4.24 FISH VALUES

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

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

Permit compliance requirements, including standard and special terms and conditions, best management practices (BMPs), and environmental monitoring would be established by regulatory agencies and landowners with permitting authority. These requirements would be implemented as part of construction management and facility operations to avoid, minimize, and control risks to fish and aquatic habitat in the project area.

4.24.1 No Action Alternative

Under the No Action Alternative, the Pebble Project would not be constructed, and no new impacts to aquatic resources would occur.

4.24.2 Action Alternative 1

4.24.2.1 Habitat Loss

<u>Mine Site</u>

North Fork Koktuli

As described in Section 3.1, Introduction to Affected Environment, approximately 82 percent of the 10.7-square-mile (mi^2) mine site footprint would occur in the North Fork Koktuli (NFK) River basin (Figure 4.24-1). Tributary 1.19 would be blocked to anadromous and resident fish by the tailings storage facility (TSF) sedimentation pond and dam immediately above the tributary's confluence with the NFK. This anadromous tributary and its sub-tributaries provide 6.2 miles of spawning and rearing habitat for coho salmon, 2.9 miles of rearing habitat for Chinook salmon, and 12.7 miles of spawning and rearing habitat for resident fish species, including rainbow trout, Dolly Varden, Arctic grayling, and sculpin (Table 4.24-1). This direct loss of habitat would occur during project construction, and would be permanent, although a sub-tributary of Tributary 1.19 would remain free–flowing, and may provide habitat for resident species.

Table 4.24-1: Miles of Stream Channel Impacted Due to Fill, Excavation, Inundation, or Blockage to Upstream Migrant Fishes and Resident Fishes

Tributary	Channel Function	Miles
NFK Tributary 1.19	Chinook Salmon Rearing	2.9
	Coho Salmon Rearing	6.2
	Coho Salmon Spawning	3.9
	Resident Salmonid Presence	12.1
	Resident Non-Salmonid Presence	12.7
	Fishless	8.1
SFK Mainstem	Resident Non-Salmonid Presence	0.5
	Fishless	1.0
Tributaries to upper SFK	Resident Non-Salmonid Presence	0.8
	Fishless	2.2

When compared to the total mileage of currently documented anadromous waters in the three tributaries associated with the mine site (i.e., the NFK, South Fork Koktuli River [SFK], and the Upper Talarik Creek [UTC]), the loss of Tributary 1.19 habitat represents 4 percent and 3 percent of spawning and rearing habitat for coho salmon, respectively; and 3 percent of Chinook salmon rearing habitat. In the context of the entire Bristol Bay drainage, with its 9,816 miles of currently documented anadromous waters, the loss of Tributary 1.19 represents a 0.002 percent reduction in miles of anadromous stream habitat, or a 0.03 percent decrease in accessible drainage area.

Documented anadromous waters only represent waters where salmon have been observed, and are not considered representative of all anadromous waters in the Bristol Bay drainage. The total estimated mileage of anadromous waters in Bristol Bay drainage is likely much higher than currently documented. The mine site area is one of the few areas in the Bristol Bay drainage where numerous small channels and tributaries have been surveyed for salmon.

Within the mine site footprint, approximately 2.3 miles of Tributary 1.19 mainstem and sub-tributary stream channels would remain free-flowing. This habitat would not be accessible to anadromous fish due to blockage by downstream dams, but may continue to provide spawning and rearing habitat for resident species. In addition to the remaining free-flowing channels, approximately 1.4 miles of stream channel would be converted to reservoir habitat.

Approximately 276 acres of riparian wetland would be directly and permanently impacted by the mine site footprint; predominately in the NFK watershed. These impacts would include reduced surface water infiltration, retention, and groundwater flow; increased surface water runoff; and reduced water quality functions. Surface water BMPs would be implemented during construction, operations, and closure; and changes in riparian wetlands would likely not be detectable downstream from the mine site.

South Fork Koktuli River

The open pit and related mine facilities are expected to directly and permanently impact approximately 2.0 miles of fish habitat in the upper mainstem SFK and a headwater tributary (Table 4.24-1). The affected stream channels are not classified as anadromous, but provide habitat for populations of resident fish, including sculpin, Arctic grayling, and stickleback

Comment [A1]: NPS requests that this section include citations to peer-reviewed information support these statements and the data in this table. Over the life of the project what will be the loss in salmon and resident fish production to potential subsistence users downstream?

Comment [A2]: Please provide a reference or proof to support the claim that these reaches are fishless.

Comment [A3]: Does this include the mainstem plus tributaries that feed into each mainstem or just the mainstem? Please provide your methodology or exactly where the scientific reference is located.

Comment [A4]: Please provide the citation to support this statement.

Comment [A5]: Using a linear measure to compare the loss of Trib 1.19 (and potentially the NFK, Mulchatna, Nushagak... should there be a failure), is not defensible since productivity among all the different salmon habitat types of Bristol Bay varies drastically. This section should identify volume of the spawning area, or at least area, and the fact that different species have specific habitat preferences. Since 80% of the region is actually headwaters, and coho use much of that to spawn in but these are generally not as large an area or as productive as rivers such as North Fork, South Fork and Upper Talarik. This linear measure is deceptive and misleading relative to what is really important salmon habitat.

Comment [A6]: It is difficult to determine, based on Fig. 4.24.01, what all the acronyms mean and which species are going to be impacted where. Please define acronyms on the figure and which species will be impacted where.

Comment [A7]: Again, during spring and fall floods, the NFK and UTC can join together into one big wetland and mixing will occur.

Comment [A8]: The State Anadromous Waters Catalog seems to indicate that the Mine Site Layout in Fig. 2-3 will impact subsistence salmon habitat documented in the Upper SFKoktuli. It also indicates that a waste tailings pond pipe will be discharging into a documented anadromous salmon stream that feeds into Upper Talarik Creek. NPS recommends that the preferred alternative be changed to prevent discharge into Upper Talarik Creek. Mine impacts should be retained as much as possible in a single watershed. This section should analyze the exact discharge and analyze whether it will pose a threat to subsistence users of fish and or water. Please provide citation or page reference.

(Buell 1991). The extent of these impacts would be limited to waters in the footprint of the mine site footprint.

Upper Talarik Creek

The open mine pit and perimeter road are expected to extend to the western edge of the UTC drainage; the only mine site components that would occur in the UTC drainage are the transportation corridor road, the buried natural gas pipeline, and the eastern water treatment plant discharge pipe and facility (Figure 4.24-1). No aquatic habitat would be directly lost in the UTC due to mine construction, operations, or closure.

Transportation Corridor

Road/Pipeline

The road and pipeline would cross nine anadromous and 35 resident fish streams. Bridge and culvert crossings would be designed and installed in accordance with established Alaska Department of Transportation & Public Facilities (ADOT&PF) and Alaska Department of Fish and Game (ADF&G) standards to provide fish passage for all life stages resulting in minimal loss of aquatic habitat, except for the permanent loss of streambed joel

habitat within the footprint of bridge piers on the Newhalen and Gibraltar rivers. Single-span bridge crossings would be designed to maintain a riparian buffer between the bridge abutments and the active channel. The road/pipeline footprint and associated crossing structures would impact approximately 13.5 acres of riparian vegetation, and interrupt floodplain connectivity in certain locations. The impact to riparian vegetation would be permanent for the life of the project. BMPs such as road fill drain culverts may be considered during design and permitting to maintain floodplain connectivity and to maintain riparian habitat function.

Ferry Terminal/Iliamna Lake Pipeline

Docking facilities for the ice-breaking ferry at the north and south ferry terminals are expected to include rock and gravel ramps extending approximately 40 feet into Iliamna Lake. Consequently, there would be permanent, direct impacts due to loss of approximately 1 acre of benthic habitat under the ramp footprints.

Horizontal directional drilling (HDD) and trenching from lay barges would be used to install the pipeline segments from the lakeshore into waters deep enough to avoid navigational hazards. There would be temporary impacts to near-shore benthic habitats during construction, and permanent impacts to benthic habitat beneath the footprint of the pipeline in deeper waters.

Amakdedori Port

Amakdedori port would be a gravel causeway with a footprint of 14 acres. Placement of gravel in the nearshore environment would have permanent impacts on marine benthos habitat.

Natural Gas Pipeline

The construction phase would include installation of a 104-mile-long, 12-inch diameter gas pipeline on the floor of Cook Inlet from between the Kenai Peninsula and Amakdedori port. HDD would be used to install the pipeline segments from the shoreline into waters deep enough to avoid navigational hazards. These activities may involve displacement of some substrate material along with the associated organisms. There would be a permanent, direct loss of benthic habitat beneath the pipeline footprint on the bottom of Cook Inlet. Habitat alteration

Comment [A9]: Recommend referencing the State Anadromous Waters Catalog and their Freshwater Fish Inventory Database which is much more contemporary than this citation. Dolly Varden and other species have been documented in this region recently, please check ADFG and update information.

Comment [A10]: Roads and other infrastructure can have significant impacts on aquatic biodiversity and productivity (see Maitland et al. 2016; Trombulak and Frissell. 2001; and Review of ecological effects of roads on terrestrial and aquatic communities. Conservation Biology. Vol. 14. 1:18-30). The proposal includes an industrial road, with culverts, a buried pipeline and other road crossings along Upper Talarik Creek, which supports salmon and other subsistence species. Surveys of roads throughout Alaska that were supposed to support fish passage were unsuccessful (see https://www.fws.gov/alaska/fisheries/restoration/pdf/fish_passage_program.pdf https://www.arlis.org/docs/vol1/F/FishPassage/index.html) Please revise the conclusion of "no impact" or provide supporting doumentation of why these actions will not impact species in Upper Talarik Creek.

Comment [A11]: Ferry terminals can impact migrations of both adult and juvenile salmonids. The ferry port will be in the migration corridor of subsistence species migrating to spawning grounds throughout Iliamna and Lake Clark and smolt emigrating from freshwater to the sea. This section should address the following questions: How might this affect their migration? Will the ferry be treated with antifouling paints (typically containing copper, zine etc, which are toxic to fish) Will any treated pilings be used in construction? Will the terminal be lighted? Please see provided report of how ferry terminals and ferrys can impact fish. Please revise or provide references for conclusion of "no impact". See additional studies of ferry terminal impacts on salmon showing impacts to behavior of juvenile salmon here:
http://depts.washington.edu/trac/bulkdisk/pdf/472.1.pdf,
https://www.wsdot.wa.gov/Research/Reports/600/648.1.htm
and
http://depts.washington.edu/trac/bulkdisk/pdf/272.1.pdf
What are anticipated effects of potential spills of ore or an accident? How frequently are those anticipated to happen?

would be limited over time, and would not have quantifiable effects to populations of fish and shellfish.

4.24.2.2 Fish Displacement, Injury, and Mortality

Mine Site

North Fork Koktuli and South Fork Koktuli

Direct displacement, injury, and mortality of fish would occur during project construction in the NFK and SFK. Timing (May 15 to July 15) of construction in anadromous fish streams according to the ADF&G Fish Habitat Permit would minimize impacts to out-migrating juveniles and avoid the presence of spawning adults. Fish capture and relocation would be implemented according to ADF&G Aquatic Resource Permit (ARP) requirements to reduce impacts to resident fish. Stipulations contained in the ARP would determine timing, capture methods, and relocation protocols. Regardless of the scope of the capture and relocation effort, some fish would be displaced and experience injury or mortality. The extent or scope of these impacts would likely be limited to waters in the vicinity of the mine site footprint, and may not be measurable or detectable downstream from the affected stream channel.

Comment [A12]: This construction season would not avoid spawning adults. Spawning adult Chinook, Sockeye, and Coho Salmon all occur after July 15 in both systems. Spawning salmon were observed by Northern Dynasty consultants well into October. See NDM Progress Report. Chapt. 4. 2004.

Comment [A13]: NPS staff with experience working with impacts to fish at mine development sites suggest otherwise. There may be downstream changes in water quality and flow such as increased turbidity and changes in water flow regimes. Please consider the extent of potential impacts to aquatic resources and subsistence fish resources.

Upper Talarik

No fish displacement or mortality would be expected in the UTC due to mine construction, operations, or closure.

Comment [A14]: Again please address WTP Discharge East?(See Fig. 2-3 and ADFG AWC maps) in this section. What will be discharged into upper Talarik from the waste tailpipe? What about fugitive dust from the tailings or waste rock? What will be the impacts of blasting at the mine site on the local area fish streams near the pit? Many of the streams in that region are groundwater fed during winter and provide important overwintering fish and incubation habitat. Will groundwater feeding into area streams be affected by potentially contaminated water from the mine site and pit?

Transportation Corridor

Bridge, Culvert, and Natural Gas Pipeline Installation

Direct and localized mortality of fish from construction activities at stream crossings and the ferry terminals may occur, although with limited impact. Temporary water diversions or dewatering of stream reaches during construction could result in direct mortality due to fish stranding and desiccation. Fish entrainment or impingement at screens during pumping may also result in direct mortality or injury.

As stated above, timing and capture/relocation would be conducted according to established ADF&G practices and permit conditions to reduce impacts. Water pump intake screens used for dewatering and water withdrawal would be designed, constructed, and certified according to ADF&G standards to prevent fish impingement to reduce impacts.

Iliamna Lake Pipeline

The construction phase would include installation of an 18-mile-long gas pipeline on the floor of Iliamna Lake between the north and south ferry terminals. HDD and extended-reach backhoes would be used to install the pipeline segments from the lakeshore into waters deep enough to avoid navigational hazards. These activities may involve displacement of some substrate material along with the associated organisms. There would be permanent, direct mortality of benthic organisms beneath the pipeline footprint on the bottom of Iliamna Lake.

Sockeye salmon are known to use shoreline habitat for spawning, and therefore could be potentially affected; however, documented spawning areas are more than 0.5 mile from the ferry terminals and primary entry points of the pipeline into the lake (EPA 2014).

Ferry Terminals

Comment [A15]: Will there be any blasting associated with the construction of the ferry terminals? If so, please address impacts.

Docking facilities for the ice-breaking ferry at the north and south ferry terminals are expected to include rock and gravel ramps extending approximately 40 feet into Iliamna Lake. There would be permanent, direct mortality to benthic organisms within the approximately 1-acre total ramp footprints.

Ferry Operations

Propeller Entrainment or Injury

Direct impacts of propeller-induced injury or mortality to anadromous or resident fishes by motorboat propellers are not frequently assessed, and are limited to a few studies (Holland 1986; Killgore et al. 2011; Whitfield and Becker 2014). These primarily involved non-salmonid species; the paucity of field studies has been largely due to physical constraints imposed by sampling behind towboats (Killgore et al. 2011). A review of these publications indicated a number of biotic factors may affect fish strike rates by ferry propellers at Iliamna Lake, including:

- Life history traits of a species (pelagic versus nest or redd builders)
- Coincidence in timing of emigration and migration /movement of specific life stages with the path of a moving ferry
- Distribution of fish size/ species in the water column relative to ferry draft
- Spawning behavior
- Fish avoidance behavioral responses to ferry noise/turbulence
- Number, speed, and configuration of propeller blades (horizontal versus vertical)
- Fish size.

Table 3.24-2 in Chapter 3 shows the estimated seasonal presence and activity of life stages of common species that may be exposed to ferry/boat transiting between the north and south ferry terminals. Documented sockeye lake spawning is concentrated towards the northeastern portion of the lake (see Section 3.24, Fish Values); likely due to numerous islands and abundant sheltered habitats. As discussed below under wake stranding, the ferry terminals are on exposed, high-energy beaches with no documented beach spawning habitat in the immediate vicinity; therefore, ferry operations impacting adult sockeye salmon~~s~~ is unlikely. Juvenile sockeye have the highest potential to interact with the ferry operations due to their relative abundance and wide distribution throughout the Iliamna Lake system.

The potential exists for chronic, direct adverse interaction of ferry propeller blades and various life stages of migratory and non-migratory fish species throughout the 20-year operations phase of the project. The ferry has the potential to entrain fish into the turbulent zone created by propeller blades, although benthic species or midwater species larger than 10 millimeters are less susceptible to entrainment, and are expected to detect and avoid propeller-related impacts. Although unlikely, propeller strikes or shear forces could result in fish injury or mortality. Impacts are expected to be at the individual level.

Wake Impacts

Analysis of juvenile salmon stranding data from the lower Columbia River by Pearson et al. (2006) identified the following factors in affecting stranding:

- Fish availability in the shallow nearshore zone along the beach
- Nearshore ship-wake properties and wave run-up characteristics (wave height and period), as well as direction and extent of wave draw-down and run-up on the beach
- River elevation (river stage and tidal height)

Comment [A16]: Adult Sockeye Salmon returning to spawn in Iliamna Lake generally follow the shoreline. How will the terminals affect their migration which can number in the hundreds of thousands, as well as on emigrating smolt.

Comment [A17]: There is potential for adult salmon migrations to be impacted since the salmon follow the shoreline in large groups and will likely end up in the path of the ferry if the dock is built out in a solid wall versus piers that salmon could just swim under.

Comment [A18]: Do you mean "impacting spawning Sockeye Salmon is unlikely?"

- Beach characteristics (slope, distance to navigation channel).

Pearson et al. (2006) also noted that fish stranding occurred primarily during nighttime vessel passages, and no stranding occurred at the same locations during daytime passages. A radio telemetry study by Otter Tail (2010) on the Kuskokwim River reported no evidence of stranding of seaward-emigrating salmon when the prevailing wake height was less than 1.5 inches along the gravel bars surveyed; however, these fish did not occupy confined segments of the river.

The ferry terminal locations are relatively exposed, short beaches unprotected from wave energy. Numerous small storm berms are present on the beach faces, indicative of changing seasonal water levels. In contrast to studies conducted on rivers, stranding of fry from ferry wakes is not expected to be a detectable source of mortality in Iliamna Lake due to the perpendicular route of travel in relation to the shoreline. The Iliamna Lake ferry is expected to produce a 4-inch wake at its 6-knot approach speed; however, the wake would dissipate within 30 feet of the hull. Consequently, any impacts on juvenile and adult fish due to boat wake would be extremely limited in scale—both spatially and temporally.

Comment [A19]: The EIS should consider the impacts of the actions in this section on harbor seals.
What about the harbor seals?, which are an important subsistence resource and live year round in the lake on islands and along pressure cracks in the ice. Will they favor the ferry route the icebreaker makes? Will that increase potential for impacts? NPS recognises that this topic may already be addressed in another section.

Amakdedori Port

Short-term effects on both migratory and non-migratory marine fish species may occur during construction of the port. Fish are susceptible to injury and mortality from sound waves generated by pile-driving during construction of the proposed dock (Caltrans 2015). Mortality from sheet-pile installation is possible, but unlikely, due to the fish moving into existing available habitat in Cook Inlet.

Propeller Entrainment or Injury

Various propeller-driven tugs and other ships would be accessing Amakdedori port to transport equipment and personnel during project construction, operations, and closure. The impacts are similar to the above description of the Iliamna Lake ferry operations. This disturbance is expected to be chronic, but infrequent in duration, and localized in geographic extent.

Wake Impacts

During mine operations, marine barges or lightering vessels are expected to make up to 33 trips per year between the port and the offshore anchored bulk carriers. The barge's low transit speeds (5 to 7 knots), minimal draft (3 to 8 feet), distance from shoreline to jetty mooring locations (approximately 1,500 feet), and the presence of naturally occurring waves in Kamishak Bay, are all expected to limit wake-induced impacts on fish.

Natural Gas Pipeline

There would be permanent, direct mortality of benthic organisms beneath the pipeline footprint on the bottom of Cook Inlet during pipeline installation. The effect is expected to be of short duration and local to construction activities.

4.24.2.3 Stream Flow

Mine Site

Operation of the mine site is expected to result in an overall net reduction in available water for release into downstream channels. Reductions of instream flows in the mainstem and select tributary reaches of the NFK, SFK, and the UTC, due to filling of stream channels by the TSF or other stockpiles, excavation of channels and capture of groundwater at the mine pit, or the retention of surface runoff from mine facilities, would result in direct and long-term impacts to aquatic habitat and fish species. Streamflow reductions would begin during project construction, and would continue through operations and post-closure.

During project construction and operations, a network of seepage and sedimentation ponds would collect runoff and seepage from stockpiles, the mine pit, and other mine components (e.g., roads, embankments, and construction sites). Runoff and seepage water would be routed into the mill for ore processing and reuse, or routed to one of two water treatment plants for use in dust control or power plant cooling. Water would also be treated and released into stream channels at three locations: 1) NFK Tributary 1.19 immediately upstream of the NFK confluence; 2) the SFK at its confluence with Frying Pan Lake; and 3) a tributary to the UTC approximately 2 miles below its headwaters (Figure 4.24-1). The water would be treated before discharge in compliance with water quality standards to protect aquatic life, as specified in an Alaska Pollutant Discharge Elimination System (APDES) permit. Treated water would be discharged to groundwater via buried infiltration chambers designed to provide energy dissipation, erosion control, and freeze protection.

Reduction in streamflows could directly impact the quantity and quality of instream habitat for upstream migration of adult salmonids, spawning, and egg incubation, and rearing habitat for juvenile fish. Reductions in flows could also directly impact available habitat for benthic macroinvertebrate (BMI) production, which is critical for fish growth and survival. The magnitude and extent of impact would vary among the three principal tributaries, according to the degree of surface water and groundwater capture, the location of impacts in the basin, the proximity and size of downstream tributaries, and the magnitude of flow augmentation at the water release facilities.

Fish Habitat Changes Associated with Stream Flow

Downstream of the project footprint, habitat changes—as measured by weighted usable area—vary by species and life stage; drainage basin and reach; and for wet, average, and dry years (R2 Consultants 2018). Treated water releases from mine site facilities would be optimized to benefit priority species and life stages for each month and stream.

In general, most species would have larger-percentage reductions in usable spawning habitat in reaches just below the mine site than further downstream during project operations and post-closure. The percentage reductions in habitat would generally decrease in a downstream direction until reaching the confluence of the NFK and the SFK (with a few exceptions). Rainbow trout, chum, sockeye, Dolly Varden, and Arctic grayling would have habitat decreases only in the headwater tributaries. Chinook and coho spawning habitat would decrease throughout the NFK and SFK drainages. Once the mainstem Koktuli is reached, flow changes would not be detectable. Therefore, the downstream extent of habitat impacts associated with flow reductions would be downstream of the confluence of the NFK and the SFK, and upstream of the mainstem Koktuli River confluence with the Swan River (the end of the model domain).

Comment [A20]: What is the anticipated net flow reduction into each system based on seasonal cycles?

Comment [A21]: How will water be treated and what will be the anticipated water quality and quantity upon release? Are any negative impacts to aquatic subsistence species anticipated? Because salmon imprint on stream natural water chemistry, how might the water chemistry change?

Comment [A22]: Why is treated water being discharged to groundwater? How will it be monitored? Since groundwater from the mine region likely feeds subsistence salmon streams in the area what if any potential impacts might that have?

Comment [A23]: Is there a quantitative estimate of reductions in streamflows for each river?

Comment [A24]: Please provide a copy of this report for review. NPS is unfamiliar with the measure "weighted usable area" and with the supporting quantitative studies. This is not part of Pebble's EBD or readily available in any scientific reference search or on R2s or Pebble's website.

Comment [A25]: Please clarify. NPS is unfamiliar with mine sites releasing treated water to optimize "priority" species and life stages. Any citiations to supporting documents would be useful.

Comment [A26]: Provide citations to supporting documents or make the data and analysis available for review.

Comment [A27]: Rearing habitat for these species will also be affected.

Comment [A28]: What and where will these percent reductions be? How do these translate to loss of subsistence fish production for people over the life of the mine? Provide citations to supporting documents and make the data and analysis available for review.

Table 4.24-2: Priority species and life stages used to determine habitat flow needs in the Mine Site Area

Month	Priority Species/Life Stages		
	SFK	NFK	UTC
Jan	Chinook Juvenile Rearing	Chinook Juvenile Rearing	Coho Juvenile Rearing
Feb			
Mar			
Apr	Arctic Grayling Spawning	Arctic Grayling Spawning	Arctic Grayling Spawning
May			
Jun	Rainbow Spawning	Rainbow Spawning	Rainbow Spawning
Jul	Chinook Spawning	Chinook Spawning	Sockeye Spawning
Aug			
Sep	Coho Spawning	Coho Spawning	Coho Spawning
Oct			
Nov			
Dec	Chinook Juvenile Rearing	Chinook Juvenile Rearing	Coho Juvenile Rearing

Spawning Habitat

Throughout the mine site area in average precipitation years, Chinook and coho spawning habitat would be reduced; while chum, sockeye, rainbow, Dolly Varden, and Arctic grayling spawning habitat generally would be increased (Table 4.24.3). In wet years, the decreases in habitat would be lower, and the increases greater; in dry years, the habitat decreases would be greater and the increases would be lower. Post-closure, flow reductions would be lower than during mining, resulting in smaller reductions and increases in habitat.

Comment [A29]: How were these predicted changes in various species spawning habitats determined? What areas are included in these calculations? It is not clear whether there are quantitative models that examined habitat selection and preference by these species for potentially affected reaches. Please provide citation.

Table 4.24-3 Average precipitation year spawning habitat for all streams and species in the mine site area pre-mine, during operations, and post-closure

Comment [A30]: Please provide the scientific analysis that supports this table or citations to sources. How does this translate to changes in number of fish produced for subsistence users in the region over the life of the mine?

Comment [A31]: What is an average precipitation year? How does this compare to predicted changes relative to climate changes forcast for the region over the life of the mine? Please provide citation.

	Habitat Available			Change in Available Habitat			
	Pre-Mine	During Operations	Post Closure	During Operations		Post Closure	
Species	(acres)	(acres)	(acres)	(acres)	(% diff)	(acres)	(% diff)
Chinook	*82.54*	*79.51*	*81.14*	*-3.02*	*-3.7%*	*-1.40*	*-1.7%*
Coho	*105.56*	*102.87*	*104.21*	*-2.69*	*-2.6%*	*-1.34*	*-1.3%*
Chum	*180.10*	*181.07*	*180.84*	*0.97*	*0.5%*	*0.74*	*0.4%*
Sockeye	*133.00*	*133.73*	*133.65*	*0.73*	*0.5%*	*0.65*	*0.5%*
Rainbow	*98.46*	*101.40*	*100.01*	*2.94*	*3.0%*	*1.55*	*1.6%*
Dolly Varden	*203.58*	*204.02*	*203.90*	*0.44*	*0.2%*	*0.32*	*0.2%*
Arctic Grayling	*132.24*	*135.59*	*133.10*	*3.34*	*2.5%*	*0.86*	*0.7%*

North Fork Koktuli

The trends in habitat change modeled in the entire mine area are shown in the changes in NFK spawning habitat. In average precipitation years during mine operations, salmonid habitat availability would decrease by 2.01 acres (8.1 percent) for spawning Chinook, and 1.86 acres (5.5 percent) for coho, while it would increase by 2.12 acres (5.8 percent) for spawning rainbow trout, 1.42 acres (4.4 percent) for sockeye, and 1.95 acres (5.5 percent) for Arctic grayling. Post-closure, habitat changes are predicted to be reduced to a 2.7 percent loss in Chinook, and 2.1 percent loss for coho. Habitat gains for the other species follow the same trend.

Comment [A32]: Provide the models and data to support these predicted changes, and describe how this applies to the tens of thousands of fish that spawn in these rivers and support subsistence? Please provide citation.

South Fork Koktuli

The trends in habitat change modeled indicate there would be a reduction in sockeye spawning habitat in the SFK. In average precipitation years, salmonid habitat availability would decrease by 1.02 acres (2.8 percent) for spawning Chinook, 0.82 acre (2.4 percent) for coho, and 0.69 acre (1.3 percent) for sockeye. Habitat would increase by 0.80 acre (2.4 percent) for spawning rainbow trout, and 1.18 acres (2.6 percent) for Arctic grayling. Habitat changes for Dolly Varden and chum salmon are less than 1 percent.

Comment [A33]: Are these trends predicated on the PHABSIM models submitted in the EBD? Or have new models and studies been conducted to correct the deficiencies in those models? Please see provided citation by Parasiewicz 2012.

Upper Talarik Creek

Due to low-magnitude flow changes in the UTC basin, spawning habitat changes for all species would be less than 1 percent during both mining operations, and post-closure.

Comment [A34]: Construction and use of an industrial road and the other road crossings will potentially have an impact on salmon spawning habitat. Increased fine sediments, chemicals from truck brake pads, etc.

Juvenile Habitat

Juvenile salmonid habitat would be affected by the reduced flows associated with both mining and post-closure operations. In general, Chinook and rainbow trout juvenile habitat would be reduced, while sockeye juveniles (and the other salmonid species, to a lesser extent) would generally benefit from reduced flows associated with the mining operations. Sockeye juvenile habitat increases would generally be associated with the SFK-C reach, where habitat would be increased by 0.76 acre (44 percent) during mining operations; while rainbow habitat losses would be greatest in SFK-190, where habitat would decrease by 0.15 acre (13.3 percent) during operations.

Comment [A35]: How does this translate into fish production?

Comment [A36]: Supporting data is lacking regarding these claims. Please provide quantitative studies for review.

Changes in habitat for juveniles would be reach-specific. The changes in habitat availability would be less associated with upstream or downstream reach locations, and more dependent on reach-specific habitat features. For example, beginning at the mine site in the NFK drainage, moving downstream in average years, juvenile coho habitat would alternate between increases and decreases in habitat in each reach (NKF-190, NFK-C, NFK-B, NFK-A).

Table 4.24-4 Average precipitation year juvenile habitat for all streams and species in the mine site area pre-mine, during operations, and post-closure

Comment [A37]: Please provide citations and scientifically defensible quantitative data and analysis to back up the claim that there will be more Coho, Chinook, and Dolly Varden juvenile habitat during mining than prior to mining. The PHABSIM data do not suppot this claim (see Parasawicz 2012). The sockeye salmon in these systems do not rear in the river so it is not pertinent to include them in this table. Delete.

	Habitat Available			Change in Habitat Available			
	Pre-Mine	During Operations	Post Closure	During Operations		Post Closure	
Species	(acres)	(acres)	(acres)	(acres)	(% diff)	(acres)	(% diff)
Chinook	*57.44*	*57.40*	*57.23*	*-0.05*	*-0.1%*	*-0.22*	*-0.4%*
Coho	*55.47*	*55.58*	*55.43*	*0.11*	*0.2%*	*-0.03*	*-0.1%*
Chum	--	--	--	--	--	--	--

Table 4.24-4 Average precipitation year juvenile habitat for all streams and species in the mine site area pre-mine, during operations, and post-closure

	Habitat Available			Change in Habitat Available			
	Pre-Mine	During Operations	Post Closure	During Operations		Post Closure	
Sockeye	*41.11*	*41.85*	*41.20*	*0.75*	*1.8%*	*0.09*	*0.2%*
Rainbow	*56.01*	*55.70*	*55.59*	*-0.31*	*-0.6%*	*-0.42*	*-0.8%*
Dolly Varden	*62.97*	*63.25*	*63.06*	*0.27*	*0.4%*	*0.09*	*0.1%*
Arctic Grayling	*101.06*	*101.91*	*101.39*	*0.85*	*0.8%*	*0.33*	*0.3%*

Comment [A37]: Please provide citations and scientifically defensible quantitative data and analysis to back up the claim that there will be more Coho, Chinook, and Dolly Varden juvenile habitat during mining than prior to mining. The PHABSIM data do not suppot this claim (see Parasawicz 2012). The sockeye salmon in these systems do not rear in the river so it is not pertinent to include them in this table. Delete.

North Fork Koktuli

In average precipitation years, juvenile salmonid habitat availability would increase for all species by between 0.03 acre, or 0.2 percent (sockeye) and 0.96 acre or 2.9 percent (Arctic grayling), except for a decrease in rainbow trout habitat of 0.02 acre (0.2 percent). Post-closure, habitat changes would be reduced to less than 1 percent for all species. As mentioned above, the habitat changes would vary based on reach-specific conditions, with the largest percentage of changes occurring in small tributary NFK-190. However, in a downstream direction, reaches would alternate between habitat gains and losses for several species.

Comment [A38]: Clarify the measure average precipitation year. How does this compare with the predicted increases in precipitation for SW AK in the coming decades? And how does this translate to subsitence fish production?

South Fork Koktuli

In average precipitation years, juvenile salmonid habitat availability would decrease for all species by between 0.07 acre, or 0.2 percent (Arctic grayling), and 0.31 acre, or 1.5 percent (rainbow trout), except for an increase in sockeye juvenile habitat of 0.73 acre (7.1 percent). Post-closure, habitat changes would be less than 1 percent for all species, except for a decrease in rainbow trout habitat of 0.27 acre (1.3 percent), and an increase in sockeye habitat of 0.14 acre (1.3 percent). The largest changes in habitat in the SFK area are associated with rainbow trout habitat, which increased in the SFK-C reach.

Comment [A39]: Juvenile sockeye salmon do not rear in-river.

Upper Talarik Creek

Comment [A40]: The impact of an industrialized road will impact qualty and quantity of subsistence fish habitat.

Due to low-magnitude flow changes in the UTC basin, juvenile habitat changes for all species would be less than 1 percent during both mining operations and post-closure.

Comment [A41]: Will groundwater have to be pumped out of the pit constantly during operations? If so, does that groundwater also feed Upper Talarik Creek? Because groundwater is so critical for overwintering fish and incubating embryos, it seems that would be an important consideration.

Transportation Corridor

Road Construction

Except temporarily during construction, potential impacts on stream flows are not expected to occur at bridge and culvert crossings. All work in fish-bearing streams would be subject to design considerations, restoration requirements, and timing windows, as specified by ADF&G Title 16 Fish Habitat Permits (AS 16.05.841-871). In accordance with ADF&G criteria, bridge and culvert construction activities in anadromous waters would occur from May 15 to June 15, to avoid impacts to migrating salmon. Infrequent barriers to fish passage could occur at stream crossings using culverts due to temporary blockage. The impact is expected to be localized and temporary. Routine inspection and maintenance of culverts, bridges, and roads would be regularly conducted in compliance with right-of-way (ROW) and ADF&G permit conditions, to ensure that culvert-related erosion, wash-out, or debris blockage do not result in permanent

Comment [A42]: Based on NDM studies, spawning rainbow trout begin at breakup and adult salmon spawn throughout the entire summer through October. Impacts will be difficult to avoid and thus should be quantified and acknowledged.

impacts to fish passage or downstream habitat. More stringent monitoring and maintenance standards may be required by ROW lease stipulations from respective land owners.

Water withdrawals would occur at lakes, ponds, and streams along the road corridor, according to ADNR and ADF&G permit conditions for dust control and hydrostatic testing during the summer construction seasons; and would not be expected to impact overwintering fish or habitat. Withdrawals from fish-bearing waters would use pump screens certified by ADF&G to prevent fish impingement. Disposal methods for hydrostatic test water would be developed in accordance with APDES General Permit AKG320000 for energy dissipation and sediment control. No chemicals would be added to the hydrostatic test waters.

Natural Gas Pipeline

The final configuration of the natural gas pipeline would generally be within the prism of the access road. Stream crossings would be open cut or HDD at culvert crossings, and attached to bridges at major river crossings. This configuration would reduce the risk of ponding, interception of surface water flows, and sedimentation, as related to the pipeline ditch.

Potential impacts to groundwater and surface water during pipeline construction would likely involve interception of shallow groundwater and surface water during trenching activities, which would be captured and locally flow along the trench backfill. Impacts could extend beyond the life of the project, because the pipeline would be abandoned in place. Ditch plugs are typically installed to intercept shallow groundwater flows. Typical BMPs for surface water management could include maintaining natural surface water patterns; crowning of ditch backfill to allow for settlement to original ground level; contouring of surrounding terrain; construction of settlement infiltration basins; and prompt revegetation of riparian and wetlands and a robust monitoring and maintenance program. Ditch dewatering and hydrotest water would be discharged to approved sites as per Alaska Department of Environmental Conservation (ADEC) requirements. All work in fish-bearing streams would be subject to design considerations, restoration requirements, and timing windows, as specified by ADF&G Title 16 Fish Habitat Permits (AS 16.05.841-871).

4.24.2.4 Stream Productivity

Mine Site

The loss of connection between Tributary 1.19 and the mainstem NFK due to stockpile embankments and pond dams could result in permanent, direct effects on the quantity of spawning habitat by interrupting gravel transport into the mainstem NFK. Geomorphic studies conducted as part of the environmental baseline effort concluded that most instream gravel is recruited from local streambank erosion, rather than transported from upstream reaches, EBD Chapter 3, Geology and Mineralization); however, a source like Tributary 1.19 would also be expected to contribute gravel into mainstem reaches. Two other sizeable tributaries (NFK Tributaries 1.17 and 1.12) meet the mainstem NFK within 5 miles below the mine site, so the effects of reduced gravel recruitment would likely be limited in area. Spawning surveys conducted from 2004 to 2008 indicated the heaviest spawning by coho and chum salmon was concentrated in the mainstem NFK in the 9-mile reach immediately below the mine site and Tributary 1.19. In contrast, Chinook and sockeye salmon spawning areas were concentrated in the mainstem NFK 10 to 20 miles downstream of the mine site, where potential impacts of upstream gravel interruptions are less likely.

Baseline concentrations of dissolved organic carbon in the surface waters in the project area ranged from 1 milligram per liter (mg/L) to 2 mg/L; concentrations of nitrate+nitrite ranged from 0.1 to 0.3 mg/L; and mean concentrations of total phosphorous ranged from 0.02 to 0.04 mg/L, indicative of oligotrophic nutrient status in the aquatic ecosystem. This is consistent with the characteristics of headwater stream orders 1, 2, and 3; with existing riparian vegetation providing low inputs of organic matter. The lack of a mature deciduous overstory likely contributes to the oligotrophic conditions, and is unique to headwater streams in the project area; specifically, the NFK and SFK. The extent or scope of the loss of riparian productivity would likely be limited to waters in the vicinity of the mine site footprint, and may not be measurable or detectible downstream from the affected stream channel.

Comment [A43]: Please provide citation.

The importance of marine-derived nutrients in Bristol Bay watershed lakes from returning salmon is well documented, as noted in Chapter 3, Affected Environment. As shown in the baseline data above, marine-derived nutrients does not appear to have a measureable influence on the nutrient availability in the Koktuli or uppermost reaches of the Upper Talarik watersheds in the project area. This may be due to the comparatively small numbers of spawning fish, high flushing flows in the fall after spawning has occurred and the lack of large woody debris for carcass retention. The extent or scope of these impacts would likely be limited to waters in the vicinity of the mine site footprint, and may not be measurable or detectible downstream from the affected stream channel.

Transportation Corridor

Road and Pipeline

The road and pipeline would cross 9 anadromous and 35 resident fish streams (Appendix K3.24). In some locations, such as culvert crossings, the road/pipeline footprint would impact riparian and floodplain connectivity in the 100-year floodplain. This could reduce allochthonous inputs and downstream productivity, and would be permanent for the life of the project. Culverts would be designed and installed in accordance with ADOT&PF and ADF&G standards to provide fish passage for all life stages. Other BMPs, such as road fill drain culverts, may be considered to maintain floodplain connectivity. Because of the available riparian habitat that would not be impacted throughout the watersheds, the impacts from the transportation corridor would be expected to be of short duration.

Iliamna Lake Pipeline

HDD would be used to install the pipeline segments from the lakeshore into waters deep enough to avoid navigational hazards, then laid and secured on the lake bottom. Approximately 2.18 acres of the approximately 647,000 acres of available benthic habitat in Iliamna Lake would be permanently impacted.

Ferry Terminal and Operation

Docking facilities for the ice-breaking ferry at the north and south ferry terminals are expected to include rock and gravel ramps extending approximately 40 feet into Iliamna Lake. Consequently, there would be short-term, indirect disturbance effects from ramp construction along the shoreline; and permanent, direct impacts due to loss of approximately 1 acre of benthic habitat under the terminal's footprint. Because of the quantity of available benthic habitat (approximately 234 miles of shoreline/647,000 acres), there would be no anticipated impacts to the overall productivity of Iliamna Lake.

Amakdedori Port

The port site would permanently impact 14 acres of benthic habitat. Because of the existing 30 million acres of available benthic habitat in Cook Inlet, there would be no anticipated impacts to the overall benthic productivity in Cook Inlet.

4.24.2.5 Stream Sedimentation and Turbidity

The effects of stream sedimentation on fish could occur during all three phases of the project: construction, operations, and closure/post-closure. Mine site activities have the potential to release particulates and sediment into drainages and tributaries from a range of activities and sources, including:

- Soil disturbance, compaction, and vegetation removal;
- Wetland in-filling that reduces sediment retention and exposes soils to erosive forces of wind and/or water;
- Stream erosion from increased flows released as a result of inter-basin diversions and transfers;
- Rock fracturing/processing activities; and
- Runoff from constructed roads, pipeline, and materials sites.
- Fugitive dust from tailings reservoirs

Sedimentation is known to affect the quality and quantity of aquatic habitat. Fine sediments in streams are associated with degradation of salmonid spawning habitat quality, and can ~~affect~~ reduce ~~the~~ survival of incubating eggs; inhibit fry emergence; reduce instream cover and overwintering refuge for juvenile fish; reduce overall fish-carrying capacity; and decrease fish food (BMI) availability (Limpinsel et al. 2017). Although sediment transport and deposition are natural stream processes, major disruptions of the stream system and its functions could occur when sediment delivery is substantially changed, or when the ability or capacity of the stream to transport sediment is altered due to natural events or human activities. Erosion and sedimentation also may elevate turbidity, which can adversely affect fish feeding, growth, and survival (Lloyd 1987).

Elevated turbidity in streams from suspended sediments can have adverse impacts on fish and other aquatic organisms through several mechanisms, such as reduced foraging efficiency of drift-feeding fish, elevated water temperature through increased light absorption, reduced primary production, and damage to gill membranes under conditions of severe turbidity (Bash et al. 2001; Newcombe and Jensen 1996).

The mine site construction would disturb 8,130 acres of surface soil. Components of the mine site that could release sediment into waterways include the 13 embankments for various stockpiles (TSF, overburden, etc.) and ponds (seepage, sedimentation, and water management); parking, laydown and construction sites; materials sites; and haul, access, and service roads. During construction and operation of the mine, surface runoff would be captured by drainage ditches that would route runoff into ponds for treatment at one of two water treatment facilities before discharge into downstream waters. Likewise, seepage from stockpiles would drain into ponds for subsequent treatment and discharge.

The magnitude of stream sedimentation that could result from such disturbance would depend on the effectiveness of required state-of-the-process BMPs under stormwater pollution prevention regulations implemented, monitored, and maintained during all phases of the project. BMPs are designed to mitigate the intensity of surface runoff, erosion, and sediment loads in stream channels. A range of BMPs, including silt fences, bale check dams, sediment retention

Comment [A44]: This amount of soil disturbance will significantly change run-off patterns and has potential to increase occurence of flashy flows such as urban areas experience.

Comment [A45]: Some of the surface runoff would be captured but, in high rainfall years and during spring breakup and fall floods, it will be extremely difficult to capture and control runoff. In addition, previously unexposed sulfide materials can generate acid runoff and introduce heavy metals toxic to aquatic life (copper, zinc, lead, etc.) into the environment affecting the entire aquatic food chain (see USEPA 1995, Maret and Macoy 2002, Maret et al. 2003, Daniel et al. 2015). This can impact fish species important to subsistence including anadromous salmon by impacting their ability to smell which is how they identify predators, prey, kin and mates impacting survival (Baldwin,et al. 2003, McIntyre et al. 2006, Sandahl et al. 2006, McIntyre et al. 2012, Morin et al. 2012).

Comment [A46]: Best Management Practices are not required and permit conditions, or applicable regulations, are generally just minimum requirements. BMPs are often not followed and therefore cannot be assumed to be applicable in the case of Pebble Project.

basins, cross bars and ditches, runoff interception and diversions, gabions and sediment traps, mulching of disturbed surfaces and stockpiles, and other measures, would be implemented and monitored along the mine site road corridors and at all bridge and culvert crossings to ensure minimization of potential impacts from erosion and sedimentation. BMPs would also be employed to minimize impacts of surface runoff and erosion at materials sites.

Measurable changes in the quality and character of aquatic habitat from sedimentation would be likely, although impacts are expected to be limited to the mine site and road corridor footprint and immediate downstream areas in the NFK, SFK, and UTC drainages. The duration of sedimentation impacts is likely to be temporary and of short duration. Permit-required monitoring of fine sediments deposited in spawning gravel would identify any degradation in spawning habitat quality and sources of potential impact.

Mine Site

Development and operation of the mine site and its associated facilities (e.g., roads, embankments, and housing) are expected to result in increased surface runoff, which—if not captured and re-routed to treatment facilities—can lead to elevated turbidity in adjacent stream channels. Increased turbidity of discharge effluent may result if treatment of captured water in sediment and seepage ponds is not successful in removing all suspended sediments. Turbidity may also occur due to dissolved solids, which can alter color in treated discharge water. BMPs would be implemented and maintained during construction and maintenance of all mine facilities to minimize surface runoff. All effluent discharged from water treatment plants would be subject to water quality criteria dictated by discharge permits. Treated water would be discharged through buried infiltration chambers designed to provide energy dissipation, erosion control, and freeze protection. Sampling at water discharge locations at all three principal tributaries would monitor any changes in turbidity over background levels, and would identify any out-of-permit conditions and initiate remediation procedures. Impacts to turbidity would most likely be within the mine site footprint; particularly when extreme weather events coincide with ground-disturbance activities.

Transportation Corridor

Road construction, maintenance, and use can result in short- and long-term impacts to streams and drainages from increased surface erosion and deposition of fine sediments; alteration of water temperature; delays or barriers to fish migration at culverts; changes in streamflow and hydrologic processes; and introduction of invasive plant species (Limpinsel et al. 2017). Surface erosion can also result from clearing and grading activities and from poorly surfaced or maintained roads with steep grades, high traffic volume, and insufficient stormwater management facilities. Accumulations of fine sediments in streams have been associated with decreased fry emergence, reductions in winter carrying capacity and benthic production, and changes in species composition in benthic invertebrate communities (NMFS 2011a).

The proposed road would be constructed through existing bedrock and glacial fluvial surface geology using locally processed materials with low erosion potential. Therefore, the indirect effects of erosion and sedimentation are expected to be limited to bridge or culvert crossings. Construction-related sedimentation is expected to be temporary in nature due to permit stipulations and timing windows. Additional monitoring, BMPs, and maintenance standards may be required by ROW lease stipulations from the respective landowners.

The proposed design of the natural gas pipeline would be within the prism of the access road, and attached to bridges at river crossings. This configuration would reduce the risk of ponding, interception of surface water flows, and sedimentation, as related to the pipeline ditch.

Operations are expected to require 35 truck round trips per day, which would result in dust impacts in proximity to roads, including at stream crossings. Implementation of dust suppression and enforcement of slow speed limits at all stream crossings would minimize dust-related impacts to aquatic ecosystems. Impacts are expected to extend through the life of the project.

Road and Pipeline

Potential impacts on stream turbidity are not expected to occur at bridge or culvert crossings, except temporarily during construction. The impact is expected to be localized to the immediate location of the drainage structure. Bridge and culvert construction activities in anadromous waters would occur from May 15 to June 15 to avoid impact to migrating salmon, according to ADF&G criteria. As stated above, routine inspection and maintenance of culverts, bridges, and roads would be regularly conducted, in compliance with permit conditions to ensure that drainage-structure–related erosion, wash-out, or debris blockage do not result in impacts to water quality or downstream habitat.

Comment [A47]: Wherever dirt/gravel roads cross streams and particularly where heavy truck traffic occurs there will be increased sedimentation into streams at crossings, particularly during rain events. See earlier provided sedimentation references. If salmon or fish spawning and rearing habitat is present at crossings, subsistence fish production can be impacted depending on the amount of habitat lost or degraded.See provided references.

Ferry Terminals

Docking facilities for the ice-breaking ferry at the north and south ferry terminals are expected to include rock and gravel ramps extending approximately 40 feet into Iliamna Lake. Consequently, there would be localized, short-duration turbidity effects on fish and benthic organisms during construction.

Amakdedori Port

Temporary increases in turbidity would occur during construction of the Amakdedori Port. Turbidity and deposition of suspended sediments in the nearshore environment at the port site could impact marine benthos. Temporary effects on both migratory and non-migratory marine fish species may also occur, particularly for benthic fish species expected to inhabit the immediate area. Sediment deposition on aquatic vegetation could also reduce potential spawning habitat for species such as Pacific herring. Any impacts from port construction are expected to be of short duration, and localized to the area of disturbance.

4.24.2.6 Fish Migration

Mine Site

The mine site service and haul roads would cross seven fish-bearing streams, not including road crossings where channels enter stockpile embankments or the open pit (Figure 4.24-1). Two of the stream crossings involve anadromous streams, four cross non-resident salmonid streams, and one crosses a sculpin-bearing stream. The anadromous crossing in the NFK drainage is over a branch of Tributary 1.19 that would be permanently blocked to anadromous fish during project construction and operations. The second anadromous crossing is in the headwaters of the mainstem SFK, approximately 1,000 feet below the southern edge of the mine pit. Implementation of BMPs that would minimize the magnitude of impact on fish migration resulting from such disturbances would depend on the effectiveness of BMPs. The seven culverts would be designed and sized for fish passage according to ADF&G standards.

Transportation Corridor

Road and Pipeline

Potential impacts on fish passage are not expected to occur at bridge crossings, except temporarily during bridge construction. Bridge, pipeline, and culvert construction activities in anadromous waters would occur from May 15 to June 15 to avoid impact to migrating salmon, according to ADF&G criteria. Infrequent barriers to fish passage could occur at culverts due to temporary blockage. The impact is expected to be localized, and temporary in nature. Routine inspection and maintenance of culverts, bridges, and roads would be regularly conducted and reported, in compliance with permit conditions, to ensure that culvert-related erosion, wash-out, or debris blockage do not result in acute or chronic impacts to fish passage or downstream habitat.

Ferry Terminal

As stated above, docking facilities for the ice-breaking ferry at the north and south ferry terminals are expected to include rock and gravel ramps extending approximately 40 feet into Iliamna Lake. There are no anticipated impacts to fish migration associated with these structures due to existing migratory habitat available in Iliamna Lake.

Comment [A48]: Again, because Sockeye Salmon tend to aggregate and follow shorelines there may be impacts on adult and/or smolt migrations depending on design and materials used in construction of the ferry terminal.

Amakdedori Port

There are no anticipated impacts to fish migration associated with the port structure due to existing migratory habitat available along the shores of Cook Inlet.

Natural Gas Pipeline

The pipeline has the potential to hinder migrations of marine invertebrates (e.g., crabs) but impacts are expected to be minimal and occur at the individual level.

4.24.2.7 Water Temperature

Construction and operations of the mine site may lead to changes in several water quality parameters in area streams that have the potential to impact fish. The ADEC (2009) standards for water temperature criteria associated with growth and propagation of fish, shellfish, and other aquatic life and wildlife in freshwater state that at no time should maximum water temperatures exceed 20 degrees Celsius (^{o}C), with the following life-stage specific maxima: 15^{o}C for migration and rearing, and 13^{o}C for spawning and egg incubation. Ambient water temperatures monitored from 2004 to 2009 frequently exceeded the ADEC 15°C criteria in many stream reaches (ADEC 2009). In each year of study, the daily maximum water temperature in the NFK immediately upstream of the mine site exceeded the 20^{o}C criteria on about 28 percent of all instantaneous readings during the summer months. The lower temperature thresholds for migration and rearing (15^{o}C) were exceeded on 78 percent of summer readings; and the spawning and egg incubation criteria (13^{o}C) were exceeded on 89 percent of summer readings.

Summer baseline water temperatures also exceeded ADEC thresholds in several reaches of the SFK, and to a lesser degree in the UTC. Maximum daily water temperatures exceeded the general 20^{o}C criteria in 17 percent of measurements at multiple stations in the SFK, but daily maxima remained below the threshold in the UTC. Exceedance percentages for the 15^{o}C migration and rearing thresholds for the SFK and UTC were 76 percent and 44 percent, respectively; whereas comparable exceedance values for the 13^{o}C spawning and egg incubation criteria were 93 percent of summer readings in the SFK, and 59 percent of readings in the UTC.

Although the water temperature regimes in the project area frequently exceeded the ADEC criteria during the 2004-2009 sampling period, adult and juvenile salmon and resident trout remained abundant. However, any reduction in streamflows during the summer base-flow period may have a direct impact on salmonids through increased water temperatures; and potentially, through decreased temperatures during the winter base-flow period. Direct impacts could affect egg/fry incubation and availability of prey species during low-flow events. Although the water temperature regimes in the project area frequently exceeded the ADEC criteria during the 2004-2009 sampling period, adult and juvenile salmon and resident trout remained abundant. Impacts associated with changes in water temperature are discussed below by drainage area.

North Fork Koktuli River

Average changes in water temperature are expected to increase approximately 1.2 degrees Celsius (°C) during summer, and 2.8°C during winter within 0.5 mile downstream of the water discharge location. As described in Chapter 3, Affected Environment, Chinook and other salmon species have been observed spawning in this reach of the NFK. Modeled discharges indicate that water temperatures would not exceed ADEC's temperature threshold for spawning fish of 13°C for the summer months during mine operations and closure. Baseline winter water temperatures in this reach are just above 0°C. A 2.8°C increase in surface water temperature would be well below the ADEC threshold, and would not be expected to adversely impact incubating eggs, juveniles, or other overwintering resident fish.

South Fork Koktuli River

Average changes in water temperature are expected to decrease approximately 0.15°C during summer, with no change in winter water temperatures 1 mile downstream of the water discharge location. Sockeye and coho salmon have been documented using this reach of the SFK and Frying Pan Lake as rearing habitat. A decrease of 0.15°C in water temperature would not be expected to adversely impact rearing fish.

Upper Talarik Creek

Average changes in water temperature are expected to increase approximately 0.12°C during summer and 0.54°C in winter 3 miles downstream of the water discharge location. As described in Chapter 3, Affected Environment, Chinook, sockeye, and coho salmon use this reach of the UTC for spawning and rearing. Modeled discharges indicate that water temperatures would not exceed ADEC's temperature threshold for spawning fish of 13°C for the summer months during mine operations and closure (2018 PLP-RFI 047). Baseline winter water temperatures in this reach are just above 0°C. A 0.54°C increase in surface water temperature would be well below the ADEC threshold, and would not be expected to adversely impact incubating eggs, juveniles, or other overwintering resident fish.

Water Chemistry

Baseline natural water quality conditions have been documented throughout the project area, and can be referenced in the EBD Section 4.18, Water and Sediment Quality. Water would be treated prior to discharge into NFK, SKF, and UTC in compliance with applicable water quality standards established to protect aquatic life, as specified in the APDES permit described in Section 4.18, Water and Sediment Quality. Treated water would be discharged to buried infiltration chambers designed to provide energy dissipation, erosion control, and freeze protection. Compliance monitoring during construction, operations, and closure would assure water quality standards are maintained to protect fisheries resources. Any water chemistry impacts to fish and other aquatic life would not be measurable.

Metals concentrations in surface water would be expected to increase 0.11 – 0.66% due to fugitive dust deposition. Surface water quality at the open pit and main Water Management Ponds (WMPs) would exceed water quality standards. As described in Appendix K4.18, both WTP#1 and WTP#2 would utilize treatment plant processes commonly used in the 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 (RO) (Figures 2-10 and 2-11). The open pit WTP would also include biological selenium removal, and the main WTP would also include nanofiltration through high-pressure membranes (expected to remove selenium and other salts) and multi-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, 2018-RFI 021d).

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

- Alaska Pollutant Discharge Elimination System (APDES) Individual Permit for point source discharge into WOTUS
- Integrated Waste Management Permit for solid waste disposal and wastewater discharge not into WOTUS
- APDES Multi-Sector General Permit for storm water discharge
- Domestic Wastewater Discharge Permit.

State of Alaska regulations require that the condition of these permits ensure compliance with the state water quality standards that are based on the use classification for the water body receiving discharge, and the state's anti-degradation policy. Some water bodies may also have site-specific water quality criterion. For constituents that exceed criteria in background surface water and groundwater (Section 3.18.1, Appendix K3.18), there are currently no plans to incorporate site-specific background levels of constituents into discharge limits (ADEC 2018-RFI 064a).

4.24.2.8 Essential Fish Habitat

[NOTE: EFH ASSESSMENT CURRENTLY UNDER WAY. EFH WILL BE INCLUDED IN THE DRAFT EIS].

Summer Only Ferry Operations Variant

The summer only ferry options variant is described in Chapter 2, Alternatives. Potential impacts associated with this variant would be similar to those described under Alternative 1.

Kokhanok East Ferry Terminal Variant

The route into Kokhanok East avoids the requirement for a bridge across the Gibraltar River, a major river crossing under Alternative 1. Potential impacts to fish and aquatic habitat in the Gibraltar River would be reduced under this variant. Potential impacts to fish and aquatic habitat for the eight streams crossed by this route would be similar to impacts described under Alternative 1, transportation corridor. Potential impacts associated with the ferry terminal location on Illiamna Lake would be similar to those described under Alternative 1.

Pile Supported Dock Variant

The pile supported dock variant is described in Chapter 2, Alternatives. Under this variant, less benthic habitat would be potentially impacted in Cook Inlet due to the smaller port footprint.

4.24.3 Action Alternative 2 – North Road and Ferry

4.24.3.1 Mine Site

Impacts would be similar to those described in Alternative 1.

4.24.3.2 Transportation Corridor

The Alternative 2 road alignment crosses the same number of anadromous fish streams, but 28 fewer resident fish streams than Alternative 1; consequently, there would be less permanent impacts to fish habitat. Short-duration, localized impacts to habitat and water quality during construction would be similar to Alternative 1. Ferry operations from Eagle Bay to Pile Bay would have similar impacts to fish and fish habitat as ferry operations described under Alternative 1.

Summer-Only Ferry Variant

Ferry operations from Eagle Bay to Pile Bay would have similar impacts to fish and fish habitat as ferry operations described under Alternative 1.

4.24.3.3 Diamond Point Port

Construction of dock facilities at Diamond Point would have a greater spatial and temporal direct impact on marine fisheries and benthic invertebrates than Alternative 1, because the footprint of these structures would cover roughly 90 more acres of benthic habitat than the Amakdedori port (PLP 2018-RFI 072). Dredging of the approximately 650,000-cubic-yard marine substrate at the Diamond Point location would be required to achieve a 20-foot depth of water required for operations. Benthic organisms within the footprint of the dock facilities and dredge channel would experience direct impacts and mortality for the life of the project. Short-term turbidity and sedimentation could impact fish migration and spawning substrates during construction. Noise impacts from sheet-pile installation during construction could cause injury or mortality to fish and benthic organisms.

Maintenance dredging over 2 decades of the mine life would impact an area of approximately 60 acres. These activities would impact benthic organisms, and temporarily increase turbidity and suspended sediment in the water column, which would be redeposited on marine substrate, effects that would not occur under Alternative 1. The extent of these effects could range from localized, to beyond the mouth of Iliamna Bay, depending on tides and wave conditions.

Pile-Supported Dock Variant

Construction of a pile-supported dock at Diamond Point would result in less direct impact to benthic habitat and organisms than a fill causeway, because piles would be driven through vibratory and hammer methods, and require no fill (PLP 2018-RFI 072). Noise impacts from pile installation during construction could cause injury or mortality to fish and benthic organisms. Short-duration and limited suspended sediment impacts would be expected to occur during construction of the pile structure.

4.24.3.4 Natural Gas Pipeline Corridor

Impacts to fish habitat and water quality would be the same as described under Alternative 1 for the portion of the pipeline beginning on the Kenai Peninsula and crossing Cook Inlet to Kamishak Bay. Impacts would be the same as described under Alternative 3–transportation Corridor for the portion from Diamond Point to the mine site.

The pipeline corridor through Ursus Cove to Diamond Point would cross two additional anadromous fish stream crossings with associated impacts to fish and fish habitat similar to other sections of the natural gas pipeline corridor. Additionally, the pipeline trench has the potential to impact benthic and intertidal habitats in Ursus Cove during construction.

4.24.4 Action Alternative 3 – North Road Only

Under Alternative 3, impacts to the pipeline corridor would be the same as those described under Alternative 2. The following section describes impacts for the mine, transportation corridor, and port that would be different under Alternative 3.

4.24.4.1 Mine Site

Under Alternative 3, impacts to the mine site would be the same as described under Alternative 1.

Concentrate Pipeline Variant. The concentrate pipeline from the mine to the port under this alternative 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 alternative would also reduce the amount water treatment plant water released at discharge locations at the mine site by approximately 1 to 2 percent (PLP 2018-RFI 066), which could result in slight reductions of temperature effects, aquatic habitat availability, and turbidity or erosional effects at treated water discharge locations.

4.24.4.2 Transportation Corridor

While Alternative 3 would increase the project footprint, fisheries impacts associated with the ferry crossing of Iliamna Lake would be eliminated. The North Road Only route would result in an increase of 15 anadromous stream crossings, and a reduction of four resident stream crossings relative to Alternative 1, with a corresponding increase in fish habitat and riparian wetlands impacts (described under Alternative 1).

4.24.4.3 Diamond Point Port

Under Alternative 3, impacts to the port site would be the same as described under Alternative 2.

4.24.4.4 Natural Gas Pipeline

Impacts to fish habitat and water quality would be the same as described under Alternative 1 for the portion of the pipeline beginning on the Kenai Peninsula and crossing Cook Inlet to Kamishak Bay. Impacts would be the same as described under Alternative 3 – transportation corridor for the natural gas pipeline portion from Diamond Point to the mine site.

Concentrate Pipeline Variant. Inclusion of a concentrate pipeline under this alternative would result in a slightly greater impact to fish and fish habitat than Alternative 3 without the concentrate pipeline. The concentrate pipeline would be buried at the same time as road construction, and the road corridor widened by less than 10 percent for inclusion of the pipeline, which could result in a marginal increase in water quality impacts during construction and fill placement over riparian wetlands. 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 impacts from dust, erosion, and runoff.

4.24.5 Summary of Key Issues

Table 4.24-5: Summary of Key Issues for Fish and Aquatics

Impact Causing Project Component	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variants
Mine Site			
Mine Site Construction and Operations	**Aquatic Habitat:** **NFK**: Permanent loss of 6.2 miles of anadromous fish stream habitat and 12.7 miles of resident fish stream habitat. **SFK**: Permanent loss of 1.1 miles of resident fish stream habitat Permanent effects to instream habitat downstream of mine site during operations and closure due to reduced stream flows. Permanent loss of 276 acres of riparian habitat functions within mine site footprint. **NFK**: Average temperature changes due to water discharge would be expected to be approximately 1.2 C (summer) and 2.8 C (winter) ½ mile downstream of discharge point. **SFK**: Average temperature changes due to water discharge would be expected to be approximately -0.15 C (summer) 1 mile downstream of discharge point. **UTC:** Average temperature changes due to water discharge would be expected to be approximately 0.12 C (summer) and 0.54 C (winter) 3 miles downstream of discharge point. Metals concentrations in surface water would be	Impacts similar to those of Alternative 1. 45 to 60% increase in fill required, increasing impacts associated with larger fill volume/footprints, including potential for increased erosion and surface water turbidity impacting aquatic habitat and organisms.	Impacts similar to those of Alternative 1. **Concentrate Pipeline Variant** – mine site footprint increased by 0.7 acre with potential impact on aquatic habitat. Concentrate pipeline variant – estimated decreased discharge volume by 1-2% at discharge locations. Potential reduction in effects on aquatic habitat and organisms.

Table 4.24-5: Summary of Key Issues for Fish and Aquatics

Impact Causing Project Component	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variants
	expected to increase 0.11 – 0.66% due to fugitive dust deposition. Surface water quality at the open pit and main Water Management Ponds (WMPs) would exceed water quality standards. Water would be contained within the mine site and treated to meet water quality standards prior to discharge to the environment. Metals concentrations in sediment would be expected to increase 0.11 – 3.17% due to fugitive dust deposition. Local fish disturbance and mortality would occur during construction would be expected.		
Transportation Corridor			
Transportation Corridor Construction and Operations	**Aquatic Habitat:** Permanent loss of approximately 13.5 acres of riparian habitat within corridor footprint at fish stream crossings. Disturbance of instream habitat at culvert and bridge crossings during construction would be expected. Temporary and localized impacts to water quality including increases in sedimentation and turbidity during culvert and bridge construction would be expected. Temporary and localized impacts to shallow groundwater during pipeline installation would be expected, **Aquatic Organisms** Fish disturbance and	Impacts would be similar to those described in Alternative 1 although greater in geographic extent due to the increased number of waterbodies crossed by the road corridor. **<u>Road Stream Crossings</u>** Total: 21 Resident: 8 Anadromous: 6	Impacts similar to those of Alternative 1. Increase of 15 anadromous stream crossings, and a reduction of four resident stream crossings relative to Alternative 1. **Concentrate Pipeline Variant** – increased area of disturbance as the road corridor would be widened for pipeline inclusion,

Table 4.24-5: Summary of Key Issues for Fish and Aquatics

Impact Causing Project Component	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variants
	mortality during culvert and bridge construction Temporary and localized impacts to fish migration during culvert and bridge construction would be expected. <u>Stream Crossings</u> Total: 97 Anadromous: 8 Resident: 36		
Ferry Construction and Operations	**Aquatic Habitat:** Permanent loss of approximately 1 acre benthic habitat below OHW beneath footprint of Ferry terminal. Temporary and localized increase in sedimentation and turbidity during construction would be expected. **Aquatic Organisms:** Temporary disturbance and mortality of benthic organisms within the terminal footprint would be expected. Temporary and localized impacts to fish migration during construction would be expected. Temporary and localized impacts of propeller and wake disturbances during operation would be expected.	Impacts similar to Alternative 1.	No ferry under Alternative 3.
Port Site			
Port Site - causeway fill/construction	**Aquatic Habitat:** Permanent loss of 14 acres of benthic habitat beneath footprint of causeway and jetty. Temporary and localized increase in sedimentation and turbidity during construction would be expected. **Aquatic Organisms:** -	**Aquatic Habitat:** Permanent loss of 15 acres of benthic habitat beneath dock footprint and 61 acres associated with channel dredging. **Pile-Supported Dock Variant** Reduction from 15 acres aquatic habitat loss beneath dock footprint to	Impacts similar to Alternative 2.

Table 4.24-5: Summary of Key Issues for Fish and Aquatics

Impact Causing Project Component	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variants
	Disturbance and mortality of benthic organisms within the port footprint below OHW. Potential for disturbance and mortality during installation of sheet pile would be expected. Temporary and localized impacts to fish migration during construction would be expected. Temporary and localized impacts of propeller and wake during operation would be expected. **Pile-Supported Dock Variant** Foot print reduced to 0.1 acre of benthic habitat impact compared to 14 acres compared to Alternative 1. Reduced mortality due to smaller footprint. Potential for increased noise induced mortality during installation of piles.	0.1 acres. Other impacts similar to Alternative 1.	
Natural Gas Pipeline			
Construction and Installation of Natural Gas Pipeline	**Aquatic Habitat:** Permanent loss of 2.1 acres benthic habitat beneath footprint in Iliamna Lake and 22.79 acres of benthic habitat in Cook Inlet. Localized increase in sedimentation and turbidity during construction. Temporary and localized disturbance of aquatic organisms during construction.	Impacts similar to Alternative 1. Additional area of disturbance three additional stream crossings. **Pipeline Stream Crossings:** Total: 116 Resident: 28 Anadromous: 23	Impacts similar to Alternative 1. **Pipeline Stream Crossings:** Total: 116 Resident: 28 Anadromous: 23

4.24.6 Cumulative Effects

Past, present, and reasonably foreseeable future actions (RFFAs) in the cumulative impact study area have the potential to contribute cumulatively to aquatic resource impacts. Section 4.1, Impact Assessment Framework, details the past, present, and RFFAs considered for evaluation. Several of the RFFAs detailed in Section 4.1 are considered to have no potential for cumulatively impacting aquatic resources in the study area. These would include non-industrialized point source activities that are unlikely to result in any appreciable impact beyond a temporary basis (e.g., tourism, recreation, and hunting). Other RFFAs removed from further consideration include those sufficiently distant from the study area to eliminate infrastructure co-use by other parties (e.g., Donlin, Copper Joe).

RFFAs that could contribute cumulatively to aquatic resource impacts, and are therefore considered in this analysis, are those activities that would occur in the Nushagak River or Kvichak River drainages, or in other waterbodies intersected by the transportation corridor in the Cook Inlet drainage. RFFAs, combined with natural events, have the potential to contribute to adverse effects on aquatic resources by altering flow regimes and drainage patterns; direct habitat loss; diminishing water quality from riverbank erosion, turbidity, and sedimentation; changes in water chemistry; and degrading the extent of productive habitat conditions.

The following RFFAs identified in Section 4.1, Impact Assessment Framework, were carried forward in this analysis based on their potential to impact aquatic resources in the analysis area:

- Pebble project buildout – develop 55 percent of the resource over a 78-year period
- Pebble South/PEB*
- Big Chunk South*
- Big Chunk North*
- Fog Lake*
- Groundhog*
- Shotgun
- Alaska Stand Alone Pipeline
- Alaska LNG Project
- Drift River Oil Facility Demobilization
- Cook Inlet Oil and Gas Sales
- Lake and Pen Borough Transportation and Renewable Energy Initiatives
- Nushagak Electric CO-OP Village Intertie Project
- Diamond Point Rock Quarry

**Indicates exploration activities only.*

The most important potential future actions included in this analysis are those that are likely to contribute to aquatic resource conditions, and are regionally common to the project. Because development at remote locations can be financially prohibitive, RFFAs in proximity to the project that could potentially minimize costs through co-use of project infrastructure are also considered important in this analysis.

The Pebble Project buildout and commercialization of the Shotgun prospect are the only mineral deposit RFFAs considered for exploration and development. All other mineral deposit RFFAs are considered for exploration only. The Pebble Project buildout is the most notable RFFA, and would result in additional development not included under Alternative 1:

- Increased pit footprint
- Increased TSF and waste rock storage capacity
- Additional processing infrastructure

- Construction of a new port site with diesel fuel and concentrate pipeline(s) extending to the mine site.

The additional acreage of disturbance at the mine site would be greater than Alternatives 1 and 2 combined, based on infrastructure build-out at the mine site. The build-out would correspond to an increase in magnitude and local extent of disturbance impacts and potential for aquatic resource impacts would increase, and would be greater than Alternatives 1 and 2 combined. Additional design features to capture and treat impacted water and waste streams would be necessary to manage mine site impacts. Also, the addition of a diesel fuel line would increase the likelihood of hydrocarbon spills along and at the terminals of the pipeline, potentially contributing to the cumulative impact of spills on aquatic resources.

Development of the Shotgun prospect could reduce fish habitat. The Shotgun prospect would not physically overlap with the Pebble project area, and the cumulative impact in the common areas of the lower Nushagak watershed would be expected to be minimal if BMPs are applied, and engineering design features achieve the anticipated water quality controls.

Some limited RFFAs associated with mineral exploration activities (e.g., Pebble South, Big Chunk North, Big Chunk South, Fog Lake, and Groundhog) could have some limited aquatic resource impacts, primarily water quality, in watersheds common to the project (e.g., drill pads, camps); however, they would be seasonally sporadic, temporary, and localized, based on remoteness. Although exploration activities are considered to have minimal cumulative impacts to soil resources, there could be potential for greater surface water and substrate impacts from future development through transportation infrastructure co-use with the project.

The footprint of the Diamond Point rock quarry coincides with the Diamond Point port footprint under Alternatives 2 and 3. Cumulative impacts would be limited to a potential increase in localized aquatic resource impacts from commonly shared project footprints with the quarry site under Alternatives 2 and 3.

Cook Inlet RFFAs, including Alaska Stand Alone Project, Alaska LNG, and Cook Inlet lease sales, would increase shipping traffic, and result in temporary disturbance to aquatic resources. Loss of fish habitat associated with new ports and drill rigs would be minimal in the context of Cook Inlet. Construction and operations of these projects would increase the likelihood of a spill; however, this is considered unlikely. Temporary effects from sedimentation during construction are likely, but expected to be minimal.

Overall, the magnitude of cumulative impacts to aquatic resources from RFFAs in general would be expected to be minimal, with the exception of RFFA activities in the immediate mine site (e.g., Pebble Project buildout). The cumulative effects in the mine site footprint, expanded to include buildout development, would increase; but it is expected that controls would be in place to manage those impacts to mitigate adverse effects on aquatic resources.

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