4.0 ENVIRONMENTAL CONSEQUENCES

4.1 INTRODUCTION

Chapter 4, Environmental Consequences, describes the potential impacts on the environmental resources addressed in Chapter 3, Affected Environment, that would occur under the No Action Alternative and the action alternatives.

Chapter 4 sections discuss direct, indirect, and cumulative effects[1] for each resource described in Chapter 3, and for spills in Section 4.27, Spill Risk,[2] for each alternative.

4.1.1 Impact Characterization

4.1.1.1 Scope of Analysis

The Environmental Impact Statement (EIS) analysis area refers to the entire area of resource analysis that is specific to each resource discussed in Section 3.2 to Section 3.26.[3] Although the EIS analysis area can be delineated based on the physical footprint of the action alternatives, potential resource impacts are considered in a spatial context appropriate to each resource. The EIS analysis area is defined in each Chapter 3 and Chapter 4 section. See Section 3.1, Introduction to Affected Environment, for a detailed description of the scope of analysis for this EIS.

The project area refers to the exact project footprint for each action alternative.

4.1.1.2 Factors of Analysis

Beneficial and/or adverse effects of the project were evaluated and described for each of the resources. Each resource characterizes impacts in relation to four factors:

- **Magnitude or Intensity—**The intensity the impact would have, measured in terms of change or degree of change in a resource condition. Common characterizations are acres of impact, number of units of change, differences in levels of use, etc.
- **Duration—**How long the impact would be expected to occur or last, measured in length of time. Common characterizations are short-term, long-term, for the life of the project, etc.
- **Geographic extent—**Where the impact would be expected to occur geographically in the EIS analysis area.
- **Potential to occur (likelihood)—**How probable the impact would be. Common characterizations include the likelihood of the impact if the project were to be permitted, or probability of occurrence based on the results of analysis or modeling.

[1] Note that in this document, the terms “effect” and “impact” have the same meaning and are used interchangeably.
[2] As noted in Section 3.1, Introduction to Affected Environment, there is no corresponding spill risk section in Chapter 3, because spill risk would be considered an environmental consequence to the resources discussed in Section 3.2 through Section 3.26.
[3] Note that in Chapter 3 and Chapter 4, Waters of the US (WOUS) as defined under the Clean Water Act (CWA) and determined to be jurisdictional under US Army Corps of Engineers (USACE) authority (see Appendix J for the Preliminary Jurisdictional Determination from USACE) are discussed collectively with wetlands and other waters; all WOUS, wetlands, or other waters are together termed “wetlands and other waters.” The term WOUS may appear in Chapter 3 and Chapter 4 under specific regulatory context.

Each section in Chapter 4 describes analysis methodology and includes explanations of how each factor applies to that resource. Note that analysis assumes normal operating conditions for the proposed project.

Project component values, such as road lengths and pad acreage, are approximations based on best available data. Due to differences in data processing systems (e.g., Geographic Information System [GIS]) and methodologies (e.g., number rounding), the values presented in the EIS may differ slightly from values presented in other project-related documents, such as permit drawings. These differences have been reviewed and were determined to have no material consequence to the analysis or the overall permitting process.

Project components—In Chapter 3 and Chapter 4, the project is discussed by its four major components (mine site, transportation corridor, ports, and natural gas pipeline corridor) for each alternative. See Section 3.1, Introduction to Affected Environment, for a brief description of project components. See Chapter 2, Alternatives, for a detailed description of components.

Project alternatives—See Chapter 2, Alternatives, for a detailed description of alternatives. Note that the action alternatives in Chapter 3 and Chapter 4 are referred to by name without including the word “Action” in front of the alternative name as is done in Chapter 2, Appendix K2, and Appendix B.

Project phases—Impacts on some resources may vary depending on the project phase. See Chapter 2, Alternatives, for a detailed description of the proposed project phases. Chapter 4 includes analysis in the following phases:

- **Construction phase—**The period of construction of mine infrastructure prior to operations (4 years).
- **Operations phase—**The 20-year period of mine operations. Mining and milling operations would continue for the full 20-year operating life of the project.
- **Closure phase—**Activities occurring in the 20 years following the end of operations (for example, at closure year 15, pit backfilling would be completed; at closure year 20, reclamation of the pyritic tailings storage facility [TSF] and water management ponds [WMPs] would be completed, and the pit lake would be at maximum level).
- **Post-closure phase—**The period of time after the 20-year closure phase (for example, at closure year 50, maximum tailings consolidation would be expected).

4.1.2 Resource Interrelationships

Although resources are discussed in Chapter 3 and the impacts on those resources analyzed in Chapter 4 in discrete sections, these resources are dynamic and interrelated. A change in one resource can have cascading or synergistic impacts to other resources.

The site of the proposed project and the nature of open-pit mining activity would lead to a complex interaction between groundwater, surface water, and a number of water-related resources. The proposed project would also lead to a complex interaction between the aforementioned water-related resources and fish and aquatic resources. Impacts to water, fish, and wildlife resources could in turn have impacts on subsistence or commercial fishing; for example, water quality may affect fish populations, which in turn may influence subsistence or commercial fishing harvests and have implications for other human outcomes such as health and socioeconomics. Impacts described in one section may depend on the analysis from another section. During the writing process, preparers collaborated by sharing data and discussing interrelated aspects of the analyses to better capture the interrelated nature of environmental resources in both Chapter 3 and Chapter 4.

4.1.2.1 Types of Effects Considered

The National Environmental Policy Act (NEPA) requires three types of impacts to be evaluated: direct, indirect, and cumulative effects.

Direct, indirect, and cumulative effects are analyzed in each of the Chapter 4 sections by the four factors of analysis.

Direct and Indirect Effects

Under NEPA, direct and indirect effects are defined as:

Direct Effects—Effects caused by the action and occurring at the same time and place (40 Code of Federal Regulations [CFR] Part 1508.8).

Indirect Effects—Effects that are "caused by an action and are later in time or farther removed but are still reasonably likely. Indirect impacts may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems" (40 CFR Part 1508.8). Indirect effects are caused by the project, but do not occur at the same time or place as direct effects.

Cumulative Effects

Cumulative effects are described under a separate subheading near the end of each section of Chapter 4.

Cumulative effects are interactive, synergistic, or additive effects that would result from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions (RFFAs) regardless of what agency (federal or non-federal) or person undertakes those other actions (40 CFR Part 1508.7). This includes incremental impacts of the proposed action or alternatives when added to other past, present, and RFFAs. Interactive effects may be either greater or less than the sum of the individual effects; therefore, the action's contribution to the cumulative case could increase or decrease the net effects. Assessing the cumulative impacts from multiple projects/activities requires considering the impacts of their combined potential affected area and associated actions. It also requires a logical nexus with the potential effects of the proposed action. This means that the specific past, present, or RFFAs must have potential interactive, synergistic, and/or additive effects with direct and indirect impacts on a specific resource resulting from a proposed action and its alternatives.

Past actions—Past actions include activities that may have been initiated in the past but could also involve present operations such as infrastructure development and non-mining-related actions. These actions may have lingering effects in degrading the environment or may influence trends in the physical, biological, or social environment.

Present actions—Present actions include mining projects and related activities that have just been initiated or are currently underway and causing impacts. They may also include other non-mining-related projects that are currently in progress such as transportation, oil and gas development, or community development.

Reasonably foreseeable future actions—For this analysis, RFFAs are existing plans, permit applications, or fiscal appropriations that are likely (or reasonably certain) to occur. The Pebble Project expansion is considered an RFFA in this EIS.

Past and Present Actions in the EIS Analysis Area

Past and present actions that have an interactive, synergistic, and/or additive effect (per 40 CFR Part 1508.7) with a specific resource (such as lingering effects or influencing trends), are relatively limited for this project, and are described below:

- **Commercial and Subsistence Harvest of Fish and Wildlife**—Past and present harvest of fish and wildlife for commercial and subsistence purposes put some degree of pressure on those resources. Although commercial fishing in the Bristol Bay Watershed and Cook Inlet started in the 1880s, the period from the turn of that century through the adoption of the Alaska Limited Entry Act by the State of Alaska in 1972 saw incremental changes in both fishing technology and the understanding of the salmon fishery resource. It was likely that there were historic instances of overharvest, with implications for the overall salmon resource. As shown in Section 3.6, Recreational and Commercial Fisheries, the commercial harvest of salmon in Bristol Bay fisheries districts over the last 20 years has fluctuated significantly; in 2018, Bristol Bay saw record returns, even though Cook Inlet and other areas of the state saw declining returns. Factors influencing returns are complex and there are no clear long-term trends with commercial harvests. However, Fall et al. (2009) noted that subsistence harvest of salmon in the Kvichak and Nushagak rivers declined from long-term averages, even though the number of Bristol Bay subsistence salmon permits has been stable. Similarly, local and non-local residents have historically harvested fish and wildlife in pursuit of traditional subsistence activities and may affect such resources. For example, the subsistence harvest of Cook Inlet beluga whale is thought to have depleted its population and contributed to its listing as an endangered species (73 Federal Register [FR] 62919). There have been natural variability and changes in the historic distribution of some species harvested for subsistence and recreational purposes, such as returning salmon and caribou, although there is no clear agreement why. Regardless, fish and wildlife resources are managed by the Alaska Department of Fish and Game (ADF&G) and federal agencies to maintain sustainable populations and optimize public uses and economic benefits (ADF&G 2018p). Management tools such as harvest limits and areas open and closed to sport and commercial harvest of fish and wildlife are applied to maintain sustainable resources and allocate harvest. Section 4.23, Wildlife Values (non-threatened and endangered species), and Section 4.24, Fish Values, discuss historic trends for area wildlife and fish populations where appropriate.
- **Commercial Recreation and Tourism**—Southwest Alaska, including the Bristol Bay region and the project area, is renowned for sport fishing, hunting, boating, and wildlife viewing opportunities; there is a long history of these activities in the area. Similar to commercial fishing, sport harvest of fish and game is managed by the ADF&G and federal land managers to maintain sustainable populations. These activities take place primarily from late spring to early fall, and there may be small plane, helicopter, and boat traffic associated with access that contribute to the disturbance of wildlife, as well as recreational and subsistence activity experience.
- **Community Development and Infrastructure**—The transition from seasonal communities to fixed locations with housing, public facilities, and transportation infrastructure has resulted in wetlands fill and loss of habitat. These communities also generate sewage and solid waste and use fossil fuels for energy and heat generation. The limited number of communities, their relatively small footprint and population size, and the distance between communities have resulted in little past and present cumulative effects on a regional basis. Some transportation infrastructure such as

airports, boat docks, and connecting roads have increased accessibility to the region. This reduces costs for communities, but facilitates visitation to the region, including airport facilities in King Salmon and Iliamna.

- **Offshore Oil and Gas Exploration and Development in Cook Inlet**—Offshore exploration, development, and production of oil and gas in Cook Inlet has occurred in state and federal waters since the 1960s. These activities have the potential to impact marine mammals and are visible from key observation points on the shore of Cook Inlet and from aircraft and vessels transiting the area. Marine vessel and helicopter traffic are associated with these activities, and both oil and liquefied natural gas (LNG) have been shipped by tanker out of Cook Inlet. There have been minor spills and pipeline integrity incidents over the years; in 1987, the SS Glacier Bay struck a submerged obstacle in Cook Inlet, and an estimated 3,100 barrels of oil were assumed lost (Northern Economics 1990).
- **Mining Exploration Activities**—There are a number of mineral claims and resources in the Bristol Bay watershed that have been subject to mineral exploration activities. Exploration activities have been intermittent depending on the specific claim or resources. There has been small plane, helicopter, and boat traffic associated with exploration contributing to the disturbance of wildlife, as well as recreational and subsistence activity experience. There have also been areas of ground disturbance associated with exploration drilling and support facilities, including in the project area. In the immediate vicinity of the project, there has not been past or present mineral production activity. In Alaska, where infrastructure is limited and there are long distances to market, it is fairly common for deposits to undergo exploratory activity, but not progress to a stage where the nature of the mineral reserves, costs of development, and market price for minerals makes development feasible.
- **Williamsport-Pile Bay Road**—The Williamsport-Pile Bay Road, constructed in the 1930s, provides access between Cook Inlet and Bristol Bay via a 15.5-mile road to Iliamna Lake and down the Kvichak River. The road allows portage of fishing vessels bound for Bristol Bay commercial fisheries, as well as some goods and supplies for lake and river communities, which contributes to road and lake traffic during the summer season. This results in noise disturbance and dust during the summer months along the road, and noise from waterborne activities at Williamsport, Pile Bay, and along Iliamna Lake. The road is owned and maintained by the State of Alaska.

Reasonably Foreseeable Future Actions in the EIS Analysis Area

For this analysis, RFFAs are existing plans, permit applications, or fiscal appropriations that are likely (or reasonably certain) to occur. The Pebble Project expansion is considered an RFFA in this EIS. Actions are considered reasonably foreseeable if they would occur or have potential impacts in the area analyzed for direct and indirect effects on a specific resource. In addition, the likelihood that a specific RFFA would occur must also be assessed. This is not based on speculation, but must be anticipated, to enter the permitting process based on project documentation, identified in public or private planning documents as scheduled for development, have identified indicated resources/reserves sufficient to develop a project, or have advanced exploration activities under way in the timeframe being used for assessment.

The following categories of RFFAs were considered for the cumulative effects analysis:

- Mineral Exploration and Mining
- Oil and Gas Exploration and Development
- Transportation and Infrastructure
- Energy and Utilities
- Commercial Fishing
- Subsistence
- Tourism, Recreation, and Sport Hunting and Fishing
- Scientific Research and Surveys
- Contaminated Sites and Industrial Pollutants
- Residential/Community Development

With regard to mineral and oil and gas resources, a distinction was made between exploration and development activities. Many of the mineral projects assessed are on lands open to mineral entry and have been the subject of exploration activities for more than 30 years but have not been developed. Detailed knowledge of the amount and grade of mineral reserves, along with ore price and the cost to develop, mine, and transport the ore to market is generally needed to make a development decision. For example, the Red Dog Project was originally developed in 1989, and the Alaska Industrial Development and Export Authority (AIDEA) constructed the Delong Mountain Transportation System to provide a public road and port system to serve the mine and potentially other mineral deposits in the region. Since that time, the mine has expanded to develop an adjacent deposit under the same ownership, but none of the nearby deposits (notably the Lik deposit) have been developed in nearly 30 years, despite the availability of the transportation system.

There are similar patterns of mine expansion in Alaska, developing adjacent, commonly owned, and measured/indicated reserves, including Greens Creek, Usibelli, and Fort Knox. The presence of existing mine/transportation infrastructure has not resulted in the development of a new mine in any of these cases but often results in mine expansion and/or an extended processing life. Similarly, oil and gas lease sales have been regularly held in waters of Cook Inlet for over 50 years; although exploration continues to occur, not all exploration activities have led to oil and gas development. Mineral and oil and gas exploration and development activities can have a variety of impacts on the physical, biological, and social environments.

The 2014 EPA *Assessment of Potential Mining Impacts on Salmon Ecosystems in Bristol Bay Alaska* evaluated the potential for other mineral deposits in the project area to be developed for the purpose of assessing potential cumulative effects from mineral development. Compared to NEPA guidance for assessing potential cumulative effects, the EPA study had a different purpose and used different assumptions regarding the development of additional mining projects and their relationship to the proposed project. EPA indicated that the purpose of the assessment was to determine the significance of Bristol Bay's ecological resources and evaluate the potential impacts of large-scale mining on these resources, using the methodology of an ecological risk assessment. The agency developed three Pebble Project mining scenarios based on preliminary details put forth in Wardrop 2011, the largest of which is Pebble 6.5 (it should be noted that the Pebble 6.5 scenario is similar to the Pebble mine expansion scenario, determined to be reasonably foreseeable and developed for analysis in this EIS). With regard to their assessment of cumulative risks of multiple mines, the EPA evaluated a number of known mineral deposits with potentially significant resources in the two major Bristol Bay watersheds. The EPA assumed that if the infrastructure for one mine is built, it would likely facilitate the development of other mines, and for the purposes of their study assumed that six additional mines would be developed. Based

on the factors described above associated with development of mines in Alaska, the parameters for evaluating potential RFFAs described below, and the detailed assessment of regional mineral deposits presented in Table 4.1-1, this EIS generally differs in concluding which specific mineral prospects are reasonably foreseeable for exploration and development.

Table 4.1-1 presents the potential projects considered for analysis of cumulative effects, and conclusions regarding whether they are reasonably foreseeable. Figure 4.1-1 illustrates the location of RFFAs. Development of any of these projects would require some level of federal, state, and local permits and approvals. In many cases, development would be subject to a separate environmental assessment or EIS as part of the review and approval process. As discussed under past and present actions, activities associated with commercial, recreational, and subsistence harvest will continue to occur and have the potential to impact fish and wildlife populations. Although taken into consideration by federal and state management programs, these activities can contribute to cumulative effects of developing the project. Effects can include mortality and injury on an individual and population level, as well as disturbance and changes in distribution and migration, which can affect availability to various users. Climate change and other changes in the natural environment can contribute to cumulative effects through past, present, and RFFAs. Climate trends can affect water balance and stream flow, fish and wildlife habitat and distribution, and affect access for pursuit of subsistence activities and community travel. Climate change analysis framework for this EIS is included Section 3.1, Introduction to Affected Environment.

The following parameters were applied to identify and evaluate specific RFFAs for the cumulative effects analysis in the EIS:

- **Potential expansion of the proposed project**—The US Army Corps of Engineers (USACE) has determined that expansion of the Pebble Project, as originally discussed in the Wardrop 2011 Preliminary Assessment Technical Report (commissioned by Northern Dynasty Minerals to independently review and analyze project economics, current mineral resources, and valuation estimates in compliance with National Instrument 43-101, Standards of Disclosure for Mineral Projects in Canada) and refined in the response to RFI 062 (PLP 2018-RFI 062), will be analyzed under cumulative effects (Table 4.1-1; a list of assumptions associated with Mine Expansion are shown in Table 4.1-2). Estimates of permanent footprint acreage, direct wetlands impact acreage, miles of direct stream impacts, and number of stream crossings associated with expansion of the Pebble mine have been developed using GIS and are included in specific resource sections. As presented in the response to RFI 062 (PLP 2018-RFI 062), if Pebble Project expansion occurs, it is assumed to begin in year 20 of the proposed project operations.
- **Land status subject to mining**—Mineral projects must be on public lands designated as open to mineral entry or development, or on Alaska Native Claims Settlement Act lands where previous mining exploration or development activity have been allowed. When lands are classified as open to mineral development, it facilitates obtaining permits and other approvals for exploration and development activities.
- **Development projects with dedicated funding, currently in a federal, state, and/or local permitting process, undergoing a state or federal environmental assessment, or listed in a government planning document with a specific timeframe for development**—Projects may also be considered reasonably foreseeable for development if they: have dedicated funding and a schedule for development; have federal, state, or local permit applications under review or approved; are currently being evaluated through a federal NEPA compliance effort or State Best Interest Finding document (i.e., a state decision-making document that

determines if granting a permit is in the best interest of the state); or are identified in a published federal, state, or local planning document (e.g., scheduled lease sales and community capital projects) with a specific project description and timeframe for development.

- **Information to support the viability of development has been documented in a published or online report**—Projects that have conducted extensive exploratory drilling and analysis to compile information on mineral reserves in terms of measured, indicated, and inferred resources, along with characterization of the grades of ore in the deposit are included. The potential feasibility for development is evaluated based on the published information on results of drilling and delineation of measured, indicated, inferred, and grade of reserves. Estimated costs associated with development are also assessed to the extent available.
- **Proximity to project infrastructure and factors affecting co-use by other parties**—The question of whether development of the proposed project would facilitate development of other nearby mineral deposits depends in part on the proximity of a potential RFFA to the proposed project and ability to use project infrastructure. Creating access to project transportation infrastructure is expensive and depends on land ownership access and sensitivity of environmental resources along the access route. Project infrastructure would be privately funded; co-use of mining, port, and natural gas pipeline facilities would be dependent on permission from Pebble Limited Partnership (PLP). With regard to use of the access road by other parties, while privately funded, the State of Alaska would likely require PLP to allow access to other mineral deposit owners if an agreement could be reached regarding operation and maintenance costs. This is based on the precedent set in state permit conditions for granting Pogo Mine access (S. Buckley, personal communication 2018).
- **Geographic nexus with the direct and indirect effects of project development on specific resources evaluated in the EIS**—Along with the factors previously described, there would need to be interactive and synergistic effects of an RFFA (per 40 CFR Part 1508.7) on resources directly and indirectly affected by development of the project in a specific geographic range that varies by resource.

Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
Potential Mineral Deposits in Southwest and Southcentral Alaska				
Pebble Project expansion—develop 55% of delineated resources	Expansion of the Pebble Project to develop 55% of its reserves over an additional 58 years of mining, and 20 to 40 years of post-mining processing low-grade ore and pyritic material, as outlined in response to RFI 062 PLP 2018-RFI 062) and summarized in Table 4.1-2. It would use the same transportation facilities, power plant, and natural gas pipeline facilities. It would need additional tailing storage, additional water storage, new waste rock storage facilities, additional processing facilities, a concentrate pipeline and a deep-water loading facility. It is not part of the proposed action, and would require additional permits and separate NEPA compliance. Table 4.1-2 presents assumptions for Pebble Project expansion development.	Potential project expansion. Expansion was identified as an option in the Wardrop 2011 report and refined in the response to RFI 062 (PLP 2018-RFI 062). A similar expansion concept was analyzed as Pebble 6.5 in the EPA)Watershed Assessment (EPA 2014) on the basis of lands being classified as open for mineral exploration and development, and assuming access to Pebble Project infrastructure.	Wardrop 2011, EPA 2014, RFI 062 (PLP 2018-RFI 062)	**Yes—for continued exploration and development.** Project expansion would begin in the timeframe of the proposed Pebble Project, in year 20 of proposed project operations. Expansion would occur on state lands that are subject to PLP mining claims and open to mineral development. PLP has existing permits for resource exploration, but has not submitted permit applications for expanded development; expansion is not part of a current NEPA compliance or Best Interest Finding effort, and is not described as reasonably foreseeable in a government planning document. PLP has conducted extensive exploratory drilling and analysis to compile a 43-101 feasibility assessment level of information on mineral reserves in terms of measured, indicated, and inferred resources, along with characterization of the grades of component ore in the deposit and estimated costs of development of mine expansion (Wardrop 2011). If the Pebble Project was permitted, Pebble expansion could use and expand on the project mine site and transportation infrastructure that would be in place, similar to what has happened with other Alaska mines where adjacent reserves are commonly owned.
Pebble South	A 54-square-mile porphyry copper deposit/claim approximately 9 miles southwest of Pebble deposit. Prospect is part of the PLPNDM Ltd. claim block.	Subject to further exploration. Analyzed for cumulative effects in the EPA Watershed Assessment based on land classification of the deposit and assuming access to Pebble Project infrastructure. This deposit was not included in the assessment in Wardrop 2011.	EPA 2014	**Yes—for further exploration.** **No—for development.** There is no indication that development of Pebble South would occur in the operations timeframe of the proposed Pebble Project. Resource delineation has not progressed sufficiently to forecast development with regard to identifying measured or indicated resources; a project is not subject to development permitting or in a planning document.

Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
				Pebble South claims are currently owned by NDM Ltd. If future drilling and resource delineation indicate that project development is feasible, construction and operations phases could access and use the Pebble Project transportation system. However, additional access would need to be constructed to connect to the project transportation infrastructure.
Big Chunk South	A 73-square-mile porphyry copper deposit/claim approximately 12 miles north of the Pebble project area. The claim block is entirely in the Chulitna River drainage, which flows into Lake Clark National Park and Preserve.	There have been some airborne surveys and limited drilling to delineate the resource. Mineral Claims transferred by Liberty Star to NDM Ltd. in 2014, which is when the last state exploration permit expired. Analyzed for cumulative effects in the EPA Watershed Assessment (EPA 2014) based on land classification of the deposit and assuming access to Pebble Project infrastructure.	EPA 2014	**Yes—for further exploration.** **No—for development.** There is no indication that development of Big Chunk North would occur in the operations timeframe of the proposed Pebble Project. Resource delineation has not progressed sufficiently to forecast development with regard to identifying measured or indicated resources; a project is not subject to development permitting or in a planning stage. Big Chunk South claims are currently owned by NDM Ltd. If future drilling and resource delineation indicate that project development is feasible, construction and operations phases could access and use the Pebble Project transportation system. However, additional access would need to be constructed to connect to the project transportation infrastructure.
Big Chunk North	Porphyry copper deposit approximately 21 miles northwest of the Pebble project area. The claim block straddles the drainage divide between the Nushagak and Kvichak River watersheds.	Mineral claims transferred by Liberty Star to NDM Ltd. in 2014, Liberty Star to NDM Ltd. in 2014, which is when the last state exploration permit expired. Analyzed for cumulative effects of development in the EPA Watershed Assessment based on land classification of the deposit and assuming access to Pebble Project infrastructure.	EPA 2014	**Yes—for further exploration.** **No—for development.** There is no indication that development of Big Chunk North would occur in the operations timeframe of the proposed Pebble Project. Resource delineation has not progressed sufficiently to forecast development with regard to identifying measured or indicated resources; a project is not subject to development permitting or in a planning document. Claims are currently owned by NDM Ltd. If future drilling and resource delineation indicate that project

Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
				development is feasible, construction and operations phases could access and use the Pebble Project transportation system. However, additional access would need to be constructed to connect to the project transportation infrastructure.
Fog Lake	Gold and copper in volcanic rocks approximately 46 miles southeast of the Pebble Project and south of Iliamna Lake, and roughly 10 miles north of the transportation corridor to Amakdedori port.	As of 2008, exploration was occurring, but drilling had not been initiated; the exploration permit expired at the end of 2008. Analyzed for cumulative effects of development in the EPA Watershed Assessment (EPA 2014) based on land classification of the deposit and assuming access to Pebble Project infrastructure.	EPA 2014	**Yes—for further exploration.** **No—for development.** There is no indication that development of Fog Lake would occur in the operations timeframe of the proposed Pebble Project. The deposit is on lands that have had mining claims and are open to mineral development. Resource delineation has not progressed sufficiently with regard to identifying measured or indicated resources; a project is not subject to development permitting or in a planning document. Given the proximity to the proposed Pebble Project transportation corridor, if future drilling and resource delineation indicate that it is feasible to develop the project, it is possible that construction and operations phases could access and use the Pebble Project transportation system if an arrangement could be reached with PLP. However, additional access would need to be constructed to connect to the project transportation infrastructure.
Groundhog	196-square-mile porphyry copper claim approximately 3 miles east of the Pebble Project area.	Exploration drilling under way. Hard rock exploration permit issued by the ADNR in 2017. Analyzed for cumulative effects of development in the EPA Watershed Assessment (EPA 2014) based on land classification of the deposit and assuming access to Pebble Project infrastructure.	EPA 2014	**Yes—for further exploration.** **No—for development.** There is no indication that development of Groundhog would occur in the operations timeframe of the proposed Pebble Project. Resource delineation has not progressed sufficiently with regard to identifying measured or indicated resources; a project is not subject to development permitting or in a planning document. Given the proximity to the proposed Pebble Project transportation corridor, if future drilling and resource

Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
				delineation indicate that it is feasible to develop the project, it is possible that construction and operations phases could access and use the Pebble Project transportation system if an arrangement could be reached with PLP. However, additional access would need to be constructed to connect to the Pebble Project transportation infrastructure.
Humble	Also known as Kemuk, a 173-square-mile gold and porphyry copper deposit/claim considered geologically similar to the Pebble deposit. Deposit is approximately 83 miles southwest of the Pebble Project area.	This project has been removed from the Millrock Resources website and no longer appears to be active; the exploration permit expired in 2017. Analyzed for cumulative effects of development in the EPA Watershed Assessment (EPA 2014) based on land classification of the deposit, and assuming access to Pebble Project infrastructure.	EPA 2014	**No—for further exploration.** **No—for development.** There is no indication that development of Humble would occur in the operations timeframe of the proposed Pebble Project. The deposit is on state lands that have had mining claims and are open to mineral development. Resource delineation has not progressed sufficiently with regard to identifying measured or indicated resources; a project is not subject to development permitting or in a planning document. The project is closer to tidewater at Dillingham than the Pebble Project and would not likely use the project transportation system.
AUDN/Iliamna	113-square-mile porphyry copper claim block approximately 55 miles southwest of the Pebble Project area in the Kvichak River watershed.	Millrock Resources began exploration in 2012, but the project has been removed from the Millrock Resources and TNR Gold Corp websites and no longer appears to be active. Analyzed for cumulative effects of development in the EPA Watershed Assessment (EPA 2014) based on land classification of the deposit.	EPA 2014	**No—for further exploration.** **No—for development.** There is no indication that development of AUDN/Iliamna would occur in the operations timeframe of the proposed Pebble Project. The deposit is on state lands that have had mining claims and are open to mineral development. Resource delineation has not progressed sufficiently with regard to identifying measured or indicated resources; a project is not subject to development permitting or in a planning document. The project is closer to tidewater at Naknek than the Pebble Project, and would not likely use the project transportation system.

Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
Kamishak	Porphyry copper in a breccia pipe roughly 49 miles southeast of the Pebble Project area, and roughly 10 miles south of the transportation corridor to Amakdedori port.	There were 18 holes drilled between 1990 and 1991; an additional 5 holes were drilled in 2006. As of 2008, reserves had not been identified, and the exploration permit expired.	EPA 2014	**No—for further exploration.** **No—for development.** There is no indication that development of Kamishak would occur in the operations timeframe of the proposed Pebble Project. The deposit is on lands that have had mining claims and are open to mineral development. Resource delineation has not progressed sufficiently with regard to identifying measured or indicated resources; a project is not subject to development permitting or in a planning document. Given the proximity to the proposed Pebble Project transportation corridor, if future drilling and resource delineation indicate that it is feasible to develop the project, it is possible that construction and operations phases could access and use the Pebble Project transportation system if an arrangement could be reached with PLP. However, additional access would need to be constructed to connect to the project transportation infrastructure.
Shotgun	Quartz-feldspar porphyry deposit with gold as the primary interest, located roughly 99 miles northwest of the Pebble Project, 90% owned by TNR Gold Corporation. If developed, Shotgun could access tide water via barge transport from Dillingham (93 miles away) up the Nushagak River to Koliganek, New Stuyahok, or Ekwok (49, 68, and 74 miles away, respectively).	There have been extensive drilling programs since the late 1980s through 2012; and as of 2013, inferred mineral resources were estimated at 20.7 million tons, with a grade of 1.06 gram of gold per ton, with a cut-off grade of 0.50 gram per ton of gold. Thirty four exploration holes have been drilled on site.	TNR Gold Corp. 2013, EPA 2014	**Yes—for further exploration.** **No—for development.** There is no indication that development of Shotgun would occur in the operations timeframe of the proposed Pebble Project. The deposit is located on lands that have had mining claims and open to mineral development. Mineral exploration has delineated inferred mineral resources, but to date have not been identified as measured or indicated. The project is not currently subject to development permitting or in a planning document. The project is closer to tidewater at Dillingham than the Pebble Project and would not likely use the project transportation system.

Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
Johnson Tract	Gold-rich poly-metallic deposit located roughly 80 miles east of the Pebble Project, owned by CIRI and subject to an exploration agreement with Constantine Metals Resources Ltd. CIRI has access rights through Lake Clark National Park and Preserve to a port site at Tuxedni Bay on Cook Inlet.	Discovered by Anaconda in 1982, 90 holes have been drilled but no exploration has occurred in more than 20 years. In 2018, Constantine Metals agreed to resume exploration and take the project to the point of evaluating feasibility of developing the mine.	Constantine 2019	**Yes—for further exploration.** **No—for development.** There is no indication that development of Johnson Tract would occur in the operations timeframe of the proposed Pebble Project. The deposit is located on private lands that have had mining claims and are open to mineral development. Resource delineation has not progressed sufficiently with regard to identifying measured or indicated resources; a project is not subject to development permitting or in a planning document. The project is closer to tidewater at Cook Inlet than the Pebble Project and would not likely use the project transportation system.
Proposed Mining and Mineral Projects in Southwestern and Southcentral Alaska				
Donlin Gold	Open-pit hard rock mine in the Kuskokwim River watershed, 277 miles west of Anchorage. The proposed mine would have a total footprint of approximately 16,300 acres. Includes a 315-mile pipeline to carry natural gas from Cook Inlet to the mine site.	FEIS issued in April 2018. USACE and BLM have issued a JROD granting major federal permits.	USACE 2018	**Yes—for further exploration.** **Yes—for development.** FEIS for the project has been completed, and the JROD was signed in August 2018. The project is considered reasonably foreseeable in the 78-year timeframe.
Diamond Point Rock Quarry	Granite quarry project near the convergence of Cottonwood and Iliamna bays on the western side of Cook Inlet. Project involves modification of shoreline to construct an access road, breakwater, barge landing, and solid fill dock. Dredging would be required in Cottonwood Bay.	The project has been developed as the first phase of a larger facility.	USACE 2010, USACE 2012b	**Yes—for development expansion.** Reserves of quarry rock have been estimated and a permit was issued in 2012. Construction has begun.

Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
Potential Oil and Gas Exploration and Development				
Alaska Stand Alone Pipeline Project (ASAP)	Proposed 737-mile natural gas pipeline from Prudhoe Bay to Point McKenzie, Alaska. The project involves the construction of an LNG extraction plant on the western side of Cook Inlet at Point McKenzie.	An FEIS was completed in 2018. A ROD was published in 2019.	ASAP JROD (USACE and BLM 2019)	**Yes—Because the project has a completed EIS and ROD, it is considered foreseeable for development.** However, it would not be built if the Alaska LNG project is funded for development.
Alaska LNG	Proposed 800-mile natural gas line from Prudhoe Bay to Nikiski, where the gas would be liquefied and shipped to foreign markets. Involves a natural gas pipeline crossing Cook Inlet and would result in increased marine traffic in Cook Inlet.	An FERC application has been filed. A DEIS was released in 2019; an FEIS is expected to be released in 2020. It is unknown if the project has funding to proceed. Construction would begin after 2020.	Alaska LNG DEIS (FERC 2019)	**Yes—Because the project has a permit application and is near completion of an EIS, it is considered foreseeable for development.** However, it might not be built if the ASAP project is funded for development.
Cook Inlet Oil and Gas Lease Sales	The ADNR is responsible for leasing oil and gas in state waters and the Bureau of Ocean and Energy Management is responsible for leasing oil and gas in federal waters. Recent assessments by the USGS estimate that the Cook Inlet region (excluding the Outer Continental Shelf) contains mean values of 637 billion cubic feet of natural gas, 600 million barrels of oil, and 46 million barrels of natural gas liquids (from BOEM 2016). There are 17 offshore production platforms in Cook Inlet state waters (ADNR 2019b; BOEM 2016).	ADNR released a preliminary best interest finding on the Cook Inlet Area-wide Oil and Gas Lease Sale in June 2018. In 2017, Federal Lease 244 resulted in bids for 14 tracts in Cook Inlet. Federal Lease Sale 258 for Cook Inlet is scheduled for 2021. Oil and gas exploration and development activities in Cook Inlet are ongoing and likely to continue.	ADNR 2019b, BOEM 2016	**Yes—for exploration; oil and gas exploration has been subject to a 2016 EIS (federal waters) and a 2018 preliminary best interest finding (state waters).** **Yes—for development.** Although no new offshore platforms are currently scheduled for construction; work on and drilling from existing offshore platforms is likely to continue.

Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
	Exploration activities continue with future development anticipated.			
Hydrocarbon Exploration Licensing and Leasing Program	ADNR, LPB, Bristol Bay Borough, and Aleutians East Borough have signed a MOU in support of oil and gas lease sales and licensing on State land in the analysis area. Similar MOUs exist between ADNR and the Aleut Regional Native Corporation and Bristol Bay Native Corporation.	Exploration has historically occurred, but not resulted in development.	Bristol Bay Area Plan for State Lands (ADNR 2013a)	**Yes—for exploration. The State of Alaska has held lease sales, and additional exploration is considered reasonably foreseeable.** **No—for development.** Given the lack of previous oil and development in the region, development and production are not reasonably foreseeable.
Transportation and Infrastructure				
LPB Transportation Projects	Several road improvement and new transportation corridors are currently being studied. Studies include the Williamsport-Pile Bay Road upgrade, Nondalton-Iliamna River Road Corridor and Bridge, and Kaskanak Road/ Cook Inlet to Bristol Bay (Igiugig).	Ongoing.	LPB Comprehensive Plan (LPB 2012)	**Yes—for development.** These projects are in a published borough planning document.
LPB Community Development and Capital Improvement Projects	Village infrastructure development projects, including power plant upgrades, sewer and water improvement projects, transmission upgrades, and energy efficiency initiatives.	Ongoing. List of projects from LPB 2017 capital improvement projects.	LPB Comprehensive Plan (LPB 2012)	**Yes—for development.** These projects are in a published borough planning document.
Rural Alaska Village Grant Program	US Department of Agriculture Rural Development program to improve rural sanitization. Grant money is used to improve water and sanitation services.	Ongoing.	USDA Rural Development 2019	**Yes—for development.** These projects are considered small-scale community improvements and could be approved for communities in the EIS analysis area.

Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
Williamsport Channel Dredging	Maintain a 150-foot by 500-foot channel and turning basin by annually dredging 2,250 cubic yards at the approach to the barge ramp.	Ongoing.	Department of Army permit, file number POA-2011-188 (USACE 2011b)	**Yes—for ongoing maintenance.**
Energy and Utilities				
Lake and Peninsula Borough (LPB) and other regional Renewable Energy Initiatives	LPB and other communities and electrical generation cooperatives are studying renewable energy projects to help combat high fuel costs. Studies include wind, hydroelectric, river, and tidal energy alternatives. Igiugig has a permit for a removable in-river power generation facility in the Kvichak River.	Studies are ongoing. Igiugig has been installing its pontoon-mounted power generator annually in the Kvichak River. The Tazimina Run of River Hydro Project upgrade has been completed 12 miles northeast of the village of Iliamna. The village of Kokhanok has received funding to refurbish its existing wind diesel power plant.	LPB Comprehensive Plan (LPB 2012)	**Yes—for development.** These projects are in a published LPB planning document.
Nushagak Electric Cooperative Village Intertie Project	The Nuyakuk Run of River Hydro Project would connect the communities of Dillingham, Levelok, New Stuyahok, Koliganek, Aleknagik, and Ekwok with power and fiber optics, with operation projected for 2024.	Nushagak Cooperative has submitted a preliminary permit application to the FERC for their hydro project on the Nuyakuk River in Wood Tikchik State Park.	US Department of Energy FERC (83 FR 15826) (FERC 2018)	**Yes—for development.** This project is in the process of submitting permits for development.
Knutson Creek Hydroelectric Project	The Knutson Creek Hydroelectric Project is a proposed 200-kW run-of-river project located on Knutson Creek near the community of Pedro Bay. It would include a diversion and intake structure at river mile 2.6, a 7,080-foot-long penstock, a 9,900-foot-long buried power cable, and some additional roads and trails.	A feasibility study was prepared for the Pedro Bay Village Council in 2013 (Polarconsult Alaska 2013) and is expected to enter permitting in the foreseeable future.	(Polarconsult Alaska Inc. 2013)	**Yes—For development** This project is expected to submit permits for development in the foreseeable future.

Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
Igiugig Hydrokinetic Project	The Igiugig Hydrokinetic Pilot Project is a proposed in-river 35 kW RivGen Power system turbine generator unit, 52-foot-long, 12-foot-high, 47-foot-wide placed in the Kvichak River in roughly 16 feet of water 100 feet off the river bank near Igiugig. The facility would be anchored and connected with a series of power/data monitoring cables to a prefabricated shore facility. Igiugig Village Council proposes maintaining between 3.5 and 7 feet of water over the top of the device. On expiration of the license, the project would be removed and the site restored.	Igiugig Village Council has applied for a 10-year pilot project license with the FERC. An Environmental Assessment was issued by FERC in 2019.	FERC 2019	**Yes—For development** This project is expected to receive permits for development in the foreseeable future.
Commercial Fishing				
Bristol Bay—Nushagak and Naknek/Kvichak State Management Districts—Salmon Lower Cook Inlet Management Area—Salmon and Herring	Continued stock assessment and allocation decisions under existing management plans.	Ongoing. Commercial fishing is anticipated to continue in the EIS analysis area.	ADF&G Commercial Fishing Management Reports 2018 (ADF&G 2018k)	**Yes—These actions will occur in response to annual stock assessments and direction from management plans.**
Subsistence Activities				
Villages of Iliamna, Newhalen, Pedro Bay, Port Alsworth, Nondalton, Igiugig, Kokhanok, Koliganek, Levelock, New Stuyahok, King	Past, present, and foreseeable subsistence activities are described in Section 3.9, Subsistence, and Appendix K3.9.	Ongoing. Subsistence practices are anticipated to continue in the EIS analysis area.	See Section 3.9, Subsistence.	**Yes—Subsistence harvest of fish, wildlife, and plants will continue for the foreseeable future.**

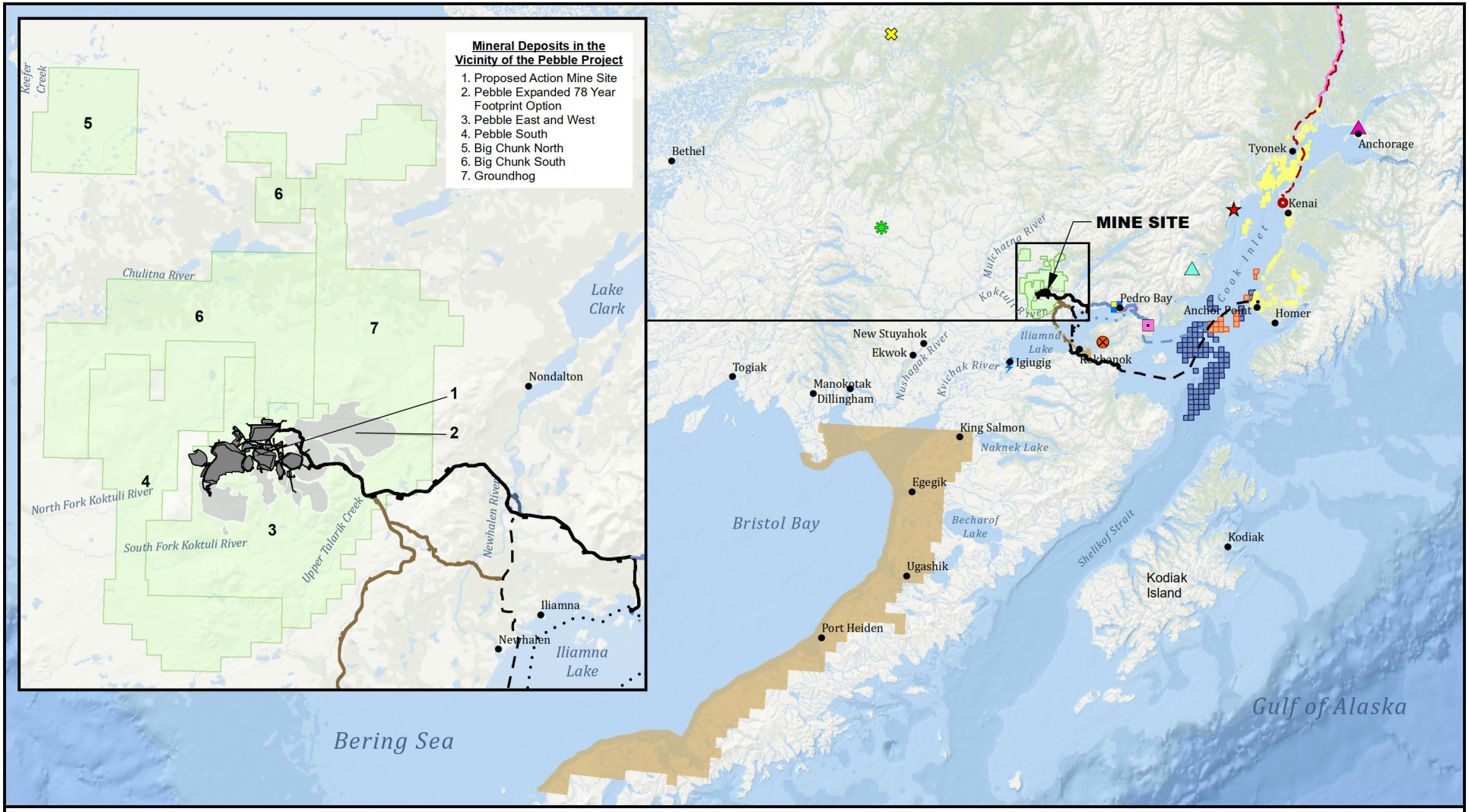
Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
Salmon, Naknek, Aleknagik, Clarks Point, Manokotak, Dillingham, Ninilchik, and Seldovia				
Tourism, Recreation, Hunting, and Fishing				
National Parks and Preserves Wildlife Refuges State of Alaska Special Management Areas Alaska Native Corporation Lands	Activities include hiking, camping, wildlife viewing, and photography. Sport fishing is the primary recreational activity that occurs in the EIS analysis area. Hunting, primarily for moose, caribou, and bear, is a major recreational activity in the region.	Activities are expected to continue in the EIS analysis area.	See Section 3.5, Recreation.	**Yes—Tourism, recreation, hunting, and fishing will continue for the foreseeable future.**
Industrial Pollutants and Contaminated Sites				
Communities in project area	Sites with low levels of contamination have been identified in many Alaskan communities. Communities with site entries in the immediate vicinity of the project include Nondalton, Iliamna, Pedro Bay, Newhalen, and New Stuyahok. Many of the sites are associated with fuel storage tanks/power generation.	Many of the sites in the ADEC database have been cleaned up. The primary potential nexus with activities proposed by the project would be in communities where PLP proposes construction and operations support activities.	ADEC 2019a	**Yes—these projects would result in additional activities associated with clean-up of contaminated sites in communities in the EIS analysis area.**

Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
Scientific Surveys and Research				
Federal, state, institutional, and private surveys and research	Scientific surveys and research conducted by government, institutional, and private parties have the potential to disturb wildlife, as well as interfere with subsistence and recreational activities and experience.	Although some agencies and organizations conduct annual surveys, others are difficult to forecast.	See Section 3.23, Wildlife Values and Section 3.24, Fish Values.	**Yes—There is a potential for airplane and helicopter traffic associated with surveys and research activities to disturb wildlife and for interaction with subsistence and recreational activities and experience.**

Notes:
ADEC = Alaska Department of Environmental Conservation
ADF&G = Alaska Department of Fish and Game
ADNR = Alaska Department of Natural Resources
ASAP = Alaska Stand Alone Pipeline
BLM = Bureau of Land Management
CIRI = Cook Inlet Region, Incorporation
DEIS = Draft Environmental Impact Statement
EIS = Environmental Impact Statement
EPA = US Environmental Protection Agency
FEIS = Final Environmental Impact Statement
FERC = Federal Regulatory Energy Commission
JROD = Joint Record of Decision
LNG = liquified natural gas
LPB = Lake and Peninsula Borough
Ltd. = Limited
MOU = Memorandum of Understanding
NDM = Northern Dynasty Minerals
NEPA = National Environmental Policy Act
PLP = Pebble Limited Partnership
RFI = Request for Information
USACE = US Army Corps of Engineers
USDA = US Department of Agriculture
USGS = US Geological Survey



Sources: PLP 2020-RFI168; PLP 2019-RFI153; ADNR 2010, 2018; BOEM 2018

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- Donlin Gold Mine Site
- Igiugig Hydroelectric Project
- Knutson Creek Hydroelectric Project
- Fog Lake Mineral Deposit
- Shotgun Mineral Deposit
- Johnson Tract Mineral Deposit
- Diamond Point Granite Quarry
- Drift River Oil Terminal Removal Pipeline Project
- Nikiski (Proposed Alaska Liquified Natural Gas Project Terminal)
- Alaska Liquefied Natual Gas Project
- Point McKenzie (Alaska Stand Alone Pipeline Construction Port)
- Alaska Stand Alone Pipeline
- Pebble Expanded 78 Year Footprint Option
- Mineral Deposits in Vicinity of Pebble Project (See Inset Map)
- Alaska Peninsula Onshore Oil and Gas Exploration
- State Cook Inlet Oil & Gas Exploration & Lease Sales
- Federal Oil & Gas Active Leases
- Cook Inlet Federal Historical Oil & Gas Leases

Action Alternatives

- Ferry Routes
- Natural Gas Pipelines
- Alternative 1a
- Alternative 1
- Alternative 1 Kokhanok East Ferry Terminal Variant
- Alternative 2
- Alternative 2 Newhalen River North Crossing Variant
- Alternative 3

LOCATION OF REASONABLY FORESEEABLE FUTURE ACTIONS

PEBBLE PROJECT EIS

FIGURE 4.1-1

Table 4.1-2: Assumptions for Pebble Project Expansion

Component	Assumptions
Assumptions/Facilities Common to All Alternatives	
General Project	**Year and Activity Description:** **Year 0 to 20:** This time period refers to the proposed project operations for a 20-year period. **Year 20 to 78:** This time period refers to expansion mining for a 58-year period. **Year 78 to 98 or 118:** This time period refers to expansion milling for a 20- to 40-year period. **Assumptions:** • The current proposed project proceeds as outlined by EIS alternative for the first 20 years. • After 20 years, mining continues for 58 years and mill throughput is expanded from 180,000 tons per day to 250,000 tons per day. This represents a 39% expansion in throughput compared to the proposed action. • After mining stops (year 78), milling continues for an additional 20 to 40 years to process low-grade ore and PAG waste that is not backhauled to the pit. Bulk and pyritic tailings would be deposited directly into the pit. • Concurrent reclamation would occur during mining, with the northern bulk TSF closed and reclaimed as soon as it is full, along with non-trafficked areas of waste rock facilities. • Concurrent reclamation would occur during milling of low-grade ore/PAG material, with a dry closure of the southern bulk TSF, and final closure of NAG WRFs. • After milling stops (year 98-118), all facilities and infrastructure not required for post-closure activities would be removed. • Post-closure monitoring and water treatment would occur as proposed, but involving an expanded mine site. • Estimates of permanent acreage, direct wetlands impact acreage, miles of direct stream impacts, and number of stream crossings associated with expansion of the Pebble mine have been estimated for each action alternative using GIS and are included in specific resource sections. • Copper concentrate and diesel would be transported via pipeline to/from Iniskin Bay. Truck traffic would be 21 round trips per day to transport molybdenum concentrate, supplies, and other consumables.
Mine Site[4]	• The mine pit would be expanded starting in year 20. • Reclamation of the pyritic TSF and placement of pyritic tailings and PAG rock from the first 20 years of mining would be postponed until year 78. • Additional bulk tailings would be stored separately in a new southern bulk TSF with a flow-through embankment; additional pyritic tails would be stored in a new lined southern PAG TSF. • With mine expansion, waste rock would increase and be stored in new northern and southern NAG WRFs. Low-grade ore and PAG waste rock would be stored on the western side of the northern WRF, which drains toward the pit. All runoff and seepage from the waste rock storage facilities would be captured and used in the process, or treated for release. • An additional ore processing train would be added to the mill, and the power plant would be expanded to 375 megawatts, requiring 70 million standard cubic feet per day of natural gas. Water treatment plants would have throughput increased or additional treatment plants would be brought online. • Water treatment plants would have throughput increased, or additional treatment plants would be brought online. For the purpose of this analysis, the increase in water required for production and treatment would increase by 39%, commensurate with the increase in production.

[4] See response to RFI 062 [PLP 2018-RFI 062] for mine layout.

Table 4.1-2: Assumptions for Pebble Project Expansion

Component	Assumptions
	• Two additional WRF water collection ponds would be constructed (one each for the northern and southern WRF), along with two additional TSF seepage collection ponds along with a TSF seepage recycle pond. • The natural gas pipeline would remain the same size and route for each alternative (see additional compression at port sites under individual alternatives below). • PLP has not ruled out that cyanide could be used for additional gold recovery during mine expansion. Therefore, it is assumed that sodium cyanide could be transferred in watertight sparge tank-tainers to the port as cargo and stored there until trucked to the mine site. A secure storage area with secondary containment could be constructed at the mine, and a cyanide solution would be prepared and applied in a leach process. After tailings leaching, processed tailings could be treated using sulfur dioxide to detoxify residual cyanide, and discharged to tailings storage.
Additional Concentrate Export Port Site	• A deepwater port facility would be constructed in Iniskin Bay for transport of copper concentrate via the concentrate pipeline. The pipeline would transport a copper/gold concentrate slurry; molybdenum concentrate would continue to be transported by truck. • The concentrate handling, dewatering, and treatment facilities would be similar to those discussed at the Diamond Point port under the Alternative 3 Concentrate Pipeline Variant.
Additional Pipelines	• A concentrate pipeline would be constructed to the deepwater loading facility in Iniskin Bay. • A small service road would be built along the pipeline extension to Iniskin Bay. • A diesel pipeline would be constructed between the deepwater port in Iniskin Bay and the mine site, capable of carrying 100 million gallons annually, and parallel the concentrate pipeline.
Assumptions Differing by Alternative	
Alternative 1a	• The Amakdedori port and transportation system would continue to operate as proposed for the first 20 years. • After 20 years, an additional natural gas compressor station would be constructed at Amakdedori to provide for increased power demand at the mine site; the port and transportation system, including the ferry, would continue to be used for transport of supplies and consumables, and bags of molybdenum concentrate. • There would be less overall truck traffic between Amakdedori Port and the mine site with copper concentrate and diesel being transported via pipeline to/from Iniskin Bay. • A road would be constructed along the concentrate pipeline from the Eagle Bay ferry terminal to the Williamsport-Pile Bay road to provide access for servicing the pipeline, but would not be used for regular traffic. This road would have a smaller footprint than roads constructed during the first 20 years to support concentrate truck traffic.
Alternative 1	• The Amakdedori port and transportation system would continue to operate as proposed for the first 20 years. • After 20 years, an additional natural gas compressor station would be constructed at Amakdedori to provide for increased power demand at the mine site; the port and transportation system, including the ferry, would continue to be used for transport of supplies and consumables, and bags of molybdenum concentrate. • There would be less overall truck traffic between Amakdedori Port and the mine site with copper concentrate and diesel being transported via pipeline to/from Iniskin Bay. • A road would be constructed along the concentrate pipeline from the mine site to Iniskin Bay to provide access for servicing the pipeline, but would not be used for heavy truck traffic, and would have a smaller footprint.
Alternative 2—North Road and	• The Diamond Point access road and north road would continue to operate as proposed for the first 20 years.

Table 4.1-2: Assumptions for Pebble Project Expansion

Component	Assumptions
Ferry with Downstream Dams	• After 20 years, an additional natural gas compressor station would be constructed at Diamond Point to provide for increased power demand at the mine site. A road would be constructed to connect the Eagle Bay and Pile Bay ferry terminals and the ferry would be discontinued. This road would need to accommodate regular truck traffic to port facilities and have a design similar to that proposed for Alternative 3. • Diamond Point would continue to be used for transport of supplies and consumables, and bags of molybdenum concentrate. • There would be less overall truck traffic between the mine and Diamond Point with copper concentrate and diesel being transported via pipeline to/from Iniskin Bay.
Alternative 3—North Road Only, Concentrate Pipeline Variant	• The Diamond Point access road and north road would continue to operate as proposed for the first 20 years. • After 20 years, an additional compressor station would be constructed at Diamond Point to provide for increased power demand at the mine site. • Diamond Point would continue to be used for transport of supplies and consumables, and bags of molybdenum concentrate. • Under the Alternative 3 base case (i.e., no concentrate pipeline), expansion would build concentrate and diesel pipelines to Iniskin Bay. There would be 21 trucks per day during expansion, a reduction from the 35 trucks per day during the proposed project. • Under Alternative 3 with the Concentrate Pipeline Variant, there would be 21 trucks per day during expansion, an increase from 18 during the proposed project.

Notes:
GIS = geographic information system
NAG = non-acid generating
PAG = potentially acid-generating
PLP = Pebble Limited Partnership
TSF = tailings storage facility
WRFs = waste rock facilities

4.1.3 Issues Selected for Analysis

The USACE and cooperating agencies identified topics for further analysis, and eliminated others from evaluation, based on independent evaluation of topics and through scoping comments. Issues raised during scoping are documented as Statements of Concern in the Scoping Report (Appendix A). Issues selected for analysis include:

Social science topics:

- Socioeconomics
- Subsistence
- Traditional way of life
- Archaeological and cultural resources
- Land ownership, management, and use
- Transportation and navigation
- Recreation
- Environmental justice
- Public health and safety
- Visual resources
- Wilderness characteristics
- Food and fiber production

Physical science topics:

- Air quality
- Geology and seismic activity
- Surface and groundwater hydrology impacts
- Noise impacts
- Water quality and quantity

Biological science topics:

- Vegetation and ecosystems
- Fish and aquatic resources
- Wetlands and other waters and special aquatic sites
- Wildlife, birds, and mammals
- Endangered Species Act listed threatened and endangered species
- Invasive species

Other topics:

- Hazardous materials stored and transported to and from the mine site
- Tailings dams
- Fugitive dust
- Climate change
- Fuel spill risks and releases
- Natural gas supply
- Pipeline safety

4.1.4 Other Resources

NEPA provides the lead agency with discretion to determine, based on the scoping process, which categories of resources merit detailed analysis, and which categories do not. This determination and impacts to resources that did not warrant detailed analysis are briefly addressed in this section. This is particularly the case where the resource has relevance to USACE public interest review under Section 404 of the CWA (see Table 3.1-1 in Section 3.1, Introduction to Affected Environment, for a detailed list of resource categories and the section of the EIS where they are discussed). Note that affected environment for resources not specifically discussed in Section 3.2 to Section 3.26 is discussed in this section, along with environmental consequences.

4.1.4.1 Conservation

Conservation is assessed in a regional context (USACE 2017). Beneficial and/or adverse impacts in terms of conservation for the proposed project are included in various sections of Chapter 4 in this context. Supporting discussions regarding impacts on the conservation of water supply, wetlands, wildlife, fish, aquatic resources, and vegetation are provided in appropriate sections of this EIS (see Section 3.1, Introduction to Affected Environment, for details on where each resource is discussed).

4.1.4.2 General Environmental Concerns

General environmental concerns are assessed in a local, regional, state, national, and global context (USACE 2017). Beneficial and/or adverse impacts in terms of conservation for the proposed project are included in various sections of Chapter 4 in this context. Concerns with a large mineral resource extraction project are varied, interrelated, and complex. During the scoping period, concerns that did not fall into a specific social, physical, or biological science topic included: climate change, fugitive dust, hazardous materials storage and transportation to and from the mine site, tailings dams concerns, fuel spill risks and releases, natural gas supply, and pipeline safety.

Climate change: Climate change trends are discussed in Chapter 3 sections, and climate change impacts are discussed in Chapter 4 sections (effects of the project on climate change per greenhouse gas [GHG] emissions and effects of climate change on the project infrastructure). See the “Climate Change” subsection below. The framework for discussing climate change in this document is found in Section 3.1, Introduction to Affected Environment.

Fugitive dust is analyzed primarily in Section 4.10, Health and Safety; Section 4.18, Water and Sediment Quality; and Section 4.22, Wetlands and Other Waters/Special Aquatic Sites.

Hazardous materials storage and transportation to and from the mine site is discussed in Section 4.27, Spills.

Tailings dam concerns and fuel spill risks and releases: The probabilities and potential impacts of spills (unintended releases) from the project are analyzed for diesel fuel, natural gas, copper-gold ore concentrate, chemical reagents, bulk and pyritic tailings, and untreated contact water in Section 4.27, Spill Risk.

Pipeline safety is discussed in Section 4.27, Spill Risk.

Natural gas supply is addressed below under "Energy Needs."

4.1.4.3 Energy Needs

Energy needs are assessed in terms of power supplies to the mine site and port facilities, from a local and regional context (USACE 2017). Beneficial and/or adverse impacts would not be expected in terms of energy needs for the proposed project in this context.

The project purpose is not to generate energy. The purpose of the natural gas pipeline from the Kenai Peninsula is to provide a long-term stable supply of natural gas to meet the energy needs of the project by connecting to the existing regional gas supply network. See Chapter 1, Purpose and Need, for an expanded discussion on project purpose and need. The proposed natural gas pipeline would be open access; more specifically, a contract carrier (a commercial entity carrying persons or property of certain customers only, rather than the goods of or the public in general). PLP has committed to providing community access to the gas pipeline during project operations. The natural gas pipeline would be maintained through operations to provide energy to the project site. If no longer required at closure, the pipeline would be pigged (the practice of using devices or implements known as "pigs" to perform pipeline maintenance services) and cleaned. It would then either be abandoned in place or removed, subject to state and federal regulatory review and approval at the decommissioning stage of the project. Open access users that may have used the supply of natural gas during operations would no longer have access to this energy source should the pipeline be abandoned in place or removed, and would need to find alternative sources at that time.

Due to the remote location and lack of current infrastructure, the project would be required to provide basic infrastructure in addition to support facilities typically associated with mining operations. The project would generate its own electricity using natural gas from the region and diesel fuel in back-up generators. This electricity would be used for ore extraction and processing. The peak electrical load for the project would be approximately 270 megawatts (MW). Various mine load centers would be serviced by a 69-kilovolt distribution system using a gas-insulated switchgear system located at the power plant. Waste heat from the power plant would be used to heat buildings and supply process heating to the water treatment plant, resulting in conservation of energy and reducing the amount of natural gas required to power ancillary facilities. The natural gas pipeline from the Kenai Peninsula will have an offtake to distribute natural gas to the port power generation facility. Natural gas pipeline infrastructure would include a compressor station on the Kenai Peninsula side. The concentrate and water return pipeline would require two electric pump stations, one at the mine site and one at an intermediate point; the intermediate one would require a power generation facility (1-2 MW range).

PLP proposes to purchase natural gas on the open market by linking with the existing pipeline system near Anchor Point, Alaska. Gas for the project would not be from a specific source. Potential sources at this time include any natural gas producer in Cook Inlet, Alaska.

4.1.4.4 Mineral Needs

Executive Order 13817, A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals, is considered as an indication of the public's interest in mineral needs. Rhenium is a critical mineral listed in EO 13817 that is present at the Pebble deposit (PLP 2020d); however, copper, gold, and molybdenum are not mineral commodities considered to be critical based on EO 13817.

Mineral needs are assessed in terms of precious metals resource extraction in an international market and global context (USACE 2017). From the broad, macroeconomic scale, the stated project need is reflected in the demand for copper, gold, and molybdenum. The proposed project would result in a 20-year beneficial effect on the public's mineral needs for copper, gold, and molybdenum in this context. The proposed project would ultimately result in production of 7.4 billion pounds of copper, 36 million ounces of gold, and 398 pounds of molybdenum to meet global demand (see further details in the project description, Appendix N). The amount of rhenium is unknown at this time.

Copper is used in a variety of products and industries, including electrical and electronic products, industrial equipment, building construction, automobiles, and appliances. In 2019, the US consumed an estimated 2,039,276 tons of refined copper (USGS 2020c). The worldwide copper usage has tripled over the last 50 years and growth in the worldwide demand for copper is projected to continue (ICSG 2019).

Gold is used for the production of jewelry, electronics, and electrical components, official coins, and other uses (USGS 2005). In 2019, the US consumed an estimated 165 tons of gold. (USGS 2020d). Worldwide, 412 tons of gold was consumed in 2016 (USGS 2019). Worldwide consumption of gold grew by almost 8 percent per year between 1980 and 1999, and by an average of 2.8 percent per year between 1992 and 2002 (USGS 2005).

The most common use of molybdenum is the production of alloy steels and superalloys, enhancing hardness, strength, and resistance to corrosion. Examples of uses of these alloys include in food handling equipment, in automobile parts, in construction equipment, and in heavy construction (USGS 2010). The average reported amount of molybdenum used in the US between 2015 and 2018 was 18,602 tons. In 2019, the United States used an estimated 18,739 tons of molybdenum (USGS 2020e).

The production of copper, gold, and molybdenum would meet the Applicant's and the overall stated purpose and need. Project purpose and need is discussed in Chapter 1, Project Purpose and Need.

4.1.5 Traditional Ecological Knowledge

Information about traditional ecological knowledge (TEK) and the approach taken by the USACE to collect TEK is outlined in Section 3.1, Introduction to Affected Environment. The information collected is included in Appendix K3.1, Traditional Ecological Knowledge. Section 3.9, Subsistence, includes a discussion of TEK.

4.1.6 Climate Change

Chapter 3, Affected Environment, discusses climate change trends. Discussions are as follows:

- Section 3.1, Introduction to Affected Environment, provides a framework for discussion of climate change in the EIS, and the location of discussion of climate change.
- Section 3.9, Subsistence, discusses climate change in the context of traditional use change.

- Section 3.15, Geohazards and Seismic Conditions, discusses climate change trends on the potential for landslides and avalanches.
- Section 3.16, Surface Water Hydrology, discusses groundwater modeling incorporating cyclical and predicted climate data to account for changes in climate. Sea level changes are acknowledged.
- Section 3.17, Groundwater Hydrology, provides baseline details of water balance models to discuss trends and potential changes, including how climate variability is incorporated into recalibrated modeling.
- Section 3.18, Water and Sediment Quality, discusses climate trends and oscillations for temperature specifically.
- Section 3.20, Air Quality, provides detailed information about air quality and climate change in the context of estimated predicted future temperature and precipitation values.
- Section 3.22, Wetlands and Other Waters/Special Aquatic Sites, includes discussion of the potential impacts on wetlands and other waters in a changing climate. Section 3.26, Vegetation, provides similar discussion on trends, such as changes in phenology that may affect vegetation.
- Section 3.23, Wildlife, includes detailed analysis of potential impacts of climate change on terrestrial wildlife, birds, and marine mammals.
- Section 3.24, Fish Values, discusses climate change in the context of hydrological changes and potential large-scale shifts in populations.
- Section 3.25, Threatened and Endangered Species, includes discussion of climate change trends for Steller's eider.

Chapter 4, Environmental Consequences, discusses impacts of climate change from the proposed project, or contributions of the project to GHG emissions. These impacts are primarily discussed in the physical science sections. Discussions are as follows:

- Section 4.15, Geohazards and Seismic Conditions, describes the potential for increased landslide and related effects due to precipitation trends.
- Section 4.16, Surface Water Hydrology, provides analysis of water balance models specific to the project components and operations that incorporate climate variability.
- Section 4.17, Groundwater Hydrology, also discusses climate variability in the context of analyzing water flow and balance in project components such as the pit lake.
- Section 4.20, Air Quality, includes a detailed analysis of project-related GHG emissions.

4.1.7 Unavoidable Adverse Effects

The Council on Environmental Quality (CEQ) guidelines require agencies to evaluate "any adverse environmental effects which cannot be avoided should the proposal be implemented" (40 CFR Part 1502.16). Unavoidable adverse effects are those remaining after the project has complied with applicable stipulations and mitigation measures proposed by the Applicant (see Chapter 5). A detailed discussion of beneficial and/or adverse effects is presented for each resource in Section 4.2 through Section 4.26. A summary impacts subsection is presented at the end of each section. Additional mitigation may be possible, and additional mitigation measures under consideration are presented in Appendix M1.

4.1.8 Irreversible and Irretrievable Commitment of Resources

CEQ guidelines require an evaluation of "any irreversible or irretrievable commitments of resources which would be involved in the proposal should it be implemented" (40 CFR Part 1502.16). An irreversible or irretrievable commitment of resources refers to impacts on or losses to resources that cannot be recovered or reversed.

An irreversible commitment of a resource represents a loss of future options. This term applies primarily to the use of non-renewable resources, such as minerals, fossil fuels, or cultural resources, and to factors that are renewable only over long periods of time, such as soil productivity.

An irretrievable commitment of a resource represents opportunities that are foregone for the period of the proposed activities. This term applies primarily to the use of renewable resources, such as timber or human effort, or other utilization opportunities that are foregone in favor of the proposed activities.

Resources that would be irreversibly and irretrievably committed to the alternatives analyzed in this EIS include:

- **Cultural Resources and Historic Properties**—Any inadvertent effects to cultural resources or historic property would result in an irreversible commitment of resources.
- **Vegetation and Wetlands**—Ground disturbance, particularly due to project construction and operations, would cause irreversible impacts, including land to be permanently altered, soils and bedrock to be permanently displaced, vegetation to be permanently removed, and wetlands and other waters to be permanently altered or filled.
- **Aquatic Resources**—Irreversible changes to streamflows from permanent watershed alterations would eliminate aquatic habitat.
- **Aesthetics**—Development of infrastructure would create a visual contrast resulting in an irreversible commitment of resources in permanent fill areas, and an irretrievable commitment in areas subject to reclamation.
- **Resource consumption**—Irreversible consumption of renewable and non-renewable resources would be required for infrastructure development, including metals, aggregate, cement, wood, and other materials.
- **Soils and Geology**—Irretrievable and irreversible commitment of the use of copper, gold, and molybdenum ore resources.
- **Resource committal**—Non-renewable resources (e.g., gasoline, diesel, natural gas, and electrical power generated from these fuels) would be irreversibly committed for project construction, operations, and closure. Fuels would be required to operate aircraft, motor vehicles, barges, vessels, machinery, and mining equipment.
- **Funds and labor**—Funds and labor would be irretrievably committed for project permitting and development.
- **Water**—Water would be irretrievably committed for milling and processing.