities, which would be limited by use of BMPs and engineering controls (PLP 2018-RFI 086).

Eagle Bay to Pile Bay Ferry – Ferry operations from Eagle Bay to Pile Bay would have similar impacts on water and substrate quality as ferry operations in Alternative 1.

Summer-Only Ferry Operations Variant – Although the Summer-Only Ferry Operations Variant would reduce water quality impacts on the lake during the 6-month winter season, ferry operations and activity would be increased during the 6 months of ferry operations. Placement of additional fill at the mine site and the port site would be required to support additional storage areas for concentrate and diesel (PLP 2018-RFI 065), resulting in corresponding increases in burial of existing lake substrate and in suspended solids and turbidity during fill placement. Additional concentrate storage at the port site under this variant would also require an increase in fill placement along the western side of Iliamna Bay near Williamsport (see Section 4.22, Wetlands and Other Waters/Special Aquatic Sites, for the acreage of wetland and waterbody substrate coverage under this variant). The likelihood of small spills and contaminated runoff would increase because of the extra container and fuel storage under this variant, although this is expected to be mitigated by water treatment of runoff as described under Alternative 1 (major spills from extra container and fuel storage are addressed in Section 4.27, Spill Risk).

4.18.4.3 Diamond Point Port

Terminal Runoff and Lightering Locations – Impacts from surface water runoff and treatment at the terminal, and from dust at the lightering locations, would be the same as described for Alternative 1.

Groundwater Quality at Dredge Disposal Area – Because of the differences in the approaches to the proposed dock facilities between Amakdedori port and Diamond Point port, dredging of marine substrate at the Diamond Point location would be required to achieve a minimum 20-foot water depth. This dredging would generate approximately 650,000 cubic yards of material, of which a minimum of 50 percent would be used in dock construction. The remaining dredged material would be transported and disposed of onshore in a bermed facility located west and upland of the dock site, about 200 feet from the shoreline (PLP 2018-RFI 063). Most interstitial water (e.g., water contained in the dredged sediment) would be expected to drain back into Cook Inlet during placement of the dredged material onto a barge prior to transport; however, some limited amount of water would remain in the dredge spoils, and would be placed in the upland disposal site with the solids. The saline water placed in the bermed containment would be expected to seep into underlying soils, and would mix with any shallow groundwater present. The overall area of the potential groundwater impact would be somewhat limited by the proximity of the disposal site to the shoreline.

Impacts on Salinity Gradients – Salinity gradients that might occur naturally at the locations of freshwater discharges into the port area would assimilate quickly into adjacent marine waters due to natural mixing by wind-driven currents and waves, and therefore would not likely be affected by port operations.

Proposed Earthen Fill Dock: Suspended Particulates/Turbidity and Substrate Effects – Construction of dock facilities at Diamond Point would have greater direct impacts on marine substrate than construction under Alternative 1, because the footprint of these structures would cover roughly 90 more acres of seabed with fill than the Amakdedori port structures (PLP 2018-RFI 072). Placement of the fill causeway and wharf structure would contribute suspended sediment to the water column, leading to temporary turbidity and redeposition in the vicinity of construction. These effects are expected to be greater than those of the Alternative 1 causeway construction because of the greater amount of fill placement, and because the finer seabed material in Iliamna Bay is expected to travel farther before settling. This would cause an increase in the extent of turbidity effects and redeposition compared to Alternative 1, and an increase compared to the Pile-Supported Dock Variant under this alternative.

Some dredging of shallow offshore sediments would be required for construction of a marine vessel channel at the Diamond Point port. Initial dredging and maintenance dredging over 2 decades of production at the mine would cover an area of approximately 60 acres. These activities would temporarily increase suspended solids in the water column, which would be redeposited on marine substrate; effects that would not occur under Alternative 1. The extent of these effects would range from localized, to beyond the mouth of Iliamna Bay, depending on tides and wave conditions.

Pile-Supported Dock Variant: Suspended Particulates/Turbidity and Substrate Effects – Construction of a pile-supported dock at Diamond Point would result in fewer direct impacts on substrate than a fill causeway, because the piles would be driven through vibratory and hammer methods and would require no fill (PLP 2018-RFI 072). Effects would be slightly greater than the effects of constructing a pile-supported dock under Alternative 1 because the footprint of the piles would be about twice as large as the dock footprint under Alternative 1. Temporary and limited impacts from increased suspended sediment in marine waters would be expected to occur during construction of the pile structure.

4.18.4.4 Natural Gas Pipeline Corridor

For the portion of the natural pipeline corridor crossing Cook Inlet from the Kenai Peninsula, impacts on water and sediment quality would be the same as described under Alternative 1. From the point the pipeline would come ashore at Ursus Cove to the mine site, the Alternative 2 pipeline corridor would cross approximately 28 percent more waterbodies than the Alternative 1 route, but would eliminate the crossing of Iliamna Lake. The increase in waterbody crossings would suggest an incremental increase in the potential for impacts to water and sediment quality, primarily through the local and temporary direct effects of sedimentation during construction. Sedimentation would be minimized through the use of engineering controls and BMPs such as silt fences and bale check dams. In addition, the pipeline trench would have the potential to intersect shallow groundwater in the area between Ursus Cove and Diamond Point; however, impacts to groundwater would be expected to be limited and temporary.

4.18.5 Alternative 3 – North Road Only

A continuous overland access road would connect the Diamond Point port to the mine site under Alternative 3. The natural gas pipeline would be commonly aligned with the transportation corridor under this alternative, and would align with the same route as the natural gas pipeline under Alternative 2. Impacts to water and sediment quality on the pipeline corridor would be very similar to those described for the Alternative 2 transportation corridor. The following section describes impacts for the mine site, transportation corridor, and port that would be unique under Alternative 3.

4.18.5.1 Mine Site

Under Alternative 3, impacts on the mine site would be the same as for other alternatives, with minor differences in effects under the Concentrate Pipeline Variant. Impacts of this variant are described below.

Concentrate Pipeline Variant – The concentrate pipeline from the mine to the port under this variant would require an electric pump station at the mine site, which would require a small increase in fill placement over stream substrate in an NFK east tributary (PLP 2018-RFI 066). This would slightly increase the long-term direct impact at the mine site through burial of natural sediment. This variant would also reduce the amount of WTP water released at discharge locations at the mine site by approximately 1 to 2 percent (PLP 2018-RFI 066). This would result in slight reductions in temperature effects, impacts on substrate, and turbidity or erosional effects at the locations of treated water discharges. Inclusion of the concentrate pipeline would result in a slight increase in the potential for minor spills at the mine site. Section 4.27, Spill Risk, examines major spill scenarios.

4.18.5.2 Transportation Corridor

Alternative 3 would increase the project footprint, but would eliminate surface water quality impacts associated with the ferry crossing of Iliamna Lake. The northern access all-road route would result in an increase of about 20 percent in the number of stream crossings relative to Alternative 1, with a corresponding increase in direct but temporary water quality and substrate impacts (described under Alternative 1).

Concentrate Pipeline Variant – Inclusion of a concentrate pipeline under this alternative would result in slightly greater direct impacts on water and substrate/sediment quality than the all-road route alternative without the concentrate pipeline. The concentrate pipeline would be buried during road construction, and the road corridor would be widened by less than 10 percent to accommodate the pipeline, which would marginally increase the turbidity effects on water quality and fill placement over substrate. An electric pump station would be required along the transportation corridor under this variant (PLP 2018-RFI 066), resulting in a small increase in the footprint in an upland area that is unlikely to affect water quality or substrate. Inclusion and operation of the concentrate pipeline would also result in an increased potential for impacts on substrate and surface water quality due to potential minor spills/leaks, although the likelihood of occurrence would be low with the use of a leak-detection system (major spill scenarios for concentrate are discussed in Section 4.27, Spill Risk). Because only the molybdenum concentrate (2.5 percent of the total concentrate production) would be trucked from the mine site to the port, a large reduction in road traffic would be anticipated, thereby reducing some potential direct and indirect impacts from dust, erosion, and runoff.

Concentrate Return Water Pipeline Option – Under this option, the return water pipeline would be buried in the same trench as the slurry and natural gas pipeline, requiring the trench to be widened by a few feet, and resulting in an increased footprint of the transportation corridor and a slight increase in direct impacts (PLP 2018-RFI 066). Therefore, the return water pipeline would result in a minimal increase in the same water quality and substrate/sediment quality effects as described above. Under this option, there would be a potential for minor spills of contact water from the pipeline affecting water and sediment quality that would not exist under the other options.

4.18.5.3 Diamond Point Port

Concentrate Storage and Bulk Handling – Concentrate would be dewatered at the port site, and the dewatered concentrate would be stored in a large building until the loading of concentrate onto bulk carriers for transport. The storage building would result in a slight increase in the footprint at the port site beyond that of Alternative 2, with a corresponding slight increase in direct impacts from substrate burial at the small tributary to Cottonwood Bay (see Chapter 2, Alternatives, Figure 2-64). Bulk handling of the concentrate would use controls to reduce dust emissions, such as covered conveyors that are used at Red Dog Mine dock facilities (PLP 2018-RFI 066). If not properly managed, the storage and handling of bulk concentrate would result in an increased potential for direct effects on water and sediment quality.

The water removed from the concentrate would be treated in a WTP to meet marine water quality standards, and discharged through an outfall pipeline and diffuser to the marine environment. Treatment would consist of adding chemicals for pH adjustment and metals precipitation, followed by use of clarifiers for solids removal and additional metals precipitation with sodium hydrogen sulfide and filtration. Solids and/or brine captured in the clarification and filtration steps would be trucked to the mine site or barged to an off-site disposal facility (PLP 2018-RFI 066).

4.18.5.4 Concentrate Pipeline Variant

The concentrate pipeline option using a return-water pipeline would result in no additional project footprint at Diamond Point, and would preclude the need for the discharge of treated water at the Cook Inlet terminus. This Concentrate Pipeline Variant would eliminate the need for a dewatering WTP at the port; instead, requiring a return-water pump station of appropriate capacity (PLP 2018-RFI 066). This option would result in a negligible change in the footprint at the port site, and likely no changes in impacts on substrate compared to Alternative 2 or Alternative 3 without the return water pipeline. Therefore, the effects on water and sediment quality would be the same as Alternatives 2 and 3.

4.18.6 Summary of Key Issues

Table 4.18-1 summarizes general anticipated impacts on surface water, groundwater, and substrate/sediment quality from construction, operations, and closure of the mine site and associated development and activities.

Table 4.18-1: Summary of Key Issues for Water and Sediment Quality

Impact-Causing Project Component	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
Mine Site			
Mine Site Construction	**Surface Water**: Ground disturbance and fill placement would result in increased turbidity in local waterbodies and streams, to be mitigated through BMPs. **Groundwater**: Metals concentrations in shallow groundwater may increase as a result of the disruption of wetlands and fill placement. **Substrate**: Ground disturbance and fill placement would result in substrate burial[1] and increased erosion and sedimentation if BMPs are inadequate, and would reduce natural levels of coarse sediment transport to downstream substrates.	**Surface Water**: Impacts similar to those of Alternative 1. **Groundwater**: Impacts similar to those of Alternative 1. **Substrate**: Impacts similar to those of Alternative 1.	**Surface Water**: Impacts similar to those of Alternative 1. **Groundwater**: Impacts similar to those of Alternative 1. **Substrate**: Impacts similar to those of Alternative 2. *Concentrate Pipeline Variant:* Small increase in substrate burial in NFK east tributary.[1]
Tailings and Contact Water Storage (TSFs and WMPs)	**Surface Water**: Pond water quality in TSFs and WMPs would exceed water quality standards, but would be contained within the mine site footprint and treated prior to discharge to the environment. Runoff of contact water from the TSF and WMP embankments would be monitored, and diverted to WMPs or WTPs for treatment as necessary. **Groundwater**: Local impacts on shallow groundwater quality in the NFK west, east, and north drainages are likely from vertical seepage through the bulk TSF, or leakage through the pyritic TSF or WMP liners. This would result in localized exceedances of water quality standards within the mine site footprint, which would be captured and treated prior to discharge to the environment. No mine site effects on drinking water wells are expected. **Substrate**: Burial from fill placement in the NFK west, east, and north drainages.	**Surface Water**: Impacts similar to those of Alternative 1. **Groundwater**: Impacts similar to those of Alternative 1. **Substrate**: Impacts similar to those of Alternative 1.	**Surface Water**: Impacts similar to those of Alternative 1. **Groundwater**: Impacts similar to those of Alternative 1. **Substrate**: Impacts similar to those of Alternative 1.

Table 4.18-1: Summary of Key Issues for Water and Sediment Quality

Impact-Causing Project Component	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
Fugitive Dust Effects	**Surface Water**: Metals concentrations in surface water predicted to increase by 0.1% to 0.7% as a result of fugitive dust deposition, including direct fallout and through runoff, although no exceedances of water quality standards are expected. **Groundwater**: No leaching to groundwater above ADEC migration-to-groundwater levels, except for arsenic, which exceeds baseline, and with a predicted 0.6% dust-related increase. **Substrate**: Metals concentrations in sediment would increase by 0.1% to 3%, but no exceedances of SQGs.	**Surface Water**: Impacts similar to those of Alternative 1. **Groundwater**: Impacts similar to those of Alternative 1. **Substrate**: Impacts similar to those of Alternative 1.	**Surface Water**: Impacts similar to those of Alternative 1. **Groundwater**: Impacts similar to those of Alternative 1. **Substrate**: Impacts similar to those of Alternative 1.
Treated Water Discharge	**Surface Water:** WTPs would effectively treat metals and other constituents in WMPs and TSF pond water to meet discharge criteria; the potential exists for an increase in TDS during operations, requiring adaptive management of WTP processes. Temperature changes in the range of -1°C to +3.6°C are predicted in the NFK, SFK, and UTC drainages about 0.5 mile to 3 miles downstream of WTP discharges. **Groundwater:** WTPs would effectively treat dewatering water from open pit and potential groundwater contamination from TSFs captured in seepage collection systems. **Substrate:** Potential erosion effects from WTP effluent would be minimal with discharge chambers to dissipate outflow energy.	**Surface Water**: Impacts similar to those of Alternative 1. **Groundwater**: Impacts similar to those of Alternative 1. **Substrate**: Impacts similar to those of Alternative 1.	**Surface Water**: Impacts similar to those of Alternative 1. *Concentrate Pipeline Variant*: Estimated decreased discharge volume by 1% to 2% would result in marginal changes in temperature effects. **Groundwater**: Impacts similar to those of Alternative 1. **Substrate**: Impacts similar to those of Alternative 1.
Mine Site Closure	**Surface Water**: Impacted sediment between the locations of TSFs and SCPs/WMPs locations, if present, would continue to release contaminants into surface water over time. Pit lake water quality would exceed water quality standards, but would be pumped to maintain operational levels and treated prior to being discharged to the environment. **Groundwater**: Local groundwater quality in the immediate vicinity of the pit and downstream of TSFs may exceed water quality standards, but would be contained by overall gradient toward pit lake or SCP capture, and treated to meet discharge criteria. **Substrate**: Potentially contaminated sediment between TSFs and SCPs/WMPs would be monitored after closure and remediated if necessary.	**Surface Water**: Impacts similar to those of Alternative 1. **Groundwater**: Impacts similar to those of Alternative 1. **Substrate**: Impacts similar to those of Alternative 1. *Downstream Bulk TSF Variant:* Increased substrate burial beneath the bulk TSF would be permanent.	**Surface Water**: Impacts similar to those of Alternative 1. **Groundwater**: Impacts similar to those of Alternative 1. **Substrate**: Impacts similar to those of Alternative 1.

Table 4.18-1: Summary of Key Issues for Water and Sediment Quality

Impact-Causing Project Component	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
Transportation Corridor			
Road Construction and Operations	**Surface Water**: Localized (affecting stream-crossing points and areas downstream) and temporary increase in turbidity at approximately 100 stream crossings during construction. Impacts are expected to be short term and limited to the construction phase, and would be mitigated through BMPs. **Groundwater**: Impacts anticipated to be negligible. **Substrate**: Potential erosion and sedimentation during construction at stream crossings to be mitigated through BMPs. Placement of fill at bridge and culverts would bury existing substrate.[1]	**Surface Water**: Localized increased turbidity, but 50% fewer stream crossings than under Alternative 1. **Groundwater**: Impacts similar to those of Alternative 1. **Substrate**: Potential increase in substrate impacts[1] with additional stream crossings.	**Surface Water**: Magnitude of impacts similar to those of Alternative 1, but in different locations. *Concentrate Pipeline Variant*: Marginal increase in turbidity due to wider road corridor. **Groundwater**: Impacts similar to those of Alternative 1. **Substrate**: Impacts similar to those of Alternative 2. *Concentrate Pipeline Variant:* Marginal increase in substrate[1] due to wider road corridor.
Ferry Construction and Operations	**Surface Water**: Potential for ferry-induced increase in nearshore TSS/turbidity during operations; expected to return to background levels within a short distance (less than 100 feet) from ferry. *Summer-Only Ferry Operations Variant:* Reduced TSS/turbidity impacts in winter and increased impacts in summer; overall same as Alternative 1. **Groundwater**: No impacts anticipated. **Substrate**: Fill placement at the ferry during construction would extend 100 to 150 feet onto the nearshore lake substrate. *Summer-Only Ferry Operations Variant:* Increased fill placement on lake substrate during construction at terminals.[1]	**Surface Water**: Impacts similar to those of Alternative 1. Ferry terminal locations changed to Eagle Bay and Pile Bay. *Summer-Only Ferry Operations Variant:* Impacts similar to those of Alternative 1. **Groundwater**: No impacts anticipated. **Substrate**: Impacts similar to those of Alternative 1. Ferry terminal locations changed to Eagle Bay and Pile Bay. *Summer-Only Ferry Operations Variant:* Impacts similar to those of Alternative 1.	**Surface Water:** No impacts on lake water quality anticipated (no ferry). **Groundwater**: No impacts anticipated. **Surface Water:** No impacts on lake substrate (no ferry terminals).

Table 4.18-1: Summary of Key Issues for Water and Sediment Quality

Impact-Causing Project Component	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
Port Site			
Causeway Fill/ Construction	**Surface Water**: Placement of fill during construction would result in a localized increase in TSS/turbidity in Kamishak Bay for the duration of construction activities. *Pile-Supported Dock Variant*: Would reduce TSS/turbidity impacts due to reduced area of disturbance.[1] **Groundwater**: No impacts anticipated. **Substrate**: Placement of fill during causeway construction would result in disturbance of seafloor sediment and burial of substrate beneath the causeway footprint.[1] *Pile-Supported Dock Variant*: Less burial of marine substrate during construction.[1]	**Surface Water**: Greater extent of TSS/turbidity increase due to finer-grained sediment and dredging activities; extent would range from the close vicinity of the dock to the mouth of Iliamna Bay, depending on tides and waves. *Pile-Supported Dock Variant*: Impacts similar to those of Alternative 1. **Groundwater**: Impacts similar to those of Alternative 1; stockpile of dredged material may have local impacts on shallow groundwater quality. **Substrate**: Area of direct impact on substrate would increase[1] due to a larger causeway and access route. *Pile-Supported Dock Variant*: Impacts similar to those of Alternative 1.	**Surface Water**: Impacts similar to those of Alternative 1. **Groundwater**: Impacts similar to those of Alternative 1. **Substrate**: Impacts similar to those of Alternative 1. *Concentrate Pipeline Variant:* The WTP would effectively treat dewatering water to meet discharge limits prior to discharge to marine environment.
Natural Gas Pipeline			
Construction Effects	**Surface Water**: Impacts similar to those for the transportation corridor under Alternative 1. **Groundwater**: Impacts west of Cook Inlet similar to those for the transportation corridor under Alternative 1. The risk of HDD drilling fluid affecting drinking water supply wells during construction on Kenai Peninsula is expected to be localized, and minimized through pressure monitoring during drilling; drilling fluid and cuttings would be disposed of off-site. **Substrate**: Impacts similar to those for the transportation corridor under Alternative 1.	**Surface Water**: Impacts similar to those for the transportation corridor under Alternative 2 (road and ferry). **Groundwater**: Impacts west of Cook Inlet similar to those for the transportation corridor under Alternative 2. Impacts east of Cook Inlet same as those for Alternative 1. **Substrate**: Impacts similar to those for the transportation corridor under Alternative 2 (road and ferry).	**Surface Water**: Impacts similar to those for the transportation corridor under Alternative 3 (road construction). **Groundwater**: Impacts west of Cook Inlet similar to those for the transportation corridor under Alternative 3. Impacts east of Cook Inlet the same as those for Alternative 1. **Substrate**: Impacts similar to those for the transportation corridor under Alternative 3 (road construction).

Notes:
[1] Acreages of waterbody substrate burial provided in Section 4.22, Wetlands and Other Waters/Special Aquatic Sites.

4.18.7 Cumulative Effects

The cumulative effects analysis area for water and sediment quality includes all watersheds in which project-related activity would occur, where direct and indirect effects on surface water, groundwater, or substrate (encompassing the footprint of the proposed project, including alternatives and variants, and areas downgradient) could reasonably be expected to contribute to cumulative effects. 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 water and sediment quality. 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 are considered to have no potential of contributing to cumulative effects on water and sediment quality in the EIS analysis area. These include offshore-based developments, activities that may occur within the EIS analysis area but are unlikely to result in any appreciable impact on water or sediment quality, or actions outside of the cumulative effects analysis area (e.g., Donlin Gold, Alaska Peninsula oil and gas exploration).

RFFAs that could contribute cumulatively to surface water quality and sediment impacts, and that are therefore considered in this analysis, are limited to those activities that would occur within the Nushagak River or Kvichak River drainages, or in other waterbodies intersected by the transportation corridor in the Cook Inlet drainage. RFFAs that could contribute cumulatively to impacts on groundwater quality are more limited, consisting only of activities in the mine site area, or immediately within or adjacent to the transportation corridor.

Past, present, and RFFAs that could contribute cumulatively to water and sediment quality effects, and are therefore considered in this analysis, include:

- Pebble Project buildout—development of 55 percent of resource over a 78-year period
- Pebble South
- Big Chunk South
- Big Chunk North
- Fog Lake
- Groundhog
- Shotgun
- Diamond Point rock quarry

4.18.7.1 Past and Present Actions

Past and present activities that may have affected water and sediment quality in the analysis area include boat operations in Iliamna Lake and Cook Inlet used for fishing and tourism; communities that generate sewage and solid waste, and use fossil fuels for energy and heat generation; past mining exploration; and dust generation and small fuel leaks/spills along existing roads (see Section 4.1, Introduction to Environmental Consequences). Some regional organizations have expressed concerns regarding permit violations and environmental degradation associated with past Pebble project exploration activities. ADNR conducts annual inspections during exploration activities, and has generally found that exploration activities are in compliance with standard practices. In some instances, additional reclamation at explorations sites has been required. In general, past and present actions have had some localized, and in most cases, short-term effects on water and sediment quality.

4.18.7.2 Reasonably Foreseeable Future Actions

No Action Alternative

The No Action Alternative would not contribute to cumulative effects on water and sediment quality.

Alternative 1 – Applicants Proposed Alternative

Pebble Mine Expanded Development Scenario – An expanded development scenario for this project, as detailed in Section 4.1, Introduction to Environmental Consequences, Table 4.1-2, would include an additional 58 years of mining and 20 years of milling (for a total of 98 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 (see Section 4.1, Introduction to Environmental Consequences, Figure 4.1-1), which would contribute to cumulative effects on water and sediment quality due to the nearly tripled footprint area and substantially longer duration of mining activity.

The Pebble mine expanded development scenario project footprint would impact approximately 34,790 acres, compared to 12,371 acres under Alternative 1, with a notable expansion into the UTC watershed that the proposed Alternative 1 generally minimizes. The magnitude of cumulative impacts to water and sediment quality would generally be temporary, but the duration of effects would be greater than under Alternative 1 as proposed.

The Pebble project expanded development scenario would result in additional development not included under Alternative 1:

- Increased pit footprint
- Increased TSF and PAG rock storage capacity with additional SCPs
- new waste rock storage and footprints with additional SCPs
- Additional processing infrastructure
- Construction of a new port site with additional access road and pipelines (concentrate and diesel) extending to the mine site.

The estimated area of disturbance would be nearly tripled over the proposed project alone, based on projected infrastructure buildout at the mine site. The buildout would correspond to an increase in the magnitude and local extent of cumulative ground disturbance impacts potentially contributing to sedimentation and fill placement on substrate, with a duration increase of up to 98 years. The potential for cumulative impacts on surface water, groundwater, and sediment would increase substantially. Additional design features to capture and treat impacted water and waste streams would be necessary to manage mine site impacts. An access road concentrate pipeline and a diesel pipeline from the mine site to Iniskin Bay would be constructed at Year 20, all having potentially limited impacts on water and sediment quality due to trenching activities, and potentially increased erosion. The increase in diesel fuel use over an extended period of time would also increase the likelihood of hydrocarbon spills and contribute to increased potential cumulative impacts; however, installation of a pipeline would reduce the overall cumulative impacts from spills compared with truck transport of fuel from the port site to the mine site.

Other Mineral Exploration Projects – Mineral exploration is likely to continue in the EIS 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 potential cumulative effects on water and sediment quality, although impacts would be expected to be limited in extent and low in magnitude.

Several RFFAs associated with mineral exploration activities (e.g., Pebble South, Big Chunk North, Big Chunk South, Fog Lake, and Groundhog) would have some limited impacts on surface water and sediment quality in common watersheds to the Pebble project (e.g., drill pads, camps); however, they would be seasonally sporadic, temporary, and localized, based on their remoteness. The potential would also exist for greater impacts on surface water and sediment quality through local co-use of transportation infrastructure with the Pebble project.

Road Improvement and Community Development Projects – Road improvement projects would have impacts on water and sediment quality, primarily through increased erosion potential, and would contribute to cumulative effects in the EIS analysis area. The most likely road improvements in the area would be within the development footprint of existing communities, with only Iliamna and Newhalen being considered to be within the analysis area for water and sediment quality cumulative effects. Some limited road upgrades may 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 within the EIS analysis area would contribute greatly to cumulative effects on water and sediment quality.

Additional RFFAs that have the potential to affect water and sediment quality in the EIS 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, potentially resulting in increased sedimentation in local surface water or effects on sediment quality. The estimated area that would be affected by the Diamond Point rock quarry is approximately 140 acres (Diamond Point LLC 2018).

Alternatives 2 – North Road and Ferry with Downstream Dams and Alternative 3 – North Road Only

Pebble Mine Expanded Development Scenario – Under expanded mine site development, contributions to cumulative effects on water and sediment quality under Alternatives 2 and 3 would be less than under Alternative 1, because the expanded mine scenario under these alternatives would not use the southern port access corridor or Amakdedori port site. Under Alternatives 2 and 3, project expansion would use the existing Diamond Point port facility, the same natural gas pipeline, and portions of the constructed portion of the north access road. A concentrate pipeline (Concentrate Pipeline Variant) and a diesel pipeline from the mine site to Iniskin Bay would be constructed, both having potentially limited impacts on water and sediment quality due to trenching activities, and potentially increased erosion.

Other Mineral Exploration Projects, Road Improvement and Community Development Projects – Cumulative effects of these activities on water and sediment quality would be similar to those discussed under Alternative 1. As previously discussed under Alternative 1, the proposed Diamond Point rock quarry has the potential to affect water and sediment quality in the EIS 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 would result in cumulative effects on water and sediment quality, and those effects 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.

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4.19 NOISE

This section addresses primarily direct effects on human receptors during all project phases. Potential noise impacts resulting from the project on other resources are addressed in other sections of the Environmental Impact Statement (EIS): Section 4.5, Recreation; Section 4.9, Subsistence; Section 4.11, Aesthetics; Section 4.23, Wildlife Values; Section 4.24, Fish Values; and Section 4.25, Threatened and Endangered Species.

The EIS analysis area includes the mine site, transportation corridor and airports, port, and natural gas pipeline corridor for all alternatives and variants where project-associated noise could have a direct effect on human receptors. The analysis area includes a 10-mile zone around the mine site (rationale for this distance is described in Chapter 3.19, Noise), and a 2-mile zone around the other project components where project effects of noise could be expected to occur (Figure 3.19-1).

Scoping comments were received on impacts of noise pollution as a result of project construction and mining operations. Specifically, commenters requested that the EIS discuss noise impacts of blasting in the project area; describe the blasting methods that would be used; and consider noise in the water created by the proposed icebreaker ferry and the impacts to fish, bears, and other wildlife.

4.19.1 Noise Impacts Analysis Methodology

The methodology framework applied to assessing direct noise-related impacts was based on four factors of magnitude (intensity) of project-attributed sound (or the resulting increase in outdoor ambient sound level over existing [pre-project] conditions); the duration over which that project-caused noise would be expected to occur; geographic extent of noise transmission; and the potential for the impacts to occur.

The analysis factors and how they are assessed to determine impacts are described below.

- Magnitude – Impacts are assessed on the basis of noise level, which may be comparable to natural (ambient) sound; readily detectable at the nearest sensitive receptor; dominate the soundscape at the nearest sensitive receptor; or the level could cause a risk of hearing impairment to (human) sensitive receptor(s).
- Duration – Impact duration may be short-term, intermittent, or last only through the construction phase; may last several years through the operations phase; intermittent and persisting through closure; or long-term and last beyond closure and post-closure (monitoring and maintenance).
- Extent – Impact may be limited geographically; extend beyond a local area, potentially affecting the whole EIS analysis area; or impacts may affect receptors beyond the EIS analysis area.
- Potential – Impacts would be certain to occur if the project would be permitted and built. In this section, potential is certain for this resource under the alternatives and associated variants, and this factor is not further discussed.

The quantitative and qualitative descriptions in this section use US Environmental Protection Agency (EPA) noise concepts and guidelines (EPA 1978) to assess the degree of noise impacts at noise-sensitive receptors (NSRs) for each project phase, and for each alternative, component, and variant.

To quantitatively assess potential noise impacts at NSRs, this analysis considers the aggregate of project-attributed noise sources of interest, on average, emitting from a common point (or in some cases, a line segment, such as for transportation routes) and applies the following sound attenuation factors:

- Geometric divergence – for point-source sound propagation, this yields 6 A-weighted decibels (dBA) of noise reduction per doubling of distance (DD) traveled by the sound, or 3 dBA per DD for a line source.
- Atmospheric absorption – although frequency-dependent, the rate of sound attenuation due to sound energy absorbed by the air can typically be expressed as 1 dBA per 1,000 feet traveled.
- Ground absorption – given acoustically absorptive ground surfaces near the source of noise emission and the receiver, up to 5 dBA can be realized.

Although natural terrain may offer trees, vegetation, and ridgelines that might occlude the direct sound paths between project noise source(s) and the NSRs of interest within the noise analysis area, these additional attenuation factors are, conservatively, not incorporated into these analyses.

Reference sound levels of equipment, vehicles, and activities associated with the project are provided in AECOM 2018c. AECOM 2018c also includes acoustical terminology and concepts used during analysis and discussed in this section.

4.19.2 No Action Alternative

Under the No Action Alternative, the project would not be undertaken; there would be no mine site, transportation corridor, port development, or natural gas pipeline corridor. Under the No Action Alternative, Pebble Limited Partnership (PLP) would have the same options for exploration activities that currently exist. 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 (PLP 2018-RFI 073) that could include noise from activities such as drilling and aircraft overflights. This noise would be expected to be at current levels, or less.

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. Although these activities would also cause some noise and disturbance, reclamation would benefit the setting.

4.19.3 Alternative 1 – Applicant's Proposed Alternative

4.19.3.1 Mine Site

The following rationale was used in the noise impact analyses, and would be common to all project phases for the mine site component:

- There is no known residential land use or other type of possible NSR within 10 miles of the mine site (see Section 3.19, Noise). However, subsistence hunters and recreationists may be temporarily present within the 10-mile analysis distance, including Alaska Department of Fish & Game (ADF&G) Management Areas that adjoin or are near the mine site (Mulchatna River, Lake Clark, and Iliamna Lake).
- The existing ambient noise level at the mine site and its adjoining vicinity would be estimated to be comparable to "wilderness ambient" per Table 3.19-1, and therefore is 35 dBA day-night average sound levels (L_{dn}).

Although there are caribou, moose, bear, and other wildlife in the Bristol Bay Area Plan Management Unit Region 9 (ADNR 2013a) area that surrounds the mine site, there are no unique resources, or resources protected by legislation with respect to noise. Impacts from noise on terrestrial wildlife are addressed in Section 4.23, Wildlife Values.

Mine Site Noise Sources

AECOM (2018c) lists noise levels emitted by expected mobile and stationary machinery that would be operated at the mine site during construction, operations, and closure.

Construction – Construction of the mine site would occur over a 4-year period, including excavation of overburden and construction of mine site facilities such as the mill and ore processing facilities, water treatment plants, water management ponds, power plant, and other infrastructure supporting utilities, mine maintenance, and safety. Construction would require use of heavy equipment such as wheel-loaders, dozers, drills, and haul trucks.

Typical construction noise levels are rarely steady; instead, they fluctuate and are intermittent, depending on the number and type of equipment in use at any given time. There would be times when no large equipment would be operating, and noise would be at or near existing ambient levels. In addition, construction-related sound levels experienced by an NSR in the vicinity of construction activity would be a function of distance, and the presence and extent of vegetation and intervening topography between the noise source and the sensitive receptor (although the potentially beneficial influences of intervening topography were not considered in the calculated impact distances).

Operations – Mine site operations would involve noise-producing activities and processes that include extracting rock from the ground (including heavy equipment operation, haul trucks, and blasting) and delivering ore by truck to the milling facilities. Routine and preventive maintenance of support facilities and infrastructure would occur in the mine site area for management and safety practices. It was also assumed that all operational activity could occur during daytime or nighttime periods.

Closure – In addition to reclamation activities conducted during mine closure, concurrent reclamation would be performed during operations whenever possible in areas that are no longer required for operations. Closure earthwork activities would require major grading, contouring, and possible growth media placement using industry-standard heavy equipment; operation of this heavy equipment would in turn cause noise and vibration.

Mine Site Impacts Analysis

Sound attenuation factors considered in prediction of noise impacts are described above under “Noise Impacts Analysis Methodology”. Table 4.19-1 presents results of the predicted noise analyses, listing distances within which adverse noise effects would be expected for the indicated NSR types, as described below.

- **Recreationists and subsistence hunters sleeping outdoors and subject to disturbance:** In terms of magnitude and extent of impacts, when the predicted mine site noise level would exceed 30 dBA equivalent noise level (L_{eq}) at a location, it could still be audible (even in a 35 dBA L_{dn} environment), and it would risk causing sleep disturbance for recreationists and subsistence hunters sleeping outdoors during their seasonal activities on lands considered “wilderness ambient” per Table 3.19-1. This 30 dBA L_{eq} threshold at night is based on World Health Organization (WHO) guidance for sleep disturbance (WHO 1999), assuming that these receptors are not housed, and therefore fully exposed to the outdoors (e.g., fabric tents, “lean-to” structures, hunting blinds, and other temporary structures assumed to provide no meaningful noise reduction).

- **Occupants of structures:** In terms of magnitude and extent of impacts, the noise level attributed to the mine site would exceed 45 dBA L_{dn} at a building exterior, and therefore be 10 dBA greater than the existing outdoor ambient sound level at a potential NSR (e.g., taking into account the minimal 10 dBA noise reduction of a temporarily occupied seasonal shelter).

Table 4.19-1: Distances from Mine Site within which Noise-Sensitive Receptors in Wilderness (35 dBA L_{dn}) would be Impacted

Project Phase	Operational Season/Notes	Distance from Mine Site (feet), where 30 dBA L_{eq} Predicted	Distance from Mine Site (feet), where > 10 dBA over Existing L_{dn} Predicted
Construction	Summer & Winter	17,250	11,900
Operations	Summer & Winter	18,450	12,900
Closure	Summer & Winter	15,900	10,750

Notes:
> = greater than
dBA = A-weighted decibel
L_{eq} = equivalent sound level (e.g., hourly)
L_{dn} = day-night sound level, expressed as dBA; presumes outdoor ambient noise is 35 dBA L_{dn} (wilderness)

In terms of duration of impacts, the opportunity for noise effects at potential NSRs within the indicated distances would be short term, lasting as long as the project phase under consideration. The only NSRs that could be impacted by the long-term mine site noise are the possible occasional NSRs described above: 1) recreationists and subsistence hunters sleeping outdoors and subject to disturbance; and 2) occupants of structures. Impacts would last only as long as the project phase, and as long as the possible NSR is present.

4.19.3.2 Transportation Corridor

The facilities associated with the transportation corridor are discussed below in terms of the subcomponents of surface transportation, air transportation, and water transportation.

<u>Surface Transportation</u>

The four primary road segments in Alternative 1 are the mine access road, Iliamna spur road, port access road, and Kokhanok spur road. Road segments were studied individually and by project phase, as described in the following paragraphs.

Mine Access Road Noise Sources

Construction – AECOM 2018c (Table 5) provides an estimated roster of equipment that would be required to construct the mine access road, including at and between material sites. This analysis conservatively assumes that all the equipment would be operating and emitting noise from a common geographic point along the road alignment. As road construction progresses, this acoustical center-point would slowly travel from one endpoint (the mine site) to the other (north ferry terminal). Therefore, in terms of extent, a potential NSR would only be as close to the construction activity as its perpendicular distance to the road alignment.

Operations – During operations, truck traffic along the mine access road would require up to 39 round-trips per day to transport concentrate, fuel, reagents, and consumables (PLP 2018-

RFI 065). Given this anticipated average daily truck roundtrip rate, plus an assumed similar number of light vehicles expected for transport of locally residing mine workers (i.e., not living at the mine site camp), the magnitude and extent of traffic noise can be estimated with general assessment techniques from Federal Transit Administration (FTA) guidance, with inputs as follows:

- Reference sound exposure levels (SEL) of 82 dBA at 50 feet for the big vehicles, and 74 dBA for the passenger vehicles (pick-up trucks and vans).
- Maximum road speed of 25 miles per hour (mph).
- Speed constants (C_s) of 15 for the large diesel-engine vehicles, and 30 mph for the passenger vehicles.

With these inputs, the magnitude and extent of traffic noise estimate, in terms of L_{dn}, would be as follows:

- Within a distance of approximately 200 feet from the mine access road, the estimated traffic-attributed noise level would be greater than 45 dBA L_{dn} at a building exterior, and therefore 10 dBA greater than the existing outdoor ambient sound level at a potential NSR (e.g., a temporarily occupied seasonal shelter).

In addition to regular truck traffic, operation of the mine access road would involve regular maintenance activities that vary with the summer and winter seasons. AECOM 2018c (Table 6) provides an estimated roster of equipment required to maintain the road for each of these two seasons. This analysis conservatively assumes that all listed equipment for the season in AECOM 2018c (Table 6) would be operating, and emitting noise from a common geographic point along the road. As maintenance progresses, this acoustical center-point would slowly travel from one endpoint (the mine site) to the other (north ferry terminal). Therefore, an NSR would only be as close to the maintenance activity as its perpendicular distance to the roadway alignment. The duration of these noise impacts would be intermittent if from maintenance activities, and short term for construction activities.

Closure – The mine access road would be needed for closure and post-closure (beyond Closure Year 50) monitoring and maintenance. Therefore, no noise would be expected related to project closure activities associated with the mine access road. However, where there may be material sites or staging areas adjoining the road that would undergo reclamation, this analysis assumed the same equipment listed in AECOM 2018c (Table 4) for the Amakdedori port closure would be involved.

Mine Access Road Impacts Analysis

The predicted magnitude and extent of noise impacts relevant to the mine access road are presented in Table 4.19-2, showing distances within which adverse noise effects would be expected for two types of NSRs: 1) recreationists and subsistence hunters sleeping outdoors and subject to disturbance; and 2) occupants of structures.

Table 4.19-2: Distances from Mine Access Road within which Noise-Sensitive Receptors in Wilderness (35 dBA L_{dn}) would be Impacted

Project Phase or Activity(ies)	Operational Season/Notes	Distance from Alignment (feet), where 30 dBA L_{eq} Predicted	Distance from Alignment (feet), where > 10 dBA over Existing L_{dn} Predicted
Construction	Summer & Winter	8,800	5,280
Operations	Summer	800	200
Operations	Winter	800	200
Closure	Summer & Winter	800[1]	200

Notes:
> = greater than
dBA = A-weighted decibel
L_{eq} = equivalent sound level (e.g., hourly)
L_{dn} = day-night sound level, expressed as dBA; presumes outdoor ambient noise is 35 dBA L_{dn} (wilderness)
[1] During closure, traffic would be less, only supporting mine site closure and maintenance of the road: therefore, impacts would be infrequent and the same or less extent than operations.

The duration of these noise impacts would be short term, lasting for as long as the construction phase occurs, and only as long as the NSR would be present.

During operations, and with respect to a subsistence hunter or recreationist who may be sleeping outdoors at some distance from the mine access road, the sleep disturbance criteria would be the aforementioned 30 dBA L_{eq} value per WHO guidance (WHO 1999); therefore, in terms of magnitude and extent, the perpendicular distance from the this road within which this truck noise might awaken an unhoused receptor is about 800 feet. Although not included in this calculated value, should wide expanses of dense, linearly occluding vegetation or the presence of terrain features like ridgelines or hills obscure the receptor's view of the mine access road, the actual traffic noise L_{eq} value should be less at this distance. Put another way, a line-of-sight blocking ridgeline could potentially yield up to a 10 dBA reduction in the propagated sound, which would enable the outdoors-sleeping receptor to be up to 2,500 feet away from the road without experiencing sleep disturbance from traffic.

In terms of duration, the anticipated noise impacts would be long term, lasting for as long as the operations phase occurs, and only as long as the NSR would be present.

Iliamna Spur Road

Construction – The Iliamna spur road would connect the mine access road with the existing Portage Road, at a T-intersection approximately 2 miles north of Iliamna Airport. Construction of the Iliamna spur road would be expected to involve the same type of equipment shown in AECOM 2018c (Table 5); therefore, the magnitude, extent, and duration of anticipated noise levels during construction would be similar to those predicted for the mine access road, and the distances at which 30 dBA L_{eq} and 45 dBA L_{dn} occur would also be the same (Table 4.19-2).

Operations – The Iliamna spur road would be expected to experience traffic between the mine site and the communities of Iliamna and Newhalen. The type of traffic would probably be limited to lighter vehicles (e.g., passenger cars, vans) for commuting project workers and approved visitors. The regular flow of truck traffic making deliveries to and from the north ferry terminal would tend to avoid this spur; and as a result, the magnitude and extent of the predicted traffic noise levels along the Iliamna spur road would be lower than that of the mine access road. Using the same FTA-based mathematical expression and input parameters, but without the trucks, the traffic noise estimate in terms of L_{dn}, is as follows:

- Within a distance of approximately 20 feet from the spur road, the estimated traffic-attributed noise level would be greater than 45 dBA L_{dn} at a building exterior, and therefore 10 dBA greater than the existing outdoor ambient sound level to a potential NSR (e.g., a temporarily occupied seasonal shelter). This distance would be close to the road, because the day-night project-attributed traffic noise level would be, without the trucks, much quieter.

With respect to a subsistence hunter or recreationist who may be sleeping outdoors at some distance from this road, the highest level of noise from project traffic possibility would be a concurrent pass-by of two vehicles on the Iliamna spur road—traveling in opposite directions. The sleep disturbance criteria in this context would be the aforementioned 45 dBA L_{max} value per WHO guidance (WHO 1999); therefore, in terms of extent of the impact, perpendicular distance from the road within which an unhoused receptor might be awakened would be 1,000 feet.

In addition to traffic noise from vehicles on the Iliamna spur road, noise from regular maintenance activities would also occur during summer and winter seasons, as studied for the mine access road, with the same magnitude and extent of noise impact potential, depending on distance as shown in Table 4.19-2.

The duration of anticipated noise effects associated with project-attributed traffic and road maintenance would be long term, continuing through the operations phase.

Closure – Any reclamation activities for areas adjoining the Iliamna spur road would be expected to involve equipment similar to the closure roster presented in AECOM 2018c (Table 4), and generate the same predicted magnitude and extent potential for noise impact, depending on distance and type of NSR (i.e., unhoused or housed receptor). The duration of impacts would be throughout the closure phase.

Port Access Road

Construction – The port access road would connect the south ferry terminal with the Amakdedori port site. Construction of the port access road would be expected to involve the same type of equipment shown in AECOM 2018c (Table 5). Therefore, magnitude and extent of anticipated noise levels would be similar to those predicted for the mine access road, and the distances at which 30 dBA L_{eq} and 45 dBA L_{dn} occur would also be the same (see Table 4.19-2). Given these distances, noise impacts may be realized, depending on the location of potential inhabited structures, recreationists, or subsistence hunters. However, duration of these impacts would be short term.

Operations – The port access road traffic would largely be the trucks identified in the study of the mine access road operations, with a few expected lighter vehicles (e.g., passenger cars, vans) for commuting project workers and approved visitors who may originate at Kokhanok. As a result, the predicted traffic noise levels along the port access road would be comparable to those of the mine access road, adjusted by using the same FTA-based mathematical expression and input parameters, but only a fraction (10 percent) of the passenger vehicle traffic as assumed for the mine access road. The resulting traffic noise estimate, in terms of L_{dn}, is as follows:

- In terms of magnitude and extent, within a distance of approximately 200 feet from the port access road, the estimated traffic-attributed noise level would be greater than 45 dBA L_{dn} at a building exterior, and therefore 10 dBA greater than the existing outdoor ambient sound level for a potential NSR (e.g., a temporarily occupied seasonal shelter).

- With respect to a subsistence hunter or recreationist who may be sleeping outdoors at some distance from the port access road, the highest level of noise from operations phase traffic would be a concurrent pass-by of two trucks, traveling in opposite directions. The sleep disturbance criteria in this context would be the aforementioned 45 dBA L_{max} value per WHO guidance (WHO 1999); therefore, the perpendicular distance from the port access road within which an unhoused receptor might be awakened would be 0.5 mile.

In addition to traffic noise from vehicles on the port access road, noise from regular road maintenance activities would also occur during summer and winter seasons, as studied for the mine access road, with the same noise impact magnitude, extent, and potential, depending on distance as shown in Table 4.19-2. The duration of anticipated noise effects associated with project-attributed traffic and road maintenance would be long term, lasting through the operations phase.

Closure – Any reclamation activities for areas adjoining the port access road would be expected to involve equipment similar to the roster presented under closure in AECOM 2018c (Table 4), and generate the same predicted magnitude, extent, duration, and potential for noise impact, depending on distance and type of NSR (i.e., housed or unhoused receptor).

Kokhanok Spur Road

Construction – The Kokhanok spur road would connect the port access road with the community of Kokhanok and its airport. Construction of Kokhanok airport spur road would be expected to involve the same type of equipment shown in AECOM 2018c (Table 5). Therefore, the magnitude, extent, duration, and potential of anticipated noise levels would be similar to those predicted for the mine access road, and the distances at which 30 dBA L_{eq} and 45 dBA L_{dn} occur would also be the same (Table 4.19-2). Given these distances, noise impacts may be realized depending on the location of potential inhabited structures, recreationists, or subsistence hunters in the vicinity of the Kokhanok airport spur road.

Operations – Because the Kokhanok spur road would be essentially a short connection between the existing Kokhanok Airport and its community and the port access road, the type of traffic would probably be limited to lighter vehicles (e.g., passenger cars, vans) for commuting project workers and approved visitors. The regular flow of truck traffic making deliveries to and from the south ferry terminal would tend to not use Kokhanok spur road; and as a result, the magnitude and extent of predicted traffic noise levels along the Kokhanok airport spur road would be much less than that of the mine access road. Using the same FTA-based mathematical expression and input parameters, but without the trucks, and only a fraction (10 percent) of the light vehicle traffic as expected on the mine access road on the northern side of Iliamna Lake, the traffic noise estimate for Kokhanok spur road in terms of L_{dn}, would be as follows:

- With respect to a subsistence hunter or recreationist who may be sleeping outdoors at some distance from the road, the highest level of noise from project traffic would be a concurrent pass-by of two vehicles on the Kokhanok spur road, traveling in opposite directions. The sleep disturbance criteria in this context would be the aforementioned 45 dBA L_{max} value per WHO guidance (WHO 1999); therefore, in terms of magnitude and extent, the perpendicular distance from the roadway within which an unhoused receptor might be awakened would be 1,000 feet. Should linearly occluding forest or ground terrain features block line-of-sight and yield a 10 dBA reduction in the propagated sound, the distance at which sleep disturbance might occur would shorten to 330 feet.

In addition to traffic noise from vehicles on the Kokhanok airport spur road, noise from routine road maintenance activities would also occur during summer and winter seasons. Road maintenance would be expected to have the same noise impact potential as that assessed for the mine access road, and impacts would depend on distance of the receptor. The anticipated noise effects associated with project-attributed traffic and road maintenance would be long term, lasting through operations.

Closure – Reclamation activities for areas adjoining the Kokhanok airport spur road would be expected to involve equipment similar to closure presented in AECOM 2018c (Table 4), and generate the same predicted magnitude, extent, duration, and potential for noise impact, depending on distance and type of NSR (i.e., unhoused or housed receptor).

Air Transportation

Already constructed and operating as public airports, existing airfields at Iliamna and Kokhanok would be expected to experience project-related aviation traffic. However, the Kokhanok Airport would not be used to support project construction until the Kokhanok airport spur road would be completed. Therefore, for the first year of construction, the airstrip at Amakdedori port would be temporarily used as described in the following paragraphs.

Amakdedori Port Airstrip

The air strip at Amakdedori port would be constructed as part of the proposed project (under Alternative 1). To support the project construction phase, the airstrip at Amakdedori port would be expected to experience between 20 and 40 flights per month by a Twin Otter (Bombardier DHC-6 or similar aircraft type) during the May-September periods of the first and second years of project construction (PLP 2018-RFI 027a). Between these periods, during the winter months, up to 20 flights per month may be required. According to Federal Aviation Administration (FAA) data, the Twin Otter is estimated to exhibit 67 dBA (at a distance of 4 miles from takeoff start roll) during takeoff; and 78 dBA (at 1.2 miles from runway threshold) during approach.

With respect to a subsistence hunter or recreationist who may be sleeping outdoors at some distance from the airstrip; in terms of magnitude, the highest level of noise from project air traffic activity would be an aircraft takeoff or landing at night. Using the same aforementioned sleep disturbance criterion of 45 dBA L_{max}, the extent of the perpendicular distances within which an unhoused receptor might be awakened would be 6.5 miles and 4.5 miles for takeoff and approach, respectively.

For potential receptors within shelters, where exterior noise levels not exceeding 45 dBA L_{dn} would be expected for avoiding adverse effects with respect to existing outdoor ambient noise levels (35 dBA L_{dn}), the extent of perpendicular distances would need to be within 3.4 miles for takeoff and 1.8 miles for approach.

In terms of magnitude, noise associated with project flights during use of the Amakdedori port airstrip would be expected to be from aircraft similar to those described above, with equivalent noise levels. In terms of magnitude and duration, the frequency and number of flights would be expected to be much less than during the project construction phase, because workers would be flown to Iliamna or Kokhanok (PLP 2018-RFI 027) during operations and closure.

Iliamna Airport

An air field at Iliamna is already constructed and operating as a public airport.

During airport operations, major noise sources would consist of operating aircraft and on-site facility operations. These are pre-existing sources of noise that contribute to the outdoor sound environment close to the airport.

For the 12-month period ending December 31, 2015, the airport had 15,400 aircraft operations, an average of 42 per day: 73 percent general aviation, and 27 percent air taxi (AirportIQ™ 5010, 2018).

In terms of magnitude of impacts from noise, the project would be expected to increase the frequency of fixed-wing and rotary-wing aircraft by an average quantity of 11 aircraft per week, and include Twin Otter and Q400 (Bombardier DHC-8) type aircraft. Assuming the airport's stationary noise sources do not change, the increase in noise from the airport would primarily be due to the increase in aviation traffic. The average increase in daily operations of no more than 2 per day represents less than a 5 percent increase in traffic volumes. Unless the size and/or power of project-related aircraft are substantially different than that comprising existing aviation traffic, the per-event magnitude, extent, and duration of sound levels associated with aircraft takeoff, landing, and taxiing would not change.

On closure of the project, noise levels would likely revert to pre-project conditions.

Kokhanok Airport

An air field at Kokhanok is already constructed and operating as public airport. Major noise sources would consist of operating aircraft and on-site facility operations. These are presumably pre-existing sources of noise that acoustically contribute to the outdoor sound environment close to the airport. However, for the 12-month period ending December 31, 2013, the airport had no aircraft operations (AirportIQ™ 5010, 2018).

Operations – The magnitude of impacts would be that the project would be expected to add an average quantity of up to 10 Twin Otter–type aircraft flights per week during project construction, and 5 to 10 Twin Otter aircraft flights per week during project operations. Assuming the airport's stationary noise sources do not change, the increase in noise from the airport would primarily be due to the increase in aviation traffic. If levels of aircraft activity at Kokhanok continue to be modest or non-existent, then these project-attributed operations could be considered relatively new sources of noise, and—for purposes of this analysis—be assessed in a manner similar to what was previously described for the temporary reliance on the proposed Amakdedori port airstrip. In terms of extent, distances within which adverse effects would be anticipated for outdoor subsistence hunters, recreationists, or occupants of shelters and other structures due to Twin Otter takeoffs and landings would be the same as those presented for Amakdedori port. The impacts would be expected to be long term, lasting through the operations phase.

Closure – On closure, anticipated aviation traffic at Kokhanok would likely return to pre-project levels.

Water Transportation – North and South Ferry Terminals

Water Transportation Noise Sources

The ferry terminals would serve as transfer points for cargo conveyed over the lake via an ice-breaking ferry, at an expected average frequency of one round trip per day. Consistent with the project description (Appendix N), this analysis assumes that each terminal has a manned office with a generator and some equipment (e.g., forklifts) to handle loading and unloading of cargo between the moored ferry and trucks. The ferry engine would be shut down during loading and unloading.

Construction – Construction activities associated with the ferry terminals would include ground preparation and development of ferry terminal facilities. In terms of magnitude and extent of impacts, this analysis assumes that the intensity of construction activity, as well as type and quantity of equipment and vehicles involved, would resemble AECOM 2018c (Table 5) for the mine access road, and thereby demonstrate an overall reference sound level of 88 dBA L_{eq} at 50 feet. Based on PLP 2018-RFI 037, construction of the ferry terminals would occur from June through September in one construction year (Year 2); therefore these impacts would be considered short term.

Operations – This analysis assumes the local power supply (generator) at each ferry terminal would conservatively operate continually (day and night), and represents the dominant site sound source (apart from intermittent forklift operation and related activity during up to twice-per-day ferry loading or unloading). In terms of magnitude, extent, and duration, this would produce a reference sound level no greater than 70 dBA L_{eq} at a distance of 50 feet, over the long-term project operations phase.

Closure – The ferry terminals would likely be used to support closure activities. Because activities at the ferry terminals would continue, the magnitude, extent, duration, and potential for noise impacts would be similar to those discussed under operations. However, it is assumed that after operations and closure activities would be completed, the amount of activity at these ferry terminals would decrease. Reclamation activities for areas adjoining the ferry terminal sites would be expected to involve equipment similar to closure, as presented in AECOM 2018c (Table 4); and generate the same predicted potential for noise impact, depending on distance and type of NSR (e.g., unhoused or housed receptor).

Water Transportation Impacts Analysis

For the north ferry terminal site and surrounding lands, the predicted analysis findings would be as shown in Table 4.19-3.

Table 4.19-3: Distances from Iliamna Lake Ferry Terminals within which Noise-Sensitive Receptors in Wilderness (35 dBA L_{dn}) would be Impacted

Project Phase or Activity(ies)	Operational Season/Notes	Distance from Alignment (feet), where 30 dBA L_{eq} Predicted	Distance from Alignment (feet), where > 10 dBA over Existing L_{dn} Predicted
Construction	Summer & Winter	8,550	5,000
Operations	Summer & Winter	2,250	1,000
Closure	Summer & Winter	10,600	6,500

Notes:
> = greater than
dBA = A-weighted decibel
Leq = equivalent sound level (e.g., hourly)
Ldn = day-night sound level, expressed as dBA; presumes outdoor ambient noise is 35 dBA Ldn (wilderness)

The anticipated noise impacts within the two above-stated distances would last only as long as the project phase noise sources occur.

4.19.3.3 Amakdedori Port

Port Noise Sources

Construction – Construction of the port would involve conventional heavy construction equipment, vehicles, and stationary systems (e.g., air compressors, generators) similar to those listed in AECOM 2018c (Table 3), and would be expected to prepare and grade the site and construct the port terminal and facilities, including power generation plant and offshore facilities (dock and causeway). Using FTA general assessment techniques to estimate construction noise, in terms of magnitude and extent of the impacts, it could be assumed that two pieces of equipment, each exhibiting no more than 85 dBA L_{max} (e.g., two simultaneously operating graders on site) at 50 feet and operating at full power, would yield an aggregate average sound level of 88 dBA L_{eq} at 50 feet, and represent the noise from most port construction activities. However, unique to this facility, impact pile-driving would occur during construction. The magnitude and extent of noise impacts from pile driving would be the generation of noise levels of 95 dBA L_{max} at 50 feet (FHWA 2006). (Sheet piles would be vibratory driven for placement; then impact pile-driving would occur to refusal [PLP 2018-RFI 030]). The duration of noise generated during pile driving would be short term.

Operations – Operation of the port would involve generally persistent stationary noise sources such as on-site power generation and heating and ventilation systems, punctuated by loading/off-loading activity to handle concentrate containers, other cargo, and fuel from vessels.

Closure – As the port continues to support closure activities, potential noise impacts at the sensitive receptor would be similar to those discussed under the operations above. However, it is assumed that once mine closure is completed, the amount of activity at the port site would decrease from project levels to support port maintenance as needed.

AECOM 2018c (Table 4) lists noise levels emitted by expected mobile and stationary machinery that would be operated at Amakdedori port during the construction, operations, and closure. Unless otherwise noted, these lists per project phase represent estimates of maximum operating units at one time.

Port Impact Analysis

The nearest potential NSR to the port would be subsistence hunters and seasonal visitors (recreationists) temporarily inhabiting the surrounding ADNR parcel (ID# 24103002). Such NSRs may also dwell on public lands beyond this parcel boundary. Although the equipment and vehicle rosters would be different, the technique for estimating noise exposure at NSRs due to Amakdedori port operation would be similar to that used for estimating aggregate noise emission from mine site operation, and use the same conservative assumptions. The predicted magnitude and extent of impacts and are presented in Table 4.19-4, showing distances within which adverse noise effects would be expected for the same two types of NSRs: recreationists and subsistence hunters sleeping outdoors and subject to disturbance; and occupants of structures.

Table 4.19-4: Distances from Amakdedori Port within which Noise-Sensitive Receptors in Wilderness (35 dBA L_{dn}) would be Impacted

Project Phase or Activity(ies)	Operational Season/Notes	Distance from Alignment (feet), where 30 dBA L_{eq} Predicted	Distance from Alignment (feet), where > 10 dBA over Existing L_{dn} Predicted
Construction	Summer & Winter	8,550	4,900
Operations	Summer & Winter	9,750	5,800
Closure	Summer & Winter	10,550	6,400

Notes:
> = greater than
dBA = A-weighted decibel
L_{eq} = equivalent sound level (e.g., hourly)
L_{dn} = day-night sound level, expressed as dBA; presumes outdoor ambient noise is 35 dBA Ldn (wilderness)

The duration of anticipated noise impacts at potential NSRs within the above-stated distances would be long term, lasting as long as the project phase occurs.

With pile-extraction during closure, in terms of magnitude, a subsistence hunter or recreationist who may be sleeping outdoors at some distance from the port may be startled if exposed to 45 dBA L_{max} per WHO guidance (WHO 1999). The extent of the perpendicular distance from the pile-driving activity within which this awakening of an unhoused NSR would occur would be 5,100 feet. The duration of the impact would be short term, lasting only while pile driving would be occurring during the construction phase.

4.19.3.4 Natural Gas Pipeline Corridor

For purposes of this noise analysis, the pipeline corridor study is organized as follows:

- Mainline, which includes the temporary construction and operational rights-of-way (ROWs), and temporary work areas outside of the ROW (e.g., shoe-fly roads, construction camps, pipe and equipment storage yards)
- Pipeline above-ground facilities would include the new compressor station at Anchor Point, the main line block valve stations, metering stations, and pig launching and receiving facilities.

Mainline

The distances of the nearest NSR vary for each subcomponent (surface, water, and air) being analyzed; however, the general existing ambient noise level would be estimated at 35 dBA L_{dn} (adapted from Table 3.19-3).

Construction – In terms of duration, noise impacts associated with the mainline would occur mainly during construction. Construction-related noise sources would be generated by helicopter traffic, diesel-powered mobile equipment, pipe installation equipment, equipment operating at material sites, and blasting (in the event it would be necessary). In terms of magnitude and extent, increased noise levels would vary depending on the construction stage, and would be localized to the vicinity of the construction equipment, and transitory as construction activity proceeds at various locations along the length of the pipeline. Noise impacts for specific construction activities are described below.

The overall project schedule for construction of infrastructure build-out, pipe installation, and ROW stabilization, rehabilitation, and reclamation work concurrent with and immediately following pipe installation would take place over a period of 3 to 4 years. The first year would involve ROW civil work and mobilization of material and equipment, including clearing of vegetation (as applicable), preliminary civil construction of access roads, airstrips, barge landings, pipe storage yards, construction campsites, etc. The pipeline installation would occur for a period of 2 to 3 years.

AECOM 2018c (Table 5) lists equipment used for construction of a typical pipeline section, the corresponding magnitude of noise levels, and season of operation, grouped by construction activities. Because noise impacts and affected sensitive receptors vary with specific construction activities during a certain period of time, as well as the conditions of the affected environment where the activities may be located with respect to potential NSRs, the noise impacts are discussed relative to the pipeline major construction activities, as described below.

The equipment rosters presented in AECOM 2018c (Table 5) show the expected assortment of stationary and mobile equipment per construction phase; this analysis predicts distant NSR noise exposure from only the two loudest units operating at full power—in a manner similar to the FTA "general assessment" technique (FTA 2006). By way of example, in terms of magnitude and extent of impacts for the general activities and utility equipment category, the forklift and carrier are each rated at 85 dBA at 50 feet; therefore, the combined representative reference noise level for this phase would be 88 dBA L_{eq} at 50 feet.

Table 4.19-5 lists the distances from the centerline of the pipeline alignment on land in which the indicated sound levels attributed to construction would be exceeded. As consistently used in the preceding analyses, the 30 dBA L_{eq} metric would be the impact criterion applied to recreationists and subsistence hunters sleeping outdoors during their seasonal activities on lands considered "wilderness ambient," per Table 4.19-1. Correspondingly, the 45 dBA L_{dn} limit (representing a 10 dBA increase over the presumed existing 35 dBA L_{dn} of the pre-project outdoors) applies to such individuals sleeping within structures. These impacts would be expected to occur over the long term, through the operations phase of the project.

Table 4.19-5: Distances from Construction of the Pipeline within which Noise-Sensitive Receptors in Wilderness (35 dBA L_{dn}) would be Impacted

Construction Phase or Activity(ies)	Operational Season/Notes	Distance from Alignment (feet), where 30 dBA L_{eq} Predicted	Distance from Alignment (feet), where > 10 dBA over Existing L_{dn} Predicted
General Activities and Utility Equipment (GA&UE)	Summer & Winter	8,550	5,000
GA&UE with helicopter support (40%)	Summer & Winter	19,500	14,000
Civil Construction	Summer & Winter	8,550	5,000
Drilling and Blasting	Summer & Winter	12,600	8,000
Ice Road Construction and Maintenance	Winter	8,550	5,000
Pipe Laying	Summer & Winter	8,550	5,000
River Crossings and Horizontal Directional Drilling (HDD)	Summer	7,800	4,400
Backfilling and Ground Restoration	Summer & Winter	8,550	5,000

Table 4.19-5: Distances from Construction of the Pipeline within which Noise-Sensitive Receptors in Wilderness (35 dBA L_{dn}) would be Impacted

Construction Phase or Activity(ies)	Operational Season/Notes	Distance from Alignment (feet), where 30 dBA L_{eq} Predicted	Distance from Alignment (feet), where > 10 dBA over Existing L_{dn} Predicted
Pipe Cleaning, Pressure Testing and Drying	Summer & Winter	5,100	2,600

Notes:
> = greater than
dBA = A-weighted decibel
HDD = horizontal directional drilling
Leq = equivalent sound level (e.g., hourly)
Ldn = day-night sound level, expressed as dBA; presumes outdoor ambient noise is 35 dBA Ldn (wilderness)

The magnitude, extent, and duration anticipated noise effects within the two distances noted in Table 4.19.5 would last only as long as the indicated construction-phase activities occur, and in the vicinity of the receptors. In other words, pipeline construction activity tends to be intensive at a particular area, and moves away from a stationary NSR as construction progresses.

Where the pipeline makes the east Cook Inlet landfall, the existing outdoor ambient sound environment would be anticipated to be higher (50 dBA L_{dn}), due to road traffic on the nearby Sterling Highway and other human development; therefore, in terms of extent of impacts, the distance buffers within which pipeline construction noise would potentially cause impacts to neighboring NSRs would be much shorter, as presented in Table 4.19-6. In this sound environment, the magnitude of the outdoor ambient noise is already well above 30 dBA L_{eq}, and would not be expected to have receptors sleeping outdoors. For people sleeping inside their residences in this developed environment, the EPA guidance level of 55 dBA L_{dn} for the NSR exterior serves as the impact threshold for project-attributed noise.

Table 4.19-6: Distances from Construction of the Pipeline within which Noise-Sensitive Receptors in Anchor Point (50 dBA L_{dn}) would be Impacted

Construction Phase or Activity(ies)	Operational Season/Notes	Distance from Alignment (feet), where 55 dBA L_{dn} Predicted
General Activities and Utility Equipment (GA&UE)	Summer & Winter	2,150
GA&UE with helicopter support (40% AUF)	Summer & Winter	8,300
Civil Construction	Summer & Winter	2,150
Drilling and Blasting	Summer & Winter	4,000
Ice Road Construction and Maintenance	Winter	2,150
Pipe Laying	Summer & Winter	2,150
River Crossings and HDD	Summer	1,850
Backfilling and Ground Restoration	Summer & Winter	2,150
Pipe Cleaning, Pressure Testing and Drying	Summer & Winter	990

Notes:
dBA = A-weighted decibel
HDD = horizontal directional drilling
L_{dn} = day-night sound level, expressed as dBA; presumes outdoor ambient noise is 50 dBA L_{dn}

The magnitude and extent of impacts, with the exception of helicopter-supported activities and drilling, are provided in Table 4.19-6 for pipeline construction. Construction activities would be expected to cause impactful noise levels within a distance of 2,150 feet from the pipeline alignment. Therefore, it would be possible that up to 43 of the potential NSRs counted as being within 0.5 mile of the compressor station (in Section 3.19, Noise) may experience temporary impacts, lasting only as long as construction. Development of a detailed construction noise mitigation plan, including scheduling of noise-producing activities, the proper design and implementation of practical and site-appropriate noise-reducing measures, and sound level monitoring to check for compliance with the outdoor EPA guidance threshold, would help reduce the magnitude of construction noise, and thereby reduce the likelihood, duration, and quantity of impacted NSRs (see Chapter 5, Mitigation).

Construction and installation of the proposed pipeline segments along the bottom of Iliamna Lake and Cook Inlet would be carried out by appropriate equipment and vessels sufficiently distant from NSRs, and would not cause noise impacts (see Section 4.23, Wildlife Values and Section 4.25, Threatened and Endangered Species).

Operations

Pipeline Operations – There would be no major noise-producing sources along the pipeline corridor during pipeline operation. Gas traveling through the pipeline would not emit audible noise at potential NSRs; therefore, there would be no noise impacts associated with pipeline operation.

Periodic Pipeline Maintenance and Inspection – Periodic maintenance and routine inspection would be conducted on the mainline, and noise sources would include pigging. Given the similarity of expected activities, the magnitude and extent of noise level emissions from pigging would be considered comparable to those of the pipeline cleaning, pressure testing, and drying activities, as described in AECOM 2018c (Table 5), with the potential for impact at NSRs, depending on the existing sound environment and the proximity (i.e., within the indicated screening distances), per Tables 4.19-5 and 4.19-6. The frequency of these impacts would be intermittent throughout the project operations, as defined by permit (if issued) requirements.

Pipeline ROW Maintenance and Safety Inspection – As part of maintenance and safety procedures, the pipeline ROW would be cleared of brush at approximately 10-year intervals, or as required to preserve pipeline integrity and access. AECOM 2018c (Table 6) lists equipment operated for a typical ROW clearing and the corresponding noise levels, and represents an estimate of maximum operating units at one time.

Using the aforementioned FTA-based general assessment technique of estimating construction noise from the two loudest pieces of equipment operating at full power, the magnitude and extent of the resulting reference noise level for pipeline ROW maintenance would be 88 dBA L_{eq} at 50 feet. The predicted analysis findings are as follows:

- Within a distance of approximately 8,550 feet from the pipeline area being cleared, the magnitude of the estimated noise level would be at least 30 dBA L_{eq}, and therefore risk causing sleep disturbance for recreationists and subsistence hunters sleeping outdoors during their seasonal activities on lands considered "wilderness ambient," per Table 3.19-3. At Anchor Point, such receptors would not be expected, and therefore not impacted.
- Within a distance of approximately 5,000 feet, the magnitude of estimated operations noise level would be at least 45 dBA L_{dn} at a building exterior, and therefore 10 dBA greater than the existing outdoor ambient sound level at a potential NSR (e.g., a

temporarily occupied seasonal shelter). For NSRs at Anchor Point, where such ROW maintenance may occur, the screening distance would only be 2,150 feet.

The duration of anticipated noise impacts within the two distances noted above would be intermittent, lasting only as long as the ROW maintenance activity would be occurring, but has the potential to occur throughout the operations phase.

Closure - All disturbed areas (such as the ROW, temporary construction camps, pipe storage yards, material sites, airstrips, roads, barge landings, and other temporary use areas) would be cleaned up, stabilized, prepared for natural revegetation, and reclaimed to their original state. Noise estimates are calculated based on the two loudest equipment units from AECOM 2018c (Table 5) under the backfilling and ground restoration. In terms of magnitude and extent of impacts, the two loudest equipment units from the table each have a noise level of 85 dBA at 50 feet, and would therefore combine to a source reference level of 88 dBA L_{eq} at 50 feet. Because this is the same reference level for the pipeline maintenance activity, potential impacts would be anticipated at NSRs within the same distances. The duration anticipated noise effects would last through closure and extent would be limited to the immediate vicinity of closure activities at any given time.

Intermittent noise impacts from helicopters used to transport personnel to and from pipeline locations would also be expected. However, because the flight routes and vertical aircraft distances are unknown at this time, the magnitude and extent of resulting noise levels during an NSR fly-over could not be estimated.

Pipeline Aboveground Facilities

Pipeline aboveground facilities consist of a compressor station, metering stations, mainline valves, and pig launcher and receiver stations. Noise impacts for each of these facilities are described below.

Compressor Station

For purposes of this noise analysis, the compressor station is assumed to feature the following:

- 1,000-horsepower natural gas compression machines driven by two gas-fired microturbines (one 100 percent unit and a 100 percent backup)
- Outdoor fin-fan cooler
- Unmanned, with fully automated equipment operated by a remote-control system
- Pig launcher and a mainline block valve (as an emergency shutdown or blowdown valve) on the site.

The nearest NSR to the Kenai compressor station would be residents and seasonal visitors of Anchor Point.

Construction – Noise impacts during the construction of the compressor station would be generated during operations of heavy construction equipment. Noise and vibration calculation methodologies and assumptions would be in accordance with the FTA guidance on general assessment for noise impacts (FTA 2006), whereby noise estimates are predicted based on two of the loudest expected equipment units shown under the general activities category of Table 4.19-5 and Table 4.19-6 The predicted magnitude and extent of impacts would be 88 dBA L_{eq} at 50 feet. The predicted analysis finding is as follows:

- Within a distance of approximately 2,150 feet, the magnitude of the estimated noise level would be at least 55 dBA L_{dn} at a building exterior, and therefore potentially greater than the EPA guidance level for the exterior of an NSR in the Anchor Point CDP boundary (USCB 2018a).

Subsistence hunters and recreationists would not generally be expected to be sleeping outdoors in this developed area of the Kenai Peninsula; therefore, they would not be expected to be potential NSRs with respect to this noise source. The duration and extent of anticipated noise effects within the above-stated distance would be short term, and limited to the immediate vicinity of where such activities occur during construction of the facilities.

Operations – Noise generated at the compressor station during operations would originate mainly from operation of the compressor machines, one microturbine, fin-fan coolers, blowdown processes, and pipeline pig(s). This analysis assumes:

- The compressors and microturbines would be housed inside buildings or provided enclosures to reduce noise emissions.
- External to these buildings or enclosures, air intakes and combustion exhaust ducting for the power units would feature typical sound-attenuating means.
- In aggregate, sound levels attributed to the enclosed compressors and power units operating at full load would be limited to 68 dBA L_{eq} at a distance of 50 feet (based on line source propagation from an exterior wall, where the emitted noise would be 80 dBA L_{eq} at 3.28 feet from the surface).
- Unenclosed fin-fan coolers would emit up to 88 dBA L_{eq} at a distance of 50 feet, and would be the dominant compressor station noise sources.

The predicted analysis finding for compressor station operation noise is as follows:

- Within a distance of approximately 2,150 feet, the magnitude of estimated operations noise level would be at least 55 dBA L_{dn} at a building exterior, and therefore potentially greater than the EPA guidance level for the exterior of an NSR in the community of Anchor Point.

Subsistence hunters and recreationists would not generally be expected to be sleeping outdoors in this developed area of the Kenai Peninsula; therefore, they would not be expected to be potential NSRs with respect to this noise source. The duration of anticipated noise effects within the above-stated distances would be long term, lasting as long as the compressor station operates during the operations phase.

Pipeline pigging would be needed for maintenance and testing, and most likely would be performed on an annual basis. The noise duration and extent of noise from pipeline pigging would be transient in nature, and would only occur at the pig trap, and the short, aboveground pipe segment. The potential of noise from a pipeline blowdown event would be rare, because it would only occur during an emergency pressure relief or blowdown due to an incident requiring a major repair on a pipeline segment or compressor station equipment. The magnitude and duration of noise from a pipeline blowdown would be loud and transient, lasting for several minutes, until the pressure is relieved.

Closure – Reclamation activities at the compressor station would occur following construction, and at the beginning of closure. Disturbed ground would be graded and stabilized after construction of facilities. At closure, all equipment at the compressor station would be dismantled and transported away for salvage, recycling, or disposal, as appropriate. Noise estimates are calculated based on the two loudest equipment units from AECOM 2018c (Table 5) under backfilling and ground restoration. In terms of magnitude and extent, the two loudest equipment units from the table each have a noise level of 85 dBA at 50 feet, and would therefore combine to a source reference level of 88 dBA L_{eq} at 50 feet. Because this would be the same reference level for the pipeline maintenance activity, the magnitude and extent of these potential impacts would be anticipated at Anchor Point NSRs within the same distances. The duration of these anticipated noise effects would last only through project closure.

Metering Stations

Metering stations would be at the project pipeline tie-ins with existing natural gas pipeline infrastructure in the vicinity of the compressor station at the eastern pipeline terminus and at Amakdedori port. Each of the metering stations would have a mainline block valve and a pig launcher and receiver. Noise impacts would generally not be anticipated due to construction, operations, and closure of metering facilities, where outdoor noise sources such as the unenclosed fin-fan gas coolers would be expected to dominate the local sound environment.

Mainline Block Valve Stations

Mainline block valves would be placed at no more than 20-mile intervals along the pipeline route. They would be constructed as part of the pipeline installation, and operate with aboveground features that would be designed to emit low noise levels due to exterior thermal/acoustic lagging materials or insulated housings or enclosures. No noise impacts would be anticipated at distances beyond the pipeline ROW when the mainline block valves would be conveying gas to the mine site under normal conditions. Maintenance of these facilities would be considered categorized as pipeline maintenance, which has been previously discussed.

4.19.3.5 Alternative 1 – Summer-Only Ferry Operations Variant

The magnitude, extent, and duration of noise impacts with implementation of summer-only ferry operations would be identical to Alternative 1 during the summer. These impacts would be certain to occur under this variant.

4.19.3.6 Alternative 1 – Kokhanok East Ferry Terminal Variant

Aside from a relocation of the south ferry terminal to the east of the community of Kokhanok, the Kokhanok East Ferry Terminal Variant avoids a road crossing the Gibraltar River. Regarding the magnitude, extent, and duration of noise impact, this variant would be identical to Alternative 1. These impacts would be certain to occur under this variant.

4.19.3.7 Alternative 1 – Pile-Supported Dock Variant

With regard to noise impacts on human receptors, the Pile-Supported Dock Variant would not produce impacts with a magnitude, extent, and duration beyond those calculated for the main Alternative 1. These impacts would be certain to occur under this variant. Impacts to wildlife are addressed under Section 4.23, Wildlife, and Section 4.25, Threatened and Endangered Species.

4.19.4 Alternative 2 – North Road and Ferry with Downstream Dams

Compared to Alternative 1 overall (including all components, but primarily associated with road, port, ferry terminal, and pipeline construction and closure phases), Alternative 2 would include up to 76 Native allotments consisting of 6,022 acres within its primary 2-mile analysis distance; compared to Alternative 1, with 22 Native allotments and 2,715 acres. Also, while both alternatives pass thought Iliamna and Anchor Point census-designated places (CDPs), Alternative 1 passes through Kokhanok CDP; Alternative 2 passes through Pedro Bay CDP (Table 3.19-5). See Section 3.19, Noise, for explanation of using Native allotments and census-designated areas in the noise impacts analysis for the largely remote (unpopulated) EIS analysis area.

4.19.4.1 Mine Site

The magnitude, extent, duration, and likelihood of noise impacts to NSRs with respect to the construction, operations, and closure of the mine site would be the same as those for Alternative 1.

4.19.4.2 Transportation Corridor

Chapter 2, Alternatives, provides a detailed description of Alternative 2. This section is organized by the subcomponents of the transportation corridor: surface transportation, air transportation, and water transportation.

Potentially affected NSRs may include the same property parcels, if occupied, identified for Alternative 2 in Section 3.19, Affected Environment. Along the transportation corridor for Alternative 2, distances within which impacts would be anticipated at NSRs would be the same as those as previously discussed in Section 4.19.3, and listed in Tables 4.19-2 and 4.19-3.

4.19.4.3 Diamond Point Port

The facility would be comparable to those of a port at Amakdedori, except there would be no airstrip at the port site. The magnitude, extent, and duration of noise impacts to NSRs with respect to the construction, operations, and closure of the Diamond Point port would be the same as for Alternative 1. These impacts would be expected to occur under Alternative 2 with construction of the Diamond Point port.

4.19.4.4 Natural Gas Pipeline Corridor

In terms of magnitude, extent, duration, and likelihood, impacts anticipated at NSRs would be the same as those presented in Section 4.19.3, and listed in Tables 4.19-5 and 4.19-6.

4.19.4.5 Alternative 2 – Summer-Only Ferry Operations Variant

Implementation of the summer-only ferry operations under Alternative 2 would have the same magnitude, extent, and duration of noise impacts as Alternative 1 during the summer. The impacts would be expected to occur under this variant.

4.19.4.6 Alternative 2 – Pile-Supported Dock Variant

In terms of magnitude, extent, duration, and likelihood of noise impacts on human receptors, the Pile-Supported Dock Variant would not produce impacts beyond those calculated for Alternative 1. Impacts to wildlife are addressed under Section 4.23, Wildlife and Section 4.2, Threatened and Endangered Species.

4.19.5 Alternative 3 – North Road Only

Compared to Alternative 1 overall (including all components, but primarily associated with roadway, port, terminal, and pipeline construction and closure phases), Alternative 3 would include up to 70 Native allotments consisting of 5,616 acres within its primary 2-mile impact screening distance, compared to Alternative 1, with 22 Native allotments and 2,715 acres. Also, although both alternatives pass thought Iliamna and Anchor Point CDPs, Alternative 1 passes through Kokhanok CDP, while Alternative 3 passes through Pedro Bay CDP (Table 3.19-5).

4.19.5.1 Mine Site

The magnitude, extent, duration, and likelihood of potential noise impacts to NSRs with respect to the construction, operations, and closure of the mine site would be the same as those for Alternative 1, because the mine site component would be common to all alternatives.

4.19.5.2 Transportation Corridor

Potentially affected NSRs may include those property parcels, if occupied, identified in Section 3.19, Affected Environment. Along the transportation corridor for Alternative 3, distances within which impacts would be anticipated at NSRs would be the same as those described for Alternative 1 (Section 4.19.3), and listed in Tables 4.19-5 and 4.19-6. The route passes near the community of Pedro Bay; therefore, the existing outdoor ambient sound environment would not be 35 dBA L_{dn}, but in terms of magnitude, would reflect those values shown in Table 3.19-4, and therefore cause the impact distances to reflect use of the EPA guidance-based noise threshold of 55 dBA L_{dn} for the exteriors of occupied residences or seasonal shelters. In terms of extent of impacts during construction of the mine access road near the Pedro Bay community, this distance would be 2,250 feet.

In terms of magnitude and extent of impacts during the operations phase, expected road traffic would cause noise impact to NSRs at a distance of up to 200 feet in an otherwise 35 dBA L_{dn} undeveloped environment; but near Pedro Bay, the distance would shorten to 35 feet. Maintenance of the road would potentially cause noise impacts to NSRs near Pedro Bay at a distance of up to 2,150 feet in summer, and 1,800 feet in the winter. During closure and reclamation activities along the road near the Pedro Bay community, the impact distance would be 3,000 feet. These impacts would be long term, lasting for the life of the project, and would be expected to occur under Alternative 3.

4.19.5.3 Diamond Point Port

The facility features, construction, and operations would be comparable to those of Amakdedori port (Alternative 1); therefore, the magnitude, extent, duration, and likelihood of noise impacts to NSRs with respect to the construction, operations, and closure of the Diamond Point port would be the same as those for Alternative 1.

4.19.5.4 Natural Gas Pipeline Corridor

The magnitude, extent, duration, and likelihood of noise impacts to NSRs with respect to the construction, operations, and closure of the natural gas pipeline corridor should be the same as those for Alternative 1, as shown in Section 4.19.3, and listed in Tables 4.19-5 and 4.19-6. The proposed pipeline route passes near the community of Pedro Bay; therefore, the existing outdoor ambient sound environment would not be 35 dBA L_{dn}, but would reflect values shown in Table 3.19-4, and therefore cause the impact distances to reflect use of the EPA guidance-based noise threshold of 55 dBA L_{dn} for the exteriors of occupied residences or seasonal shelters.

4.19.5.5 Alternative 3 – Concentrate Pipeline Variant

There would be no difference in impacts under this variant.

4.19.6 Summary of Key Issues

Table 4.19-7 provides summary statements of key issues and impacts from the project on noise.

Table 4.19-7: Summary of Key Issues for Noise Resource

Impact Causing Project Component/Activity	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
Note: The following acronyms are used to describe three categories of potentially impacted receivers: • *RSH* = outdoor sleeping Recreationists and Subsistence Hunters in a remote rural or wilderness setting (where 35 dBA day-night sound level [L_{dn}] is the expected existing outdoor ambient sound environment). • *SPR-W* = occupants of Seasonal shelters and Permanent Residences in a remote rural or Wilderness setting (where 35 dBA L_{dn} is the expected existing outdoor ambient sound environment). • *SPR-D* = occupants of Seasonal shelters and Permanent Residences in a Developed (e.g., Pedro Bay) setting (where exterior noise threshold of 55 dBA L_{dn} per EPA guidance would be expected to apply).			
Mine Site			
Operating stationary and mobile equipment, including occasional blasting	By project phase, distance (feet) from open pit within which RSH may be disturbed: *Construction* = 17,250 *Operations* = 18,450 *Closure* = 15,900 By project phase, distance (feet) from mine site pit within which SPR-W may be disturbed: *Construction* = 11,900 *Operations* = 12,900 *Closure* = 10,750	By project phase, distance (feet) from open pit within which RSH may be disturbed: *Construction* = 17,250 *Operations* = 18,450 *Closure* = 15,900 By project phase, distance (feet) from mine site pit within which SPR-W may be disturbed: *Construction* = 11,900 *Operations* = 12,900 *Closure* = 10,750	By project phase, distance (feet) from open pit within which RSH may be disturbed: *Construction* = 17,250 *Operations* = 18,450 *Closure* = 15,900 By project phase, distance (feet) from mine site pit within which SPR-W may be disturbed: *Construction* = 11,900 *Operations* = 12,900 *Closure* = 10,750
Transportation Corridor			
Operating equipment, including occasional blasting, to *construct* access road(s)	Distance (feet) from access road(s) within which RSH may be disturbed: 8,800 Distance (feet) from access road(s) within which SPR-W may be disturbed: 5,280	Distance (feet) from access road(s) within which RSH may be disturbed: 8,800 Distance (feet) from access road(s) within which SPR-W may be disturbed: 5,280	Distance (feet) from access road(s) within which RSH may be disturbed: 8,800 Distance (feet) from access road(s) within which SPR-W may be disturbed: 5,280 Distance (feet) from access road(s) within which SPR-D may be disturbed: 2,250
Seasonal (winter/summer) maintenance activities of access or spur roads	Distance (feet) from access road(s) within which RSH may be disturbed: *Winter* = 7,600 *Summer* = 8,500 Distance (feet) from access road(s) within which SPR-W may be disturbed: *Winter* = 4,500 *Summer* = 5,000	Distance (feet) from access road(s) within which RSH may be disturbed: *Winter* = 7,600 *Summer* = 8,500 Distance (feet) from access road(s) within which SPR-W may be disturbed: *Winter* = 4,500 *Summer* = 5,000	Distance (feet) from access road(s) within which RSH may be disturbed: *Winter* = 7,600 *Summer* = 8,500 Distance (feet) from access road(s) within which SPR-W may be disturbed: *Winter* = 4,500 *Summer* = 5,000 Distance (feet) from

Table 4.19-7: Summary of Key Issues for Noise Resource

Impact Causing Project Component/Activity	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
			access road(s) within which SPR-D may be disturbed: *Winter* = 1,800 *Summer* = 2,150
Expected traffic on roadway (during operations and closure phases of the project)	Distance (feet) from road(s) within which RSH may be disturbed: *Access Road* = 2,640 *Spur Road* = 1,000 Distance (feet) from access road(s) within which SPR-W may be disturbed: 200	Distance (feet) from road(s) within which RSH may be disturbed: *Access Road* = 2,640 *Portage Road* = 1,000 Distance (feet) from access road(s) within which SPR-W may be disturbed: 200	Distance (feet) from road(s) within which RSH may be disturbed: *Access Road* = 2,640 *Portage Road* = 1,000 Distance (feet) from access road(s) within which SPR-W may be disturbed: 200 Distance (feet) from road(s) within which SPR D may be disturbed: 35
Operating equipment, including occasional blasting, for *closure and reclamation* of road land(s)	Distance (feet) from access road(s) within which RSH may be disturbed: 10,550 Distance (feet) from access road(s) within which SPR-W may be disturbed: 6,400	Distance (feet) from access road(s) within which RSH may be disturbed: 10,550 Distance (feet) from access road(s) within which SPR-W may be disturbed: 6,400	Distance (feet) from access road(s) within which RSH may be disturbed: 10,550 Distance (feet) from access road(s) within which SPR-W may be disturbed: 6,400 Distance (feet) from access road(s) within which SPR-D may be disturbed: 3,000
Construction of Lake Ferry Terminals	Distance (feet) from ferry terminal within which RSH may be disturbed: 8,550 Distance (feet) from ferry terminal within which SPR-W may be disturbed: 5,000	Distance (feet) from ferry terminal within which RSH may be disturbed: 8,550 Distance (feet) from ferry terminal within which SPR-W may be disturbed: 5,000	Not Applicable
Operation of Lake Ferry Terminals	Distance (feet) from ferry terminal within which RSH may be disturbed: 2,250 Distance (feet) from ferry terminal within which SPR-W may be disturbed: 1,000	Distance (feet) from ferry terminal within which RSH may be disturbed: 2,250 Distance (feet) from ferry terminal within which SPR-W may be disturbed: 1,000 (No impacts for ferry operation during winter for Summer-Only Ferry Operations Variant)	Not Applicable
Aviation traffic at airports/airstrips during Project *Construction*	Distance (miles) from Amakdedori Airstrip or Kokhanok Airport, within	Distance (miles) from existing Pile Bay airstrip, within which RSH may be	Distance (miles) from existing Pile Bay airstrip, within which RSH may be

Table 4.19-7: Summary of Key Issues for Noise Resource

Impact Causing Project Component/Activity	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
	which RSH may be disturbed = 6.5 (takeoff); 4.5 (approach) Distance (miles) from Amakdedori Airstrip or Kokhanok Airport, within which SPR-W may be disturbed = 3.4 (takeoff); 1.8 (approach)	disturbed = 6.5 (takeoff); 4.5 (approach) Distance (miles) from existing Pile Bay Airstrip, within which SPR-W may be disturbed = 3.4 (takeoff); 1.8 (approach)	disturbed = 6.5 (takeoff); 4.5 (approach) Distance (miles) from existing Pile Bay Airstrip, within which SPR-W may be disturbed = 3.4 (takeoff); 1.8 (approach)
Aviation traffic at airports/airstrips during Project *Operations*	Distance (miles) from Kokhanok Airport, within which RSH may be disturbed = 6.5 (takeoff); 4.5 (approach) Distance (miles) from Kokhanok Airport, within which SPR-W may be disturbed = 3.4 (takeoff); 1.8 (approach)	Not Applicable	Not Applicable
Port Site			
Construction of port site	Distance (feet) from port site within which RSH may be disturbed: 8,550 Distance (feet) from port site within which SPR-W may be disturbed: 4,900	Distance (feet) from port site within which RSH may be disturbed: 8,550 Distance (feet) from port site within which SPR-W may be disturbed: 4,900	Distance (feet) from port site within which RSH may be disturbed: 8,550 Distance (feet) from port site within which SPR-W may be disturbed: 4,900
Port site operation	Distance (feet) from port site within which RSH may be disturbed: 9,750 Distance (feet) from port site within which SPR-W may be disturbed: 5,800	Distance (feet) from port site within which RSH may be disturbed: 9,750 Distance (feet) from port site within which SPR-W may be disturbed: 5,800	Distance (feet) from port site within which RSH may be disturbed: 9,750 Distance (feet) from port site within which SPR-W may be disturbed: 5,800
Port site closure and reclamation	Distance (feet) from port site within which RSH may be disturbed: 10,550 Distance (feet) from port site within which SPR-W may be disturbed: 6,400	Distance (feet) from port site within which RSH may be disturbed: 10,550 Distance (feet) from port site within which SPR-W may be disturbed: 6,400	Distance (feet) from port site within which RSH may be disturbed: 10,550 Distance (feet) from port site within which SPR-W may be disturbed: 6,400
Natural Gas Pipeline			
Construction of Mainline	Depending on activity, distance (feet) from mainline within which RSH may be disturbed: 5,100 to 19,500 Depending on activity, distance (feet) from mainline within which SPR-W may be disturbed: 2,600 to 14,000 Depending on activity,	Depending on activity, distance (feet) from mainline within which RSH may be disturbed: 5,100 to 19,500 Depending on activity, distance (feet) from mainline within which SPR-W may be disturbed: 2,600 to 14,000 Depending on activity,	Depending on activity, distance (feet) from mainline within which RSH may be disturbed: 5,100 to 19,500 Depending on activity, distance (feet) from mainline within which SPR-W may be disturbed: 2,600 to 14,000 Depending on activity,

Table 4.19-7: Summary of Key Issues for Noise Resource

Impact Causing Project Component/Activity	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
	distance (feet) from mainline within which SPR-D (Anchor Point) may be disturbed: 990 to 8,300	distance (feet) from mainline within which SPR-D (Anchor Point) may be disturbed: 990 to 8,300	distance (feet) from mainline within which SPR-D (Anchor Point) may be disturbed: 990 to 8,300
Construction of compressor station	Distance (feet) from compressor station within which SPR-D (Anchor Point) may be disturbed: 2,150	Distance (feet) from compressor station within which SPR-D (Anchor Point) may be disturbed: 2,150	Distance (feet) from compressor station within which SPR-D (Anchor Point) may be disturbed: 2,150
Mainline maintenance	Distance (feet) from mainline within which RSH may be disturbed: 8,550 Distance (feet) from mainline within which SPR-W may be disturbed: 5,000 Distance (feet) from mainline within which SPR-D (Anchor Point) may be disturbed: 2,150	Distance (feet) from mainline within which RSH may be disturbed: 8,550 Distance (feet) from mainline within which SPR-W may be disturbed: 5,000 Distance (feet) from mainline within which SPR-D (Anchor Point or Pedro Bay) may be disturbed: 2,150	Distance (feet) from mainline within which RSH may be disturbed: 8,550 Distance (feet) from mainline within which SPR-W may be disturbed: 5,000 Distance (feet) from mainline within which SPR-D (Anchor Point or Pedro Bay) may be disturbed: 2,150
Compressor station operation	Distance (feet) from compressor station within which SPR-D (Anchor Point) may be disturbed: 2,150	Distance (feet) from compressor station within which SPR-D (Anchor Point) may be disturbed: 2,150	Distance (feet) from compressor station within which SPR-D (Anchor Point) may be disturbed: 2,150
Mainline and compressor station closure and reclamation of land(s)	Distance (feet) from pipeline feature within which RSH may be disturbed: 8,550 Distance (feet) from pipeline feature within which SPR-W may be disturbed: 5,000 Distance (feet) from pipeline feature within which SPR-D (Anchor Point) may be disturbed: 2,150	Distance (feet) from pipeline feature within which RSH may be disturbed: 8,550 Distance (feet) from pipeline feature within which SPR-W may be disturbed: 5,000 Distance (feet) from pipeline feature within which SPR-D (Anchor Point or Pedro Bay) may be disturbed: 2,150	Distance (feet) from pipeline feature within which RSH may be disturbed: 8,550 Distance (feet) from pipeline feature within which SPR-W may be disturbed: 5,000 Distance (feet) from pipeline feature within which SPR-D (Anchor Point or Pedro Bay) may be disturbed: 2,150

4.19.7 Cumulative Effects

The EIS analysis area for cumulative effects on noise includes the footprint of the proposed project, including all alternatives and variants where direct and indirect noise effects could reasonably be expected to occur, and where a nexus may exist with other past or present activities, as well as reasonably foreseeable future actions (RFFAs) that could contribute to a cumulative effect on noise.

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 noise in the EIS analysis area. These include offshore-based developments, activities that may occur within the EIS analysis area, but are unlikely to result in any appreciable impact on noise, or actions outside of the cumulative effects analysis area (e.g., Donlin Gold, Alaska LNG).

Most RFFAs listed in Section 4.1, Introduction to Environmental Consequences, are not within the noise cumulative impacts analysis area. The RFFAs that could contribute cumulatively to noise impacts in the cumulative effects analysis area are:

- Pebble Project buildout – develop 55 percent of the resource over an additional 78-year period
- Diamond Point rock quarry

The potential future actions are similar to the proposed project in how they may generate noise from construction and operations activities. Even if those actions are not concurrent with project activities, such as sequential construction activities, noise emission could not combine, and create a cumulative effect. Additionally, if only the proposed project is in proximity to the receptor, and other cumulative projects are sufficiently distant, the acoustic contributions from the other projects would not meaningfully contribute to cumulative noise impacts.

4.19.7.1 Past and Present Actions

Past and present actions that have contributed to noise in the area consist of aircraft traffic associated with mineral exploration and commercial recreation, occasional vessel traffic on Iliamna Lake, and noise sources typical of small Alaskan communities, including airports. Scoping comments have indicated concerns with past helicopter noise associated with mineral exploration activities.

4.19.7.2 Reasonably Foreseeable Future Actions

No Action Alternative

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

Alternative 1 – Applicant's Proposed Alternative

Pebble Mine Expanded Development Scenario – An expanded development scenario for this project, as detailed in Table 4.1-2, would include an additional 58 years of mining and 20 more years of milling (for a total of 98 years) over a substantially larger mine site footprint, and would include increases in port and transportation corridor infrastructure (see Section 4.1, Introduction to Environmental Consequences, Figure 4.1-1).

The Pebble Project expanded development scenario would result in additional development not included under Alternative 1 that may contribute cumulatively to noise, including a separate transportation corridor and port facility. The magnitude of impacts to noise would not be expected to increase because sources of noise are similar to the currently proposed project; however, construction, operations, and closure of the expanded development scenario would occur decades beyond the currently proposed project, and therefore would cause increase in duration of noise within the cumulative impacts analysis area. An increase in extent of noise within the mine site may occur because of the increase in areas of activity that would generate noise, but impacts to NSRs would not be expected to increase in the mine site noise analysis area.

Mineral Exploration Activities – Mineral exploration activities would continue to occur at adjacent mineral deposits such as the Groundhog deposit. This could include helicopter support, and construction of temporary support facilities at exploration sites. These activities could generate noise noticeable to people in their vicinity. These activities would be seasonal in nature, primarily during the summer.

Road Improvement and Community Development Projects – Road improvement projects could contribute cumulatively to noise impacts through additional construction and operations in the EIS analysis area. The most likely road improvements in the area would be within the development footprint of existing communities (e.g., Iliamna, Newhalen, Pedro Bay, Kokhanok). Some limited road upgrades could occur in the vicinity of the natural gas pipeline starting point near Stariski Creek, within the Anchor Point census-designated area. None of the anticipated transportation development within the EIS analysis area would be expected to contribute greatly to cumulative effects on noise.

Alternative 2 – North Road and Ferry with Downstream Dams, and Alternative 3 – North Road Only

Pebble Mine Expanded Development Scenario – Expanded mine site development and associated contributions to cumulative effects on noise would the same for all alternatives. Under Alternatives 2 and 3, project expansion would use the existing Diamond Point port facility; would use the same natural gas pipeline; and would use portions the constructed portion of the north access road. A concentrate pipeline and a diesel pipeline from the mine site to Iniskin Bay would be constructed, and potentially increase erosion and sedimentation. Cumulative impacts from the Diamond Point rock quarry would be less under Alternatives 2 and 3 than under Alternative 1, because of the commonly shared project footprints between the Pebble port facilities and the proposed quarry site.

Mineral Exploration Activities – Contribution to cumulative impacts associated with mining exploration activities would be similar to those discussed under Alternative 1.

Diamond Point Quarry – Another RFFA that has the potential to affect noise in the EIS analysis area under Alternatives 2 and 3 would be the Diamond Point rock quarry. That RFFA would include the excavation of rock, which would require removal of soil overburden materials and rock using heavy equipment and blasting. If activity is concurrent, there is a possibility of this RFFA contributing cumulatively to noise impacts locally around the Diamond Point area.

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4.20 AIR QUALITY

This section addresses air quality impacts during the project. Direct and indirect air quality impacts from all phases of the project were evaluated using project emissions, and where applicable, air modeling results. Project emissions consist of criteria pollutants, hazardous air pollutants (HAPs), and greenhouse gases (GHG). The project's HAPs with the largest emissions are acetaldehyde, benzene, formaldehyde, hexane, hydrochloric acid (HCl), toluene, lead compounds, mercury compounds, and arsenic compounds.

The Environmental Impact Statement (EIS) analysis area includes the area of each project component. Emissions and impacts caused by a project component in its respective defined area of analysis are described as direct impacts. The direct impacts are caused by the project component's activity, and occur at the same time and location of the activity.

Scoping comments were received regarding impacts to air quality from construction, fugitive dust emissions, vehicle equipment emissions, and mining activities. Concerns were stated regarding fugitive dust pollution from the mine and roads, and what chemicals would be used to control dust. Scoping comments also included requests for assessment of: impacts from transporting ore and materials, and loading and shipping ore and concentrate; impacts to related values (e.g., visibility); and identification of sensitive receptors in the vicinity. Additional comments regarding GHG included requests to assess the contribution to GHG from the power plant and to provide an emissions inventory of criteria pollutants, greenhouse gas emissions, and significant HAP emissions for all project components and phases. However, all project components would be in remote areas of Alaska characterized as attainment/unclassified areas for air quality. Section 4.11, Aesthetics, discusses the potential effects of localized changes to smells that could result from project-related actions, which alter the natural smells that exist under current conditions.

4.20.1 Methodology for the Analysis of Air Quality Impacts

Expected air quality impacts are evaluated based on the emission source and emission estimates, dispersion modeling, and screening criteria.

Emission sources are categorized three ways: fugitive, mobile, and stationary point sources:

- Fugitive emission sources are those that could not reasonably pass through a stack, chimney, vent, or other functionally equivalent opening (40 Code of Federal Regulations [CFR] Part 52.21[b][20]). Some examples of fugitive sources are fugitive dust from vehicles on unpaved roads, fugitive leaks from piping and connectors, blasting, or dust from material handling.
- Mobile sources include on-road and off-road vehicles, non-road engines, or portable sources such as light plants, heaters, portable generators, construction equipment, ships, and aircraft.
- Stationary point sources are those that pass through a stack, chimney, vent, or other functionally equivalent opening (40 CFR Part 52.21[b][20]). Examples of stationary sources associated with the project are enclosed material processing and handling activities (for which emissions pass through a stack or vent), power plant generators, and incinerators.

The impacts are assessed based on the following factors:

- Magnitude – Impact magnitude is based on comparing modeled project impacts to Alaska Ambient Air Quality Standards (AAAQS) and Prevention of Significant

Deterioration (PSD) increments (Appendix K4.20, Table K4.20-1). For this analysis, the magnitude is quantified as follows:

- Minimal impact for:
  - Near-field impact is below the AAAQS and/or PSD increment
  - Far-field impact is under the screening criteria.
- Substantial impact for:
  - Near-field impact is above the AAAQS and/or PSD increment
  - Far-field impact is above the screening criteria.

- Duration – Impact duration is assessed by the length of time project activity would impact the air quality conditions. For this analysis, duration is quantified as follows:
  - The air quality impacts would only remain while the project's activity is ongoing, returning to the baseline conditions once the activity is complete; this would be short-term if occurring only during construction and long-term if lasting though construction, operations, and closure.
  - The air quality impact would remain after post-closure; this would be considered permanent.
- Geographic Extent – Geographic extent is assessed based on the spatial range of where the project activity would impact the air quality conditions. For this analysis, geographic extent is quantified as follows:
  - Localized impact – modeled concentrations return to background levels within 1,640 feet of modeled ambient air boundary.
  - Regional impact – modeled concentrations return to background levels beyond 1,640 feet of modeled ambient air boundary.
- Potential – Impact potential is assessed based on the likelihood that the project activity would impact the air quality conditions. For this analysis, potential is quantified as follows:
  - Air quality impacts that may occur have a greater than 50 percent chance of occurring; or
  - Air quality impacts that are unlikely to occur have a less than 50 percent chance of occurring.

The PSD increments and AAAQS criteria used to evaluate the impact to air quality based on the magnitude of the dispersion model-predicted pollutant concentrations are provided in Section K4.20. The comparison of impacts to PSD increments has been provided for informational purposes only, and does not represent a regulatory PSD increment analysis, which would require a detailed assessment of increment consumption and expansion possibility of regional sources. PSD increment consumption would be assessed as part of a formal increment consumption analysis during the permitting process, if required.

Project direct impacts are compared to applicable thresholds using near-field dispersion models for Class II areas, and far-field modeling assessments tools for Federal Class I areas. The Federal Class I area status is assigned to federally protected wilderness areas, and allows the lowest amount of permissible deterioration. All other areas are Class II, allowing for a moderate amount of air quality deterioration. The near-field dispersion model is used to assess the impact near the project area, extending out to roughly 30 miles. The far-field modeling assessment tools are used to project impacts beyond the near-field.

4.20.1.1 Emission Inventory

Because the action alternatives would have similar emission sources and locations of stationary emissions (except for the location of the port and transportation corridor route), emissions estimates and air dispersion modeling for Alternative 1 provide a proxy for all action alternatives. Differences among alternatives in road and pipeline length and location would result in different road-related emissions. These differences among alternatives, as well as differences in locations of the port, were not separately modeled, but instead were evaluated qualitatively.

Total potential criteria pollutant and hazardous pollutant emissions are calculated using vendor data, US Environmental Protection Agency (EPA) AP-42 emission factors, mass balances equations, EPA Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories, and New Source Performance Standards (NSPS). The methods for estimating GHG emissions for fuel combustion sources are applied in accordance with the guidance provided in Subpart C of the Mandatory Reporting of Greenhouse Gases Rule (40 CFR Part 98) for Tier 1 units, and EPA Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories for marine vessel emissions. The carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) emission estimates are calculated for all stationary and mobile equipment on an individual basis using Equation C-1 from 40 CFR Part 98. In addition, to estimate emissions for the air quality impact analyses for all project components, several avoidance and control measures were considered, as outlined in PLP 2018 RFI-007.

Project direct and indirect GHG emissions and impacts from those emissions present a special case when assessing impacts under the framework previously described. Because GHG emissions are long-lived in the atmosphere, project GHG emissions will become well mixed in the atmosphere and transported globally without directly causing short-term and local impacts. Additionally, it is the aggregation of project emissions with all other global emissions past and present that have the potential to translate into impacts in the analysis area. Due to these complexities, no standard methodology currently exists to assess how a proposed project's GHG emissions would translate into physical effects in the analysis area. Therefore, while the project's direct GHG emissions are presented for Alternative 1; the magnitude of the impacts from those emissions is not addressed. However, given GHG emissions are long-lived in the atmosphere and globally transported, the impact duration will always be long-term, and the geographic extent global. Under all action alternatives, the project would contribute to global GHG emissions during all phases of construction, drilling, and operations.

4.20.2 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 air quality 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). 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. Impacts to air quality from exploration would continue at current levels.

PLP would be required to reclaim any remaining sites at the conclusion of their exploration program. If reclamation approval is not granted immediately after the cessation of reclamation activities, the State may require continued authorization for ongoing monitoring and reclamation work as deemed necessary by the State of Alaska. While these activities would also cause some changes to air quality, reclamation would benefit the air quality after complete.

4.20.3 Alternative 1 – Applicant's Proposed Alternative

The results of the assessment of emissions and impacts of Alternative 1 are addressed for each project component by project phase (construction, operations, and closure) in the following sections. When discussing emissions and impacts of one project component on another, the direct impact from one of the other project components is considered an indirect impact on the project component being assessed and vice versa.

For the project, the federal action that could cause an air impact includes the construction and operations of the Amakdedori port, construction and operations of the ferry terminals at Iliamna Lake, and construction and operations of the underwater/offshore pipeline across Iliamna Lake and Cook Inlet. The magnitude, duration, extent, and potential of impacts from each these components is described in the sections below. Based on those assessments, minimal and localized impacts (as defined under "Methodology for the Analysis of Air Quality Impacts" above) would occur while the components are being constructed and/or operated. The area would return to baseline conditions once the activity ceases.

4.20.3.1 Mine Site

For the mine site, the analysis area for the direct impacts and emissions encompasses the area where the mine site activities would occur. The direct emissions from the construction, operations, and closure phases are presented. The extent of potential mine site direct impacts is presented for mine construction activities and mine operations activities by completing a near-field and far-field impact assessment that primarily relies on the results of dispersion modeling. For the indirect impacts, the analysis area includes the Amakdedori port site and transportation corridor, because these areas would be indirectly affected by the mine site.

Relevant and primary indirect air quality impacts associated with the construction, operations, and closure phases of the mine site would result from emissions associated with transporting manpower, supplies, construction equipment, and materials to and from the mine site through the Amakdedori port and transportation corridor. The impacts from transporting supplies through the transportation corridor are discussed in the "Transportation Corridor" section, and the impacts from transportation to and from the port are discussed as direct impacts in the "Amakdedori Port" section. As stated in the respective sections, if indirect impacts from the mine site occur, the magnitude and extent would be minimal and localized, and impacts would only occur for the duration of the construction, operations, and closure.

Construction

Direct emissions during construction would be related to quarry crushing operations, concrete batch plant operation, incineration, and power generation.

The total emissions were calculated based on the worst-case mine site construction year. Emissions were calculated assuming that each emission unit would be operated continuously 24 hours a day, 7 days a week, for a total of 8,760 hours per year, with the appropriate load factors; with the exception of those emission units, such as fire water pump engines, that would be subject to operating restrictions under an air quality permit, if issued. The potential emissions for restricted emission units were calculated assuming those emission units would be operated at the maximum load for the maximum allowed hours per year; which, for the fire water pump engines is 500 hours per year. The construction emission inventory for the mine site is provided in Table 4.20-1 for a worst-case construction year.

Table 4.20-1: Mine Site Construction Emission Summary

Air Pollutant	Stationary Emission Units (tons/year)	Non-road Engines (tons/year)	Mobile Emission Units (tons/year)	Fugitive and Blasting Emission Units (tons/year)	Total Emissions (tons/year)
NOx	110	24	2,050	9	2,193
CO	589	23	1,414	54	2,080
PM_{10}	17	1	83	1,030	1,131
$PM_{2.5}$	16	1	83	124	224
VOCs	34	5	171	N/A	209
SO_2	1	negligible	0	N/A	1
Pb	0.0	negligible	negligible	N/A	0.0
Total HAPs	5.5	0.1	negligible	N/A	5.5
CO_2	99,302	2,064	20,095	N/A	121,461
CH_4	4.6	0.1	0.8	N/A	5.5
N_2O	0.9	0.0	0.1	N/A	1.0
CO_2e	99,696	2,071	20,164	N/A	121,931

CH_4 = methane
CO = carbon monoxide
CO_2 = carbon dioxide
CO_2e = CO_2 equivalent
HAPs = hazardous air pollutants
N/A= not applicable
Negligible= values less than 0.001 ton per year
N_2O = nitrous oxide
NO_x = oxides of nitrogen
Pb = lead
PM = particulate matter
PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 microns
$PM_{2.5}$ = particulate matter with an aerodynamic diameter less than or equal to 2.5 microns
SO_2 = sulfur dioxide
VOCs = volatile organic compounds
Source: PLP 2018-RFI 007

The magnitude of representative air quality near-field impacts related to mine site construction was assessed using a near-field model demonstrating compliance with applicable AAAQS and PSD Class II Increments. Maximum impacts are less than 45 percent of the AAAQS, and less than 2 percent of the PSD Class II increments. The extent of maximum impacts reaches to the project boundary closest to the modeled sources. Minimal and localized impacts may occur during construction of the mine site. The duration of the impacts would be short term, occurring only during construction and air quality would return to the baseline conditions once the construction was complete. Details of the near-field impact assessment are presented in Appendix K4.20.

The far-field impacts would be comparable to those described as occurring during the operations phase of the mine site. However, because construction activities are temporary and occur over a shorter time period relative to the operation phase, far-field impacts are unlikely to occur (i.e., less than 50 percent probability). If impacts do occur, the magnitude and duration would be minimal and temporary.

Operations

Direct emissions during mine site operations would be related to mining activities, ore-processing activities, incineration, and power generation. The mine site stationary emission unit inventory would include a combined-cycle combustion turbine power plant, fire water pump engines, back-up generator, boilers, fuel storage tanks, and a small incinerator. The mobile equipment inventory would include haul trucks, bulldozers, graders, shovels, light-duty vehicles, and loaders that would be used in the mining activities. Fugitive emissions would result from blasting, drilling, vehicle traffic on unpaved roads, and material handling. The fuel-burning mobile and stationary emission units are sources of combustion-related air pollutant emissions. A summary of the emissions during operations at the mine site is presented in Table 4.20-2 for a representative operations year.

Table 4.20-2: Mine Site Operations Emission Summary

Air Pollutant	Stationary Emission Units (tons/year)	Mobile Emission Units (tons/year)	Fugitive and Blasting Units (tons/year)	Total Emissions (tons/year)
NO_x	83	4,321	31	4,436
CO	133	2,658	179	2,970
PM_{10}	159	164	2,686	3,009
$PM_{2.5}$	159	164	322	645
VOC	32	305	N/A	337
SO_2	8	2	N/A	10
Pb	0.0	negligible	negligible	0.0
Total HAPs[1]	9.1			9.1
CO_2	640,226	201,393	N/A	841,618
CH_4	12.7	8.2	N/A	20.8
N_2O	1.3	1.7	N/A	3.0
CO_2e	640,940	202,084	N/A	843,024

[1] Total HAPs are calculated for all emission units and are not broken out by type.
CH_4 = methane
CO = carbon monoxide
CO_2 = carbon dioxide
CO_2e = CO_2 equivalent
HAPs = hazardous air pollutants
N/A= not applicable
Negligible= values less than 0.001 ton per year
N_2O = nitrous oxide
NO_x = oxides of nitrogen
Pb = lead
PM = particulate matter
PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 microns
$PM_{2.5}$ = particulate matter with an aerodynamic diameter less than or equal to 2.5 microns
SO_2 = sulfur dioxide
VOCs = volatile organic compounds
Source: PLP 2018-RFI 007

A near-field modeling assessment was prepared to assess air quality impacts related to the operation of the mine site. Compliance with modeled AAAQS and PSD Class II Increments is demonstrated. Maximum impacts are less than 55 percent of the AAAQS, and less than 90 percent of the PSD Class II increments. The extent of maximum impacts reaches to the project boundary closest to the modeled sources.

A far-field impact assessment was prepared to assess representative air quality impacts related to the operation of the mine site, and included an analysis of impacts to air quality-related values (AQRVs) at nearby Federal Class I areas. AQRVs are a resource adversely affected by a change in air quality, such as visibility, deposition, and ozone. Based on the combination of inputs, distances modeled, and conservative model assumptions, the model-predicted impacts show that the visibility and deposition screening criteria established for Federal Class I areas would not be exceeded at any Federal Class I area, obviating the need for a cumulative impact analysis to demonstrate this project will not contribute to regional haze and deposition.

However, because future project assessments may require further analysis of deposition impacts, a sulfur and nitrogen deposition analysis was conducted. Based on the low SO_2 emissions, the SO_2 impacts were not modeled for the mine site, and it is unlikely (i.e., less than 50 percent probable) that the SO_2 emissions from the mine site operations would be large enough to contribute to sulfur deposition impacts. Although the nitrogen deposition value presented in Appendix K4.20 is a conservatively high estimate, the analysis still shows the magnitude of impacts to be equal to the lowest critical-load value for lichens and the bryophytes ecosystem, which is an ecosystem found in Denali National Park and other nearby Federal Class I areas. The extent of impact would be 0.6 mile from the source. Therefore, because Denali National Park and other nearby Federal Class I areas are more than 62 miles from the source, negligible impacts (i.e., less than 0.001 ton per year) are expected.

Based on the near and far-field analyses, air quality impacts that may occur due to mine operations would be minimal in magnitude and localized in extent. However, the duration of impacts would be long term, lasting throughout operations. The impacts would be certain to occur if the project were permitted and constructed. Appendix K4.20 presents additional information regarding the near-field and far-field assessments.

Closure

Closure and reclamation activities are described in Chapter 2, Alternatives. Support facilities would include operation of the camp and power generation. The reclamation emissions inventory would include internal combustion engines, a gas turbine, boilers, and an incinerator. The mobile equipment would include haul trucks, shovels, bulldozers, compactors, graders, and service and light-duty vehicles. Fugitive dust emissions would result from stockpiled overburden handling, bulldozing, grading, vehicle traffic on unpaved roads, and wind erosion of road surfaces and active reclamation areas. The duration of the closure phase at the mine site is expected to be approximately 20 years. The maximum closure and construction activities and emissions in a given year would be similar to each other. Assuming closure impacts would be similar to those from the construction phase, near-field impacts may be possible, but far-field impacts are unlikely (i.e., a less than 50 percent probability) to occur because closure activities are temporary and occur over a shorter time period relative to the operations phase. If near-field impacts were to occur, they would be minimal in magnitude, localized in extent, and of short-term duration, occurring while closure activities are ongoing. Impacts would be limited to the duration of mine site closure, and air quality would return to the baseline conditions once closure is complete. They would be certain to occur if the project were to be permitted and constructed. Table 4.20-3 presents a summary of the mine site closure emissions for a representative closure year.

Table 4.20-3: Mine Site Closure Emission Summary

Air Pollutant	Stationary Emission Units (tons/year)	Mobile Emission Units (tons/year)	Fugitive Emission Units (tons/year)	Total Emissions (tons/year)
NO_x	30	2,194	N/A	2,224
CO	77	2,318	N/A	2,395
PM_{10}	28	118	978	1,124
$PM_{2.5}$	28	118	139	285
VOC	11	284	N/A	295
SO_2	1.7	0.3	N/A	2.0
Pb	0.005	Negligible	N/A	0.0
Total HAPs[1]	4.7			4.7
CO_2	140,134	32,923	N/A	173,057
CH_4	3.3	1.3	N/A	4.6
N_2O	0.4	0.3	N/A	0.7
CO_2e	140,331	33,036	N/A	173,367

[1] Total HAPs are calculated for all emission units and are not broken out by type.
CH_4 = methane
CO = carbon monoxide
CO_2 = carbon dioxide
CO_2e = CO_2 equivalent
HAPs = hazardous air pollutants
N/A= not applicable
Negligible= values less than 0.001 ton per year
N_2O = nitrous oxide
NO_x = oxides of nitrogen
Pb = lead
PM = particulate matter
PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 microns
$PM_{2.5}$ = particulate matter with an aerodynamic diameter less than or equal to 2.5 microns
SO_2 = sulfur dioxide
VOCs = volatile organic compounds
Source: PLP 2018-RFI 007

4.20.3.2 Transportation Corridor

For analysis of direct impacts to air quality, the analysis area of the transportation corridor includes gravel roads, ferry terminals on Iliamna Lake, port, spur roads, and the onshore pipeline segment at the port, because the pipeline and road would be constructed jointly. The transportation corridor would be operational throughout the life of the project. The area of analysis for the indirect impacts include the area encompasing the Amakedori port site.

This section addresses the direct and indirect emissions from the construction, operations, and closure phases of the transportation corridor facilities. Because the road and onshore pipeline would be constructed in the same right-of-way (ROW) at the same time, the emissions from the construction of both the road and onshore pipeline are calculated together.

Relevant and primary indirect air quality impacts associated with the construction, operations, and closure phases of the transportation corridor would result from emissions associated with transporting labor, supplies, and construction materials to and from the Amakdedori port via marine vessels. The impacts from transporting supplies to and from the port are discussed as direct impacts under the “Amakdedori Port” section. As stated in the “Amakdedori Port” section, if impacts do occur, their magnitude and duration would be would be minimal and localized.

However, the duration of impacts would be long term, occurring during construction, operations, and closure. The impacts would be expected to occur if the project were permitted and constructed.

Construction

During construction, the main direct emission sources would be heavy-duty, non-road, and mobile construction vehicles, as well as fugitive dust generated by vehicles on unpaved roads, and wind erosion. Additional fugitive emissions would result from blasting, drilling, rock crushing, and material handling. Stationary emissions sources would include engines and vapor vented from fuel storage tanks. Emissions from material mining and crushing operations required for fill material, principally for the earthen access causeway at the port, are also included in this assessment. The representative emissions were calculated based on the total construction duration of the transportation corridor and estimated equipment operation. The duration of construction for the road corridor and onshore pipeline facilities is expected to be approximately 1 year. Table 4.20-4 presents a summary of the construction emissions for the transportation corridor. Further details of the transportation corridor emission inventory are provided in PLP 2018-RFI 007.

Table 4.20-4: Transportation Corridor Construction Emission Summary

Air Pollutant	Stationary Emission Units (tons/year)	Non-road Engines (tons/year)	Mobile Emission Units (tons/year)	Fugitive Emission Units (tons/year	Total Emissions (tons/year
NO_x	13	48	288	4	353
CO	80	46	1,057	23	1,205
PM_{10}	2	2	24	1,838	1,866
$PM_{2.5}$	2	2	6	N/A	11
VOC	7	9	59	N/A	76
SO_2	0.14	0.04	0.21	N/A	0.39
Pb	0.01	negligible	negligible	N/A	0.01
Total HAPs	7.25	0.10	negligible	N/A	7.35
CO_2	18,401	4,128	22,532	N/A	45,061
CH_4	1.4	0.2	0.9	N/A	2.5
N_2O	0.2	0.0	0.2	N/A	0.5
CO_2e	18,506	4,142	22,611	N/A	45,259

CH_4 = methane
CO = carbon monoxide
CO_2 = carbon dioxide
CO_2e = CO_2 equivalent
HAPs = hazardous air pollutants
N/A= not applicable
Negligible= values less than 0.001 ton per year
N_2O = nitrous oxide
NO_x = oxides of nitrogen
Pb = lead
PM = particulate matter
PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 microns
$PM_{2.5}$ = particulate matter with an aerodynamic diameter less than or equal to 2.5 microns
SO_2 = sulfur dioxide
VOCs = volatile organic compounds
Source: PLP 2018-RFI 007

It is anticipated that construction of the transportation corridor would have lower near-field and far-field impacts than those presented for the mine site, because the construction of the transportation corridor would require less activity and therefore, fewer emissions. As discussed in the mine site impact analysis, air quality near-field and far-field impacts would be possible, although the far-field impacts are not likely to occur. If near-field impacts did occur, they would be minimal in magnitude, localized in extent and short-term in duration, and only occur during construction. Once construction is complete, air quality would return to baseline conditions.

Operations

Direct emissions during the transportation corridor operations would come from power generators at the ferry terminals, vapor vented from fuel storage tanks, and other fuel-burning engines such as ferry engines, light-duty vehicles, truck/trailer vehicles, container-handing forklifts, graders, and aircraft. Additionally, fugitive dust emissions would result from vehicle traffic on unpaved roads. A summary of the operations emissions in the transportation corridor is presented in Table 4.20-5. Further details of the transportation corridor emission inventory are provided in PLP 2018-RFI 007.

Table 4.20-5: Transportation Corridor Operations Emission Summary

Air Pollutant	Stationary Emission Units (tons/year)	Mobile Emission Units (tons/year)	Fugitive Emission Units (tons/year)	Total Emissions (tons/year)
NO_x	25.9	49.4	N/A	75.3
CO	84.2	101.6	N/A	185.8
PM_{10}	1.6	7.3	398.5	407.4
$PM_{2.5}$	1.6	7.3	38.4	47.3
VOC	18.1	8.4	N/A	26.5
SO_2	0.1	0.6	N/A	0.7
Pb	0.0	negligible	N/A	0.0
Total HAPs[1]	2.6			2.6
CO_2	13,111	10,605	N/A	23,716
CH_4	0.6	0.4	N/A	1.0
N_2O	0.1	0.1	N/A	0.2
CO_2e	13,156	10,642	N/A	23,798

[1] Total HAPs are calculated for all emission units and are not broken out by type.
CH_4 = methane
CO = carbon monoxide
CO_2 = carbon dioxide
CO_2e = CO_2 equivalent
HAPs = hazardous air pollutants
N/A= not applicable
Negligible= values less than 0.001 ton per year
N_2O = nitrous oxide
NO_x = oxides of nitrogen
Pb = lead
PM = particulate matter
PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 microns
$PM_{2.5}$ = particulate matter with an aerodynamic diameter less than or equal to 2.5 microns
SO_2 = sulfur dioxide
VOCs = volatile organic compounds
Source: PLP 2018-RFI 007

Because of lower activity level and emissions at the transportation corridor relative to the mine site, it is anticipated that the operations of the transportation corridor would have lower near-field and far-field impacts than those presented for the mine site. As discussed in the mine site impact analysis, air quality near-field and far-field impacts would be minimal in magnitude, localized in extent and short-term in duration, only occurring during the activity. The impacts would be expected to occur if the project were permitted and constructed.

Closure/Post-Closure

The transportation system would be retained as long as required for the transport of bulk supplies needed for long-term post-closure water treatment and monitoring. As operations end, the Iliamna Lake ferry terminal facilities would be removed, and all supplies would be transported across the lake using a summer barging operation. The closure/post-closure and construction activities and emissions in a given year would be similar. Assuming impacts would be similar to those from the construction phase, near-field impacts may be possible, but far-field impacts are unlikely (i.e., less than 50 percent probable) to occur because closure activities are temporary short-term. If near-field impacts did occur, they would be minimal in magnitude, localized in extent, and of short-term duration, only occurring during closure/post-closure activities. Similarly, air quality would return to the baseline conditions once closure was complete.

4.20.3.3 Amakdedori Port

This section presents the emissions from the construction, operations, and closure phases of the Amakdedori port. Additionally, the underwater pipeline portions in the Cook Inlet and Iliamna Lake are included in the analysis of the port construction phase. For the port, the area of analysis for the direct impacts includes the Amakdedori port and marine transport in Cook Inlet. For the indirect impacts, the area of analysis includes the region beyond the project boundary in Cook Inlet.

The transportation of labor, supplies, and materials in Cook Inlet to Amakdedori port are included in the assessment of the direct impacts. However, relevant and primary indirect air quality impacts associated with the construction, operations, and closure phases of the Amakdedori port would result from emissions associated with transporting supplies and construction materials beyond the project boundary in Cook Inlet. To quantify the possible impacts from marine vessel traffic in Cook Inlet, the assessment completed for the Bureau of Ocean Energy Management (BOEM) Cook Inlet Planning Area Oil and Gas Lease Sale 244 Final EIS (referred to as BOEM Lease Sale FEIS) (BOEM 2016) was reviewed. The BOEM Lease Sale FEIS was an assessment of oil and gas lease sales in Cook Inlet, and found increased air pollutant concentrations due to emissions from engines and generators on drill rigs, platforms, marine vessel traffic in Cook Inlet, and helicopters. The emission estimate used for the modeling assessment of the impacts included about 312 support vessel per year during the production and development phase of the BOEM Lease Sale FEIS. This is comparable to the amount of vessel traffic included in the Pebble Project, which estimates about 330 support vessels per year during the operations phase of the project. Given the BOEM Lease Sale FEIS finding of minimal impacts in Cook Inlet, and that it included other emission sources in addition to marine vessel traffic, which is comparable to the Pebble Project, it is likely the Pebble Project indirect impacts would also be minimal. The indirect impacts are unlikely to lead to additional impacts beyond the existing air quality conditions in Cook Inlet.

Construction

The construction of the port and offshore pipeline uses similar equipment and methods. Therefore, the emissions are calculated together; however, the construction would not occur at the same time. The construction of the offshore pipeline would occur after the port construction. The construction emissions are calculated based on the estimated construction time, regardless of which activity would occur first.

The port site construction activity would include construction of port facilities to support later phases of construction and mine operations. Emissions from material mining and crushing operations required for fill material, principally for the earthen access causeway, are captured in the road construction emissions provided for the transportation corridor. Emissions associated with operation of the port facilities, including trucking or offshore pipeline construction, are assumed to be similar to emissions during mine operation, and are represented by the annual transportation emissions estimate for mine operations.

The construction activity associated with the port and offshore pipeline would include engines, an asphalt plant, boilers, fuel storage tanks, and a small incinerator. The mobile equipment inventory would include bulldozers, excavators, loaders, and cranes in the port construction; and tugs, long-reach excavators, and welders in the pipeline construction. Fugitive emissions would result from site grade preparation and mobile equipment traffic. The construction of the port and offshore pipeline is expected to take approximately 1 year. Table 4.20-6 presents an emission summary for construction of the port and associated offshore pipelines. It is assumed that the construction of the Amakdedori port would have lower near-field and far-field impacts than those presented for the mine site during construction, because the emissions are lower for the port relative to the mine site. Based on that similarity, the magnitude, extent, and duration of air quality impacts would be minimal, localized, and short-term, only occurring during construction activities. Once construction is complete, air quality would return to baseline conditions. These impacts would be expected to occur if the project is permitted and the Amakdedori port is constructed.

Table 4.20-6: Amakdedori Port and Offshore Pipeline Construction Emission Summary

Air Pollutant	Stationary Emission Units (tons/year)	Non-road Engines (tons/year)	Mobile Emission Units (tons/year)	Fugitive Emission Units (tons/year)	Total Emissions (tons/year)
NO_x	6.2	11.3	363.0	N/A	380.5
CO	13.5	16.5	164.0	N/A	194.0
PM_{10}	17.5	0.3	14.5	1.3	33.6
$PM_{2.5}$	17.5	0.3	14.5	0.2	32.5
VOC	2.5	2.7	23.7	N/A	28.9
SO_2	0.4	0.0	4.7	N/A	5.1
Pb	0.007	negligible	negligible	N/A	0.007
Total HAPs	3.6	0.0	negligible	N/A	3.6
CO_2	5,890	17,591	30,314	N/A	53,794
CH_4	0.6	0.1	0.3	N/A	0.9

Table 4.20-6: Amakdedori Port and Offshore Pipeline Construction Emission Summary

Air Pollutant	Stationary Emission Units (tons/year)	Non-road Engines (tons/year)	Mobile Emission Units (tons/year)	Fugitive Emission Units (tons/year)	Total Emissions (tons/year)
N_2O	0.1	0.0	1.4	N/A	1.5
CO_2e	5,937	17,597	30,724	N/A	54,258

CH_4 = methane
CO = carbon monoxide
CO_2 = carbon dioxide
CO_2e = CO_2 equivalent
HAPs = hazardous air pollutants
N/A= not applicable
Negligible= values less than 0.001 ton per year
N_2O = nitrous oxide
NO_x = oxides of nitrogen
Pb = lead
PM = particulate matter
PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 microns
$PM_{2.5}$ = particulate matter with an aerodynamic diameter less than or equal to 2.5 microns
SO_2 = sulfur dioxide
VOCs = volatile organic compounds
Source: PLP 2018-RFI 007

Operations

Direct emissions from operations would consist of marine vessels traveling in Cook Inlet, barge loading and unloading activities, lightering activities, power generation, heating, and incineration.

The Amakdedori port emission unit inventory would include engines, heaters, vapor vented from fuel storage tanks, and a small incinerator. Mobile equipment would include light-duty vehicles, skidsteers, forklifts, and container-handing forklifts. Marine vessels would include barges, tugs, and bulk carriers at the lightering locations. The concentrate containers would be emptied into the bulk carriers at the bulk carrier lightering point, potentially creating fugitive dust emissions. A summary of the operations emission at the port is presented in Table 4.20-7 for representative year of operations activity.

Table 4.20-7: Amakdedori Port Operations Emission Summary

Air Pollutant	Stationary Emission Units (tons/year)	Mobile Emission Units (tons/year)	Fugitive Emission Units (tons/year)	Total Emissions (tons/year)
NO_x	53.8	271.1	N/A	324.9
CO	169.0	37.0	N/A	206.0
PM	4.0	15.4	2.00E-03	19.4
PM_{10}	4.0	15.4	1.00E-03	19.4
$PM_{2.5}$	4.0	14.5	1.00E-03	18.5
VOC	38.2	14.3	N/A	52.5
SO_2	0.3	1.9	N/A	2.2
Pb	0.0	negligible	N/A	0.0
Total	8.9			8.9

Table 4.20-7: Amakdedori Port Operations Emission Summary

Air Pollutant	Stationary Emission Units (tons/year)	Mobile Emission Units (tons/year)	Fugitive Emission Units (tons/year)	Total Emissions (tons/year)
HAPs[1]				
CO_2	30,246	15,106	N/A	45,352
CH_4	1.5	0.6	N/A	2.1
N_2O	0.3	0.7	N/A	1.0
CO_2e	30,370	15,303	N/A	45,673

[1] Total HAPs are calculated for all emission units and are not broken out by type.
CH_4 = methane
CO = carbon monoxide
CO_2 = carbon dioxide
CO_2e = CO_2 equivalent
HAPs = hazardous air pollutants
N/A= not applicable
Negligible= values less than 0.001 ton per year
N_2O = nitrous oxide
NO_x = oxides of nitrogen
Pb = lead
PM = particulate matter
PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 microns
$PM_{2.5}$ = particulate matter with an aerodynamic diameter less than or equal to 2.5 microns
SO_2 = sulfur dioxide
VOCs = volatile organic compounds
Source: PLP 2018-RFI 007

Near-field air quality impacts from port operations emissions have been demonstrated to be in compliance with modeled AAAQS and PSD Class II Increments. The magnitude and extent of maximum impacts would be less than 90 percent of the AAAQS, with the maximum impact occurring on the project boundary closest to the modeled sources. The far-field impact assessment is based on an analysis of the port emissions that would affect the AQRVs in the nearby Federal Class I areas. As a result of this assessment, the AQRVs would not likely be impacted at any of the Federal Class I areas. Near- and far-field impacts from the port may occur, but the impacts would be minimal in magnitude, localized in extent, and long-term lasting for the duration of port operations. The details of the near-field and far-field impact assessment are in Appendix K4.20.

Closure

There would continue to be emissions and air quality impacts associated with the port until operations end, when physical site closure work would commence. At that time, the Amakdedori port facilities would be removed, except for those required to support shallow draft tug and barge access to the dock for the transfer of bulk supplies. Closure and construction activities and emissions in a given year would be similar to each other. Assuming closure impacts would be similar to those from construction, near-field impacts may be possible, but far-field impacts are unlikely (i.e., less than 50 percent probability) to occur, because closure activities are temporary and short-term. If near-field impacts were to occur, their magnitude would be minimal and localized in extent, and short-term in duration, occurring while closure activities are ongoing. While impacts are expected to occur if the project is permitted, built and undergoes closure, air quality would return to the baseline conditions once the closure was complete.

4.20.3.4 Natural Gas Pipeline Corridor

The analysis area for the direct impacts from the pipeline corridor consists of the onshore pipeline in the transportation corridor, the offshore pipeline at Cook Inlet and Iliamna Lake, and the Kenai compressor station. The construction air quality impacts of the onshore portion of the pipeline are addressed above under transportation corridor. The construction air quality impacts of the offshore portion of the pipeline are addressed above under "Amakdedori Port." Therefore, this section only addresses emissions and air quality impacts from the construction of the Kenai compressor station on the eastern landfall of the natural gas pipeline corridor, as well as the air quality impacts from operations and closure of the entire pipeline corridor. For the indirect impacts, the area of analysis includes the mine site and Amakdedori port.

Relevant and primary indirect air quality impacts associated with the construction, operations, and closure phases of the pipeline corridor would result from emissions associated with transporting manpower, supplies, and construction materials through Amakdedori port during the construction, operations, and closure of the pipeline and compressor station. The impacts from transporting supplies through, and to and from, the port are discussed as direct impacts in the "Amakdedori Port" section. Additional indirect impacts would be from the combustion of the natural gas at the mine site. The impacts from these emissions are discussed as direct impacts under the "Mine Site" section. As stated in the respective sections, if indirect impacts from construction activities in the pipeline corridor occur, they would be minimal in magnitude, localized in extent, and short term, only occurring during construction, operations, and closure.

Construction

Construction of the compressor station would involve site grading and mobile equipment use for assembly of the compressor station from pre-constructed modules. The compressor station emissions inventory would include engines and mobile equipment, as well as bulldozers, loaders, excavators, cranes, and light-duty vehicles. The fuel-burning equipment would be sources of combustion-related air pollutant emissions. Fugitive dust emissions would result from site grade preparation and mobile equipment traffic. The emissions from the compressor station construction are presented in Table 4.20-8. Further details of the compressor station emission inventory are provided in PLP 2018-RFI 007. It is assumed that the construction of the compressor station would have lower near-field and far-field air quality impacts compared to those presented for the construction of the mine site in Section 4.20.3, because the construction of the compressor station has fewer emissions than the construction of mine site, making the mine site a conservative surrogate. As a result, the magnitude, extent, and duration of air quality impacts would be minimal, localized, and short-term, only occurring during construction. The potential of impacts is such that impacts would be expected to occur if the project is permitted and constructed. Once construction is complete, air quality would return to the baseline conditions.

Table 4.20-8: Compressor Station Construction Emission Summary

Air Pollutant	Stationary Emission Units (tons/year)	Non-road Engines (tons/year)	Mobile Emission Units (tons/year)	Fugitive Emission Units (tons/year)	Total Emissions (tons/year)
NO_x	N/A	2.60	1.40	N/A	4.00
CO	N/A	6.40	5.60	N/A	12.00
PM_{10}	N/A	0.10	0.03	0.53	0.66
$PM_{2.5}$	N/A	0.10	0.03	0.08	0.21

Table 4.20-8: Compressor Station Construction Emission Summary

Air Pollutant	Stationary Emission Units (tons/year)	Non-road Engines (tons/year)	Mobile Emission Units (tons/year)	Fugitive Emission Units (tons/year)	Total Emissions (tons/year)
VOC	N/A	0.68	0.30	N/A	0.98
SO_2	N/A	0.01	0.01	N/A	0.02
Pb	N/A	negligible	negligible	N/A	negligible
Total HAPs	N/A	negligible	0.02	N/A	0.02
CO_2	N/A	877	956	N/A	1,833
CH_4	N/A	0.04	0.04	N/A	0.1
N_2O	N/A	0.01	0.01	N/A	0.02
CO_2e	N/A	881	959	N/A	1,840

CH_4 = methane
CO = carbon monoxide
CO_2 = carbon dioxide
CO_2e = CO_2 equivalent
HAPs = hazardous air pollutants
N/A= not applicable
Negligible= values less than 0.001 ton per year
N_2O = nitrous oxide
NO_x = oxides of nitrogen
Pb = lead
PM = particulate matter
PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 microns
$PM_{2.5}$ = particulate matter with an aerodynamic diameter less than or equal to 2.5 microns
SO_2 = sulfur dioxide
VOCs = volatile organic compounds
Source: PLP 2018-RFI 007

Operations

During the operations in the pipeline corridor, the direct emissions and associated impacts from the onshore and offshore pipelines would be negligible (i.e., less than 0.001 tons per year). The Kenai compressor station, which would be the single compressor station for the natural gas pipeline, would have emissions and possible air impacts. For the operations phase, only the compressor station is assessed.

The Kenai compressor station inventory would include natural-gas–fired simple-cycle combustion turbines. A summary of the operations emissions at the compressor station is presented in Table 4.20-9.

Table 4.20-9: Pebble Compressor Station Operations Emission Summary

Air Pollutant	Total Emissions (tons/year)
NO_x	69.30
CO	17.80
PM_{10}	1.40
$PM_{2.5}$	1.40
VOC	0.50
SO_2	0.20

Table 4.20-9: Pebble Compressor Station Operations Emission Summary

Air Pollutant	Total Emissions (tons/year)
Pb	negligible
Total HAPs	0.22
CO_2	25,344
CH_4	0.47
N_2O	0.04
CO_2e	25,370

CH_4 = methane
CO = carbon monoxide
CO_2 = carbon dioxide
CO_2e = CO_2 equivalent
HAPs = hazardous air pollutants
N/A= not applicable
Negligible= values less than 0.001 ton per year
N_2O = nitrous oxide
NO_x = oxides of nitrogen
Pb = lead
PM = particulate matter
PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 microns
$PM_{2.5}$ = particulate matter with an aerodynamic diameter less than or equal to 2.5 microns
SO_2 = sulfur dioxide
VOCs = volatile organic compounds
Source: PLP 2018-RFI 007

Near-field air quality impacts from the compressor station have been demonstrated to be in compliance with modeled AAAQS and PSD Class II Increments. The far-field impact assessment is based on an analysis of the compressor station emissions that would affect the AQRVs in the nearby Federal Class I areas. As a result of this assessment, the AQRVs would not likely be impacted at any nearby Federal Class I areas. Based on the modeling conducted, both near- and far-field impacts from the compressor station would be minimal in magnitude, localized in extent, long-term in duration, lasting as long as the pipeline is in operation. The impacts would be certain to occur if the project is permitted and the pipeline and compressor station are constructed. The details of the near-field and far-field impact assessment are provided in Appendix K4.20.

Closure

The natural gas pipeline would be maintained until such time as it is no longer required to provide gas to the project site. The pipeline would be pigged and cleaned before being abandoned in place, which would result in negligible (i.e., less than 0.001 ton per year) impacts to air quality. The compressor station associated with the pipeline would be removed, and the compressor site reclaimed. The closure and construction activities and emissions in a given year would be similar to each other. Assuming closure impacts would be similar to those from the construction phase, near-field impacts may be possible, but far-field impacts are unlikely to occur because closure activities are temporary and short-term. If near-field impacts did occur, their magnitude, extent, and duration would be minimal, localized, and short-term; only occurring while closure activities are ongoing for compressor station closure. The impacts would be certain to occur if the project is permitted, the pipeline and compressor station are constructed, and eventually undergo closure. Air quality would return to the baseline conditions once closure was complete.

4.20.3.5 Alternative 1 Variants

Under the Summer-Only Ferry Operations Variant, concentrate would be stored at or near the mine site for up to 6 months per year. The mine site would increase by 40 acres resulting in a larger footprint but indirect impacts on air quality and from fugitive dust would not be expected to increase under this variant (see Section 4.26, Vegetation).

The Kokhanok East Ferry Terminal Variant has different access road configurations and road corridors which would generate indirect impacts from fugitive dust (see Section 4.26, Vegetation), but the magnitude, extent and duration of impacts from fugitive dust and other air quality parameters would not differ from Alternative 1. Under the Pile-Supported Dock Variant, air quality and fugitive dust impacts would not change from those described for Alternative 1.

4.20.4 Alternative 2 – North Road and Ferry with Downstream Dams

The mine site under Alternative 2 would be similar to the mine site under Alternative 1, with the exception of embankment designs (see Chapter 2, Alternatives). Under Alternative 2, the locations of the transportation corridor, natural gas pipeline corridor, and port would be different. However, it is anticipated that emissions and impacts from the construction, operations, and closure of the project components from Alternative 2 would be similar to Alternative 1, because the total permanent footprint from each alternative is similar. As presented in Table 2-2, the total footprint for Alternative 2 is slightly larger than Alternative 1. It is not anticipated that this difference would result in meaningful air quality impact differences. The results of the assessment of emissions and impacts of Alternative 2 are addressed for each project component by project phase in the following sections.

4.20.4.1 Mine Site

Emissions from mine construction, operations, and closure would be similar to those presented for Alternative 1, because the mine site footprint (Chapter 2, Alternatives, Table 2-2) and construction, operations, and closure activities for Alternative 2 would be similar to Alternative 1. Although modeling was not directly assessed for Alternative 2, the magnitude, extent, duration, and likelihood of representative near-field and far-field air quality direct and indirect impacts from mine construction, operations, and closure would be similar to impacts predicted under Alternative 1.

4.20.4.2 Transportation Corridor

Relative to Alternative 1 as presented in Chapter 2, Alternatives, Table 2-2, the length of road for Alternative 2 is slightly smaller, and the distance of the ferry route for Alternative 2 is slightly longer. Although the total length of road and distance of the ferry route would be different under Alternative 2 versus Alternative 1, it is not anticipated that the total emissions presented for Alternative 1 would differ from Alternative 2, and would not result in a change of the possible project direct and indirect impacts.

4.20.4.3 Diamond Point Port

Different from Alternative 1, the Diamond Point port location would require dredging to ensure year-round marine vessel access. Because this activity would not be required for Alternative 1, the construction of the port could result in more emissions and slightly larger near-field impacts than the direct and indirect impacts presented under Alternative 1. However, because the magnitude and extent of Alternative 1 near-field and far-field impacts from port construction would be minimal and localized, it is not anticipated that the increase of emissions due to dredging are enough to result in substantial and regional impacts. Therefore, the impacts due to port construction for Alternative 2 should be similar to those presented under Alternative 1.

Because operations for a port at Diamond Point would be similar to Amakdedori port (Alternative 1), the magnitude, extent, duration, and likelihood of impacts from emissions during operations would be consistent with those presented for Alternative 1. Maximum potential near-field effects from the operations at the port would be similar to direct and indirect impacts presented under Alternative 1.

4.20.4.4 Natural Gas Pipeline Corridor

For the onshore and offshore pipeline segments, the magnitude, extent, duration, and likelihood of emissions and impacts from the construction of the pipeline would be similar to those presented in Alternative 1 (Chapter 2, Alternatives, Table 2-2). Although a portion of the pipeline would not follow a road alignment, the differences in emissions based on pipeline construction changes would not be meaningfully different compared to Alternative 1, which is predicted to have minimal and localized impacts. Therefore, it is not anticipated that the increase of emissions due to the increased pipeline footprint would result in substantial and regional impacts. As a result, the impacts due to pipeline construction for Alternative 2 should be similar to those presented under Alternative 1. For reasons similar to those discussed under Alternative 1, the emissions from the operations and closure of the pipeline would be negligible (i.e., less than 0.001 tons per year).

Because the compressor station would be identical to Alternative 1, emissions from compressor station construction and operations would be the same with those presented for Alternative 1. Therefore, maximum potential near- and far-field effects from the compressor station operations would be the same as the direct and indirect impacts presented under Alternative 1.

4.20.4.5 Alternative 2 Variants

The magnitude, extent, duration and likelihood of impacts on air quality of the Summer-Only Ferry Operations Variant and the Pile-Supported Dock Variant would be the same as those described for Alternative 2 (during summer) without either of these variants.

4.20.5 Alternative 3 – North Road Only

Alternative 3 eliminates the need for ferry operations across Iliamna Lake, slightly increasing the north access road length (requiring trucking of concentrate instead of hauling by ferry). All other project components remain the same as those detailed under Alternative 1, with the exception of the port location, which would be at Diamond Point. As a result, it is anticipated that emissions and impacts from the construction, operations, and closure of the project components from Alternative 3 would be similar to those for Alternative 1, for reasons similar to those discussed under Alternative 2. As presented in Chapter 2, Alternatives, Table 2-2, the total footprint for Alternative 3 is slightly bigger than Alternative 1, due to the increase of access road length in the transportation corridor. However, it is not anticipated that this difference would result in any meaningful air quality impact differences. The assessment of emissions and impacts of Alternative 3 are addressed for each project component by project phase in the following sections.

4.20.5.1 Mine Site

Direct and indirect emissions from mine construction, operations, and closure would be the same as those presented for Alternative 1, because the mine construction, operation, and closure are the same as for Alternative 1. Although modeling was not directly assessed for Alternative 3, maximum potential near-field and far-field effects from mine construction, operations, and closure would be the same as the direct and indirect impacts predicted under Alternative 1.

4.20.5.2 Transportation Corridor

Alternative 3 does not include ferry transportation because traffic and materials transport would only use mine and north port access roads. Relative to emissions calculated for the Alternative 1 transportation corridor construction, the increase in road length under Alternative 3 would increase construction emissions, while the removal of ferry traffic and terminal construction would decrease emissions. Overall, the changes in the construction emission inventory are not anticipated to be different from Alternative 1, and would not result in a change of the possible construction impacts. The operations and closure emissions and direct and indirect air quality impacts are not anticipated to be different than Alternative 1, because the ferry terminals would not be operated and constructed.

4.20.5.3 Diamond Point Port

Different from Alternative 1, the Diamond Point port location would require dredging to ensure year-round marine vessel access. Because this activity would not be required for Alternative 1, the construction of the port could result in more emissions and slightly larger near-field impacts than the direct and indirect impacts presented under Alternative 1. However, because the Alternative 1 near-field and far-field impacts from port construction would be minimal and localized, it is not anticipated that the increase of emissions due to dredging are enough to result in substantial and regional impacts. Therefore, the impacts due to port construction for Alternative 3 should be similar to those presented under Alternative 1.

Because operations for a port at Diamond Point would be similar to Amakdedori port (Alternative 1), emissions from operations would be consistent with those presented for Alternative 1. Maximum potential near-field effects from the operations at the port would be similar to direct and indirect impacts presented under Alternative 1.

4.20.5.4 Natural Gas Pipeline Corridor

For the onshore and offshore pipeline segments, the emissions and impacts from the construction of the pipeline would be similar to those presented in Alternative 1 (Chapter 2, Alternatives, Table 2-2). The differences in emissions based on pipeline construction changes would not be meaningfully different compared to Alternative 1, which are predicted to have minimal and localized impacts. Therefore, it is not anticipated that the small increase of emissions due to the increased pipeline footprint would result in substantial and regional impacts. As a result, the impacts due to pipeline construction for Alternative 3 should be similar to those presented under Alternative 1. For reasons similar to those discussed under Alternative 1, the emissions from the operations and closure of the pipeline would be negligible (i.e., less than 0.001 tons per year).

Because the compressor station would be identical to Alternative 1, emissions from compressor station construction and operations would be same as those presented for Alternative 1. Therefore, maximum potential near- and far-field effects from the compressor station operations would be the same as the direct and indirect impacts presented under Alternative 1.

4.20.5.5 Alternative 3 Variants

Under the Concentrate Pipeline Variant, the mine site footprint would be increased by approximately 1 acre. This variant would also slightly increase the north access road corridor width due to the concentrate pipeline and the optional return water pipeline that would be co-located in a single trench. Truck traffic and associated emissions would decrease along the transportation corridor with concentrate shipped through the pipeline. There could be added emissions at the port site, depending on concentrate water treatment options.

4.20.6 Climate Change

As outlined in Section 3.20, Air Quality, it is projected that the project area will see an overall increase in temperatures, with an increase in precipitation during the winter months, and a slight decrease of precipitation during the summer months. The near-field and far-field modeling impacts discussed previously would not be sensitive to small projected changes in temperature and precipitation. However, a decrease in precipitation, especially in the summer months, could result in drier exposed areas associated with the project, which could lead to more fugitive dust if left unmitigated (see Chapter 5, Mitigation). Additionally, an increase of temperature and changes in precipitation could lead to an increase of wildfire frequency and duration, and increase in sparsely vegetated areas, which would increase the background particulate matter concentrations. All projected impacts of climate change on the project area, including temperature, precipitation, and wildfire, are anticipated under all alternatives (including the No Action Alternative).

4.20.7 Summary of Key Issues

Table 4.20-10 provides summary statements regarding key issues or impacts related to air quality for the project.

Table 4.20-10: Summary of Key Issues for Air Quality Resources

Impact-Causing Project Component and Phase	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
Mine Site			
Construction	Direct, indirect, minimal, and localized impacts to air quality may occur as a result of stationary, fugitive, and mobile sources. Impacts would return to baseline conditions once the construction was complete. Impacts due to air emissions would not exceed the modeled AAAQS and PSD Class II Increments, and would meet regulatory standards during this phase.	The impacts are anticipated to be similar to Alternative 1.	The impacts are anticipated to be similar to Alternative 1.
Operations	Direct, indirect, minimal, and localized impacts to air quality may occur as a result of stationary, fugitive, and mobile sources. Impacts would return to baseline conditions once the mine operation was complete. Impacts due to air emissions would not exceed the modeled AAAQS and PSD Class II Increments, and would meet regulatory standards during this phase.	The impacts are anticipated to be similar to Alternative 1.	The impacts are anticipated to be similar to Alternative 1.
Closure	Direct, indirect, minimal, and localized impacts to air quality may occur as a result	The impacts are anticipated to be similar to	The impacts are anticipated to be similar to

Table 4.20-10: Summary of Key Issues for Air Quality Resources

Impact-Causing Project Component and Phase	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
	of stationary, fugitive, and mobile sources. Impacts would return to baseline conditions once the closure was complete.	Alternative 1.	Alternative 1.
Transportation Corridor			
Construction	Direct, indirect, minimal, and localized impacts to air quality may occur as a result of stationary, fugitive, and mobile sources. Impacts would return to baseline conditions once the construction was complete.	The impacts are anticipated to be similar to Alternative 1. However, different geographic areas would be affected along the transportation corridor. Potential impacts associated with dust would vary with road length.	The impacts are anticipated to be similar to or less than Alternative 1. However, different geographic areas would be affected along the transportation corridor. Because Alternative 3 entails a longer road, potential impacts associated with dust would occur over a larger geographic area than Alternatives 1 and 2.
Operations	Direct, indirect, minimal, and localized impacts to air quality may occur as a result of stationary, fugitive, and mobile sources. Impacts would return to baseline conditions once the transportation corridor operation was complete.	The impacts are anticipated to be similar to Alternative 1. However, different geographic areas would be affected along the transportation corridor. Potential impacts associated with dust and vehicle emissions would vary with road length.	The impacts are anticipated to be similar to or less than Alternative 1. Because Alternative 3 entails a longer road, potential impacts associated with dust and vehicle emissions would occur over a larger geographic area than Alternatives 1 and 2.
Closure	Direct, indirect, minimal, and localized impacts to air quality may occur as a result of stationary, fugitive, and mobile sources. Impacts would return to baseline conditions once the closure was complete.	The impacts are anticipated to be similar to Alternative 1. Depending on any agreements associated with public use of transportation corridors, different geographic areas would be affected by road dust.	The impacts are anticipated to be similar to or less than Alternative 1. Depending on any agreements associated with public use of transportation corridors, different geographic areas would be affected by road dust.
Port Site			
Construction	Direct, indirect, minimal, and localized impacts to air quality may occur as a result of stationary, fugitive, and mobile sources. Impacts would return to baseline conditions once the construction was complete.	The impacts are anticipated to be similar to Alternative 1. However, different geographic areas would be affected.	The impacts are anticipated to be similar to Alternative 1 and 2.
Operations	Direct, indirect, minimal, and localized impacts to air quality may occur as a result	The impacts are anticipated to be similar to Alternative 1. However,	The impacts are anticipated to be similar to

Table 4.20-10: Summary of Key Issues for Air Quality Resources

Impact-Causing Project Component and Phase	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
	of stationary, fugitive, and mobile sources. Impacts would return to baseline conditions once the port operation was complete. Impacts due to air emissions would not exceed the modeled AAAQS and PSD Class II Increments, and would meet regulatory standards during this phase.	different geographic areas would be affected.	Alternative 1 and 2.
Closure	Direct, indirect, minimal, and localized impacts to air quality may occur as a result of stationary, fugitive, and mobile sources. Impacts would return to baseline conditions once the closure was complete.	The impacts are anticipated to be similar to Alternative 1.	The impacts are anticipated to be similar to Alternative 1.
Natural Gas Pipeline			
Construction	Direct, indirect, minimal, and localized impacts to air quality may occur as a result of stationary, fugitive, and mobile sources. Impacts would return to baseline conditions once the construction was complete.	The impacts are anticipated to be similar to Alternative 1. However, different geographic areas would be affected along the transportation corridor portion of the pipeline route.	The impacts are anticipated to be similar to Alternatives 1 and 2.
Operations	Direct, indirect, minimal, and localized impacts to air quality may occur as a result of stationary, fugitive, and mobile sources, and would be limited to the compressor station. Impacts would return to baseline conditions once the operations activities were complete. Impacts due to air emissions would not exceed the modeled AAAQS and PSD Class II Increments, and would meet regulatory standards during this phase.	The impacts are anticipated to be the same as Alternative 1.	The impacts are anticipated to be the same as Alternative 1.
Closure	Direct, indirect, minimal, and localized impacts to air quality may occur as a result of stationary,	The impacts are anticipated to be similar to Alternative 1.	The impacts are anticipated to be similar to Alternative 1.

Table 4.20-10: Summary of Key Issues for Air Quality Resources

Impact-Causing Project Component and Phase	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
	fugitive, and mobile sources. Impacts would return to baseline conditions once the closure was complete.		
Variants			
	Summer Only Ferry Operations, Kokhanok East Ferry Terminal, and Pile-Supported Dock Variants: The impacts of any of these variants are anticipated to be similar to Alternative 1 impacts without the variants, except that there would be no emissions from ferry operations during the winter season, and that truck traffic would double during the summer period with associated emissions.	Summer-Only Ferry Operations Variant: The impacts of this variant are anticipated to be similar to Alternative 1 impacts with the variant and Alternative 2 impacts without the variant. However, different geographic areas would be affected along the transportation corridor and ferry route.	Concentrate Pipeline Variant: The impacts of this variant are anticipated to be similar to Alternative 2 impacts without the variant, except that truck traffic and associated emissions would decrease along the transportation corridor with concentrate shipped through the pipeline. There could be added emissions at the port site, depending on concentrate water treatment options.

4.20.8 Cumulative Effects

The geographic area considered in the cumulative effects analysis for air quality would extend through a wide-reaching EIS analysis area, including all project components. The EIS analysis area is not near a Class I area, or in or near a non-attainment, maintenance, or area with local regulations. Relevant future actions for air quality impacts include mineral exploration and mining activities occurring in southwest Alaska; oil and gas exploration and development in Cook Inlet; surface, marine, and air transportation developments such as new roads, bridge rehabilitation, shipping and barging traffic, and port and airport improvement projects; and transmission upgrades, installations, and maintenance. The increase of air emissions may result in minimal and localized cumulative impacts. Overall, the cumulative impacts to air quality from the project, and the past, present, and future actions are expected to increase air emissions, including GHGs, in the region and the state. In addition, as GHG emissions are long-lived in the atmosphere and globally transported, the GHG emissions from the project and reasonably foreseeable future actions (RFFAs) would have a global extent.

Past, present, and RFFAs in the cumulative impact study area have the potential to contribute cumulatively to impacts on air quality. Section 4.1, Introduction to Environmental Consequences details the past, present, and RFFAs that may impact air quality. All RFFAs are similar to the Proposed Project in how they impact air quality by emitting combustion-related air pollutant emissions from fuel-burning equipment; and with few exceptions (Alaska Stand Alone Pipeline [ASAP], Alaska Liquefied Natural Gas [LNG], and oil and gas exploration and development), all are similar in that they have fugitive emissions from blasting, drilling, vehicle traffic on unpaved roads, and material handling. The following RFFAs identified in Section 4.1, Introduction to Environmental Consequences, were carried forward in this analysis, based on their potential to impact air quality in the analysis area:

- Pebble Project buildout – develop 55 percent of the resource over the 78-year period
- Pebble South *
- Big Chunk South*
- Big Chunk North*
- Fog Lake*
- Groundhog*
- Shotgun*
- Johnson Tract*
- Donlin Gold
- Diamond Point Rock Quarry
- ASAP
- Alaska LNG
- Drift River Oil Pipeline
- Cook Inlet Lease Sales*
- Hydrocarbon Exploration Licensing and Leasing Program*
- Lake and Peninsula Borough (LPB) Transportation, Infrastructure and Energy Projects
- Villages and Communities in/nearby the project area

**Indicates exploration activities only.*

4.20.9 Past and Present Actions

The past and present actions that have influenced air quality in the EIS analysis area are discussed in greater length in Section 3.20, Air Quality. Current development consists of a small number of towns, villages, and roads. Present activities include mining exploration and non-mining-related projects, such as transportation, oil and gas development, or community development actions. All project components would be in remote areas of Alaska characterized as attainment/unclassified areas for air quality. Actions that have in the past—or are currently—affecting air quality in the analysis area are minimal.

4.20.10 Reasonably Foreseeable Future Actions

4.20.10.1 No Action Alternative

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

4.20.10.2 Alternative 1 – Applicant's Proposed Alternative

Pebble Mine Expanded Development Scenario – A description of the scenario for the Pebble Mine Expanded Development Scenario for Alternative 1 is provided in Section 4.1, Introduction to Environmental Consequences. The Pebble mine expanded development scenario project footprint would impact approximately 34,790 acres, compared to 12,371 acres under Alternative 1. Project construction of the additional facilities, pipelines, and roads would generate addition emissions from the construction-related sources. The construction activities would be similar to those analyzed in Alternative 1; therefore, it is not anticipated the air quality impacts would be meaningfully different. The mine operations activities would continue to generate emissions from fugitive, stationary, and mobile sources. As with the construction activities, it is not anticipated that mine operations would be meaningfully different than those analyzed for Alternative 1. The expansion would result in similar magnitude, duration, and geographic extent of the air quality impacts described under Alternative 1 for a given year. However, with the mine and milling operations continuing for an additional 78 years, the minimal and localized air quality impact would continue until the expanded mine closure. Effects of any noticeable local air quality changes on local users are discussed in Section 4.11, Aesthetics.

Other Mineral Exploration and Oil and Gas Development Projects – Mineral and oil and gas exploration is likely to continue in the analysis area for the mining and oil and gas projects listed previously in this section. As discussed in Appendix K4.20, RFFAs were identified in the EIS analysis area (e.g., Pebble South/PED, Big Chunk South, Groundhog), but these would likely only result in minimal cumulative changes to air quality because of their small scale. For the other RFFAs, the increase of air emissions from any individual project would only result in localized impacts, and is unlikely to interact cumulatively on a regional scale. These RFFAs are either too far away to influence the cumulative project impacts, or they are near the Pebble Project, with no indication that development of the RFFAs would occur within the operations timeframe of the Pebble Project. The two closest and largest of these are the Donlin Gold Mine and the Alaska LNG facility. The proposed Donlin Gold Mine would be situated roughly 175 miles northwest of the Pebble mine site, and the proposed Alaska LNG facility would be roughly 140 miles east of the Pebble mine site. Even when combined with the RFFAs mentioned above, these projects are too dispersed to result in cumulative effects on air quality. Therefore, given the distance between the RFFAs and the project components, and that the majority of the RFFAs are only foreseeable for exploration and would be developed on different timelines, the potential for regional cumulative air quality impacts would be minimal. As discussed, the regional cumulative impacts and cumulative impacts in the vicinity of the project would be minimal, and local to the RFFAs themselves. Due to the different timelines of RFFAs and the Pebble Project, these cumulative impacts may remain after closure of the Pebble Project.

Road Improvement and Community Development Projects – Anticipated road improvement projects in the region include new transportation corridors currently being studied in the Lake and Peninsula Borough, such as the Williamsport-Pile Bay Road upgrade. The most likely road improvements are in the development footprint of existing communities. Some road upgrades and additional residential development could occur in the vicinity of the natural gas pipeline Cook Inlet eastern terminus near Stariski Creek. The roads would affect air quality through construction, and vehicle travel on the road would affect air quality through operations. During construction, the main direct emission sources would be heavy-duty, non-road, and mobile construction vehicles, as well as fugitive dust generated by vehicles on unpaved roads, and wind erosion. During road operations, combustion emissions and fugitive dust emissions would result from on-road vehicles. The activities would be similar; therefore, the air impacts that could occur are likely to be similar to those analyzed above under Alternative 1, Transportation Corridor.

4.20.10.3 Alternative 2 – North Road and Ferry with Downstream Dams and Alternative 3 – North Road Only

Pebble Mine Expanded Development Scenario – Expanded mine site development and associated contributions to cumulative impacts would be the same for all action alternatives. Cumulative effects of construction, operations, and closure would be similar to those discussed under Alternative 1.

Other Mineral Exploration Projects, Oil and Gas Development, Road Improvement, and Community Development Projects – Cumulative effects of these activities would be similar to those discussed under Alternative 1.

4.21 FOOD AND FIBER PRODUCTION

While there may be some small outdoor or indoor garden projects in individual communities, there are no designated prime or unique farmlands in the project area. Therefore, there would be no impact to farmlands from the proposed project or any of the alternatives discussed in this Environmental Impact Statement (EIS).

In the project area, subsistence activities (e.g., hunting, fishing, and gathering) are the primary sources of food and fiber production; discussed in Section 4.9, Subsistence.

4.21.1 Cumulative Effects

There would be no contribution of cumulative impacts to farmlands from the proposed project or any of the reasonably foreseeable future actions (RFFAs) discussed in this EIS due to the absence of designated prime or unique farmlands in the project area.

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4.22 WETLANDS AND OTHER WATERS/SPECIAL AQUATIC SITES

The following section provides a description of the potential environmental consequences from the project on wetlands and other waters.

4.22.1 EIS Analysis Area

The Environmental Impact Statement (EIS) analysis area (hereafter referred to as "analysis area") for wetlands and other waters for each project component is defined below. The analysis area includes the area affected by potential direct and indirect impacts from construction and operations. The EIS analysis area collectively includes areas for all four components (mine site, transportation corridor, ports, and natural gas pipeline) and the variants under each component in each alternative. See Figure 3.26-1 in Section 3.26, Vegetation, for a general overview of the analysis area for vegetation, which is identical to that for wetlands and other waters.

Mine Site – The analysis area for the mine site includes the direct disturbance footprint; areas of indirect disturbance due to habitat fragmentation; a 330-foot zone around the direct disturbance footprint to account for fugitive dust impacts; and the zone of influence to account for impacts from dewatering.

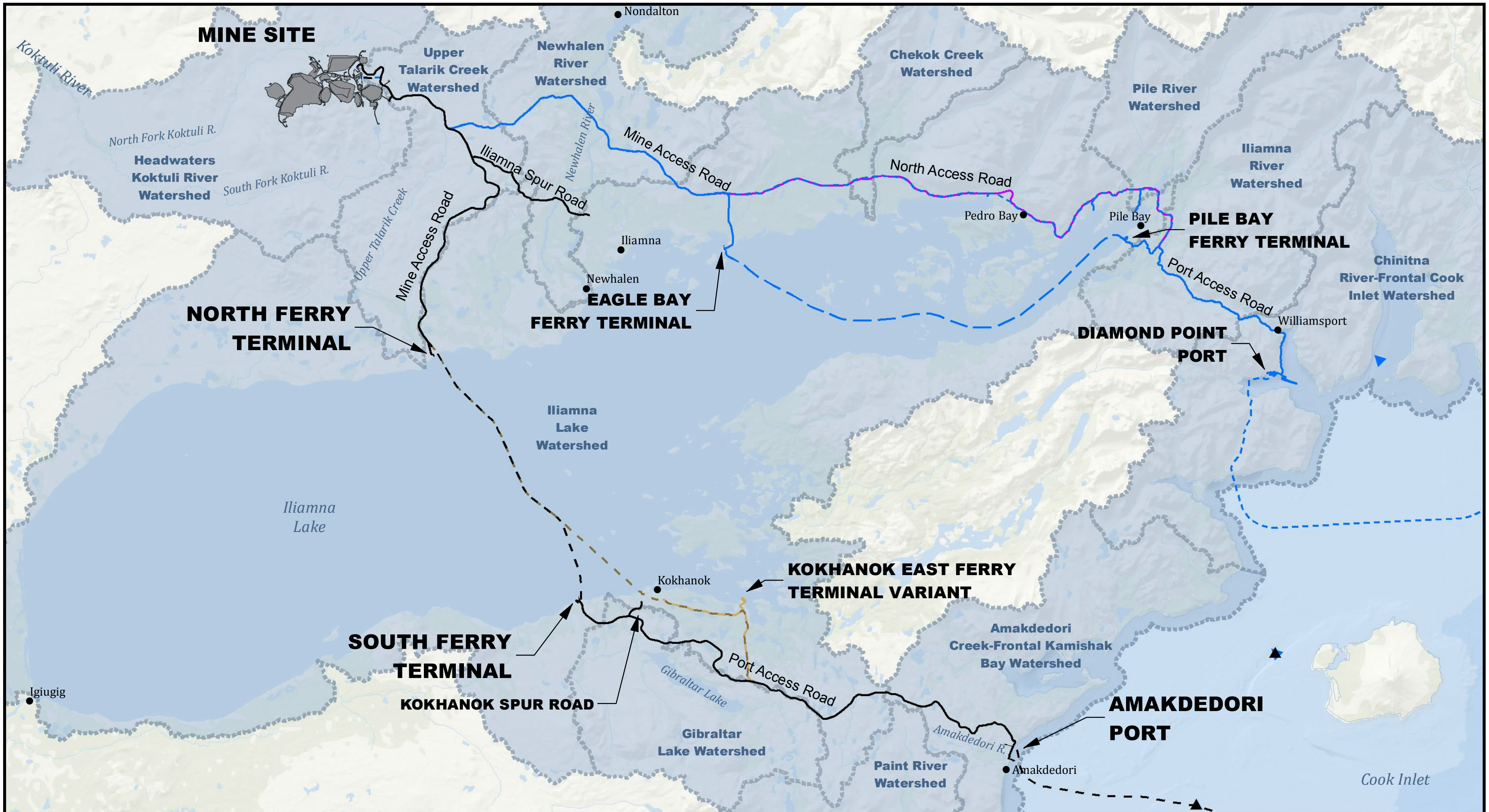
Transportation Corridor and Ports – The analysis area for the transportation corridor and ports includes a 330-foot zone around the direct disturbance footprint.

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

4.22.2 Analysis Methodology

Potential direct and indirect effects to wetlands and other waters were assessed according to four factors: the magnitude or intensity of the impacts; the duration (how long the impact would last); the extent (the area of the impact); and the likelihood of the effect (the certainty that the impact would occur, should the project be permitted). Details of how the four factors were assessed are discussed below.

Assessments were based on the US Geological Survey Hydrologic Unit Code (HUC) Tenth Level (HUC 10) watersheds (Figure 4.22-1). National Wetland Inventory (NWI) mapping was available for the entire Upper Koktuli River watershed, and was used to estimate relative abundance of wetland and other water types. NWI mapping was not available for large portions of the other watersheds, so relative abundance of wetland and other water types for these watersheds was estimated from vegetation mapping provided by the Alaska Center for Conservation Science (ACCS). Vegetation class descriptions from the Vegetation Map and Classification guidebook (Boggs et al. 2016) were reviewed, and vegetation classes mapped in the watersheds were assigned to one of the following types for comparison with wetlands mapped for the project: upland, forested wetland, shrub wetland, herbaceous wetland, aquatic bed wetland, or other waters. The acreages and percentages of wetland types for each watershed should be considered an approximation for comparison purposes only. Note that all calculations for impacts in this section are rounded to the nearest whole acre; or tenth of a mile for stream channels. Apparent minor inconsistencies in sums are the result of rounding.



Sources: PLP 2018; USGS

US Army Corps of Engineers

5 0 5 10
Miles

HUC10 Watershed

Alternative 1

Lightering Locations

Mine Site

Transportation Corridor

Natural Gas Pipeline

Ferry/Port Site

Kokhanok East Ferry Terminal Variant

Transportation Corridor

Natural Gas Pipeline

Ferry Terminal

Alternative 2

Transportation Corridor

Ferry Route

Ferry Site

Alternative 2/3

Lightering Location

Natural Gas Pipeline

Port Site

Alternative 3

Transportation Corridor

HUC 10 WATERSHEDS

PEBBLE PROJECT EIS

FIGURE 4.22-1

Magnitude – The magnitude of direct impacts to wetlands and other waters was assessed based on the number of acres of impacts relative to the extent of the impacted resources within a watershed, as well as the perceived regional importance of the resource. Regionally important wetlands are discussed in Section 3.22, Wetlands and Other Waters/Special Aquatic Sites. The magnitude of impacts to aquatic resources is dependent not only on the resource type, but its relative abundance and location within a watershed (EPA 2018d).

The magnitude of indirect impacts is assessed differently than direct impacts, because indirect impacts are not expected to result in a complete loss of wetland area or function in all cases. The magnitude of indirect impacts is simply the number of acres impacted by the indirect disturbance.

Duration – Impacts were also assessed in terms of duration, because some wetlands or other waters would be partially or fully reclaimed during or after the construction phase, and others would not. The duration of impacts is considered temporary or short term when wetland or aquatic functions would be reduced during the construction phase only, with pre-construction function returning after construction ends. Specifically, impacts associated with construction of the natural gas pipeline in Cook Inlet and Iliamna Lake are considered temporary, because movements of the substrate would cause the return to natural bed conditions. Dredging is also considered a temporary impact, because sediment would refill the dredged area and benthic microorganisms would repopulate the area.

The total construction phase is expected to last for 4 years, but individual temporary impacts are likely to last for only one or two growing seasons. Reduction or elimination of wetland or aquatic functions occurring after the construction phase, through the operations, and into the closure and post-closure phases, would be considered permanent, and not able to be reclaimed.

It is expected that a detailed reclamation and closure plan would be developed for the project after the publication of the Draft EIS (DEIS). The plan would provide details on reclamation location, type, and success metrics. The duration of impacts (temporary or permanent) would be reassessed at this time.

Extent – The extent of impacts would be limited to areas of the project area where wetlands or other waters would be removed or disturbed, or where the project would affect wetlands and other waters outside of the project area in one or more HUC 10 watersheds (Figure 4.22-1).

Likelihood – The likelihood of direct impacts to wetlands and other waters would be certain if the project is permitted and constructed. Implementation of the project would entail filling, excavating, clearing, or otherwise altering these resources within the disturbance footprint. This factor is not further discussed in this section for direct impacts, because there is no difference in likelihood among the three alternatives.

4.22.3 Direct and Indirect Impacts

The project has the potential to result in the following direct and indirect impacts to wetlands and other waters:

- Direct impacts from:
  - Clearing and removal of wetland vegetation
  - Excavation or removal of soil and vegetation
  - Placement of fill materials
  - Dredging and discharges of dredged materials
  - Alteration and removal of stream channels

- Indirect impacts from:
    - Disruption of wetland hydrology
    - Conversion of wetland type
    - Habitat degradation downstream of the mine site
    - Fragmentation of habitats
    - Water quality and quantity changes
    - Erosion and sedimentation
    - Fugitive dust

Impacts to wetlands, open freshwaters, estuarine waters, marine waters, streams, and other waters are assessed here from a National Environmental Policy Act (NEPA) perspective, which may differ from how they are treated under the Clean Water Act (CWA) Section 404(b)(1) guidelines. Impacts, when used alone, include both direct and indirect impacts unless otherwise stated as direct impacts or indirect impacts. The US Army Corps of Engineers (USACE) would complete the Section 404(b)(1) analysis as part of the Joint Record of Decision.

Scoping comments were received on filling of wetlands and alternations of wetlands habitat fragmentation, and loss of wetland habitat as a result of project activities. Commenters requested that all wetlands that could be affected by the project be delineated, that direct and secondary impacts be addressed, and that the areal or linear extent of impacts and expected change in functions be addressed. Other commenters expressed concern regarding impacts from dewatering and changes to downstream habitat, potential contamination from mine operations, and the clearing and removal of wetland vegetation that would degrade wetland function.

4.22.4 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 wetlands or other waters would be expected. Although 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. Current state-authorized activities associated with mineral exploration and reclamation and scientific studies would be expected to continue at similar levels. PLP would be required to reclaim any remaining sites at the conclusion of their exploration program. If reclamation approval is not granted immediately after the cessation of reclamation activities, the state may require continued authorization for ongoing monitoring and reclamation work, as deemed necessary by the State of Alaska. Although these activities would also cause some disturbance, reclamation would benefit the wetlands and other waters.

4.22.5 Alternative 1 – Applicant's Proposed Alternative

In terms of magnitude, extent and duration, Alternative 1 would permanently discharge dredged or fill material into 3,560 acres of wetlands and other waters, including 3,443 acres of wetlands, 55 acres of lakes and ponds, 50 acres of streams in 81 miles of channels, and 11 acres of marine waters. It would temporarily discharge dredged or fill material into 510 acres of wetlands and other waters, including 48 acres of wetlands, 76 acres of lakes and ponds, 3 acres of streams in 4.7 miles of channels, and 382 acres of marine waters. An additional 1,896 acres of wetlands and other waters would be indirectly impacted by fugitive dust from the mine site and transportation corridor, including 1,555 acres of wetlands and 340 acres of other waters. Dewatering at the mine site would indirectly impact 449 acres of wetlands and other waters, including 341 acres of wetlands, and 108 acres of other waters. Fragmentation would indirectly impact 462 acres of wetlands and other waters, including 449 acres of wetlands and 13 acres of other waters. A mapbook showing impacts for all project components is provided in Appendix K4.22.

In terms of duration and extent of impacts to navigable waters, Iliamna Lake and Cook Inlet would be permanently and temporarily affected by Alternative 1. In terms of magnitude, there would be a direct permanent impact to 13 acres of navigable waters, including 11 acres of marine waters for the port, and 2 acres of Iliamna Lake for ferry terminals (described below). There would be a total of 452 acres of temporary impacts, including 381 acres of marine waters and 71 acres of Iliamna Lake. These acreages are also included in the accounting above of other waters.

Alternative 1 includes a port with a causeway and wharf, which combined is 1,900 feet long by a maximum of 500 feet wide, below the high tide line (HTL) of Cook Inlet. The project would also include two lighted navigation buoys, and two 1,700- by 2,300-foot mooring spreads in approximately 80 feet of water, each consisting of 10 anchors and six mooring buoys. The primary lightering location would be 12 miles offshore east of the port.

The south ferry terminal on Iliamna Lake includes a landing ramp that is 155 feet long, with a maximum of 115 feet in width and 10 feet thick below the ordinary high water mark (OHWM) of the lake. The north ferry terminal would be 105 feet long by a maximum of 85 feet wide and 10 feet thick below the OHWM of Iliamna Lake. The project would also include two mooring buoys attached to anchors at both the north and south ferry terminals; and a 200-foot-wide by 160-foot-long and an up to 2-foot-thick ferry construction ramp with five launching rails; each 15 inches high and extending 36 feet waterward of the OHWM, and to a water depth of up to 35 feet in Iliamna Lake.

Special aquatic sites that would be permanently or temporarily impacted include wetlands, mudflats, vegetated shallows, and riffle and pool complexes (see Section 3.22, Wetlands and Other Waters/Special Aquatic Sites, for a description of these sites). These habitats were not specifically mapped during the environmental baseline study program. Mudflats may occur in the impacted marine intertidal waters (1 acre permanent and 1 acre temporary impacts). Vegetated shallows are similar to aquatic bed wetlands (less than 1 acre permanent and temporary impacts). Eelgrass beds are not known to occur in the impact area. Riffle and pool complexes occur in an undetermined portion of the upper perennial and intermittent stream channels. The magnitude and duration of permanent and temporary impacts to these channel types would total 44 acres and 2 acres, respectively.

4.22.5.1 Mine Site Direct Impacts

Most project-related direct impacts to wetlands and other waters would be initiated during the construction phase and would result in temporary or permanent loss of wetlands and waters, or alteration in wetland functions. Facilities would be sited to avoid and minimize wetland impacts where possible, and allow efficient reclamation of disturbed areas.

Primary direct construction-related impacts to wetlands and other waters would include:

- Clearing and removal of wetland vegetation
- Placement of fill in wetlands and other waters
- Excavation that eliminates wetlands and other waters
- Compaction, rutting, and mixing of wetland soils.

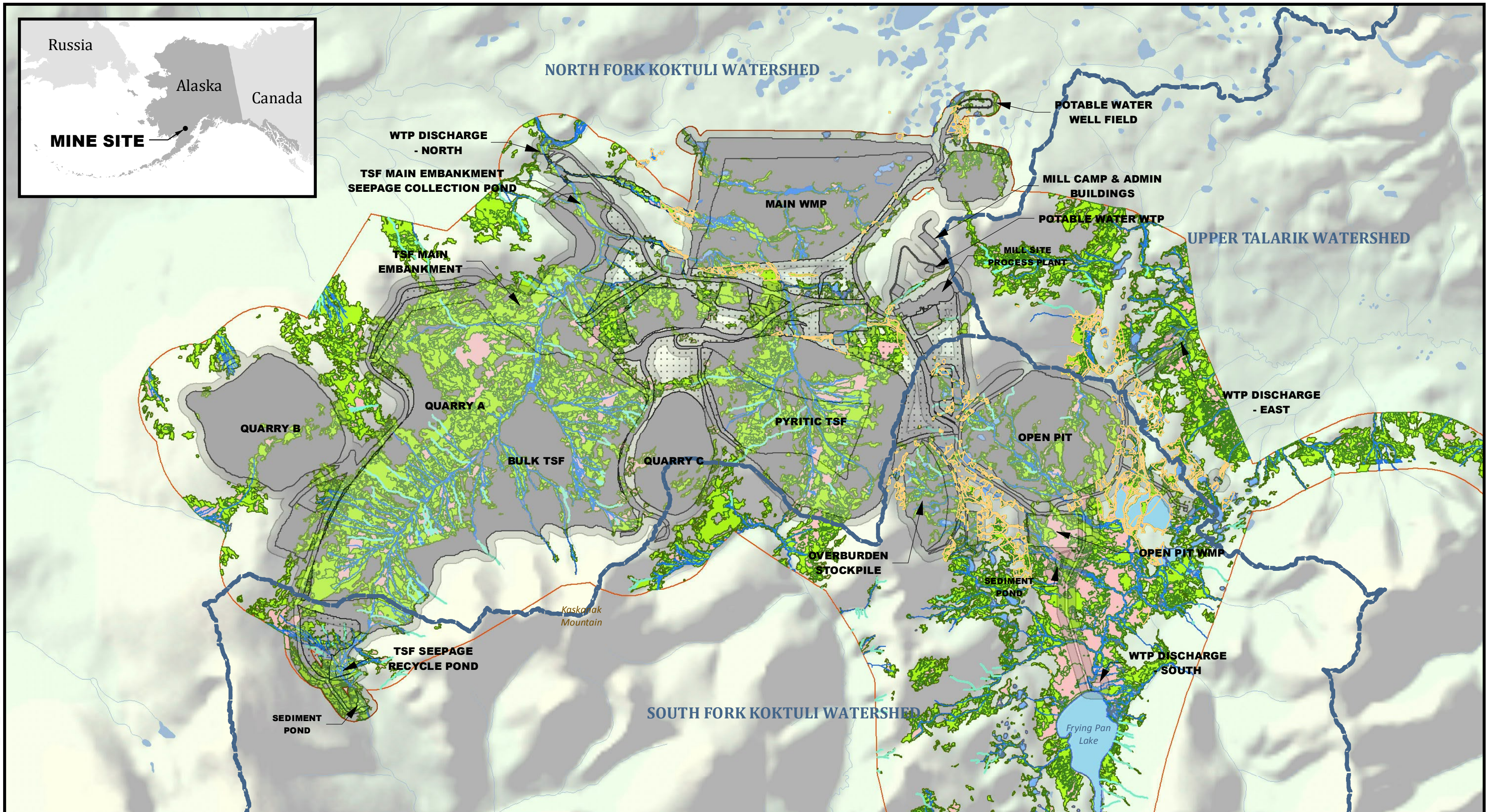
Excavation of the open pit, quarries, and sediment ponds and filling in the tailings storage facility (TSF) and stockpiles would occur throughout the active life of the mine. The maximum extents of all surface disturbance impacts were used to evaluate direct wetlands and other waters impacts for the mine site. The duration of all impacts in the direct disturbance footprint is considered to be permanent for this analysis, although some wetland reclamation would begin shortly after the start of construction, and would continue throughout operations and closure. Therefore, no temporary impacts are assessed.

In terms of magnitude and extent, a total of 3,458 acres of wetland and other waters would be directly affected by the proposed mine site facilities (Table 4.22-1 and Figure 4.22-2). The maximum extents of all surface disturbance impacts were used to evaluate direct wetlands impacts for the mine site. The greatest impacts would occur from the bulk TSF cell (1,562 acres), Area E embankment, tailings and waste rock storage facility (560 acres), the TSF and associated facilities (363 acres), and the open pit and associated facilities (346 acres). In the mine site, almost all of the direct impacts to wetland and other waters (3,450 acres) would occur in one of the HUC 10 watersheds, the Headwaters Koktuli River watershed. Only 9 acres of impacts would occur in the Upper Talarik Creek (UTC) watershed (Table 4.22-1).

Table 4.22-1: Alternative 1 Mine Site Wetlands and Other Waters Direct Impacts (Acres)

NWI Group	Watershed		
	Headwaters Koktuli River	Upper Talarik Creek	Combined Watershed Area
Deciduous Shrub Wetlands	2,665	6	2,671
Herbaceous Wetlands	690	2	693
Aquatic Bed Wetlands	<0.1	0	<0.1
Ponds	47	<1	47
Lakes	<0.1	0	<0.1
Perennial Streams	44	<0.1	44
Intermittent Streams	3	<0.1	3
Uplands	4,617	10	4,627
Total Area	8,067	19	8,086
Wetland and Other waters Totals	3,450	9	3,458
Wetland and Other waters (%)[1]	43%	47%	43%
Wetlands Totals	3,355	8	3,364
Wetlands (%)[1]	42%	42%	42%
Other waters Totals	94	<1	94
Other waters (%)[1]	1%	<1%	1%
Perennial Streams (Miles)	69.2	0.2	69.4
Intermittent Streams (Miles)	3.8	0	3.8

[1] Proportion of direct impact area



Sources: PLP 2018; FWS; USGS

US Army Corps of Engineers

0.5 0 0.5 1

Miles

NWI Classes
- Aquatic Bed
- Broad Leaved Deciduous Shrubs
- Herbaceous
- Lakes
- Ponds
- Rivers/Streams (Intermittent)
- Rivers/Streams (Perennial)
- Upland

Watershed

Mine Site Impact Type
- Direct
- Indirect
- Drawdown (End of Mining)
- Fragmentation

MINE SITE IMPACTS

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FIGURE 4.22-2

The magnitude and extent of impacts would be approximately 3,364 acres of wetlands that would be directly impacted at the mine site, consisting primarily of broad-leaved deciduous shrub wetlands (2,671 acres) and herbaceous wetlands (693 acres). These occur predominantly on slopes. Approximately 3,046 acres (90 percent) of impacted wetlands at the mine site are in the slope hydrogeomorphic (HGM) class, 7 percent are in the riverine class, and 3 percent in the flats class.

A total of 94 acres of other waters would be directly impacted, including ponds (47 acres), perennial streams (44 acres), and intermittent streams (3 acres). A total of 69.4 miles of perennial stream channel and 3.8 miles of intermittent stream channel would be directly impacted.

Excavation, filling, and clearing of wetlands and other waters would alter or remove their capacity to provide hydrologic, biogeochemical, and biological functions. Biological functions that would be lost or altered include habitat for wetland-dependent and aquatic species, and contribution of organic matter to support stream biota. Biogeochemical functions that would be lost or altered include nutrient cycling and carbon sequestration.

Hydrologic functions that would be lost or altered include modification of groundwater functions (recharge and discharge), and contribution to stream base flows; reduction in stormwater and floodwater storage; and modification of streamflow functions by decreasing the wetlands' potential to dissipate energy and reduce peak flows. Impacts to riverine wetlands also remove or alter their capacity to retain sediment and other particulates; stabilize shorelines; moderate water temperatures; and contribute woody debris to support fish habitat.

Many of the impacted wetlands at the mine site, especially slope wetlands, are considered headwater wetlands from a watershed perspective. These are the source of intermittent and first order perennial streams. Impacts to these wetlands would alter groundwater discharge that helps maintain hydrology and water quality in these streams. These altered hydrologic functions would extend to the wetlands and streams connected to or downstream from the affected wetlands. See Section 4.16, Surface Water Hydrology, for a discussion of surface water hydrology impacts. Impacts to fish habitat, including wetlands and other waters from surface flow reductions, are discussed in Section 4.24, Fish Values.

Construction on or through wetlands would decrease or remove the wetlands' potential to improve water quality by preventing erosion and settling sediments. Sediment barriers and erosion control planning would mitigate some of the loss of this wetland function. Vegetation clearing with no soil disturbance reduces wetlands' ability to modify water quality and contribution to the abundance and diversity of wetland fauna. It also may reduce the export of detritus and contribution to the abundance and diversity of wetland flora functions, depending on the extent of vegetation being cleared.

Construction on or through wetlands would result in habitat loss, fragmentation, and degradation. Habitat fragmentation is addressed under indirect impacts, below. Temporary and permanent habitat modifications would occur as existing vegetation is disturbed, or removed and replaced with mine site facilities and infrastructure. See Section 4.23, Wildlife Values; Section 4.24, Fish Values; and Section 4.26, Vegetation, for discussion of habitat-related impacts.

The Headwaters Koktuli River watershed is approximately 171,000 acres. Based on NWI wetland mapping, the watershed is estimated to contain approximately 36,500 acres of wetlands and other waters, which is roughly 21 percent of the watershed. Approximately 22,400 acres (13 percent of the watershed) are shrub wetlands, and 9,250 acres (5 percent) are herbaceous wetlands. Forested and aquatic bed wetlands are each estimated to cover less than 1 percent of the watershed. In terms of magnitude and extent, mine site activities would directly affect 2,665 acres of shrub wetlands, and 691 acres of herbaceous wetlands in the Headwaters Koktuli River watershed (Table 4.22-1). This represents approximately 12 percent and 7 percent, respectively, of shrub and herbaceous wetlands in the watershed. No forested wetlands and less than 0.1 acre of aquatic bed wetlands would be affected.

Riverine wetlands are considered regionally important in the watershed based on their connections to important fish and wildlife species (see Section 3.22, Wetlands and Other Waters/Special Aquatic Sites). The magnitude of impacts would be that a total of 236 acres of riverine HGM-class wetlands in the Headwaters Koktuli River watershed would be directly affected by activities at the mine site. The extent of riverine wetlands in the watershed is not known. They account for approximately 3 percent of the mine site analysis area. Using this percentage for the entire watershed, there would be roughly 5,000 acres of riverine wetlands. Therefore, the extent of impacts to riverine wetlands from mine site activities would represent approximately 5 percent of all riverine wetlands in the watershed. Less than 1 acre of riverine HGM-class wetlands in the UTC watershed would be directly affected by activities at the mine site.

Bogs and fens are a regionally important subclass of shrub wetlands (see Section 3.22, Wetlands and Other Waters/Special Aquatic Sites). Based on vegetation and wetland mapping for the project, 375 acres of bogs and fens within the Headwaters Koktuli River watershed would be directly affected by activities at the mine site. The total extent of bogs and fens within the watershed was not mapped and remains unknown. They account for approximately 3.5 percent of the mine site analysis area. Using this percentage for the entire watershed, there would be roughly 6,000 acres of bogs and fens in the watershed. Therefore, impacts to bogs and fens would represent approximately 6 percent of all bogs and fens in the watershed. Approximately 30 acres of bogs and fens in the UTC watershed would be directly affected by activities at the mine site. This is estimated to be roughly 1 percent of bogs and fens in the watershed.

Based on NWI mapping, the Headwaters Koktuli River watershed is estimated to contain approximately 3,640 acres of lakes and ponds, and 1,160 acres of rivers and streams. In terms of magnitude and extent, mine site activities would directly affect 47 acres of ponds, and 47 acres of rivers and streams. These impacts represent roughly 1 percent of all lakes and ponds, and 4 percent of all rivers and streams in the watershed. There are an estimated 488 miles of stream channels in the watershed, based on the National Hydrography Dataset. Approximately 73 miles of stream channels would be directly impacted by mining activities. These impacts represent roughly 15 percent of all stream channel length in the watershed.

The duration of impacts would be considered permanent, because they would last through the end of mining operations. The extent of direct impacts is the mine site disturbance footprint, which is primarily in the Headwaters Koktuli River watershed, but also includes a smaller portion of the UTC watershed.

Summer-Only Ferry Operations Variant

This variant would add to the mine site direct footprint for a container yard and sewage storage tank. The magnitude, extent, and duration of the increased footprint would be such that an additional 6 acres of deciduous shrub wetlands and 1 acre of herbaceous wetlands in the Koktuli River headwaters would be directly and permanently impacted.

Reclamation

PLP has incorporated requirements for mine closure and long-term water management into the design of the project. During the permitting phase, a reclamation plan would be developed that would include reclamation of wetlands where feasible. The discussion below is based on generally accepted wetland reclamation practices for mine sites in Alaska. Additionally, PLP has provided some conceptual-level information on reclamation in its application.

PLP has identified some of the design elements that would facilitate successful reclamation during and after the closure phase (PLP 2017, PLP 2018-RFI 024):

- Quarried and waste rock would be geochemically tested prior to being used in construction to avoid the potential for contaminated drainage during operations and post-closure.
- Topsoil and overburden would be salvaged during construction for use as growth medium during reclamation.
- TSF embankment slopes would be designed to provide long-term stability and facilitate the placement of growth medium.
- The overall project footprint would be minimized to facilitate physical closure and post-closure water management.

Material sites constructed in valley bottoms or lowland sites are candidates to be reclaimed to create new ponds with emergent wetlands where sufficient water quality and surface hydrology are available. Final contouring around created ponds could focus on providing habitat at the water's edge, and a complex interspersion between wetland and upland vegetation. Moderate to steeply sloping wetland or upland mosaics with wetland inclusions would be less feasible to reclaim to wetlands because of the marginal hydrology, and some fills may not be removed in these areas. Marginal wetland hydrology would be expected in areas where excavations and road cut through colluvium and rock have reduced overland sheet flow.

Shrub wetland successional processes, generally initiated by natural disturbances such as wildland fires, gradually reestablish typical vegetation, and eventually hydrologic characteristics. When construction disturbs wetlands, successional processes may be prolonged or may not occur. Construction disturbances differ from natural disturbances in that the organic mat and organic soil horizons are often removed completely, which removes seedbeds, and reduces surface and subsurface water storage capacity. The timing and extent of recovery likely depend on the intensity, extent, and duration of the disturbance. The time required for wetlands to return to pre-disturbance soil moisture and original vegetation cover has not been well documented in western Alaska.

Development of self-sustaining wetland plant communities on previously disturbed Alaska wetlands may occur in a 10- to 30-year duration, but may be slowed in gravelly or sandy soils, or during years with failed seedling establishment or seed production. Revegetation success may be enhanced by conducting careful planning and management; minimizing disturbance; segregating and protecting materials to be used during reclamation; using the appropriate seed mixture and seeding rates; and monitoring for erosion and revegetation success.

Reclamation of wetland conditions may be complicated in areas where less-permeable layers have been breached or removed. This would alter surface hydrology, causing previous wetland areas to drain. In these situations, reclaimed wetlands are likely to differ in type and functional capacity from the original wetlands for decades to centuries, if reestablishment is possible.

Surface water resources available to wetlands would continue to be altered in distribution and abundance, with a return of an undetermined percentage of pre-development streamflows at the downstream end of the mine development (see Section 4.16, Surface Water Hydrology). These changes in surface water distribution and abundance could cause some wetlands to dry up, while others would be inundated or become wetter.

In terms of impact duration, the pit lake would continue to fill for a period of several decades post-closure. Once the water level reaches Elevation 890 feet, water would be pumped from the pit. This elevation is at least 50 feet below the elevation at which groundwater flow would be directed outward from the open pit. Water would be maintained at this level so that potentially contaminated water could be routed to the water management and water treatment ponds prior to discharge to the watershed. As a result, a new equilibrium groundwater level would become established around the pit. Wetlands and streams above the pit lake level would potentially lose groundwater to the cone of depression (depression in the water table) created by the pit lake. This may result in long-term wetland and streamflow effects. Groundwater modeling would be used to assess potential wetland and stream dewatering, and to identify those wetlands and functions that are likely to be affected (see Section 4.17, Groundwater Hydrology, for details).

Summary of Direct Impacts at the Mine Site

In terms of magnitude, extent, and duration, the mine site would directly and permanently impact 3,458 acres of wetlands and other waters during construction and operations. During closure, wetlands and other waters would be reestablished wherever practicable. Direct and indirect effects would occur in two HUC 10 watersheds. The majority of the impacts (3,450 acres) would be in the Headwaters Koktuli River watershed. Most impacts would be to regionally common shrub and herbaceous wetland types. The direct impacts to 2,665 acres of shrub wetlands and 690 acres of herbaceous wetlands represent roughly 12 percent and 7 percent, respectively, of these wetland types in the Upper Koktuli River watershed. No forested wetlands and less than 0.1 acre of aquatic bed wetlands would be impacted.

Approximately 236 acres of riverine wetlands, identified as regionally important, would be directly impacted by the mine site. In terms of magnitude, this represents roughly 5 percent of the riverine wetlands within the watershed. Approximately 375 acres of bogs and fens, also identified as regionally important, would be directly impacted, which represents roughly 6 percent of bogs and fens in the watershed. Mine site activities would directly affect 47 acres of ponds, and 47 acres of rivers and streams, which represent roughly 1 percent and 4 percent, respectively, of these waters in the watershed. Approximately 73 miles of stream channels would be directly impacted, which represents roughly 17 percent of all stream channel length in the watershed. Impacts to these wetlands and other waters would permanently remove or alter their capacity to perform essential hydrology, water quality, and habitat functions.

4.22.5.2 Mine Site Indirect Impacts

Fragmentation

Fragmentation of wetland and other waters habitats result when development divides large, continuous habitats and their adjacent buffers into smaller, more isolated remnants. The effects of fragmentation are wide-ranging and depend on such factors as the size, shape, and complexity of the remaining patches, the nature of the development, and individual species needs and mobility (see Section 4.23, Wildlife Values, for discussions of habitat changes and consequences for wildlife).

Fragmented wetlands and other waters have reduced zones for filtering of sediments and nutrients from adjacent development. Interactions with surface and groundwater may be disrupted. Wetlands that are highly dependent on surface runoff, such as depressional wetlands, would become drier with reduced catchment areas or diversion of runoff. Groundwater-dependent slope wetlands would become drier due to interception of shallow groundwater from ditches. Established corridors for movement of species and propagules may be cut off. Microclimates may be unalterably changed. Fragmented habitats become more susceptible to infestations by non-native species.

These effects are considered an indirect but permanent consequence of development of the mine site. The magnitude of the impacts is the acres of wetlands and other waters at the mine site that would be surrounded by the direct mine site footprint. Fragmentation would affect 462 acres of wetlands and other waters, including 362 acres of shrub wetlands, 85 acres of herbaceous wetlands, 2 acres of aquatic bed wetlands, 7 acres of ponds, and 5 acres of perennial streams.

The extent of impacts is limited to the Upper Koktuli River watershed. The likelihood of the impacts would vary on a case-by-case basis. Relatively large patches of precipitation-dependent wetlands, such as flats, may not display measurable differences; whereas other wetland patches may lose wetland hydrology or have severely degraded habitat and water quality functions. Impacts from fragmentation may overlap with impacts from fugitive dust and dewatering, described below.

Fugitive Dust

Fugitive dust emissions are a byproduct of construction and operations activities. Dust would be caused by vehicle travel on the mine roads and other unpaved surfaces in the mine, as well as by mining activities at the pit. This dust has the potential to collect on vegetation in the vicinity of the dust sources. Windblown dust could affect wetland vegetation well beyond the source, but the effect diminishes with distance and is influenced by prevailing winds and topography. Dust deposition impacts wetlands primarily by reducing vegetation productivity and altering species composition. Fugitive dust impacts to vegetation are described in Section 4.26, Vegetation; impacts to soils are described in Section 4.14, Soils. A fugitive dust control plan would be developed for the project, and the project would use Best Available Control Technology (BACT) and best management practices (BMPs) for fugitive dust management (see Chapter 5, Mitigation).

A dust dispersion model was developed to predict air quality impacts of particulate matter with an aerodynamic diameter less than or equal to 10 microns in diameter (PM_{10}) from mine site operations and construction activities (PLP 2018-RFI 009a). Prevailing winds are to the northwest and southeast at the mine site. Maximum annual modeled PM_{10} deposition was 1.5 grams per square meter per year (grams/m^2/year) due to construction. Modeled deposition values as high as 30 grams/m^2/year were reported within the mine site ambient air quality boundary (see Figure 4.14-1 in Section 4.14, Soils).

Research on dust emissions and its impact on vegetation in Alaska has shown that most dust generated from mining operations and roads is deposited within 330 feet (Petavratzi et al. 2005; Walker and Everett 1987). Therefore, a potential indirect impact area was calculated using a 330-foot zone on all direct disturbance footprints. This follows methods used by recent EISs in Alaska (Donlin Gold 2018 [USACE 2018]; Point Thompson 2012 [USACE 2012]).

The magnitude of the impacts is the acres of wetlands and other waters at the mine site that would be impacted by dust emissions. A total of 957 acres of wetlands and other waters is anticipated to be affected by dust deposition at the mine site during the construction and operations phases. The dust would primarily affect deciduous shrub (641 acres) and herbaceous (258 acres) wetlands, as well as 46 acres of lakes and ponds, and 10 acres of rivers and streams. The greatest effects on wetland functions are expected to occur within

33 feet of the disturbance. Duration of dust impacts is assumed to be permanent, although this may vary for impacts to wetlands and waters at the outer edge of the 330-foot zone. The extent of impacts is the 330-foot zone primarily within the Upper Koktuli River watershed, with smaller impacts to the UTC watershed. Impacts from fugitive dust may overlap with impacts from fragmentation and dewatering.

Dewatering

Hydrology of wetlands and other waters at the mine site would be altered within the zone of influence associated with dewatering of the open pit, tailings ponds, water management ponds, and the potable water well field during mining operations. To predict the magnitude (area) of wetlands and other waters potentially affected by lowering of the groundwater, a model was developed that incorporates groundwater flow, wetland HGM class, and surficial geology permeability (PLP 2018-RFI 009a; see Section 4.17, Groundwater Hydrology, for a discussion of the model and its limitations). Impacts were calculated for the end of mine phase, when drawdown is at its maximum extent, and for the post-closure phase, when the pit lake has reached its long-term, maximum level. Impacts to wetlands and other waters were characterized in the model as either high, meaning wetland hydrology would be lost; or moderate, meaning hydrology would be altered, but not enough to eliminate wetland functions.

The magnitude of the impacts is the acres of wetlands and other waters at the mine site that would be impacted by the dewatering, and whether the impacts are considered high or moderate (as defined above) according to the model. At the end of operations, approximately 154 acres of wetlands and other waters would be highly impacted by the groundwater drawdown (wetland hydrology would be lost), including 55 acres of shrub wetlands, 34 acres of herbaceous wetlands, and 65 acres of lakes and ponds. Another 294 acres would be moderately impacted, (hydrology would be altered, but wetland functions would not be eliminated. This includes 187 acres of shrub wetlands, 65 acres of herbaceous wetlands, 41 acres of ponds, and 2 acres of streams.

The duration of all dewatering impacts would be permanent, because they would last at least until the post-closure phase. According to the model, approximately 48 acres of the highly impacted wetlands would be expected to recover wetland hydrology at the post-closure phase. The remaining 106 acres of highly impacted wetlands are not expected to recover. Approximately 121 acres of the moderately impacted wetlands would be expected to recover, leaving 173 acres of wetlands that would remain moderately impacted, so that the hydrology would be changed, but wetland functions would remain.

The extent of impacts is limited to the zone of influence within the Upper Koktuli River (76 percent of impacts) and UTC (24 percent of impacts) watersheds. Dewatering impacts are considered highly likely to occur with implementation of the project, although modeling of the severity of impacts has some uncertainty associated with it. Impacts from dewatering may overlap with impacts from fugitive dust and fragmentation, described above.

4.22.5.3 Transportation Corridor Direct Impacts

The magnitude and extent of impacts from construction of the transportation corridor from Amakdedori port to the mine site would be to directly and permanently affect 86 acres of wetlands and other waters (see Table 4.22-2), including 75 acres of wetlands and 11 acres of other waters. The port access road between the port and the south ferry terminal at Iliamna Lake would affect 41 acres of wetlands and other waters. The mine access road from the north ferry terminal to the mine site would affect 38 acres of wetlands and other waters. The remaining impacts would be from the Iliamna and Kokhanok spur roads (3 acres), material sites (3 acres), and ferry landings (1 acre).

Impacts would be permanent in duration, because the road would remain to facilitate long-term post-closure water treatment and monitoring. Previous disturbance to wetlands in this area is minimal (HDR 2018c). The corridor has been sited to avoid and minimize wetland impacts and allow for efficient reclamation of disturbed areas.

In terms of magnitude and extent, a total of 7.9 miles of streams would be directly affected by construction, including 3.9 miles of perennial streams and 4.0 miles of intermittent streams (Table 4.22-2). The larger streams with a width at ordinary high water (OHW) of 16 feet or greater would be bridged. Site-specific designs have been developed for bridges. Smaller stream crossings would use a series of standardized, conceptual culvert design categories based on stream width and fish presence. See Section 4.16, Surface Water Hydrology, for a discussion of changes in flow regime.

Within the transportation corridor, the natural gas pipeline would follow the access road and is accounted for in the direct impacts for the access roads; except for the Iliamna Lake crossing, where it would be would be installed in a trench out into waters that are deep enough to avoid navigation hazards, and then laid on the lake bottom, and anchored or supported as required.

Construction impacts to wetlands outside of the permanent road footprint would be avoided or minimized where possible by flagging wetlands ahead of construction and restricting temporary storage of material to within the road footprint (see Chapter 5, Mitigation). However, to account for temporary construction-related impacts, a 30-foot zone on either side of the permanent road footprint was assumed to be temporarily impacted. These impacts are anticipated to be reclaimed within 2 years of construction (PLP 2018-RFI 082). Temporary impacts would affect approximately 60 acres of wetlands and other waters within the transportation corridor, including 50 acres of wetlands and 10 acres of other waters. Approximately 4.6 miles of stream channels would be temporarily impacted.

Hydrology, water quality and habitat functions of wetlands and other waters in the direct road footprint would be permanently lost. Functions in the temporary construction zones would be altered due to vegetation and soil disturbance, introduction of invasive species, fragmentation of habitat, and increased runoff and sedimentation from the road surfaces. Stream and riverine wetland hydrology and habitat would be altered by placement of culverts.

Impacts associated with the natural gas pipeline not adjacent to a road footprint are discussed below.

In terms of magnitude, extent, and duration, activities in the transportation corridor would permanently affect wetlands and other waters in five HUC 10 watersheds (see Table 4.22-2). The highest number of acres impacted (39 acres) would occur in the UTC watershed. Direct impacts in this watershed would affect primarily deciduous shrub wetlands (33 acres), primarily on slopes.

Table 4.22-2: Alternative 1 Transportation Corridor Wetlands and Other waters Direct Impacts (Acres)

NWI Group	Watershed					
	Upper Talarik Creek	Newhalen River	Iliamna Lake	Gibraltar Lake	Amakdedori Creek–Frontal Kamishak Bay	Combined Watershed Area[1]
Deciduous Shrub Wetlands	33	1	10	3	6	54
Evergreen Shrub Wetlands	0	<1	1	2	<1	3
Herbaceous Wetlands	4	<1	6	3	5	18
Aquatic Bed Wetlands	0	0	<1	0	0	<1
Ponds	<1	0	1	1	3	6
Lakes	0	0	1	<1	<1	2
Perennial Streams	2	<1	1	<1	<1	3
Intermittent Streams	<1	<1	<1	<1	<1	<1
Upland	347	51	372	133	167	1,074
Total Area	386	52	392	142	183	1,160
Wetlands and Other waters Totals	39	1	20	9	16	86
Wetlands and Other waters (%)[2]	10	2	5	6	9	7
Wetlands Totals	37	1	17	8	12	75
Wetlands (%)[2]	10	2	4	6	7	6
Other waters Totals	2	<1	3	1	4	11
Other waters (%)[2]	1	<1	1	1	1	1
Perennial Streams (Miles)	0.9	0.1	1.4	0.6	0.9	3.9
Intermittent Streams (Miles)	0.3	<0.1	0.6	0.3	2.8	4.0

[1] Includes 5 acres of uplands in the Headwaters Koktuli River watershed.
[2] Proportion of direct impact area.

The UTC watershed is approximately 88,000 acres. Based on vegetation mapping, it is estimated to contain approximately 34,000 acres of wetlands and other waters, which is roughly 39 percent of the watershed. Approximately 31,000 acres (35 percent of the watershed), are shrub wetlands and 1,200 acres (1 percent) are herbaceous wetlands. Forested wetlands (636 acres) and aquatic bed wetlands (8 acres) each cover less than 1 percent. Activities in the transportation corridor and in a small portion of the mine site would affect 39 acres of shrub wetlands and 6 acres of herbaceous wetlands in the UTC watershed. This represents less than 1 percent of all shrub and herbaceous wetlands in the watershed. No forested or aquatic bed wetlands would be affected.

Riverine wetlands are considered regionally important in the watersheds based on their connections to important fish and wildlife species. In terms of magnitude, a total of 6 acres of riverine HGM-class wetlands in the UTC watershed would be directly affected by activities in the transportation corridor and a small part of the mine site. The extent of riverine wetlands in the watershed is not known. They account for approximately 2 percent of the transportation corridor analysis area. Using this percentage for the entire UTC watershed, there would be roughly 1,760 acres of riverine wetlands. Therefore, the area of impacts to riverine wetlands from transportation corridor and mine site activities would represent less than 1 percent of all riverine wetlands in the watershed.

Based on vegetation and wetland mapping for the project, 8 acres of bogs and fens would be affected by activities in the transportation corridor and the small portion of the mine site in the UTC watershed. The extent of bogs in the watershed is not known. Approximately 61 acres of bogs were mapped in the analysis area for this watershed, which represented 2 percent of the analysis area. Assuming 2 percent of the entire watershed has bogs or fens, this would be roughly 1,760 acres. Therefore, the 8 acres of impacts would represent less than 1 percent of all bogs in the watershed.

Other waters directly impacted within the UTC watershed include less than 1 acre of lakes and ponds, and 2 acres of streams in 1.2 miles of channels. These impacts represent less than 1 percent of the estimated area of other waters in the UTC watershed.

The Iliamna Lake watershed, excluding the lake itself, has an estimated 180,000 acres of wetlands and other waters (33 percent of the watershed). The project would result in direct impacts to 11 acres of shrub wetlands, 6 acres of herbaceous wetlands, 2 acres of lakes/ponds, and 1 acre of streams in 2 miles of channels (see Table 4.22-2). The Newhalen River watershed has an estimated 35,000 acres of wetlands and other waters (29 percent of the watershed); 1 acre of shrub wetlands would be directly affected. The Gibraltar Lake watershed has an estimated 34,000 acres of wetlands and other waters (41 percent of the watershed); 5 acres of shrub wetlands, 3 acres of herbaceous wetlands, and 1 acre of ponds would be directly affected. The Amakdedori Creek-Frontal Kamishak Bay watershed has an estimated 77,000 acres of wetlands and other waters (44 percent of the watershed); 6 acres of shrub wetlands, 5 acres of herbaceous wetlands, and 3 acres of ponds would be directly affected (Table 4.22-2). The transportation corridor does enter the Paint River watershed for a very short distance, but no wetland or other water impacts are anticipated.

The duration of impacts would be permanent, because they would last into the post-closure phase. The extent of direct impacts is the road disturbance footprint, which includes the natural gas pipeline and material sites. Wetlands and other waters in five watersheds would be directly impacted.

Summer-Only Ferry Operations Variant

This variant would not change the impacts to wetlands.

Kokhanok East Ferry Terminal Variant

This variant would replace a portion of the Alternative 1 transportation corridor. The magnitude of net change in direct permanent impacts would be an additional 6 acres of shrub wetlands and 42 acres of herbaceous wetlands. Two acres of lakes and ponds would not be impacted. The additional impacts would occur within the Iliamna Lake watershed. The total impacts to these resources represent less than 1 percent of the estimated area of shrub and herbaceous wetlands within the watershed.

The net change in temporary impacts would be an additional 3 acres of shrub wetlands and 16 acres of herbaceous wetlands. The net change in indirect impacts from dust would be an additional 5 acres of shrub wetlands and 145 acres of herbaceous wetlands. There would be 79 acres of fewer dust impacts to lakes and ponds.

These impacts are based on the ALOS PALSAR data, which have not been field verified, and appear to underestimate wetland and other water areas. It is expected that field-verified mapping data would be acquired in field season 2019, and would be used to update the impact numbers for the Final EIS (FEIS). Data gaps are discussed in Section 3.22, Wetlands and Other Waters/Special Aquatic Sites.

Reclamation

The road system would be retained as long as required for the transport of bulk supplies needed for long-term post-closure water treatment and monitoring. Once no longer needed, the road system would be reclaimed. Disturbed areas would be recontoured, graded, ripped, and scarified. Topsoil and growth media would be placed as needed, and surfaces would be seeded for revegetation. The Iliamna Lake ferry facilities would be removed during closure. Once energy is no longer required at the mine site, the pipeline would be pigged and cleaned, and either abandoned in place or removed, subject to regulatory review and approval at the decommissioning stage of the project. Surface facilities associated with the pipeline would be removed and reclaimed. During closure and post-closure, wetlands would be reestablished wherever practicable.

Summary of Direct Impacts in the Transportation Corridor

In terms of magnitude, extent, and duration, the Alternative 1 transportation corridor would directly and permanently impact 86 acres of wetlands and other waters during construction, including 75 acres of wetlands, 1 acre of Iliamna Lake, 7 acres of ponds and other lakes, and 3 acres of streams. Impacts would be permanent, because the mine and port access roads and spur roads would remain to facilitate long-term post-closure water treatment and monitoring. Direct and indirect effects would occur within five HUC 10 watersheds. The majority of the impacts (39 acres) would be within the UTC watershed. Most impacts would be to regionally common shrub and herbaceous wetland types. The direct impacts represent less than 1 percent of shrub and herbaceous wetlands in the UTC watershed. No forested or aquatic bed wetlands would be impacted. Approximately 6 acres of riverine wetlands, identified as regionally important wetlands, would be directly impacted by the transportation corridor in the UTC watershed. This represents less than 1 percent of the riverine wetlands in the watershed. Approximately 8 acres of bogs would be directly impacted in the UTC watershed, which represents less than 1 percent of bogs in the watershed.

4.22.5.4 Transportation Corridor Indirect Impacts

Fugitive Dust

Fugitive dust emissions would be caused by road construction and vehicle travel on unpaved surfaces. This dust has the potential to collect on vegetation in the vicinity of the dust sources. Windblown dust could affect wetland vegetation well beyond the source, but the effect diminishes with distance and is influenced by prevailing winds and topography. The heaviest dust deposition would be anticipated to occur within 35 feet of the road (Walker and Everett 1987); however, dust has been documented at distances of 330 feet from the most heavily traveled roads in Prudhoe Bay (Walker et al. 1987). Dust deposition impacts wetlands primarily by reducing vegetation productivity and altering species composition. Fugitive dust impacts to vegetation are described in Section 4.26, Vegetation; impacts to soils are described in Section 4.14, Soils. A fugitive dust control plan would be developed for the project, and the project would use BACT and BMPs for fugitive dust management (see Chapter 5, Mitigation).

The magnitude of the impacts is the acres of wetlands and other waters in the transportation corridor analysis area that would potentially be impacted by dust emissions. With application of a 330-foot zone on all permanent road footprints (as previously described), a total of 892 acres of wetlands and other waters would potentially be affected by dust deposition during construction and operations. The dust would primarily affect shrub (484 acres) and herbaceous (164 acres) wetlands, as well as 205 acres of lakes and ponds, and 37 acres of rivers and streams. The greatest effects on wetland functions are expected to occur within 33 feet of the roads.

Duration of dust impacts is assumed to be permanent, although this may vary for impacts to wetlands and waters at the outer edge of the 330-foot zone. The extent of impacts is the 330-foot zone. Impacts would potentially occur in five watersheds, listed in Table 4.22-2.

Note that there is overlap between the 330-foot dust zone and the 30-foot temporary construction impact zone within the transportation corridor.

4.22.5.5 Amakdedori Port

In terms of magnitude and duration, construction of Amakdedori port would permanently and directly affect 11 acres of marine waters in the Amakdedori Creek-Frontal Kamishak Bay watershed (see Table 4.22-3). The port terminal and associated facilities, including an airstrip, would be sited and designed to avoid almost all vegetated wetlands and other waters. No dredging would be required. Temporary construction-related impacts, such as turbidity, would affect 4 acres of marine waters. Fugitive dust impacts from construction would potentially affect 1 acre of shrub wetlands, 2 acres of herbaceous wetlands, and 42 acres of marine waters. Previous disturbance to wetlands or other waters in this area is minimal.

The Amakdedori port facilities would be removed during closure, except for those required to support shallow draft tug and barge access to the dock for the transfer of bulk supplies. Disturbed areas would be recontoured, graded, ripped, and scarified. Topsoil and growth media would be placed as needed, and surfaces would be seeded for revegetation.

Table 4.22-3: Alternative 1 Port Wetlands and Other Waters Direct Impacts

NWI Group	Direct Impacts (acres)
Herbaceous Wetlands	<1
Marine (Intertidal)	1
Marine (Subtidal)	10
Uplands	19
Total Area	30
Wetlands and Other waters Totals	11
Wetlands and Other waters (%)[1]	37%
Wetlands Totals	<1
Wetlands (%)[1]	<1%
Other waters Totals	11
Other waters (%)[1]	37%

Notes:
[1] Proportion of direct impact area

Summer-Only Ferry Operations Variant

This variant would have roughly the same magnitude of direct permanent and temporary impacts to wetlands and other waters as described for Alternative 1 without the variant. The area of wetlands potentially affected by fugitive dust would increase by 9 acres, compared to the year-round use of the port due to the increased disturbance footprint for a container yard.

Pile-Supported Dock Variant

Under this variant, the total magnitude of the offshore footprint for the dock would be reduced by 11 acres. There would be less than 1 acre of permanent direct impacts to marine waters.

4.22.5.6 Natural Gas Pipeline Corridor

Impacts for stand-alone sections of the natural gas pipeline are assessed in this subsection. Where the pipeline is being constructed adjacent to roads in the transportation corridor, impacts are assessed above for the transportation corridor. Stand-alone sections include primarily the 104-mile crossing of Cook Inlet, between Anchor Point and Amakdedori port, and the 19-mile crossing of Iliamna Lake. Onshore areas include the compressor station and pipeline near Anchor Point (Kenai Peninsula), access roads, and smaller sections where the pipeline leaves the transportation corridor.

For onshore sections of the stand-alone natural gas pipeline, a 100-foot-wide impact corridor has been assessed: 40 feet to account for the trench and side-cast material, and 60 feet for construction access. All of this area is being considered to be permanent impacts at this time, because a reclamation plan has yet to be developed. It is likely that much of this area would be reclaimed within 2 years of construction.

In terms of magnitude and duration, the onshore sections of the natural gas pipeline would permanently impact approximately 5 acres of wetlands and other waters. The impacts are broken out in Table 4.22-4 by "Fill" and "No Fill." "Fill" refers to the 40-foot section of the corridor that includes the trench and side-cast material. Approximately 2 acres of wetlands and other waters would be filled for the pipeline. "No Fill" refers to the 60-foot section of the corridor that would be impacted for construction access. Approximately 3 acres of wetlands and other waters would be impacted. Temporary mats would be placed in wetlands to facilitate construction access. No direct fill in wetlands or other waters would be anticipated in these areas.

The duration of Impacts from installation of offshore sections of the pipeline would be temporary. A 30-foot-wide construction corridor is used to assess these impacts. Approximately 378 acres of marine (subtidal) waters in Cook Inlet would be temporarily impacted. Approximately 68 acres of Iliamna Lake would be temporarily impacted.

Table 4.22-4: Alternative 1 Natural Gas Pipeline Wetlands and Other Waters Direct Permanent Impacts (Acres)

NWI Group	Watershed									
	Headwaters Koktuli River		Upper Talarik Creek		Iliamna Lake		Amakdedori Creek–Frontal Kamishak Bay		Combined Watershed Area[1]	
	Fill	No Fill	Fill	No Fill	Fill	No Fill	Fill	No Fill	Fill	No Fill
Deciduous Shrub Wetlands	<1	<1	1	1	<1	1	0	0	1	2
Herbaceous Wetlands	0	0	<1	1	<1	1	<1	<1	1	1
Lakes	0	0	0	0	<1	<1	0	0	<1	<1
Perennial Streams	0	0	<1	<1	0	0	0	<1	<1	<1
Marine (Intertidal)	0	0	0	0	0	0	<1	<1	<1	<1
Upland	1	2	4	7	5	7	1	2	12	18
Total Area	1	2	5	8	6	9	2	2	14	21
Wetlands and Other Waters Totals	N/A								2	3

Table 4.22-4: Alternative 1 Natural Gas Pipeline Wetlands and Other Waters Direct Permanent Impacts (Acres)

NWI Group	Watershed									
	Headwaters Koktuli River		Upper Talarik Creek		Iliamna Lake		Amakdedori Creek–Frontal Kamishak Bay		Combined Watershed Area[1]	
	Fill	No Fill	Fill	No Fill	Fill	No Fill	Fill	No Fill	Fill	No Fill
Wetlands and Other Waters (%)[2]	N/A								14	14
Wetlands Totals	N/A								2	3
Wetlands (%)[2]	N/A								14	14
Other waters Totals	N/A								<1	<1
Other waters (%)[2]	N/A								<1	<1
Perennial Streams (Miles)	N/A								<0.1	<0.1
Intermittent Streams (Miles)	N/A								0	0

[1] Does not include 5 acres of uplands for the compressor station, laydown area and access road near Anchor Point, Kenai Peninsula.
[2] Proportion of direct impact area.
N/A = Not Applicable

Kokhanok East Ferry Terminal Variant

In terms of magnitude and extent, changes in the natural gas pipeline corridor for this variant would result in a net addition of 11 acres of permanent impacts to shrub wetlands within the Iliamna Lake watershed, and 6 acres of temporary impacts to Iliamna Lake waters. These impacts represent less than 1 percent of these resources within the Iliamna Lake watershed.

4.22.6 Alternative 2 – North Road and Ferry with Downstream Dams

In terms of magnitude, extent, and duration, Alternative 2 would permanently discharge dredged or fill material into 3,658 acres of wetlands and other waters, including 3,512 acres of wetlands, 51 acres of lakes and ponds, 55 acres of streams in 77 miles of channels, and 41 acres of estuarine waters. It would temporarily discharge dredged or fill material into 457 acres of wetlands and other waters, including 46 acres of wetlands, 1 acre of lakes and ponds, 4 acres of streams in 1.8 miles of channels, 135 acres of estuarine waters, and 271 acres of marine waters. An additional 1,987 acres of wetlands and other waters would be indirectly impacted by fugitive dust from the mine site, transportation corridor, port, and material sites and access roads for the natural gas pipeline, including 1,528 acres of wetlands and 459 acres of other waters. Dewatering at the mine site would indirectly impact 449 acres of wetlands and other waters, including 341 acres of wetlands, and 108 acres of other waters. Fragmentation would indirectly impact 462 acres of wetlands and other waters, including 449 acres of wetlands and 13 acres of other waters. Figures showing impacts for all project components are provided in Appendix K4.22.

Navigable waters permanently affected by Alternative 2 include Iliamna Bay (Cook Inlet) and Iliamna Lake. There would be a direct permanent impact to 39 acres of navigable waters, including 38 acres of estuarine waters for the port and transportation corridor, and 1 acre of Iliamna Lake for ferry terminals (described below). There would be a total of 404 acres of temporary impacts, including 271 acres of marine waters, 132 acres of estuarine waters, and 1 acre of Iliamna Lake. These acreages are also included in the accounting above of other waters.

Alternative 2 includes a port at Diamond Point with a causeway extending out to a marine jetty, which combined would be 2,100 feet long by a maximum of 200 feet wide, below the HTL of Cook Inlet. The in-water footprint is approximately 8 acres. The shallow approach at this port site would require dredging. The magnitude and extent of the dredge footprint would be approximately 5,500 feet long by a maximum width of 900 feet wide, below the HTL of Cook Inlet. Total dredge area is approximately 58 acres, which is considered a temporary impact. The south ferry terminal at Pile Bay includes a landing ramp that is 140 feet long by a maximum of 120 feet wide below the OHWM of Iliamna Lake. The north ferry terminal at Eagle Bay would be 190 feet long by a maximum of 80 feet wide below the OHWM of Iliamna Lake. In terms of magnitude and duration, a total of approximately 14 acres of navigable waters would be permanently impacted for the port, and approximately 1 acre for the ferry terminals. Another 24 acres of navigable waters in Iliamna Bay would be permanently impacted by the Alternative 2 transportation corridor, because the road footprint would extend into the bay in places due to the very steep adjacent slopes.

Special aquatic sites that would be permanently or temporarily impacted include mudflats, vegetated shallows, and riffle and pool complexes. These habitats were not specifically mapped during the environmental baseline study program. Mudflats occur within the estuarine intertidal waters of Iliamna Bay and Cottonwood Bay. The magnitude of impact would be that an estimated 20 acres of mudflats would be directly impacted for the transportation corridor and port. Another 52 acres would be temporarily impacted during construction.

Direct and temporary impacts to vegetated shallows are estimated to be less than 1 acre. Eelgrass beds are the main type of vegetated shallows that occur in estuarine habitats of Cook Inlet. Eelgrass beds are not known to occur in the Alternative 2 impact area. Riffle and pool complexes occur in an undetermined portion of the upper perennial and intermittent stream channels. Permanent and temporary impacts to these channels total 53 acres and 4 acres, respectively.

4.22.6.1 Mine Site

The magnitude, extent, duration and likelihood of direct impacts would be the same as in Alternative 1, except that there would be an additional 60 acres of direct impacts to wetlands due to the use of the downstream dams construction method for the bulk tailings storage cell. The additional magnitude of impacted wetlands includes 49 acres of deciduous shrub wetlands, and 11 acres of herbaceous wetlands, almost all on slopes. The combined areas of direct impacts for these resources represent approximately 12 percent and 8 percent, respectively, of shrub and herbaceous wetlands within the Upper Koktuli River watershed. Indirect impacts would be the same as in Alternative 1.

Summer-Only Ferry Operations Variant

The magnitude, extent, duration, and likelihood of impacts to wetlands and other waters would be the same as those described for this variant in Alternative 1.

4.22.6.2 Transportation Corridor Direct Impacts

In terms of magnitude, extent, and duration of impacts, construction of the transportation corridor from Diamond Point port to the Pile Bay ferry terminal, and from the Eagle Bay ferry terminal to the mine site, would directly and permanently affect 101 acres of wetlands and other waters (Table 4.22-5), including 67 acres of wetlands, 4 acres of ponds, 4 acres of streams, and 27 acres of estuarine waters (24 acres of which are also considered navigable).

Table 4.22-5: Alternative 2 Transportation Corridor Wetlands and Other Waters Direct Impacts (Acres)

NWI Group	Watershed					
	Upper Talarik Creek	Newhalen River	Iliamna River	Iliamna Lake	Chinitna River–Frontal Cook Inlet	Combined Watershed Area[1]
Deciduous Shrub Wetlands	27	13	5	3	<1	48
Herbaceous Wetlands	4	1	4	<1	0	9
Deciduous Forest Wetlands	0	3	2	4	0	9
Ponds	<1	0	2	1	0	4
Lakes	0	<1	0	0	0	<1
Perennial Streams	2	0	1	<1	1	4
Intermittent Streams	<1	0	0	0	<1	<1
Estuarine (Intertidal)	0	0	0	0	20	20
Estuarine (Subtidal)	0	0	0	0	7	7
Upland	272	388	186	176	65	1,091
Total Area	305	405	200	185	92	1,192
Wetlands and Other waters Totals	33	17	14	9	27	101
Wetlands and Other waters (%)[2]	11	4	7	5	29	8
Wetlands Totals	31	17	11	7	<1	67
Wetlands (%)[2]	10	4	6	4	<1	6
Other waters Totals	2	<1	3	2	27	34
Other waters (%)[2]	1	<1	2	1	29	3
Perennial Streams (Miles)	0.6	0.1	0.4	0.2	0.1	1.3
Intermittent Streams (Miles)	0	0.5	1.0	0.8	0.1	2.4

[1] Includes 5 acres of uplands in the Headwaters Koktuli River watershed.
[2] Proportion of direct impact area.

The duration of impacts would be permanent, because the road would remain to facilitate long-term post-closure water treatment and monitoring. Previous disturbance to wetlands in this area is minimal (HDR 2018c). The corridor has been sited to avoid and minimize wetland impacts and allow for efficient reclamation of disturbed areas.

In terms of magnitude, a total of 3.7 miles of streams would be directly affected by construction, including 1.3 miles of perennial streams and 2.4 miles of intermittent streams (Table 4.22-5). The larger streams with a width at OHW of 16 feet or greater would be bridged. Site-specific designs have been developed for bridges. Smaller stream crossings would use a series of standardized conceptual culvert design categories based on stream width and fish presence. See Section 4.16, Surface Water Hydrology, for a discussion of surface water hydrology impacts.

Data gaps are acknowledged in Section 3.1. Additional field review of this area would occur in field season 2019 and updated data would be included in the FEIS.

Within the transportation corridor, the natural gas pipeline would follow the access road and is accounted for in the direct impacts for the access roads. Impacts associated with the natural gas pipeline outside of the transportation corridor are discussed below.

Construction impacts to wetlands outside of the permanent road footprint would be avoided or minimized where possible (see Chapter 5 for mitigation measures; see also Appendix M, which includes PLP's conceptual draft Compensatory Mitigation Plan). However, to account for temporary construction-related impacts, a 30-foot zone on either side of the permanent road footprint was assumed to be temporarily impacted. These impacts would be anticipated to be reclaimed within 2 years of construction (PLP 2018-RFI082). Temporary impacts would affect approximately 64 acres of wetlands and other waters within the transportation corridor, including 43 acres of wetlands, 1 acre of ponds, 4 acres of streams, and 12 acres of estuarine waters.

Activities in the transportation corridor would permanently affect wetlands and other waters in five HUC 10 watersheds. In terms of magnitude, the highest number of acres impacted (33 acres) would occur in the UTC watershed (Table 4.22-5). Direct impacts in this watershed would affect primarily deciduous shrub wetlands (27 acres), primarily on slopes. The UTC watershed is approximately 88,000 acres. Based on vegetation mapping, it is estimated to contain approximately 34,000 acres of wetlands and other waters, which is roughly 39 percent of the watershed. Approximately 31,000 acres (35 percent of the watershed), are shrub wetlands and 1,200 acres (1 percent) are herbaceous wetlands. Forested wetlands (636 acres) and aquatic bed wetlands (8 acres) each cover less than 1 percent. Activities in the transportation corridor and in a small portion of the mine site would affect 33 acres of shrub wetlands and 6 acres of herbaceous wetlands in the UTC watershed. This represents less than 1 percent of all shrub and herbaceous wetlands in the watershed. No forested or aquatic bed wetlands would be affected.

In terms of magnitude, extent, and duration, approximately 27 acres of wetlands and other waters would be permanently impacted in the Chinitna River-Frontal Cook Inlet watershed. Almost all of this area is in estuarine waters. Direct impacts to estuarine intertidal waters total 20 acres. This impact is in Iliamna Bay (Cook Inlet), and is also considered a special aquatic site (mudflats). This type of habitat is relatively scarce in the project vicinity, and provides multiple habitat functions for marine and terrestrial fish and wildlife. For these reasons, estuarine intertidal waters are considered regionally important for purposes of the environmental effects determination. Based on NWI mapping of Iliamna Bay, estuarine intertidal waters cover 543 acres of the bay. The project impacts of 20 acres represent roughly 4 percent of intertidal waters in the bay.

The Iliamna Lake watershed, excluding the lake itself, has an estimated 180,000 acres of wetlands and other waters (33 percent of the watershed). The Alternative 2 transportation corridor would result in direct impacts on 3 acres of shrub wetlands, 4 acres of forested wetlands, and 1 acre of ponds (Table 4.22-5). The Newhalen River watershed has an estimated 35,000 acres of wetlands and other waters (29 percent of the watershed); 13 acres of shrub wetlands, 3 acres of forested wetlands, and 1 acre of herbaceous wetlands would be directly affected. Approximately 14 acres of wetlands and other waters would be impacted within the Iliamna River watershed, including 5 acres of shrub wetlands, 4 acres of herbaceous wetlands, 2 acres of forested wetlands, 2 acres of ponds, and 1 acre of streams (Table 4.22-5).

Riverine wetlands are considered regionally important wetlands in the watersheds based on their connections to important fish and wildlife species. Because the entire Alternative 2 transportation corridor does not have project mapping with HGM classification, it is not possible to determine the exact area of riverine wetlands that would be directly impacted. However, for the 82 percent of the impact area with project mapping, there is a total of 10 acres of impacts to riverine wetlands across all watersheds (5 acres in Iliamna River watershed; 3 acres in Newhalen River watershed; and 2 acres in UTC watershed). These relatively small areas of impacts to riverine wetlands suggest that these impacts represent less than 1 percent of riverine wetlands in each watershed.

A relatively small area of bogs and fens, identified as regionally important wetlands, would be directly impacted across all watersheds. Most of the impacts would be within the UTC and Newhalen River watersheds. For the 82 percent of the impact area with project vegetation mapping, there are 5 acres of impacts to bogs and fens.

The combined direct impacts to wetlands and other waters in the Alternative 2 transportation corridor represent an intermediate magnitude of impacts. Impacts are considered permanent, because they would last into the post-closure phase. The extent of direct impacts is the road disturbance footprint, which includes the natural gas pipeline and material sites. Wetlands and other waters in five watersheds would be directly impacted. The impacts are certain to occur with project implementation.

Summer-Only Ferry Operations Variant

This variant would include the addition of a concentrate container storage yard along the Williamsport-Pile Bay Road, because there is insufficient space available at the Diamond Point port. The storage area would enable shipping at the port to continue during the period the ferry is not operating. The magnitude and duration of effects from this variant would be direct permanent impacts to an additional 9 acres of estuarine intertidal waters in Iliamna Bay.

Summary of Direct Impacts in the Transportation Corridor

In terms of magnitude and duration, the Alternative 2 transportation corridor would directly and permanently impact 101 acres of wetlands and other waters during construction. Impacts would be permanent, because the road would remain to facilitate long-term post-closure water treatment and monitoring. Direct and indirect effects would occur within five HUC 10 watersheds. In terms of extent, the majority of the impacts would be within the UTC and Chinitna River-Frontal Cook Inlet watersheds. Most impacts would be to regionally common shrub and herbaceous wetland types.

In the UTC watershed, 33 acres of shrub and 6 acres of herbaceous wetlands would be directly impacted. These direct impacts represent less than 1 percent of shrub and herbaceous wetlands in the watershed. No forested or aquatic bed wetlands would be impacted. Within the Chinitna River-Frontal Cook Inlet watershed, 27 acres of estuarine waters would be directly impacted. Approximately 20 acres of these waters are in the intertidal zone of Iliamna Bay, and would be considered mud flats, a special aquatic site. This impact represents roughly 4 percent of the estuarine intertidal waters in Iliamna Bay. A minimum of 10 acres of riverine wetlands and 5 acres of bogs and fens would be directly impacted across all watersheds.

4.22.6.3 Transportation Corridor Indirect Impacts

Fugitive Dust

Fugitive dust emissions would be caused by road construction and vehicle travel on unpaved surfaces. This dust has the potential to collect on vegetation in the vicinity of the dust sources. Windblown dust could affect wetland vegetation well beyond the source, but the effect diminishes with distance and is influenced by prevailing winds and topography. Dust deposition impacts wetlands primarily by reducing vegetation productivity and altering species composition. Fugitive dust impacts to vegetation are described in Section 4.26, Vegetation; impacts to soils are described in Section 4.14, Soils. A fugitive dust control plan would be developed for the project, and the project would use BACT and BMPs for fugitive dust management (see Chapter 5, Mitigation).

Research on dust emissions and its impact on vegetation in Alaska has shown that most dust generated from roads is deposited within 330 feet (Petavratzi et al. 2005; Walker and Everett 1987). Therefore, a potential indirect impact area was calculated using a 330-foot zone on all permanent road footprints. This follows methods used by recent EISs in Alaska (Donlin Gold Project EIS 2018 [USACE 2018]; Point Thomson Project EIS 2012 [USACE 2012]).

The magnitude of the impacts would be the acres of wetlands and other waters in the transportation corridor analysis area that would potentially be impacted by dust emissions. With application of a 330-foot zone on all permanent road footprints (as previously described), a total of 883 acres of wetlands and other waters would potentially be affected by dust deposition during construction and operations. The dust would primarily affect deciduous shrub (384 acres), herbaceous (127 acres), and deciduous forest (75 acres) wetlands, as well as 79 acres of lakes and ponds, and 84 acres of rivers and streams. The greatest effects on wetland functions are expected to occur within 33 feet of the roads.

Duration of dust impacts is assumed to be permanent, although this may vary for impacts to wetlands and waters at the outer edge of the 330-foot zone. The extent of impacts is the 330-foot zone. Impacts would potentially occur in five watersheds, listed in Table 4.22-5.

Note that there is overlap between the 330-foot dust zone and the 30-foot temporary construction impact zone within the transportation corridor.

4.22.6.4 Diamond Point Port

In terms of magnitude and duration, construction of Diamond Point port would directly and permanently affect 14 acres of estuarine waters (see Table 4.22-6). Cut and fill for the port would impact 6 acres; and the port barge dock would impact 8 acres of estuarine waters. The extent of most impacts would be to subtidal waters (11 acres) within Iliamna Bay (Cook Inlet). Approximately 3 acres of intertidal waters would be directly impacted. Most of this area is underlain by sand and pebble substrates, although small areas of mud flats (a special aquatic site) may also be present. No eelgrass beds would be directly impacted. The port terminal and associated facilities would be sited and designed to avoid direct and indirect impacts to wetlands, streams, and ponds.

Dredging would temporarily impact 58 acres of estuarine subtidal waters. Construction-related impacts, such as turbidity, would temporarily affect 13 acres of estuarine subtidal waters, and 2 acres of estuarine intertidal waters. Fugitive dust during construction would indirectly affect 71 acres of estuarine waters and 1 acre of streams.

The Diamond Point port facilities would be removed during closure, except for those required to support shallow draft tug and barge access to the dock for the transfer of bulk supplies. Disturbed areas would be re-contoured, graded, ripped, and scarified. Topsoil and growth media would be placed as needed, and surfaces would be seeded for revegetation.

Table 4.22-6: Alternative 2 Port Wetlands and Other Waters Direct Impacts

NWI Group	Direct Impacts (acres)
Perennial Streams	<1
Estuarine (Intertidal)	3
Estuarine (Subtidal)	11
Uplands	41
Total Area	55

Table 4.22-6: Alternative 2 Port Wetlands and Other Waters Direct Impacts

NWI Group	Direct Impacts (acres)
Wetlands and Other Waters Totals	14
Wetlands and Other Waters (%)[1]	25
Wetlands Totals	0
Wetlands (%)[1]	0
Other Waters Totals	14
Other Waters (%)[1]	25

Notes:
[1] Proportion of direct impact area

Pile-Supported Dock Variant

Under this variant, the magnitude of the total offshore footprint for the dock would be reduced substantially, as compared to the footprint for the solid fill dock and causeway. There would be less than 1 acre of permanent direct impacts to marine waters for the Pile-Supported Dock Variant. Dredging would still occur with this variant.

4.22.6.5 Natural Gas Pipeline Corridor

Impacts for stand-alone sections of the natural gas pipeline are assessed here. Where the pipeline is being constructed adjacent to roads in the transportation corridor, impacts are assessed above.

In terms of magnitude and duration, the onshore sections of the natural gas pipeline would permanently impact a total of 25 acres of wetlands and other waters (see Table 4.22-7). Approximately 11 acres of wetlands and other waters would be filled for the pipeline. Another 14 acres of wetlands and other waters would be impacted for construction access.

Data gaps are acknowledged in Section 3.1. Additional field review of this area would occur in field season 2019 and updated data would be included in the FEIS for stream channels along the Alternative 2 natural gas pipeline corridor (similar to the north access road and mine access road for the Alternative 3 transportation corridor).

The duration of impacts from offshore sections of the pipeline, between Anchor Point and Ursus Cove, and across Cottonwood Bay, would be temporary. A 30-foot-wide construction corridor is used to assess these impacts. Approximately 271 acres of marine (subtidal) waters in Cook Inlet would be temporarily impacted. The pipeline corridor across Cottonwood Bay would impact 39 acres of estuarine intertidal waters, and 11 acres of estuarine subtidal waters. An additional 3 acres of wetlands would be temporarily impacted for construction access roads. Fugitive dust from roads and material sites would potentially affect 74 acres of wetlands and other waters.

Table 4.22-7: Alternative 2 Natural Gas Pipeline Wetlands and Other Waters Direct Permanent Impacts

NWI Group	Watershed									
	Upper Talarik Creek		Iliamna Lake		Chekok Creek		Chinitna River-Frontal Cook Inlet		Combined Watershed Area[1]	
	Fill	No Fill	Fill	No Fill	Fill	No Fill	Fill	No Fill	Fill	No Fill
Deciduous Shrub Wetlands	1	1	2	3	<1	1	3	2	6	7
Herbaceous Wetlands	<1	1	<1	1	0	0	0	0	1	2
Deciduous Forest Wetlands	0	0	2	2	0	0	0	0	2	3
Perennial Streams	<1	<1	<1	1	<1	<1	1	1	2	2
Upland	4	7	139	209	7	10	48	68	221	328
Total Area	5	8	144	216	7	11	51	71	232	342
Wetlands and Other Waters Totals									11	14
Wetlands and Other Waters (%)[2]									5	4
Wetlands Totals									9	12
Wetlands (%)[2]									4	4
Other Waters Totals									2	2
Other Waters (%)[2]									1	1
Perennial Streams (Miles)									0.5	0.7
Intermittent Streams (Miles)									0.7	0.9

Notes:
[1] Includes 59 acres of uplands in the Headwaters Koktuli River, Iliamna River, and Pile River watersheds; does not include 5 acres of uplands for the compressor station, laydown area, and access road near Anchor Point, Kenai Peninsula; or 316 acres of uplands for material sites.
[2] Proportion of direct impact area.

4.22.7 Alternative 3 – North Road Only

In terms of magnitude, duration, and extent, Alternative 3 would permanently discharge dredged or fill material into 3,588 acres of wetlands and other waters, including 3,446 acres of wetlands, 50 acres of lakes and ponds, 53 acres of streams in 79.3 miles of channels, and 41 acres of estuarine waters. It would temporarily discharge dredged or fill material into 462 acres of wetlands and other waters, including 50 acres of wetlands, 1 acre of ponds, 4 acres of streams in 3.3 miles of channels, 135 acres of estuarine waters, and 271 acres of marine waters. An additional 2,097 acres of wetlands and other waters would be indirectly impacted by fugitive dust, including 1,617 acres of wetlands and 479 acres of other waters. Dewatering at the mine site would indirectly impact 449 acres of wetlands and other waters, including 341 acres of wetlands, and 108 acres of other waters. Fragmentation would indirectly impact 462 acres of wetlands and other waters, including 449 acres of wetlands and 13 acres of other waters. Figures showing impacts for all project components are provided in Appendix K4.22.

Because Alternative 3 does not include a ferry crossing of Iliamna Lake, the only navigable waters permanently affected by this alternative would be in Cook Inlet. Alternative 3 includes the same port location (Diamond Point) and design as Alternative 2, with a total of approximately 14 acres of navigable waters of the US permanently impacted. Another 24 acres of navigable waters in Iliamna Bay would be permanently impacted by the Alternative 3 transportation corridor, because the road footprint would extend into the bay in places due to the very steep adjacent slopes.

Special aquatic sites that would be permanently or temporarily impacted include mudflats, vegetated shallows, and riffle and pool complexes. These habitats were not specifically mapped during the environmental baseline study program. Mudflats occur within the estuarine intertidal waters of Iliamna Bay and Cottonwood Bay (23 acres permanent and 48 acres temporary impacts).

The magnitude of direct and temporary impacts to vegetated shallows would be estimated to be less than 1 acre. Eelgrass beds are the main type of vegetated shallows that occur in estuarine habitats of Cook Inlet. Eelgrass beds are not known to occur in the Alternative 3 impact area. Riffle and pool complexes occur in an undetermined portion of the upper perennial and intermittent stream channels. Permanent and temporary impacts to these channels total 52 acres and 4 acres, respectively.

4.22.7.1 Mine Site

Under Alternative 3, the mine site footprint would be the same as Alternative 1, described above. Therefore, the magnitude, extent, duration, and likelihood of both direct and indirect effects on wetlands and other waters would be the same as those described for Alternative 1.

Concentrate Pipeline Variant

No additional impacts to wetlands and other waters would be associated with this variant.

4.22.7.2 Transportation Corridor Direct Impacts

In terms of magnitude, extent, and duration, construction of the Alternative 3 transportation corridor from Diamond Point port to the mine site would directly and permanently affect 108 acres of wetlands and other waters (Table 4.22-8), including 75 acres of wetlands, 3 acres of lakes and ponds, 4 acres of streams in 6 miles of channels, and 27 acres of estuarine waters (24 acres of which are also considered navigable). Impacts would be permanent, because the road would remain to facilitate long-term post-closure water treatment and monitoring. Previous disturbance to wetlands in this area is minimal. The corridor has been sited to avoid and minimize wetland impacts and allow for efficient reclamation of disturbed areas.

In terms of magnitude, a total of 6 miles of streams would be directly affected by construction, including 1.8 miles of perennial streams and 4.2 miles of intermittent streams (Table 4.22-8). The larger streams with a width at OHW of 16 feet or greater would be bridged. Site-specific designs have been developed for bridges. Smaller stream crossings would use a series of standardized conceptual culvert design categories based on stream width and fish presence. See Section 4.16, Surface Water Hydrology, for a discussion of surface water hydrology impacts.

Data gaps are acknowledged in Section 3.1. Additional field review of this area would occur in field season 2019 and updated data would be included in the FEIS for the stream channels along the north access road and mine access road of the Alternative 3 transportation corridor.

Within the transportation corridor, the natural gas pipeline would follow the access road, and is accounted for in the direct impacts for the access roads. Impacts associated with the natural gas pipeline outside of the transportation corridor are discussed below.

Construction impacts to wetlands outside of the permanent road footprint would be avoided or minimized where possible. However, to account for temporary construction-related impacts, a

30-foot zone on either side of the permanent road footprint was assumed to be temporarily impacted. These impacts would be anticipated to be reclaimed within 2 years of construction (PLP 2018-RFI082). Impact magnitude and duration would be that temporary impacts would affect approximately 68 acres of wetlands and other waters in the transportation corridor, including 50 acres of wetlands, and 17 acres of other waters. Wetland impacts are primarily to shrub wetlands (34 acres), deciduous forest wetlands (9 acres), and herbaceous wetlands (7 acres). Other waters impacts are primarily to estuarine waters (12 acres), ponds (1 acre), and streams (4 acres).

Table 4.22-8: Alternative 3 Transportation Corridor Wetlands and Other Waters Direct Impacts

NWI Group	Watershed					
	Upper Talarik Creek	Newhalen River	Iliamna River	Iliamna Lake	Chinitna River–Frontal Cook Inlet	Combined Watershed Area[1]
Deciduous Shrub Wetlands	27	13	5	6	<1	53
Herbaceous Wetlands	4	1	3	1	0	9
Deciduous Forest Wetlands	0	3	2	8	0	13
Ponds	<1	0	2	<1	0	3
Lakes	0	<1	0	<1	0	<1
Perennial Streams	2	0	1	<1	1	4
Intermittent Streams	<1	0	0	0	<1	<1
Estuarine (Intertidal)	0	0	0	0	20	20
Estuarine (Subtidal)	0	0	0	0	7	7
Upland	272	388	182	654	65	1,701
Total Area	305	405	194	670	92	1,809
Wetlands and Other Waters Totals	33	17	13	16	27	108
Wetlands and Other Waters (%)[2]	11	4	7	2	29	6
Wetlands Totals	31	17	9	16	<1	75
Wetlands (%)[2]	10	4	5	2	<1	4
Other Waters Totals	2	<1	3	<1	27	33
Other Waters (%)[2]	1	<1	2	<1	29	2
Perennial Streams (Miles)	0.6	0.1	0.4	0.6	0.1	1.8
Intermittent Streams (Miles)	0	0.5	1.0	2.6	0.1	4.2

[1] Includes 5 acres of uplands in the Headwaters Koktuli River watershed, 62 acres of uplands in the Chekok Creek watershed, and 74 acres of uplands in the Pile River watershed.
[2] Proportion of direct impact area.

Activities in the transportation corridor would permanently affect wetlands and other waters in five HUC 10 watersheds. The largest area impacted (33 acres) would occur in the UTC watershed (Table 4.22-8). Direct impacts in this watershed would affect primarily deciduous shrub wetlands (27 acres), primarily on slopes. The UTC watershed is approximately 88,000 acres. Based on vegetation mapping, it is estimated to contain approximately 34,000 acres of wetlands and other waters, which is roughly 39 percent of the watershed. Approximately 31,000 acres (35 percent of the watershed), are shrub wetlands, and 1,200 acres (1 percent) are herbaceous wetlands. Forested wetlands (636 acres) and aquatic bed wetlands (8 acres) each cover less than 1 percent. The magnitude and extent of impacts from activities in the transportation corridor and in a small portion of the mine site would be on 33 acres of shrub wetlands, 6 acres of herbaceous wetlands, and 2 acres of streams in the UTC watershed. This is estimated to represent less than 1 percent of all shrub and herbaceous wetlands and streams in the watershed. No forested or aquatic bed wetlands would be affected.

In terms of magnitude, extent, and duration, approximately 27 acres of wetlands and other waters would be permanently impacted in the Chinitna River-Frontal Cook Inlet watershed. Almost all of this area is in estuarine waters. Direct impacts to estuarine intertidal waters total 20 acres; this impact is in Iliamna Bay (Cook Inlet). This area is also considered a special aquatic site (mudflats). This habitat is relatively scarce in the project vicinity, and provides multiple habitat functions for marine and terrestrial fish, as well as wildlife. For these reasons, estuarine intertidal waters are considered regionally important for purposes of the environmental effects determination. Based on NWI mapping of Iliamna Bay, estuarine intertidal waters cover 543 acres of the bay. The project impacts of 20 acres represent roughly 4 percent of intertidal waters in the bay.

The Iliamna Lake watershed, excluding the lake itself, has an estimated 180,000 acres of wetlands and other waters (33 percent of the watershed). In terms of magnitude and duration, the Alternative 3 transportation corridor would result in direct impacts to 6 acres of shrub wetlands, 8 acres of forested wetlands, and 1 acre of herbaceous wetlands (Table 4.22-8). These impacts represent less than 1 percent of these wetland types within the Iliamna Lake watershed. The Newhalen River watershed has an estimated 35,000 acres of wetlands and other waters (29 percent of the watershed); 13 acres of shrub wetlands, 3 acres of forested wetlands, and 1 acre of herbaceous wetlands would be directly affected. Approximately 13 acres of wetlands and other waters would be impacted within the Iliamna River watershed, including 5 acres of shrub wetlands, 3 acres of herbaceous wetlands, 2 acres of forested wetlands, 2 acres of ponds, and 1 acre of streams (Table 4.22-8).

Riverine wetlands are considered regionally important wetlands in the watersheds based on their connections to important fish and wildlife species (see Section 3.24). Because the entire Alternative 3 transportation corridor does not have project mapping with HGM classification, it is not possible to determine the exact area of riverine wetlands that would be directly impacted. However, for the 92 percent of the direct impact area with project mapping, there is a total of 11 acres of impacts to riverine wetlands across all watersheds (2 acres in Iliamna Lake watershed, 3 acres in Iliamna River watershed; 3 acres in Newhalen River watershed; and 2 acres in UTC watershed). These relatively small areas of impacts to riverine wetlands suggest that these impacts represent less than 1 percent of riverine wetlands in each watershed.

A relatively small area of bogs and fens, identified as regionally important wetlands, would be directly impacted across all watersheds. Most of the impacts would be in the UTC and Newhalen River watersheds. For the 92 percent of the impact area with project wetland and vegetation mapping, there are 6 acres of impacts to bogs and fens.

Impacts are considered permanent, because they would last into the post-closure phase. The extent of direct impacts is the road disturbance footprint, which includes the natural gas pipeline and material sites. Wetlands and other waters in five watersheds would be directly impacted.

Concentrate Pipeline Variant

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

Summary of Direct Impacts in the Transportation Corridor

In terms of magnitude and duration, the Alternative 3 transportation corridor would directly and permanently impact 108 acres of wetlands and other waters during construction. Impacts would be permanent, because the road would remain to facilitate long-term post-closure water treatment and monitoring. Direct and indirect effects would occur within five HUC 10 watersheds. The majority of the impacts would be in the UTC and Chinitna River–Frontal Cook Inlet watersheds. Most impacts would be to regionally common shrub and herbaceous wetland types.

Within the UTC watershed, 27 acres of shrub wetlands, 4 acres of herbaceous wetlands, and 2 acres of streams would be directly impacted. The direct impacts represent less than 1 percent of shrub and herbaceous wetlands in the watershed. No forested or aquatic bed wetlands would be impacted.

In the Chinitna River-Frontal Cook Inlet watershed, 1 acre of streams and 27 acres of estuarine waters would be directly impacted. Approximately 20 acres of these waters are in the intertidal zone of Iliamna Bay, and would be considered mudflats, a special aquatic site. This impact represents roughly 4 percent of the estuarine intertidal waters in Iliamna Bay.

A minimum of 11 acres of riverine wetlands and 6 acres of bogs and fens would be directly impacted across all watersheds.

4.22.7.3 Transportation Corridor Indirect Impacts

Fugitive Dust

Fugitive dust emissions would be caused by road construction and vehicle travel on unpaved surfaces. This dust has the potential to collect on vegetation in the vicinity of the dust sources. Windblown dust could affect wetland vegetation well beyond the source, but the effect diminishes with distance and is influenced by prevailing winds and topography. Dust deposition impacts wetlands primarily by reducing vegetation productivity and altering species composition. Specific effects are described in Section 4.26, Vegetation, and Section 4.14, Soils. A fugitive dust control plan would be developed for the project, and the project would use BACT and BMPs for fugitive dust management (see Chapter 5, Mitigation).

The magnitude of the impacts would be the acres of wetlands and other waters in the transportation corridor analysis area that would potentially be impacted by dust emissions. With application of a 330-foot zone on all permanent road footprints (as previously described), a total of 1,051 acres of wetlands and other waters would potentially be affected by dust deposition during construction and operations. The dust would primarily affect shrub (455 acres) and herbaceous (151 acres) wetlands, as well as 89 acres of lakes and ponds, and 109 acres of rivers and streams. The greatest effects on wetland functions are expected to occur within 33 feet of the roads.

Duration of dust impacts is assumed to be permanent, although this may vary for impacts to wetlands and waters at the outer edge of the 330-foot zone. The extent of impacts is the 330-foot zone. Impacts would potentially occur in five watersheds.

Note that there is overlap between the 330-foot dust zone and the 30-foot temporary construction impact zone within the transportation corridor.

4.22.7.4 Diamond Point Port

Under Alternative 3, the Diamond Point port footprint would be the same as Alternative 2, described above. Therefore, the magnitude, extent, duration, and likelihood of both direct and indirect effects would be the same. Note that Alternative 3 does not include a Pile-Supported Dock Variant.

Concentrate Pipeline Variant

There would be no changes to impacts under this variant.

4.22.7.5 Natural Gas Pipeline Corridor

Impacts for stand-alone sections of the natural gas pipeline are assessed here. Where the pipeline is being constructed adjacent to roads within the transportation corridor, impacts are assessed above. Refer to the previous discussion, above, for a description of how impacts were assessed for the pipeline corridor.

The magnitude, extent, and duration of impacts to the onshore sections of the natural gas pipeline would be permanent changes to a total of 8 acres of wetlands and other waters (Table 4.22-9). Approximately 4 acres of wetlands and other waters would be filled for the pipeline. Another 4 acres of wetlands and waters would be impacted for construction access.

The duration of impacts from offshore sections of the pipeline, between Anchor Point and Ursus Cove, and across Cottonwood Bay, would be temporary. A 30-foot-wide construction corridor is used to assess these impacts. Approximately 271 acres of marine (subtidal) waters in Cook Inlet would be temporarily impacted. The pipeline corridor across Cottonwood Bay would impact 39 acres of estuarine intertidal waters, and 11 acres of estuarine subtidal waters.

Table 4.22-9: Alternative 3 Natural Gas Pipeline Wetlands and Other Waters Direct Permanent Impacts

NWI Group	Watershed					
	Upper Talarik Creek		Chinitna River-Frontal Cook Inlet		Combined Watershed Area[1]	
	Fill	No Fill	Fill	No Fill	Fill	No Fill
Deciduous Shrub Wetlands	1	1	3	2	3	3
Herbaceous Wetlands	<1	1	0	0	<1	1
Perennial Streams	<1	<1	1	1	1	1
Upland	4	7	48	62	53	77
Total Area	5	8	51	65	58	81
Wetlands and Other Waters Totals	N/A				4	4
Wetlands and Other Waters (%)[2]	N/A				7	5
Wetlands Totals	N/A				4	3
Wetlands (%)[2]	N/A				7	4
Other Waters Totals	N/A				1	1
Other Waters (%)[2]	N/A				2	1
Perennial Streams (Miles)	N/A				0.1	0.1
Intermittent Streams (Miles)	N/A				0	0

[1] Does not include 5 acres of uplands for the compressor station, laydown area, and access road near Anchor Point, Kenai Peninsula; or 22 acres of uplands for material sites.
[2] Proportion of direct impact area N/A = Not Available

4.22.8 Summary of Key Issues

Table 4.22-10 summarizes the key issues for wetlands and other waters across all three alternatives and variants. The No Action Alternative is not included because there would be no project-related wetlands and other waters impacts. When possible, acreages of wetlands and other waters that would be directly or indirectly impacted are included.

Table 4.22-10: Summary of Key Issues for Wetlands and Other Waters

Impact	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
Total Direct Permanent Wetlands and Other Waters Impacts (excavation, fill, vegetation clearing)	3,560 acres	3,658 acres	3,588 acres
Total Direct Temporary Wetlands and Other Waters Impacts (construction access)	510 acres	457 acres	462 acres
Total Potential Indirect Wetlands and Other Waters Impacts (dust/dewatering/fragmentation)[1]	1,896 acres – dust 449 acres – dewatering 462 acres – fragmentation	1,987 acres – dust 449 acres – dewatering 462 acres – fragmentation	2,097 acres – dust 449 acres – dewatering 462 acres – fragmentation
Mine Site			
Direct Impacts to Wetlands and Other Waters	Permanent loss of 3,458 acres of wetlands and other waters, and 73.2 miles of streams. Summer-Only Ferry Operations Variant: Permanent loss of 3,465 acres of wetlands and other waters and 73.2 miles of streams.	Permanent loss of 3,518 acres of wetlands and other waters, and 73.2 miles of streams. Summer-Only Ferry Operations Variant: Permanent loss of 3,525 acres of wetlands and other waters and 73.2 miles of streams.	Same as Alternative 1. Concentrate Pipeline Variant: no additional impacts to wetlands or other waters.
Fugitive Dust Indirect Impacts to Wetlands and Other Waters	Impacts to 957 acres adjacent to the mine site throughout the life of the mine.	Same as Alternative 1.	Same as Alternative 1.
Dewatering Indirect Impacts to Wetlands and Other Waters	Impacts to 449 acres adjacent to the mine site throughout the life of the mine.	Same as Alternative 1.	Same as Alternative 1.
Fragmentation Indirect Impacts	Impacts to 462 acres adjacent to the mine site throughout the life of the mine.	Same as Alternative 1.	Same as Alternative 1.
Transportation Corridor			
Direct Impacts to Wetlands and Other Waters	Permanent loss of 86 acres of wetlands and other waters and 7.9 miles of streams. Temporary impacts to 60 acres of wetlands and other waters.	Permanent loss of 101 acres of wetlands and other waters and 3.7 miles of streams. Temporary impacts to 64 acres of wetlands and other waters.	Permanent loss of 108 acres of wetlands and other waters and 6 miles of streams. Temporary impacts to 68 acres of wetlands and

Table 4.22-10: Summary of Key Issues for Wetlands and Other Waters

Impact	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
	Kokhanok East Ferry Terminal Variant: Permanent loss of 134 acres of wetlands and other waters and <0.1 miles of streams.	Summer-Only Ferry Operations Variant: Permanent loss of 110 acres of wetlands and other waters and 3.7 miles of streams.	other waters. Concentrate Pipeline Variant: average width of corridor would increase 3 feet.
Fugitive Dust Indirect Impacts	Impacts to 892 acres adjacent to the transportation corridor throughout the life of the mine.	Impacts to 883 acres adjacent to the transportation corridor throughout the life of the mine.	Impacts to 1,051 acres adjacent to the transportation corridor throughout the life of the mine.
Port			
Direct Impacts to Wetlands and Other Waters	Permanent loss of 11 acres of marine waters. Temporary impacts to 4 acres of marine waters. No dredging Summer-Only Operations Variant: no additional impacts. Pile-Supported Dock Variant: Permanent loss of 1 acre of marine waters.	Permanent loss of 14 acres of estuarine waters and <0.1 mile of streams. Temporary impacts to 72 acres of estuarine waters, including 58 acres of dredging. Pile-Supported Dock Variant: Permanent loss of 60 acres of estuarine waters and <0.1 mile of streams.	Same as Alternative 2 (but with no Pile-Supported Dock Variant). Concentrate Pipeline Variant: No additional impacts to wetlands or other waters.
Fugitive Dust Indirect Impacts	Impacts to 3 acres of wetlands and 42 acres of marine waters adjacent to the port mainly during construction. Summer-Only Ferry Operations Variant: Impacts to 6 acres of wetlands, 5 acres of streams, and 42 acres of marine waters adjacent to the port mainly during construction.	Impacts to 1 acre of streams and 71 acres of estuarine waters. Summer-Only Ferry Operations Variant: No additional impacts to wetlands or other waters.	Same as Alternative 2.
Natural Gas Pipeline			
Direct Wetlands and Other Waters Impacts	Permanent loss of 5 acres of wetlands and other waters Temporary impacts to 446 acres in Cook Inlet and Iliamna Lake. Kokhanok East Ferry Terminal Variant: Permanent loss of 16 acres of wetlands and other waters and <0.1 mile of streams.	Permanent loss of 25 acres of wetlands and other waters and 2.8 miles of streams. Temporary impacts to 324 acres of wetlands and other waters.	Permanent loss of 8 acres of wetlands and other waters and 0.1 mile of streams. Temporary impacts to 321 acres of wetlands and other waters.
Fugitive Dust Indirect Impacts	Onshore section of pipeline is mostly associated with transportation corridor, so few pipeline-only dust impacts.	Impacts to 74 acres of wetlands and other waters from construction access and material sites mainly during construction.	Impacts to 16 acres of wetlands and other waters adjacent to material sites mainly during construction.

[1] There is some overlap at the mine site between wetlands and other waters potentially impacted by dust, by fragmentation, and by dewatering.

4.22.9 Cumulative Effects

The cumulative effects analysis area for wetlands includes the project footprint for each alternative, and the extended geographic area where direct and indirect effects to wetlands can be expected from project construction and operations. Past, present, and reasonably foreseeable future actions (RFFAs) in the cumulative impact analysis area have the potential to contribute cumulatively to impacts on wetlands. Section 4.1, Introduction to Environmental Consequences, details the past, present, and RFFAs considered for evaluation.

4.22.9.1 Past, Present, and Reasonably Foreseeable Future Actions

Past and present actions that have, or are currently, affecting wetlands and other waters in the analysis area are minimal. Current development consists of a small number of towns, villages, and roads. Present activities include mining exploration and non-mining–related projects, such as transportation, oil and gas development, or community development actions. These actions have resulted in a loss of some wetlands and other waters. Although these actions affected localized areas, they are additive to other actions, increasing the total acreage of wetlands affected. Dust effects can also be additive; as more dust-producing actions are implemented, a greater area of wetlands can be affected. The USACE has prepared HUC estimates of total acreage, acreage authorized to be filled, and percent of total watershed filled for the nine watersheds potentially affected by the Pebble Project (see Table 4.22-11). The current amount of wetlands filled by percent of watershed ranges from 0.0 percent for the headwaters of the Koktuli River and several other watersheds, to 1.6 percent for Stariski Creek-Frontal Cook Inlet at the start of the natural gas pipeline.

Table 4.22-11: Current Acres of Fill in HUC Watersheds in the Project Area

HUC 10 Name	HUC #	Area Acres	Total ORM2 Impacts (Acres) thru Dec 2016	Percentage of Watershed
Stariski Creek-Frontal Cook Inlet	1902030108	210127	3313.9	1.5771
Chinitna River-Frontal Cook Inlet	1902060207	310613	24.72	0.0080
Paint River	1902060208	128377	0.06	0.0000
Amakdedori Creek-Frontal Kamishak Bay	1902060212	231151	0	0.0000
Cook Inlet	1902080000	4190689	76.24	0.0018
Newhalen River	1903020514	119725	144.61	0.1208
Pile River	1903020601	101188	0	0.0000
Iliamna River	1903020602	122345	0.21	0.0002
Chekok Creek	1903020603	42918	0	0.0000
Gibraltar Lake	1903020606	81594	0	0.0000
Upper Talarik Creek	1903020607	87547	0	0.0000
Iliamna Lake	1903020609	1201978	1.13	0.0001
Headwaters Koktuli River	1903030211	170635	0	0.0000
Total	-	6998886	3560.87	0.0005

Source: USACE 2018e

In addition, past exploration drilling at the Pebble deposit and other mineral deposits have occurred, including over 1,600 boreholes for the Pebble prospect. Given the relatively small amount of past and present fill within individual HUC watersheds, and the project area in general, and limited footprint of drilling, past/present cumulative impacts from placement of fill in wetlands are minimal in extent and magnitude for all alternatives.

Past, present, and RFFAs in the cumulative impact analysis area have the potential to contribute cumulatively to impacts on wetlands and other waters. Several of the RFFAs detailed in Section 4.1, Introduction to Environmental Consequences, are considered to have no potential for cumulatively impacting wetlands in the analysis area. These would include off-shore based developments such as oil and gas lease sales and non-industrialized point source activities that are unlikely to result in any appreciable impact on wetlands beyond a temporary basis (such as tourism, recreation, fishing, and hunting). Other RFFAs removed from further consideration include those outside the analysis area (e.g., Donlin Gold, Copper Joe).

RFFAs that could contribute cumulatively to wetland impacts, and are therefore considered in this analysis, are those activities that would occur in the analysis area. The following were identified in Section 4.1, Introduction to Environmental Consequences, carried forward in this analysis based on their potential to impact wetlands in the analysis area:

- 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/Kenai Peninsula Transportation and Community Infrastructure – including the potential Kaskanak Road.

**Indicates exploration activities only.*

Road Improvement and Community Development Projects

Anticipated road improvement projects in the region include new transportation corridors currently being studied in the Lake and Peninsula Borough (LPB), such as the Williamsport-Pile Bay Road upgrade, Nondalton-Iliamna River Road corridor and bridge, and Kaskanak Road/ Cook Inlet to Bristol Bay. The most likely road improvements are within the development footprint of existing communities. The strategic plan for Iliamna includes a road connection to all villages in the lake area for safer travel. Some road upgrades and additional residential development could occur in the vicinity of the natural gas pipeline starting point—new Stariski Creek. As discussed previously, roads affect wetlands through direct removal and fill, and indirectly though dust deposition and potential disruption of wetland hydrology. The construction of linear features, such as gravel roads perpendicular to the predominant hydraulic gradient, has a greater potential to alter or impound sheet flow and water moving through the active layer. Sedimentation could alter or destroy wetlands, thereby reducing functional capacity.

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 and temporary camp facilities, would result in small areas of wetlands disturbance related to core sampling and temporary exploration facilities. Impacts to wetlands and other waters are expected to be temporary, limited in extent, and low in magnitude.

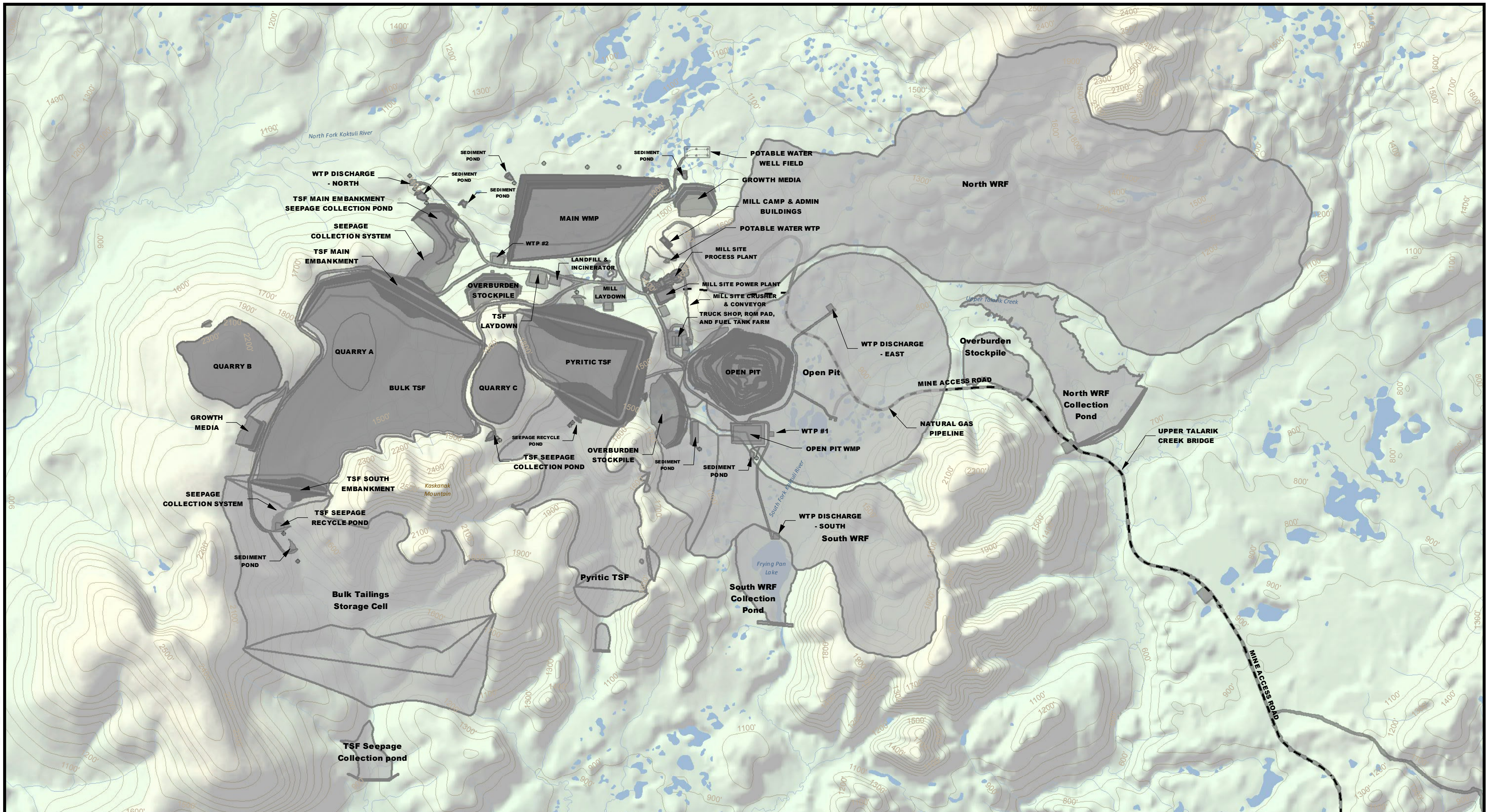
Additional RFFAs that have the potential to affect wetlands in the region include oil and gas exploration and development, energy and utility projects, the Diamond Point rock quarry, and various village infrastructure development projects. Depending on final design and permitting, these projects could impact wetlands, which when added to the past and present wetland loss, increases the total acreage affected.

The cumulative effects from past, present, and RFFAs would be consistent across project alternatives, except for the Pebble Mine Expanded Development Scenario. A discussion of impacts associated with this scenario is provided below.

Pebble Mine Expanded Development Scenario

The Pebble Mine Expanded Development Scenario is described in Section 4.1 and illustrated in Figure 4.22-3. The Pebble mine expansion would increase the amount of wetlands and other waters removal and fill, fugitive dust, and potential changes in wetland hydrology, and these impacts would be additive to those of the project. Approximately 21,546 acres of additional disturbance would occur at the mine site. It is assumed that the wetland types affected would be similar to those affected by the proposed project (herbaceous and broadleaf shrubs).

As shown in Table 4.22-12, the amount of additional ground disturbance associated with other project components would vary by alternative. The ground disturbance would occur along the same transportation/pipeline route as Alternative 3, and it is expected to affect similar wetland types (predominantly broadleaf shrub).



Sources: PLP 2018; USGS; ADNR

US Army Corps of Engineers®

0.5 0 0.5 1

Miles

Expanded Development

Alternative 1

Monitoring Wells

Natural Gas Pipeline

Mine Site Footprint

Other Features

River/Stream

Lake/Pond

100' Contour (Existing)

MINE SITE EXPANDED DEVELOPMENT

PEBBLE PROJECT EIS

FIGURE 4.22-3

Table 4.22-12: Pebble Expanded Development Footprint by Alternative

Project Component	Alternative 1		Alternative 2		Alternative 3	
	Proposed Project	Estimated Pebble Expanded Development footprint	Proposed Project	Estimated Pebble Expanded Development footprint	Proposed Project	Estimated Pebble Expanded Development footprint
Mine Site	8,086 acres	29,632 acres	8,241 acres	Mine Site	8,086 acres	29,632 acres
Port	30 acres at Amakdedori port	Additional compressor station at Amakdedori port – 3 acres	112 acres at Diamond Point port	Port	30 acres at Amakdedori port	Additional compressor station at Amakdedori port – 3 acres
Concentrate and diesel fuel pipeline to Iniskin Bay	N/A	1,022 acres (same as Alternative 3 North Road plus an additional segment between Williamsport and Iniskin Bay.	N/A	Concentrate and diesel fuel pipeline to Iniskin Bay	N/A	1,022 acres (same as Alternative 3 North Road plus an additional segment between Williamsport and Iniskin Bay.
Iniskin Bay port	N/A	30 acres	N/A	Iniskin Bay port	N/A	30 acres
Total	8,116 acres	30,717 acres	8,535 acres	Total	8,116 acres	30,717 acres

The duration of impacts would be extended, because processing of low-grade ore and potentially acid-generating (PAG) waste material would continue for another 20 to 40 years past the proposed end of mining. This would delay the reclamation of wetlands affected by the low-grade ore and PAG material storage areas, and extend the duration of impacts from dust and changes in wetland hydrology.

Expanded development and associated contributions to cumulative impacts would be the same for all alternatives at the mine site and the Iniskin Bay port; however, there would be differences in the transportation, pipelines, and natural gas compressor station footprints. As shown in Table 4.22-12, under Alternative 1, the additional compressor station would be located at the Amakdedori port, and the concentrate and diesel fuel pipelines to Iniskin Bay would include an adjacent service road (because the north access road would not have been constructed).

A discussion of cumulative effects is provided below for each project alternative.

4.22.9.2 No Action Alternative

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

4.22.9.3 Alternative 1 – Applicant's Proposed Alternative

The Pebble mine expanded development scenario mine site footprint would impact approximately 29,632 acres, compared to 8,086 acres under Alternative 1. The total number of wetlands potentially affected under this scenario would amount to an additional 12,445 acres[1]. This calculation assumes that 42 percent of the new affected area (29,632 acres) is wetlands, based on the Alternative 1 wetlands analysis. This additional 12,445 acres of potential wetlands disturbance represents 0.5 percent of the estimated 2,696,000 acres of wetlands in the analysis area. Predominant wetland types potentially impacted under this scenario include herbaceous and broadleaf shrubs.

Project construction activities would continue to disturb soil, alter surface water flow, and physically injure wetland vegetation. In areas with a high proportion of wetlands or during the construction of new mine site facilities and pipelines, wetlands could be excavated or filled. Excavation, filling, and clearing of wetlands would alter or remove their capacity to provide hydrologic, biogeochemical, and biological functions. Construction on or through wetlands would result in increased habitat loss, fragmentation, and degradation. The placement of gravel to construct project facilities could alter local hydrologic regimes, resulting in adverse effects on wetlands. Erosion from construction activities could result in sedimentation of wetland communities and alter functional capacity. These impacts would be additive to those of the proposed project. The expansion would increase the magnitude, duration, and geographic extent of the wetland impacts described under Alternative 1.

As shown in Table 4.22-12, this scenario (Alternative 1 plus expanded mine development) would cause the most impacts to wetlands among the project alternatives. This is because the ground disturbance associated with the diesel and concentrate pipelines, and associated service road, would be constructed in an area not affected by the Proposed Alternative. There would be two pipeline/road corridors operating between the mine site and Cook Inlet, rather than the one corridor that would exist under this scenario with either Alternatives 2 or 3: one in the south associated with the proposed project, and an additional one in the north associated with the expanded development. The additional pipeline/road corridor would require disturbance of an additional 1,022 acres. Similar wetland types (primarily deciduous shrub wetlands) are expected to be affected by the new road pipeline corridors, with acreages similar to the Alternative 3 Concentrate Pipeline Variant, which would permanently affect 108 acres of wetlands and waterbodies (see Table 4.22-8), including 75 acres of wetlands (predominantly deciduous shrub) and 33 acres of waterbodies. Impacts would be permanent, because the road would remain to facilitate long-term post-closure water treatment and monitoring.

The magnitude of impacts from this alternative would be the highest, because it would affect the largest area of wetlands of all the alternatives. It also involves the most acres of wetlands permanently removed, because it includes two permanent roads rather than one. The construction of linear features increases the likelihood of disruption of wetland hydrology. The duration of impacts would be extended by another 20 to 40 years past the end of mining under the Proposed Alternative. This would delay the closure and reclamation of wetlands affected by low-grade ore and PAG material storage areas. The impacts from the pipeline corridor road would be permanent. The extent of impacts would be limited to the immediate vicinity of the disturbance footprint.

[1] Wetland calculations assume 42 percent of the area is wetlands. This assumption is based on wetland mapping and field delineation data for Alternative 1 in the analysis area, and the Alaska Wetlands Initiative Summary Report (EPA 1994).

4.22.9.4 Alternative 2 – North Road and Ferry with Downstream Dams

Expanded mine site development and associated contributions to cumulative impacts would be the same for all alternatives. Under Alternative 2, project expansion would continue to use the existing Diamond Point port facility for shipment of molybdenum concentrate and transportation of supplies to the mine site; would use the same natural gas pipeline; and would use portions the constructed portion of the north road. After 20 years, the ferry would be discontinued; road connections between ferry terminals would be constructed to serve the concentrate pipeline, similar to what is described in Alternative 3; and the port site and associated facilities would be constructed at Iniskin Bay to dewater the concentrate and ship it via deeper water, as described under the variant to Alternative 3. A small service road would parallel the concentrate pipeline from the Williamsport-Pile Bay Road to Iniskin Bay. The concentrate pipeline from the mine site to Iniskin Bay would be constructed similar to Alternative 3, and a diesel pipeline from the mine site to Iniskin Bay would be constructed as discussed under cumulative effects for Alternative 1.

As shown in Table 4.22-12, the differences under Alternative 2 consist of the location of the additional compressor station (at Diamond Point port instead of the Amakdedori port); and the concentrate and diesel fuel pipelines to Iniskin Bay would be added to the natural gas pipeline corridor trench along the existing sections of the north access road. Because the natural gas pipeline and portions of the road would already exist under Alternative 2, the acres of disturbance and wetlands affected by the Pebble mine expansion would be lower under Alternative 2 than under Alternative 1.

At the mine site under Alternative 2 the additional wetlands affected at the mine site would be the same as under Alternative 1. For the transportation/pipeline corridor under Alternative 2, the additional wetlands affected would be those along the existing natural gas pipeline corridor plus any new wetlands located along the additional segment between Williamsport and Iniskin Bay. Section 3.22.5.4 describes the wetlands along the natural gas pipeline corridor. It is assumed that the additional 10-foot right-of-way (ROW) that would be added to this corridor for the diesel and concentrate pipelines would not affect any wetlands, because the ROW would have already been disturbed for the installation of the natural gas pipeline under Alternative 2. Additional wetlands may be affected by the construction and maintenance of the pipeline segment between Williamsport and Iniskin Bay. It is assumed that the wetland types affected would be similar to those affected by the proposed project (herbaceous and broadleaf shrubs).

The magnitude of impacts from this alternative would be the lower than Alternative 1. The duration of impacts would be the same, extended by another 20 to 40 years past the end of mining, delaying the reclamation of affected wetlands. The geographic extent of impacts would be limited to the immediate vicinity of the disturbance footprint, which would be smaller than Alternative 1. The extended duration of impacts also increases the likelihood of impacts from spills.

4.22.9.5 Alternative 3 – North Road Only

Expanded mine site development and associated contributions to cumulative impacts would be the same for all alternatives. Under Alternative 3, project expansion would continue to use the existing Diamond Point port facility; would use the same natural gas pipeline; and would use the same north road and Concentrate Pipeline Variant, but extend the concentrate pipeline with a service road to Iniskin Bay. The port site and associated facilities would be constructed at Iniskin Bay, as discussed under Alternative 2 above. A diesel pipeline from the mine site to Iniskin Bay would be constructed as discussed under cumulative effects for Alternative 2.

Under Alternative 3, the additional wetlands affected at the mine site would be the same as described under Alternative 1, and the additional wetlands affected for the transportation/pipeline corridor would be the same as described under Alternative 2. This is because the natural gas pipeline corridor would already exist under both Alternatives 2 and 3. Therefore, the cumulative effects of the expanded development scenario under Alternative 3 would be the same as those described under Alternative 2.