CHAPTER 4: CUMULATIVE EFFECTS

4.1 INTRODUCTION

The purpose of the cumulative impact analysis is to identify any of the project impacts that, when combined with impacts from other past, present, and reasonably foreseeable future actions (RFFAs), may become cumulatively significant. Cumulative effects are defined in the Council on Environmental Quality's (CEQ) guidance, Considering Cumulative Effects under the National Environmental Policy Act (DIRS 103162-CEQ 1997, all) as:

> the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such actions" (40 CFR 1508.7).

Direct effects are limited to the proposed action and alternatives only, while cumulative effects pertain to the additive or interactive effects that would result from the incremental impact of the proposed action and alternatives when added to other past, present, and reasonably foreseeable future actions. Interactive effects may be either greater or less than the sum of the individual effects; thus, the action's contribution to the cumulative case could increase or decrease the net effects.

Not all actions identified in this chapter would have cumulative impacts in all resource areas. Potential impacts for such actions are discussed for the appropriate resources. In some instances in which an action is reasonably foreseeable, quantitative estimates of impacts are not possible and qualitative assessments are provided.

This cumulative effects analysis considers the project as described in Chapter 2, Section 2.3.2, Alternative 2 - Donlin Gold's Proposed Action; the alternatives to the Proposed Action as described in Sections 2.3.1 and 2.3.3 through 2.3.7 (Chapter 2, Alternatives); and Chapter 5, Impact Avoidance, Minimization, and Mitigation. The analysis considers the past, present, and reasonably foreseeable future actions described below in Section 4.2.2. Chapter 3, Environmental Analysis, describes the affected environment for each resource and evaluates the direct and indirect environmental, social, and economic consequences of the project and alternatives.

4.2 METHODOLOGY

As explained in prior CEQ guidance, and described in its handbook Considering Cumulative Effects (CEQ 1997), the analysis of cumulative effects begins with consideration of the direct and indirect effects on the environment that are expected or likely to result from a proposal for agency action and its reasonable alternatives. The analysis considers effects of past, present, and reasonably foreseeable future actions that are determined to be relevant because the effects of these actions would increase or change in combination with the direct and indirect effects of the proposed action or its alternatives. Relevant cumulative effects typically result from human activities, which produce effects that accumulate within the temporal and geographic boundaries of the effects of the proposed action. The purpose of the cumulative effects analysis is to document the consideration of the context and intensity of the effects of a proposed action,

particularly whether the action is related to other actions with individually insignificant but potentially cumulatively significant impacts (40 CFR 1508.27(b)(7)).

Therefore, cumulative impacts are assessed by combining the potential environmental impacts of the project and alternatives (Chapter 3, Environmental Analysis) with the impacts of other actions that have occurred in the past, are currently occurring, or are proposed in the future in the vicinity of the project. The actions considered in the cumulative impact analysis may vary from those of the project in nature, magnitude, and duration. These actions are considered on the basis of their likelihood of occurrence, and only projects with either ongoing or reasonably foreseeable impacts are identified. The CEQ has issued guidance, but no universally accepted framework for cumulative effects analyses. The following principles are provided by CEQ:

- Cumulative effects are caused by the aggregate of past, present, and reasonably foreseeable future actions.
- Cumulative effects are the total effect, including both direct and indirect effects on a given resource, ecosystem, and human community of all actions taken, no matter who (federal, non-federal, or private) has taken the actions.
- Cumulative effects need to be analyzed in terms of the specific resource, ecosystem, and human community being affected.
- It is not practical to analyze the cumulative effects of an action on the universe; the list of environmental effects must focus on those that are truly meaningful.
- Cumulative effects on a given resource, ecosystem, and human community are rarely aligned with political or administrative boundaries.
- Cumulative effects may result from the accumulation of similar effects or the synergistic interaction of different effects.
- Cumulative effects may last for many years beyond the life of the action that caused the effects.
- Each affected resource, ecosystem, and human community must be analyzed in terms of its capacity to accommodate additional effect, based on its own time and space parameters.

4.2.1 TEMPORAL AND SPATIAL SCOPE OF ANALYSIS

Two factors are considered when establishing the affected environment for a cumulative effects analysis: the spatial / geographical environment and the temporal range of relevant past, present and reasonably foreseeable future projects. The spatial and temporal parameters for this cumulative effects analysis were developed from information provided in Chapter 2, Alternatives, on the project and alternatives, and from the results of direct and indirect effects analyses presented in Chapter 3, Environmental Analysis.

For the purposes of this EIS, present actions are those that are ongoing and have activities that contribute to potential cumulative effects. Future actions are those that are reasonably foreseeable within the life of the project or the next 30 years. The estimates of future projects are more accurate for the next 10 years; but where possible, the cumulative effects analysis extends for the life of the project.

The spatial scope for analysis of cumulative effects varies by resource. For certain resources such as migratory birds and wildlife, air quality, subsistence, and socioeconomics the area of consideration could be more extensive than the areas defined for direct and indirect impact analysis (see Section 3.0, Approach and Methodology). Figure 4.2-1 shows the project area and the region for the past, present, and RFFAs considered in the cumulative effects analysis.

4.2.2 PAST, PRESENT, AND REASONABLY FORESEEABLE FUTURE ACTIONS

Relevant past and present actions are those that have influenced the current condition of the resource. For the purposes of this EIS, past and present actions include both human-controlled and natural events. Past actions were identified using agency documentation, NEPA analyses, reports and resource studies, peer-reviewed literature, and best professional judgment.

The term RFFA is used in concert with the CEQ definitions of indirect and cumulative effects, but the term itself is not further-defined. Most regulations that refer to "reasonably foreseeable" do not define the meaning of the words, but do provide guidance on the term. For this analysis, reasonably foreseeable future actions are those that are external to the proposed action, and likely (or reasonably certain) to occur, although they may be subject to a degree of uncertainty. Typically, they are based on documents such as existing plans, permit applications, and fiscal appropriations. RFFAs considered in the cumulative effects analysis consist of projects, actions, or developments that can be projected, with a reasonable degree of confidence that would occur over the next 30 years.

The types of past, present, and RFFAs considered for the cumulative effects analysis include:

- Oil and Gas Exploration and Development
- Mineral Exploration and Mining
- Commercial Fishing
- Transportation
- Energy and Utilities
- Community Development / Capital Improvements Projects
- Subsistence Activities
- Tourism, Recreation, Sport Hunting and Fishing
- Scientific Research and Surveys
- Land Use and Planning
- Self Determination
- Climate Change
- Global Industrial Pollutants and Contaminated Sites

Recent environmental reports, surveys, research plans, NEPA compliance documents, and other source documents have been evaluated to identify these actions. RFFAs were assessed to determine if they were speculative and would occur within the analytical timeframe of the EIS. Projects and activities considered in the cumulative effects analysis are summarized in Table 4.2-1. Figure 4.2-1 is useful for determining the location and proximity of each RFFA listed in Table 4.2-1 to the project.

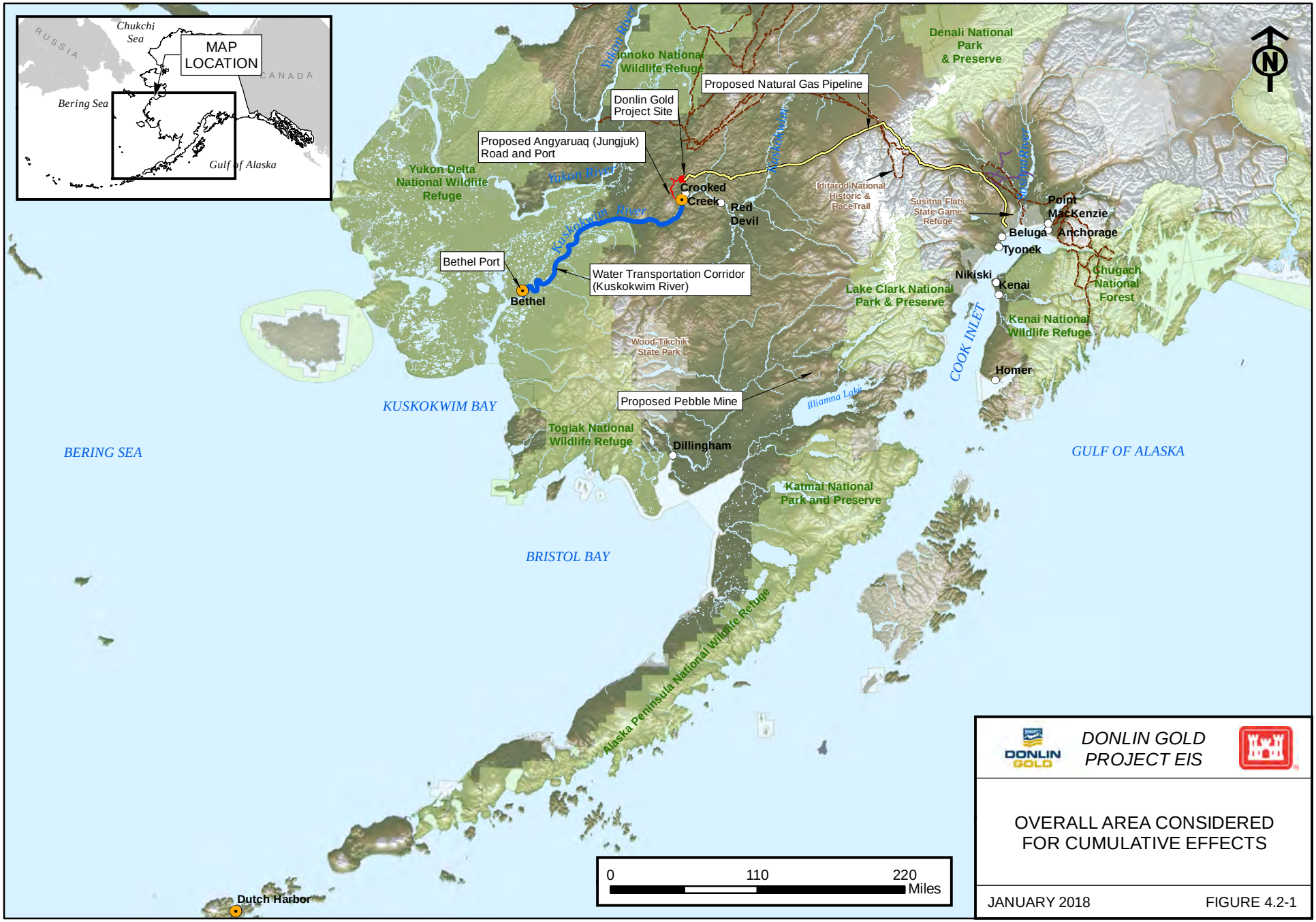
MAP LOCATION
Chukchi Sea
RUSSIA
CANADA
Bering Sea
Gulf of Alaska
Yukon River
Innoko National Wildlife Refuge
Denali National Park & Preserve
Proposed Natural Gas Pipeline
Donlin Gold Project Site
Proposed Angyaruaq (Jungjuk) Road and Port
Kuskokwim River
Yukon Delta National Wildlife Refuge
Yukon River
Crooked Creek
Red Devil
Iditarod National Historic & Race Trail
Susitna Flats State Game Refuge
Susitna River
Point MacKenzie
Beluga
Anchorage
Tyonek
Kuskokwim River
Bethel Port
Water Transportation Corridor (Kuskokwim River)
Bethel
Nikiski
Kenai
Chugach National Forest
Lake Clark National Park & Preserve
Kenai National Wildlife Refuge
Wood-Tikchik State Park
COOK INLET
Homer
KUSKOKWIM BAY
Proposed Pebble Mine
Iliamna Lake
Togiak National Wildlife Refuge
Dillingham
BERING SEA
GULF OF ALASKA
Katmai National Park and Preserve
BRISTOL BAY
Alaska Peninsula National Wildlife Refuge
Dutch Harbor
0
110
220
Miles
N
DONLIN GOLD
DONLIN GOLD PROJECT EIS
OVERALL AREA CONSIDERED FOR CUMULATIVE EFFECTS
JANUARY 2018
FIGURE 4.2-1

Table 4.2-1: Past, Present, and Reasonably Foreseeable Future Actions Considered in the Cumulative Effects Analysis

Category	Area	Project/Activity	Description
Oil and Gas Exploration and Development	Cook Inlet	• Cook Inlet Area-wide Oil and Gas Lease Sales, seismic surveys for exploration • Carrier pipelines • Baseline studies to support development of natural gas pipelines; Alaska LNG Project and Alaska Stand Alone Pipeline Project • Liquefied natural gas exports from Nikiski	Competitive oil and gas lease sales, lease exploration, and development have occurred throughout Cook Inlet. Continued activity is expected. Several pipelines exist and additional pipelines are proposed for cross-inlet pipeline development, particularly for natural gas.
Mineral Exploration and Mining	Southwest Alaska, west side of Cook Inlet Bristol Bay	• Historic Kuskokwim River Basin mining: Red Devil, NYAC, Platinum, Vinasale, Cristo, Copper Joe, and Terra Gold Small scale placer mining (e.g., Crooked Creek) and exploration activities at DeCoursey Mountain, Julian Creek, Chicken Mountain, Golden Horn, and Granite Creek, George River and Takotna River drainages and Kuskokwim Mountain mineral belt • Brazil Resources, Inc. Whistler Project • Pebble Partnership Mine Project • Localized construction material production (sand, gravel, and quarry rock)	Mineral exploration and mining have occurred in several locations in the Kuskokwim River basin, and on the west side of Cook Inlet. Small scale mining continues. Exploration activities are ongoing for potential future mining development. The Pebble Partnership submitted a DA permit application to the Corps in December 2017.
Commercial Fishing	State-managed fisheries: Kuskokwim Management Area, Upper Cook Inlet Management Area, Alaska Peninsula and Aleutian Islands Management Area Federally managed fisheries: Bering Sea and Gulf of Alaska	• Kuskokwim Management Area (salmon and herring) • Upper Cook Inlet Management Area (Pacific salmon, razor clams, Pacific herring, smelt) • Alaska Peninsula and Aleutian Islands Management Area (Bristol Bay sockeye, Pacific cod, other groundfish, crab, herring, and halibut) • Federally managed pollock ,Pacific cod and other groundfish fisheries in Bering Sea and Gulf of Alaska	Continued stock assessment and allocation decisions under existing management plans. Continued adjustment in allocation decisions as more information regarding stock status (i.e., decline of Kuskokwim River Chinook salmon, Pacific cod reductions in the Gulf of Alaska and Bering Sea) and climate change becomes available. Attention to intercept fisheries affecting Kuskokwim River-bound salmon.

Table 4.2-1: Past, Present, and Reasonably Foreseeable Future Actions Considered in the Cumulative Effects Analysis

Category	Area	Project/Activity	Description
			Continued adjustments to reduce bycatch in trawl fisheries.
Transportation	Surface, Marine, Air	• New roads – Indian Reservation Roads (IRR), federal and state-funded, local and regional • Pavement and bridge rehabilitation throughout the Central Region of the Statewide Transportation Improvement Program • Boardwalk improvements (Kipnuk, Napaskiak) • International vessel traffic on the Northern Pacific great circle route • Shipping through Dutch Harbor • Shipping/barging to Bethel • Upriver barging – Kuskokwim River • Cook Inlet shipping/barging • Port expansions/improvements at Bethel Port • Airport improvements (Bethel, Akiachak, Aniak, Goodnews Bay, Kipnuk, Kongiganak, Kwethluk, Unalaska)	Surface, marine, and air transportation services are available in the EIS Analysis Area. Federal, state, and tribal governments maintain plans for ongoing maintenance and development. International vessel traffic is estimated to increase on the Northern Pacific great circle route.
Energy & Utilities	Population centers (e.g., boroughs, cities), Cook Inlet	• Population growth induced energy consumption/demand in southcentral Alaska population centers • Renewable energy initiatives: Cook Inlet Tidal Energy Project, Fire Island Wind Project • Energy efficiency initiatives: upgrades to community power plants and improved household insulation • Transmission upgrades, installations, maintenance • Nuvista – energy development plan for	Energy consumption and demand is based in the population centers. Population forecasts estimate small levels of growth in the region. Renewable energy programs are researching and developing alternate power sources. Energy efficiency programs are reducing demand in the region.

Table 4.2-1: Past, Present, and Reasonably Foreseeable Future Actions Considered in the Cumulative Effects Analysis

Category	Area	Project/Activity	Description
		Yukon-Kuskokwim (Y-K) Delta • Buried Utilities (fiber optic cable, sewer/wastewater infrastructure, etc.)	
Community Development/Capital Improvement Projects	Yukon-Koyukuk Census Area, Bethel Census Area, Kenai Peninsula Borough, Matanuska-Susitna Borough, Southwest Alaska villages	• Village infrastructure development, such as sewer and water projects • Bank stabilization and erosion control (McGrath)	Community infrastructure projects have occurred throughout the EIS Analysis Area and are expected to continue.
Subsistence Activities	Kuskokwim River watershed, Cook Inlet, Bering Sea Coast, lower and middle Yukon River	Past and present subsistence activities are described in Section 3.21, Subsistence, of the EIS	Anticipate a continuation of traditional subsistence practices, with the exception of Cook Inlet beluga harvest.
Tourism, Recreation, Sport Hunting and Fishing	Iditarod National Historic Trail (INHT), Kuskokwim River watershed, Cook Inlet	• Iditarod trail use • Iditarod trail system improvements/installation • Flight seeing • Boating and river recreation • Camping • Sport hunting, fishing, trapping • Wildlife viewing and photography	Past uses of INHT are expected to continue. Recent funding has supported trail improvements such as shelter cabins. Past recreation, sport hunting and fishing activities are expected to continue.
Scientific Research and Surveys	Kuskokwim River watershed, Cook Inlet, Bering Sea	• Oceanographic sampling • Biological surveys • ADF&G stock assessments and harvest assessments • Arctic-Y-K Sustainable Salmon Initiative sponsored studies • Office of Subsistence Management-Fisheries Resource Monitoring Program studies • Yukon Delta NWR studies	Scientific research and surveys have occurred throughout the EIS Analysis Area and are expected to continue.
Land Use and Planning	Federal: BLM (Landowner, several areas; manager, INHT), FWS (Yukon Delta NWR)	Past and present land planning efforts detailed in Section 3.15, Land Ownership, Management, and Use, of EIS.	Implementation of existing plans is expected to continue. The BLM is in the early stages of a 5-year planning process

Table 4.2-1: Past, Present, and Reasonably Foreseeable Future Actions Considered in the Cumulative Effects Analysis

Category	Area	Project/Activity	Description
	State: ADF&G (Susitna Flats State Game Refuge), ADNR (Landowner, several areas) Local: Kenai Peninsula Borough, Matanuska-Susitna Borough, City of Bethel Private: Calista Corporation, Cook Inlet Region Inc., The Kuskokwim Corporation	• Current planning effort: Bering Sea/Western Interior (BSWI) Resource Management Plan	to develop the BSWI Resource Management Plan; implementation would occur over the next 20 years.
Self Determination	Governmental capacity in education, healthcare, housing, and local community administration	• Rural education attendance areas (e.g., Kuspuk School District) • Y-K Health Corporation services • Association of Village Council Presidents (AVCP) Housing Authority services • Regional tribal consortia (AVCP, Kuskokwim Native Association, Tanana Chiefs Conference) • City and village council governments • Kuskokwim River Inter-Tribal Fisheries Commission • Kuskokwim River Salmon Management Working Group	Existing government programs are anticipated to continue.
Climate Change	EIS Analysis Area, Alaska, U.S. International	• Trends in Climate Change (see Section 3.26) are projected to continue and to interact with other reasonably foreseeable actions in the EIS Analysis Area.	Long-term increases in temperature and precipitation, with associated changes in the atmosphere, water resources, permafrost, vegetation, wetlands, fish and wildlife habitat, and subsistence.
Global Industrial Pollutants and Contaminated Sites	The area affected directly or indirectly by contaminants released from industrial activities as they affect the Project Area.	• Air and water emissions • Contaminated soil and sediment • Bioaccumulation in habitat, fish, wildlife, and humans	Industrial activities outside the Project Area are expected to continue; contaminants are expected to continue to accumulate. Existing contaminated sites within and near the Project Area are expected to continue to affect various media.

4.2.3 EXTERNAL ACTIONS CONSIDERED BUT DISMISSED

Developments for which a solid proposal has not been submitted or which seem unlikely to occur within the foreseeable future are considered speculative. These may include projects that are discussed in the public arena, but which are not currently authorized by law or for which there is no current proposal before an authorizing agency. Speculative developments are not considered reasonably foreseeable and are not analyzed as part of the cumulative effects assessment. Table 4.2-2 summarizes external actions considered, but not included in this cumulative effects analysis.

Table 4.2-2: External Actions Considered but not included in the Cumulative Effects Analysis

Action	Description
Offshore oil and gas development in Bristol Bay and the North Aleutian Shelf	Executive withdrawal removed the area from offshore oil and gas leasing programs through 2017.
State oil and gas lease sales in the vicinity of the Alaska Peninsula	No bids were received for the sale in the last three offerings in 2013, 2011, and 2009.
Chuitna Coal Project	The permit application for this project was withdrawn in 2017 and development of the Chuitna Coal Project was not considered reasonably foreseeable at this time.
Yukon-Kuskokwim Transportation corridor	This project was proposed by the Association of Village Council Presidents (funded through a State of Alaska general fund appropriation) and is currently in the planning phase. A report on this potential project was presented at the Association of Village Counsel President's Annual Convention (2013). However, the project has no appropriation for construction, and is not currently on the Alaska Department of Transportation and Public Facilities' Statewide Transportation Improvement Program for construction funding or identified in an Alaska Statewide Long Range Transportation Plan.
Transportation through the Arctic Ocean	The U.S. Coast Guard is considering new infrastructure to augment response and management capacities in response to an anticipated increase in international vessel traffic on the Northern Pacific great circle route. However, no new infrastructure is proposed for the Transportation Corridor, and this trend is unlikely to affect the project area.
Susitna-Watana Hydroelectric Power	This project has the potential to create a large energy supply in Southcentral Alaska. However, the project is not considered to be reasonably foreseeable because it is in the preliminary stages of evaluation and is not likely to be available during Mine Site Construction Phase or the early Operations Phase.
Y-K Borough formation	The State of Alaska evaluated the potential for formation of a borough in the region, assuming a revenue stream would be generated by resource development, particularly the Donlin Gold mine. While the report concluded that formation of a borough would be feasible, the process for borough formation would be lengthy and complex. There has not been a formal proposal to develop a new borough and therefore this does not qualify as reasonably foreseeable.
Military actions and developments	Military actions or developments are not expected to occur in the Project Area.
Fukushima Daiichi nuclear power plant fallout	The debilitated Fukushima Daiichi nuclear power plant continues to release radiation into the marine environment. The proposed Donlin Gold mine project would not contribute to radiation levels in the

Table 4.2-2: External Actions Considered but not included in the Cumulative Effects Analysis

Action	Description
	environment and therefore would not contribute to cumulative effects of radiation levels in the environment. Thus, effects from the Fukushima Daiichi power plant are not considered to have a nexus with the project.

4.3 CUMULATIVE EFFECTS

The following sections describe the contribution of the project and alternatives (Alternatives 2 through 6A) to cumulative effects on the physical, biological, and social resources described in Section 3.0, Approach and Methodology. Alternative 1 – No Action would have no contribution to cumulative effects and, thus, is not discussed further in this section. The interaction of direct and indirect effects with past, present, and reasonably foreseeable future actions is analyzed for each resources according to the methodology described in Section 4.2. Discussion of cumulative effects in relation to climate change is found in Section 4.3.4.

4.3.1 PHYSICAL ENVIRONMENT

This subsection describes the contribution of the project and alternatives to cumulative effects on the physical resources described in Chapter 3, Environmental Analysis.

4.3.1.1 GEOLOGY

4.3.1.1.1 Bedrock and Surficial Geology and Related Resources

Alternative 2 – Donlin Gold's Proposed Action

The geographic area considered in the cumulative effects analysis for geologic resources is the immediate and near project vicinity (e.g., within a few tens of miles) where resource extraction could cause overlapping or accumulating geomorphic changes, competition for mineral or gravel resources, or overlapping infrastructure used for resource extraction.

The Construction, Operations, and Closure phases of the project components under Alternative 2 would result in direct impacts to bedrock associated with blasting, excavation, removal/alteration, grading, and contouring. Project activities would result in the excavation of 505 Mt of ore and 2,765 Mt of waste rock from a 1,462 acre pit; 5.6 million cy of aggregate resources (from excavated and crushed bedrock) across 900 acres associated with the Transportation Corridor and the Pipeline component; roughly 90 miles of roads and pipeline right-of-way (ROW); and topographic changes at the Mine Site up to approximately 600 feet. In terms of intensity, the majority of impacts to bedrock would occur within the footprint of the Mine Site. Additional impacts would result from use of bedrock aggregate from material sites along the mine access road and the western portion of the natural gas pipeline ROW. Where graded and revegetated, the material sites are not expected to result in adverse effects on other resources.

Direct impacts to surficial deposits from construction activities and ground disturbance such as excavation, reshaping landforms, and large-scale redistribution of materials would occur for each project component. Much of the natural gas pipeline ROW and associated access roads, and multiple airstrips are in areas that would require cut and fill construction. The removal of gravel aggregate (13 sites along the mine access road, 45 sites along the pipeline ROW) would be a noticeable change in the landforms. During reclamation, impacts would be reduced by appropriate grading and contouring.

Past, present, and RFFAs that could contribute to cumulative effects on geologic resources include mining activities that result in mineral resource depletion and topographic changes. Over the past decades, developments in southwestern Alaska have required the extraction of gravel aggregate to use in the construction of foundation pads or surfacing of roads. Small and large-scale mining operations that have or are operating in these regions have utilized these locally sourced materials. Mining has occurred in several locations in the Kuskokwim River basin to date, including Red Devil, NYAC, Platinum, Vinasale, Cristo, Copper Joe, and Terra Gold. Small scale placer mining (e.g., Crooked Creek) and exploration activities are ongoing in the region (e.g., DeCoursey Mountain, Julian Creek, Chicken Mountain, Golden Horn, and Granite Creek) from about 1 to 50 miles to the west, north, and northeast of the proposed Donlin Gold mine. Additional exploration activities have occurred and are likely to continue at the Whistler project located on the west side of Cook Inlet basin along the proposed pipeline route near MP 90 to MP 100, which would utilize local construction material resources close to those of the proposed pipeline. Potential mining development at these prospects is, for now, highly speculative, and is not considered reasonably foreseeable.

Additional past and present impacts to bedrock and surficial geology have resulted from oil and gas exploration and development on the west side of Cook Inlet basin, and from use of localized construction material for human settlements and surface, air, and marine transportation improvements in the region. These past and present actions are expected to continue throughout the EIS Analysis Area in the future. While some large-scale projects are proposed in the region, they are generally still considered to be speculative, and are not considered reasonably foreseeable, and, therefore, are not considered in this cumulative effects analysis. Overall, the impacts on bedrock and surficial geologic resources from the project and the past, present and RFFAs are geographically isolated over a very large area. While the individual impact of the project is measurable, the cumulative effect is still considered to be limited, given the limited area of disturbance over the region.

Alternative 3A – Reduced Diesel Barging: LNG-Powered Haul Trucks

Under Alternative 3A, which would reduce the need for diesel barging to the Mine Site, cumulative effects to bedrock would be considered the same as discussed under Alternative 2, and slightly reduced from the level of impacts to surficial deposits. Overall, the impact on surficial and bedrock geologic resources from the project and the past, present and RFFAs would be less significant under Alternative 3A.

Alternative 3B – Reduced Diesel Barging: Diesel Pipeline

Direct effects of Alternative 3B would be the same as Alternative 2 for bedrock resources, and have slight differences in effects on surficial deposits and gravel resources. Alternative 3B would have less indirect effects on surficial deposits at the Bethel and Dutch Harbor Ports due

to a reduction in the amount of fuel storage required. However, effects on surficial deposits and aggregate resources would increase as a result of Alternative 3B due to additional trenching and material sites between Beluga and Tyonek, and additional cut-and-fill construction and/or grading for new airstrips and helipads.

The cumulative effects for Alternative 3B (including the Port MacKenzie Option and Collocated Natural Gas and Diesel Pipeline Option), would be similar to Alternative 2. Past actions are expected to continue, such as mining operations, and transportation development and improvements. Reasonably foreseeable future actions were identified in the Project Area, but these would likely induce little change to levels of surficial geology and gravel resources. While some large-scale projects are proposed in the region, they are generally still considered to be speculative, and are not considered reasonably foreseeable.

In addition to the past, present, and reasonably foreseeable future actions Alternative 3B would result in additive, incremental direct and indirect effects on surficial geology and gravel resources.

Alternative 4 – Birch Tree Crossing Port

Direct and indirect impacts to geologic resources associated with the Mine Site, Transportation Corridor, and Pipeline component under Alternative 4 would be similar to those discussed under Alternative 2. Construction activities and ground disturbance such as excavation, reshaping landforms, and large-scale redistribution of geologic resources would occur for each project component. The BTC Road is 46 miles longer than the mine access road, would traverse approximately 10 more miles of shallow bedrock, and utilize roughly five times the amount of rock aggregate. While the BTC Road would utilize gravel aggregate sourced from 50 material sites compared to only 13 for the mine access road under Alternative 2, the volume of gravel utilized would be about the same. Despite the increases in rock aggregate and the numbers of material sites utilized for the BTC Road, the implementation of Alternative 4 would not change the impact ratings from Alternative 2.

The cumulative effects on geologic resources under Alternative 4 would be similar to Alternative 2. Past actions are expected to continue, such as mining exploration and operations, oil and gas exploration and development, and transportation development and improvements. Reasonably foreseeable future actions were identified in the Project Area, but these would likely induce few additional changes to disturbance and removal of bedrock and gravel resources.

In addition to the past, present, and reasonably foreseeable future actions Alternative 4 would result in measurable additive, incremental effects on geologic resources.

Alternative 5A – Dry Stack Tailings

While there would be small differences in the amount of bedrock excavated and rock fill used under Alternative 5A compared to Alternative 2, and an increase in the amount of gravel resources needed at the Mine Site under Alternative 5A, effects would be small compared to the range of effects for the project as a whole. Thus, the levels of direct and indirect effects would be the same as discussed under Alternative 2. Mine Site Overall, the impact on the resource from the project and the past, present and RFFAs under Alternative 5A is substantially the same as those cumulative effects under Alternative 2.

Alternative 6A – Modified Natural Gas Pipeline Alignment: Dalzell Gorge Route

Under Alternative 6A, there would be small differences in the amounts of rock aggregate utilized along the pipeline as compared to Alternative 2, and a slight net decrease in impacts to gravel resources under Alternative 6A as compared to Alternative 2, but the differences would be relatively small compared to the project as a whole. The total lengths of ROW that would impact surficial deposits under Alternatives 2 and 6A are comparable, as there is only about a one- to two-mile difference in length for the two routes. Overall, the impact on the resource from the project and the past, present and RFFAs under Alternative 6A is substantially the same as under Alternative 2.

4.3.1.1.2 Paleontological Resources

Alternative 2 – Donlin Gold's Proposed Action

The geographic area considered in the cumulative effects analysis for paleontological resources is the immediate and near project vicinity (i.e., within a few tens of miles) where resource extraction and landform changes could cause overlapping or accumulating reductions in available fossil-bearing outcrops and surficial deposits in the region.

Many geologic formations have the potential to contain paleontological resources. Fossils potentially present at the Mine Site would likely be contained within sedimentary rocks that have not been altered by hydrothermal processes, with highest potential for paleontological resources in the east and south sides of the open pit. Quaternary surficial deposits may also contain fossils, including Pleistocene age vertebrates. There are several documented fossil locations in Quaternary surficial deposits along the Kuskokwim River and the proposed Angyaruaq (Jungjuk) Port, and the proposed pipeline corridor would cross a number of potential fossil-bearing geologic formations and surficial deposits.

Potential impacts in fossil localities during construction could include direct impacts such as damage, or destruction of, fossils resulting from blasting or excavation activities; indirect impacts such as erosion of fossil beds resulting from slope regrading and clearing of vegetation; or unauthorized collection of significant fossils by construction personnel or local residents. Construction, Operations, and Closure activities could destroy or cover potentially important paleontological resources, or expose surfaces containing fossils to erosion (cut slopes and river bluffs). As part of the project, Donlin Gold would prepare a Cultural Resource Management Plan (CRMP) that would provide mitigation measures for protection of unanticipated discoveries of paleontological resources.

Past human-induced impacts to paleontological resources in the region may have occurred at mining sites in southwest Alaska and the Alaska Range if fossil-bearing deposits or sedimentary rocks were encountered; at oil and gas development sites in western Cook Inlet; and at material sites, roads and airport improvements, human settlements, and small scale recreation where disturbed rock or surficial deposits are known or suspected of being fossil-bearing. For example, past placer mining activities in Crooked Creek, and gravel borrow sites in villages along the Kuskokwim River and in small settlements and mining exploration sites along the proposed pipeline corridor, may have encountered Pleistocene fossils in surficial deposits. In addition, natural erosion along the Kuskokwim River bank periodically exposes large Pleistocene mammal fossils. These past and present actions are expected to continue.

While some large-scale projects are proposed in the region, they are generally still considered to be speculative, and are not considered reasonably foreseeable.

In addition to the past, present, and reasonably foreseeable future actions, Alternative 2 would result in additive, incremental effects on paleontological resources.

Alternative 3A – Reduced Diesel Barging: LNG-Powered Haul Trucks

While some reduced direct and indirect impacts would occur for the transportation component under Alternative 3A, the reductions would be relatively small compared to the project as a whole. Thus, the levels of effects would be the same as Alternative 2, and would not change the range of direct and indirect impacts.

Alternative 3B – Reduced Diesel Barging: Diesel Pipeline

There would be a net increase in the probability of potential effects on paleontological resources under Alternative 3B (including the Port MacKenzie Option and Collocated Natural Gas and Diesel Pipeline Option) consistent with an increased area of disturbance over Alternative 2.

Alternative 4 – Birch Tree Crossing Port

Cumulative effects on paleontological resources under Alternative 4 would be similar to those discussed under Alternative 2; however, Alternative 4 could result in additive, incremental effects on paleontological resources due to a greater area of disturbance. There are 50 material sites along the BTC Road that contain Kuskokwim Group sedimentary rock with the potential for significant fossils (as compared to three sedimentary rock material sites along the mine access road under Alternative 2. Overall, the impact on paleontological resources from the project and the past, present and RFFAs under Alternative 4 could increase from the cumulative effects on this resource under Alternative 2.

Alternative 5A – Dry Stack Tailings

Cumulative effects on paleontological resources under Alternative 5A would be similar to those discussed under Alternative 2. While there would be small differences in the amount of potential fossil-bearing bedrock excavated or covered between Alternatives 2 and 5A at the Mine Site, effects would be within the range of impacts ratings for the project as a whole. Overall, the impact on the resource from the project and the past, present and RFFAs under Alternative 5A would be substantially the same as those cumulative effects under Alternative 2.

Alternative 6A – Modified Natural Gas Pipeline Alignment: Dalzell Gorge Route

Potential paleontological resource occurrences within the Alternative 6A project footprint are generally similar to those within the Alternative 2 project footprint. Thus, the levels of direct and indirect effects would be the same as Alternative 2, and would not change the range of net impacts.

4.3.1.2 SOILS

4.3.1.2.1 Soil Disturbance and Erosion

Alternative 2 – Donlin Gold's Proposed Action

The geographic area considered in the cumulative effects analysis for soil disturbance and erosion is the close vicinity of the project footprint (i.e., within about one mile) where soil disturbance, removal, and erosion impacts could cause overlapping effects with other man-made activities or natural processes in the area.

Direct and indirect impacts to soils would include continued disturbances throughout the mine operation, which would have an active life of approximately 28 years. The soil types impacted under Alternative 2 are considered common in context based on their local and regional distribution. Project activities would result in a total of up to 20,200 acres of soils that would be altered during Construction and Operations of all three project components. Potential exposure to water and wind erosion, and intense use of heavy equipment could create medium to high magnitude impacts. The potential for hydraulic and wind erosion would be greatest in the non-winter months during the Construction and Closure phases. Selective reclamation of disturbed areas would optimize stabilization and restoration of disturbed soils in some areas during construction and operation, instead of postponement to closure. A total of approximately 1,910 acres disturbed area would not be reclaimed following closure activities; these include the ultimate pit, Angyaruaq (Jungjuk) mine access road and airstrip, and the water treatment plant and associated infrastructure. Under Alternative 2, design features, erosion sediment and control (ESC) measures, and Best Management Practices (BMPs) are expected to keep potential effects localized and of less intensity. Compliance with erosion mitigation, control, and monitoring measures in the Transportation Corridor and Pipeline components would be addressed in a SWPPP and related documents.

Cumulative changes to soils within the analysis area would occur from both natural processes (weathering and the annual freeze/thaw cycle) and human disturbance. Human-induced impacts related to soil disturbance and erosion have occurred in the analysis area as a result of industrial activities related to mining operations, localized construction material production, new roads and airport improvements in population centers along the Kuskokwim River, and oil and gas activities in western Cook Inlet. For example, past Crooked Creek placer mining, Bethel port developments, and mining exploration in the Whistler project along the pipeline have or would occur in the close vicinity of the project. Other soil disturbance and erosion in the analysis area has resulted, and would continue to occur, from human settlements and subsistence activities, Iditarod and other trail use, and recreation activities. Snow-machine induced erosion during shoulder seasons in western Cook Inlet, and subsistence and recreational ORV use in the Farewell area, are expected to continue. Natural riverbank erosion has and would continue to occur during breakup and flood events along the Kuskokwim River and other major rivers crossed by the pipeline route, and along small to moderate drainages such as Crooked Creek. Natural erosion would also continue to occur on steep slopes, debris flows, and alluvial fans along the pipeline route, particularly in the Alaska Range. These man-made and natural reasonably foreseeable future actions that overlap with the Project Area are relatively localized and would likely induce changes to levels of soil disturbance and removal.

While disturbance and potential erosion impacts to soils resulting from Alternative 2 are additive, the total and incremental amount of disturbed area is small compared to the total resource within southwestern Alaska and the pipeline region. Mobilization of equipment; excavation, grading, compaction; and erosion of soil due to potential channelization of runoff would add to other natural and man-made sources of cumulative effects on soils in the analysis area. Overall, the impact on the resource from the project and the past, present and RFFAs is expected to be measurable, but geographically limited.

Alternative 3A – Reduced Diesel Barging: LNG-Powered Haul Trucks

There would be small differences in direct impacts to soils under Alternative 3A compared to Alternative 2. Although the Bethel (connected action) and Dutch Harbor ports would not require as much expansion under Alternative 3A, and soil disturbances and erosion at barge relay points along the Kuskokwim River would be reduced, the relatively small scale of these changes would not change the conclusions that were reached under Alternative 2.

The cumulative effects for Alternative 3A would be similar to Alternative 2. Past actions are expected to continue, such as mining operations, transportation development, Iditarod and other trail use, and natural riverbank and slope erosion.

Alternative 3B – Reduced Diesel Barging: Diesel Pipeline

There would be small differences in direct impacts to soils under Alternative 3B (including the Port MacKenzie Option and Collocated Natural Gas and Diesel Pipeline Option), compared to Alternative 2. The reduction in required fuel storage under Alternative 3B would result in roughly 10 acres less required fuel storage at the Mine Site than under Alternative 2, and reduced barge traffic would result in less potential impacts to soils along the river's edge. However, these combined reductions represent a small percentage of the overall soil disturbance at the Mine Site (approximately 9,000 acres). Additionally, the expansion of the existing North Foreland Barge Facility dock in Tyonek, or upgrades to the Point MacKenzie dock area under Alternative 3B and options would require soil disturbances during construction of a temporary barge landing adjacent to the dock and staging areas to support dock extension and pipeline construction. These additional impacts would not change the overall impact rating from Alternative 2.

The cumulative effects for Alternative 3B would be similar to Alternative 2. Past actions are expected to continue in the analysis area, such as mining operations, transportation improvements, trail use, energy development, and natural riverbank and slope erosion. Overall, the impact on soil resources from the project and the past, present and RFFAs under Alternative 3B would be substantially the same as under Alternative 2.

Alternative 4 – Birch Tree Crossing Port

While the Mine Site and Pipeline components under Alternative 4 are identical to Alternative 2, the 73-mile long BTC Road would be about 46 miles longer than the mine access road under Alternative 2. The total estimated area of soil disturbance/removal associated with the BTC Road is approximately 900 acres, and the BTC Port would occupy a footprint of about 65 acres. There would be longer sections of the BTC Road along slopes requiring cut and fill construction and greater thermal erosion potential. There is also the potential for compaction and erosion along the temporary ice road needed during construction. Additionally, several critical sections

upstream of the BTC Port (Aniak, Holokuk, Upper Oskawalik), where barges would need to be relayed during low water periods, would be avoided under Alternative 4 thereby reducing potential soil disturbance and erosion effects. These additional adverse (increased area of soil disturbance and erosion potential) and beneficial (reducing barge travel distances) impacts associated with Alternative 4 would not change the overall impact rating from Alternative 2. A more robust Erosion Sediment and Control Plan (ESCP) and BMPs may be needed to help reduce the intensity of possible erosion impacts.

The cumulative effects for Alternative 4 would be similar to Alternative 2. Past actions are expected to continue, such as mining operations, transportation improvements, trail use, energy development, and natural riverbank and slope erosion. Impacts to soil disturbance/removal from Alternative 4 and from current and future actions would be additive, except in areas previously disturbed. Mobilization of equipment; excavation, grading, and compaction; and erosion of soil due to temporary ice road construction and use would add to the cumulative effects on erosion. Overall, the impact on soil resources from the project and the past, present and RFFAs under Alternative 4 is only slightly greater than under Alternative 2.

Alternative 5A – Dry Stack Tailings

There would be small differences in direct effects on soils at the Mine Site under Alternative 5A compared to Alternative 2. The overall soil disturbance footprint in the Anaconda Valley is approximately 2,461 acres, as compared to the Alternative 2 TSF which would impact 2,384 acres, or an increase of 77 acres (BGC 2014b). Small variations from Alternative 2 in soil disturbance quantities include additional areas associated with infrastructure requirements and overburden stockpile acreage. More notable soil disturbance deviations from Alternative 2 would occur during the Closure Phase of the operating pond. However, since disturbed soil acreages under this alternative are comparable to the proposed action, the same level effects on soil are anticipated. Alternative 5A would have increased erosion potential during the Operations Phase at the dry stack; and both reduced and increased erosion potential during closure at the dry stack and operating pond, respectively. While some effects would likely offset each other, a net increase in the intensity of erosion impacts under this alternative is anticipated. Planned BMPs and ESCP measures could result in the reduction of intensity levels.

Cumulative effects on soil erosion would be similar to those discussed under Alternative 2. Past, present, and reasonably foreseeable future actions that contribute to cumulative effects would be the same as those discussed under Alternative 2. Alternative 5A would result in additive, incremental effects to these actions.

Alternative 6A – Modified Natural Gas Pipeline Alignment: Dalzell Gorge Route

The Dalzell Gorge route has a greater estimated area of off-ROW surface disturbance, resulting in a total of roughly 1,300 acres, or 9 percent more surface disturbance than Alternative 2 for both ROW and off-ROW areas combined. Alternative 6A appears slightly more susceptible to wind erosion and water erosion on steep slopes, and a greater potential for thermal erosion of frozen soils than Alternative 2. BMPs and ESC measures employed for Alternative 6A would be the same as under Alternative 2. Because the increased amount of acreage under Alternative 6 is relatively small compared to total area of surface disturbance (about 15,400 acres), and because the types of construction activities would be similar for both alternatives, impacts associated with Alternative 6A would not change from Alternative 2.

Cumulative effects on soil disturbance and erosion under Alternative 6A would be greater than Alternative 2 due to the increased amount of collocated, proximate, or crossed Iditarod Trail sections (about 30 miles more collocated or proximate sections, and 21 additional crossings, than Alternative 2) (Table 3.16-7 in Section 3.16, Recreation) and increased potential for public access to the proposed ROW. In addition, past actions elsewhere are expected to continue, such as mining exploration, transportation improvements, energy development, and natural riverbank and slope erosion. Impacts to soil disturbance and erosion from Alternative 6A and from current and future actions would be additive, except in areas previously disturbed. Overall, the impact on soil resources from the project and the past, present and RFFAs under Alternative 6A is substantially the same as under Alternative 2.

4.3.1.2.2 Permafrost

Alternative 2 – Donlin Gold's Proposed Action

The geographic area considered in the cumulative effects analysis for permafrost is the immediate vicinity of the project footprint, where permafrost thaw could cause overlapping effects with other man-made activities or natural processes. While the project could potentially add to indirect climate change effects on permafrost across a wider geographic area through greenhouse gas (GHG) emissions, these effects would be extremely small compared to other contributions to climate change worldwide (see Section 3.26.4.2.1) and thus extremely small compared to other effects in the vicinity of the footprint described below.

Direct and indirect impacts of Alternative 2 on permafrost, or from permafrost hazards, would vary by location, as they would depend on the local to regional climate, soil characteristics, and hydrology. Sporadic discontinuous permafrost is present throughout the Mine Site footprint, and removal or pre-settlement of permafrost would be part of foundation preparation at large structures. Transportation facilities associated with Alternative 2 that are located where frozen soil conditions exist include the mine access road, the Angyaruaq (Jungjuk) Port, the Kuskokwim River corridor, and the Bethel Port (connected action). The primary area of concern for permafrost thaw settlement associated with operation of the pipeline would be in the Alaska Range, and on the north flank of the Alaska Range between the South Fork Kuskokwim River (MP 147) and the main stem Kuskokwim River (MP 240). However, planned mitigation measures are expected to be largely effective in reducing impact levels to and from permafrost under each project component.

The effect of GHG emissions from permafrost thaw is included in Sections 3.2 (Soils), 3.8 (Air Quality), and 3.26 (Climate Change, Atmosphere). Changes to (or loss of) permafrost in the region as a result of global climate change could adversely affect the components of Alternative 2. The amount of permafrost thaw that is reasonably expected to occur in the analysis area in the future due to climate change is discussed in Section 3.26.3.3. Ground temperature increases that would occur in the region in the absence of the project range from 0 to 7°F up to 40 years post-Closure, and would extend up to 10 to 30 feet below ground surface. For the Mine Site and most transportation facilities, however, climate change is not expected to contribute an appreciable amount of permafrost thaw beyond that expected from the project, because project-induced thaw or excavation would reach the bottom of permafrost within the life of the mine (Tables 3.2-4 and 3.2-5). For the Bethel Yard Dock, cumulative effects from both climate change and project activities could result in about 5 to 10 percent deeper thaw than that predicted from

project activities alone (Section 3.26.4.2.3). For the pipeline ROW, the cumulative amount of permafrost degradation (thaw depth) predicted to occur from climate change and ROW clearing combined is 50 feet after 45 years post-closure, of which up to 13 feet or about one-quarter is attributable to climate change. The cumulative amount of thaw settlement at the ground surface in the ice-rich region along the north front of the Alaska Range is predicted to range from 0.2 to 8.6 feet, of which 0 to 2 feet is attributable to climate change (Fueg 2014).

Besides climate change, other land-based past, present, and reasonably foreseeable future actions described in Section 4.2 could result in a cumulative impact on permafrost where present within the Project Area. Human-induced impacts related to permafrost have primarily occurred as a result of mining operations, localized construction material production, new roads and airport improvements around southwestern Alaska and along the pipeline, and Iditarod and other trail use. These past actions are expected to continue in the future.

Overall, Alternative 2 would have measurable impacts to permafrost in the Project Area. The impacts on permafrost would primarily occur in the local areas where the activities occurred, but would be more notable along certain sections of the pipeline where project-induced thaw degradation and settlement would have an additive effect on thaw caused by climate change. Overall, the impact on the resource from the project and the past, present and RFFAs under the proposed alternative is expected to be geographically limited in the region, and only a small component of the broader impact on permafrost from global climate change.

Alternative 3A – Reduced Diesel Barging: LNG-Powered Haul Trucks

There would be small differences in impacts to permafrost under Alternative 3A compared to Alternative 2. The extent of permafrost impacts at the Bethel dock could be reduced, if permafrost is indeed present. Impacts from climate change on permafrost would be the same as described for Alternative 2. Impacts on permafrost from other past, present, and future actions would primarily occur in localized areas where the activities are coincident with the project area as described under Alternative 2. Thus, cumulative effects for Alternative 3A would be similar to Alternative 2.

Alternative 3B – Reduced Diesel Barging: Diesel Pipeline

Under Alternative 3B (including the Port MacKenzie Option and Collocated Natural Gas and Diesel Pipeline Option), cumulative impacts to permafrost would be considered the same as discussed under Alternative 2. No permafrost is expected along the additional pipeline route between Tyonek and Beluga.

Alternative 4 – Birch Tree Crossing Port

Direct and indirect impacts to and from permafrost would be greater under Alternative 4 than Alternative 2. The 73-mile long BTC Road would be about 46 miles longer than the mine access road under Alternative 2, or about 1.53 times longer, and would cross areas of localized thermokarst. The duration of impacts would range from long-term (e.g., subsidence repaired over several years) to permanent, since permafrost degradation is not expected to recover, and the road would remain after mine closure. Permafrost is affected by road dust generated by traffic on unpaved roads, and over time, dust from the road could impact adjacent soils and permafrost.

The cumulative effects for Alternative 4 would be similar to Alternative 2. Impacts from climate change on permafrost would be the same as described for Alternative 2, except for effects along the Crooked Creek winter road, where permafrost degradation from climate change may continue beyond the period of vegetation recovery from project activities. Climate change is not expected to contribute an appreciable amount of permafrost thaw along the BTC Road beyond that expected from the project, because project-induced thaw would reach the bottom of permafrost within the life of the mine (Table 3.2-5). Past actions are expected to continue, such as mining operations, transportation improvements, and trail use. Impacts on permafrost from these activities would primarily occur in localized areas where the activities are coincident with the project footprint. There would be additive incremental impacts on permafrost attributable to Alternative 4, but these impacts would be geographically limited to specific Transportation Corridor facilities. Overall, the impact on the resource from the project and the past, present and RFFAs under Alternative 4 is expected to be substantially the same as under Alternative 2.

Alternative 5A – Dry Stack Tailings

As described in Section 3.2.3.6.2 (Section 3.2, Soils), a small increase in the amount of ice-rich overburden excavated at the Mine Site under Alternative 5A (due to additional dam footprint) would result; however, this difference could be potentially off-set to some degree by thermal properties of the dry stack tailings. Variation in the effects would be small compared to the range of effects for the project as a whole. Thus, the levels of direct, indirect, and cumulative effects to and from permafrost would be the same as Alternative 2

Alternative 6A – Modified Natural Gas Pipeline Alignment: Dalzell Gorge Route

Direct and indirect impacts on and from permafrost under Alternative 6A is expected to be similar to Alternative 2.

Cumulative effects for Alternative 6A would be slightly greater than Alternative 2 due to the increased amount of collocated, proximate, or crossed Iditarod Trail sections, and increased potential for public access to the proposed ROW, which could further degrade permafrost where present in the Alaska Range. Past and present actions are expected to continue, such as climate change, mining operations, transportation improvements, and other trail use near human settlements. With the exception of climate change, impacts on permafrost from these actions would primarily occur in the localized areas where the activities are coincident with the project footprint. Overall, the impact on the resource from the project and the past, present and RFFAs under Alternative 6A is expected to be the same as under Alternative 2.

4.3.1.2.3 Soil Quality/Contaminated Sites

Alternative 2 – Donlin Gold's Proposed Action

The geographic area considered in the cumulative effects analysis for soil quality and contaminated sites is the near vicinity of the project footprint (i.e., within several miles for fugitive dust effects, and within about ¼-mile for effects from contaminated sites) where soil quality could be affected by dust and contaminants from man-made activities.

Direct and indirect impacts on soils from the project would include deposition of fugitive dust generated during Mine Site Construction, Operations, and Closure that could potentially result in elevated concentrations of soils surrounding the Mine Site and along the mine access road

over time. Fugitive dust would be generated by processes such as drilling and blasting in the pit, waste rock and ore handling, road traffic, wind erosion of exposed surfaces, and ore processing. Planned mitigation measures for dust control would reduce the intensity of effects. Intensity of impacts would be that they are not expected to reach levels of concern to human health, or would exhibit small increases (up to 5 percent) above naturally high baseline conditions as described in Section 3.2.3.2.4 (Section 3.2, Soils).

Existing contaminated sites are considered part of baseline soil conditions in the evaluation of direct and indirect effects, as well as past, present, and reasonably foreseeable future activities that could contribute to cumulative effects. As described in Sections 3.2.2.2.4 and 3.2.2.3.4 (Section 3.2, Soils), there are multiple known contaminated sites located in the vicinity of the Transportation Corridor and Pipeline component facilities. About 64 contaminated sites have been identified in ADEC and Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) databases within ¼-mile of the Kuskokwim River, Bethel and Dutch Harbor ports, and pipeline facilities (Tables 3.2-5, 3.2-6, and 3.2-10; Figures 3.2-4, 3.2-5, and 3.2-9, all in Section 3.2, Soils). About 40 of these remain open; that is, contaminants in soils may be present currently, and it is reasonably foreseeable that remedial actions would continue in the future. There are no contaminated sites in the vicinity of the Mine Site. The effects of past placer mining in Crooked and Donlin creeks upstream of the Mine Site on water and sediment quality is described under 4.3.1.7 (Water Quality). Environmental impairments associated with the former Red Devil Mine, located on the Kuskokwim River about 30 miles upstream of Crooked Creek, do not affect soil quality within ¼-mile of the project transportation corridor; this site is also discussed in relation to cumulative effects on water and sediment quality in Section 4.3.1.7.

In terms of intensity, potential direct and indirect impacts from contaminated sites as a result of project activities are expected to range from such scenarios as a low likelihood of project activities collocating with Bethel or Kuskokwim River contaminated site, to scenarios such as grading being needed of pre-existing contaminated soils at Dutch Harbor or the Farewell airstrip, depending on site-specific presence/extent of existing soil contamination. Recommendations for further investigation and mitigation of contaminated sites where they are suspected of overlapping with the project footprint are provided in Chapter 5, Impact Avoidance, Minimization, and Mitigation. SWPPP compliance during construction and Operations also would make sure development activities protect terrestrial and aquatic resources from potential releases of soil contaminants to the environment.

In addition to contaminated sites, other past, present, and future actions could contribute to fugitive dust effects on soil quality. These include activities related to oil and gas development in western Cook Inlet, mining exploration and operations, localized construction material production, and unpaved road and trail use near human settlements and along the Iditarod National Historic Trail (INHT). These past and present actions are expected to continue throughout the analysis area.

The effects of past, present, and reasonably foreseeable future actions from known contaminated sites and dust-generating activities on soil quality are because of the number of open contaminated sites within a ¼-mile of the project footprint, particularly along the Kuskokwim River and at Dutch Harbor. In addition to these, Alternative 2 would result in mostly additive, incremental effects on soil quality, due to the limited intensity of expected

fugitive dust impacts, and the localized nature of known contaminated sites that overlap the project footprint.

Alternatives 3A and 6A

Under Alternatives 3A and 6A, cumulative impacts to soil quality / contaminated sites would be considered the same as discussed under Alternative 2.

Alternative 3B – Reduced Diesel Barging: Diesel Pipeline

The direct effects of fugitive dust on soil quality under Alternative 3B at the Mine Site would be the same as Alternative 2. An additional 8 contaminated sites were identified from the ADEC database along the Alternative 3B pipeline route between Tyonek and Beluga, three of which remain open (Figure 3.2-9 and Table 3.2-10 in Section 3.2, Soils). It is possible that soil disturbances during trenching or at the Tyonek barge landing could encounter contaminated soils. The levels of direct and indirect effects of these conditions (including the Port MacKenzie Option and Collocated Natural Gas and Diesel Pipeline Option) would be the same as those of similar sites in Alternative 2.

The effects of past, present, and reasonably foreseeable future actions from known contaminated sites and dust-generating activities on soil quality would be similar to Alternative 2. There would be effects because of the number of open contaminated sites within a ¼-mile of the project footprint, particularly along the Kuskokwim River, at Dutch Harbor, and the Tyonek-Beluga area. The incremental contribution of Alternative 3B to cumulative effects on soil quality would due to the limited intensity of expected fugitive dust impacts, and the localized nature of known contaminated sites that overlap the project footprint.

Alternative 4 – Birch Tree Crossing Port

The direct effects of fugitive dust on soil quality under Alternative 4 at the Mine Site would be the same as Alternative 2. There would be about 10 fewer contaminated sites located along the Kuskokwim River as a result of the shorter transportation corridor under Alternative 4 (Figure 3.2-4, in Section 3.2, Soils). The levels of direct and indirect effects from other contaminated sites identified along the lower Kuskokwim River, at Dutch Harbor, and along the pipeline would be the same as described under Alternative 2.

The effects of past, present, and reasonably foreseeable future actions from known contaminated sites and dust-generating activities on soil quality would be similar to Alternative 2 because of the number of open contaminated sites within a ¼-mile of the project footprint. The incremental contribution of Alternative 4 to cumulative effects on soil quality is due to the limited intensity of expected fugitive dust impacts, and the localized nature of known contaminated sites that overlap the project footprint.

Alternative 5A – Dry Stack Tailings

Similar to the proposed action, direct impacts to soil from dust deposition under Alternative 5A would be of limited intensity (e.g., arsenic-bearing dust deposition resulting in small increases in soil concentration exceeding naturally high baseline levels), although a slightly broader distribution of impacts is possible due to a small increase of 6.6 percent in the amount of dust for the Mine Site as a whole than Alternative 2 (Rieser 2015b). The small increase is based on

comparison of Alternative 5A air emissions calculations from dust generating sources which include an end of mine life TSF source area of 1,500 acres for exposed dry stack surfaces.

The effects of past, present, and reasonably foreseeable future actions from contaminated sites and dust-generating activities on soil quality would be the same as Alternative 2. There would be an additive, incremental contribution from implementation of Alternative 5A.

4.3.1.3 GEOHAZARDS AND SEISMIC CONDITIONS

The project and its alternatives would not directly or indirectly affect geohazards and seismic conditions. Major project structures that could be affected by these conditions do not specifically overlap other past, present, or reasonably foreseeable future actions in a way that would cause cumulative or synergistic effects on or from geotechnical instability. Therefore no cumulative effects are identified.

4.3.1.4 CLIMATE AND METEOROLOGY

The project and its alternatives would not directly or indirectly affect meteorological conditions in the region. Potential direct and indirect effects of the project and alternatives on climate change are discussed in detail in Section 4.3.4, Cumulative Effects and Climate Change.

4.3.1.5 SURFACE WATER HYDROLOGY

4.3.1.5.1 Alternative 2 – Donlin Gold's Proposed Action

The geographic area considered in the cumulative effects analysis for surface water hydrology includes all watersheds affected by the project footprint, and the area of natural lateral erosion in the Kuskokwim and other rivers crossed by the project, where other actions could have synergistic effects on flow, water use, and river scour and erosion. For example, the distance to watershed boundaries from the project footprint varies from about 5 to 15 miles at the Mine Site and along the mine access road (Figures 3.5-1 and 3.5-5, Section 3.5, Surface Water Hydrology), to up to roughly 100 miles from the footprint for larger watersheds crossed by the pipeline (Figures 3.5-16 and 3.5-17, Section 3.5, Surface Water Hydrology) and for the Kuskokwim River watershed considered in the climate change analysis (Figure 3.26-2, Section 3.26, Climate Change). The distance of natural lateral erosion along the Kuskokwim River over past decades has ranged from several feet to hundreds of feet along the upper Kuskokwim River above Aniak, to about a ½-mile in the lower Kuskokwim below Bethel (Figures 3.5-14 and 3.5-15, Section 3.5, Surface Water Hydrology).

The direct and indirect effects of Alternative 2 would result in varying intensities of impacts to surface water hydrology. Construction of the open pit requires lowering the water table around the pit, which would reduce flow in Crooked Creek. Impoundment structures such as the Tailings Storage Facility (TSF), Contact Water Dams (CWDs), and Snow Gulch Reservoir would intercept and reduce tributary stream flows. In terms of intensity, groundwater drawdown and mine pit dewatering and impounded surface water would create long-term to permanent impacts to the local surface water hydrologic system and discharge patterns, particularly in American and Anaconda creeks, but also affecting Crooked Creek. The most intense impacts would be experienced during the period of active mining. The plan for flow diversions around

major structures and discharge of treated water back into Crooked Creek serve to reduce impacts from these activities. Effects on surface water hydrology along the transportation corridor range from low magnitude drainage changes at culverts along the mine access road, to scour effects at several shallow sections of the Kuskokwim River which would be localized and temporary. Effects from the pipeline include mostly low magnitude impacts from water use during construction and drainage changes at surface water crossings. Changes to surface water hydrology as a result of global climate change are considered part of baseline and direct/indirect effects in this analysis (Section 3.26, Climate Change), as well as a key component of past, present, and future actions considered in cumulative effects. Direct and indirect effects due to climate change under Alternative 2 would range from scenarios in which sufficient barge days would be available under a low water climate change scenario to meet proposed shipping needs, to conditions such as a faster pit lake filling rate that could require changes in water management/treatment strategies in post-Closure. The duration of climate change effects would have potential impacts lasting through the life of the project (for the Transportation Corridor and Pipeline components) and in post-Closure (at the mine site). The extent of project effects would be considered local to regional. Overall hydrologic effects due to climate change are considered minor to moderate.

Besides climate change, other past, present, and reasonably foreseeable future activities in the analysis area that affect surface water hydrology include river transportation, small-scale placer mining and mine exploration, fisheries activities, water supply, and natural hydrologic processes. Impacts associated with these activities include scour from existing barges, changes in drainage patterns, changes in stream flow, competing water usage, and potential for runoff and erosion. For example, barge tows that currently serve villages upriver of Bethel would continue to create scour conditions in shallow sections that are similar to those modeled for the proposed Donlin tugs (Section 3.5.3.2.2, Surface Water Hydrology). Fish would continue to utilize stream flow in the same watersheds that would be affected by the project (Section 4.3.2.4). New roads and airport improvements in the region would increase runoff and erosion. While most community water supply use in the EIS Analysis Area is from groundwater wells, surface water would continue to be used by individuals and villages along the Kuskokwim River, recreation and subsistence users, the Whistler project and other mine sites, and oil and gas operators in western Cook Inlet. Flooding, breakup, low water conditions, and natural riverbank erosion would continue to occur throughout the analysis area, particularly affecting the Kuskokwim River and other major rivers crossed by the pipeline route. Aufeis conditions are known to develop seasonally along certain parts of the INHT; a situation that could be exacerbated by the collocated pipeline ROW near stream crossings.

The effects of past, present, and reasonably foreseeable future actions on surface water range from minor to moderate consider the relatively few human activities with overlapping flow impacts, yet relatively high impact of natural flooding and erosion processes and the potential for climate change to affect hydrology. The incremental contribution of Alternative 2 to cumulative effects on surface water hydrology would be the localized noticeable changes in resource character during the life of the project, and relatively small geographical area of effects on surface water. Overall, the impact on the resource from the project and the past, present and RFFAs in the area is expected to be small.

4.3.1.5.2 Alternatives 3A and 3B: Reduced Diesel Barging

The reduction in the number of project-related Kuskokwim River barge trips from 122 under Alternative 2 to 83 under Alternative 3A and 64 under Alternative 3B would reduce the magnitude of the potential impacts to the Kuskokwim River as there would be a decrease in barge stranding potential, barge-induced bank erosion potential, and scour from propeller wash. However, the range of effects, including those at the Mine Site, would be the same as Alternative 2.

There would be slightly fewer past, present, and future actions contributing to cumulative effects in the Kuskokwim watershed; and slightly more in the Tyonek-Beluga area under Alternative 3B, such as additional water use by oil and gas operations. Cumulative effects for Alternatives 3A and 3B (including the Port MacKenzie Option and Collocated Natural Gas and Diesel Pipeline Option), would be the same as discussed under Alternative 2.

4.3.1.5.3 Alternative 4 – Birch Tree Crossing Port

The implementation of Alternative 4 would have mostly direct impacts on surface water in the Project Area; while barging impacts would decrease, the range of effects including those at the Mine Site would be the same as Alternative 2. There would be slightly fewer past, present, and future actions contributing to cumulative effects in the Kuskokwim watershed above the BTC Port under Alternative 4.

4.3.1.5.4 Alternatives 5A and 6A

The implementation of Alternatives 5A and 6A would have impacts on surface water in the Project Area. Cumulative effects for Alternative 5A would be the same as discussed under Alternative 2. There would be slightly more past, present, and future actions contributing to cumulative effects in the Dalzell Gorge section of the pipeline route under Alternative 6A, due to the increased potential for overlapping drainage and aufeis issues with the INHT.

4.3.1.6 GROUNDWATER HYDROLOGY

4.3.1.6.1 Alternative 2 – Donlin Gold's Proposed Action

The geographic area considered in the cumulative effects analysis for groundwater hydrology is the near project vicinity (i.e., within a ½ mile to several miles) where project effects on groundwater flow patterns and use could overlap with other past, present, and reasonably foreseeable future surface and groundwater uses.

The direct and indirect effects of Alternative 2 would result in varying intensities of impacts to groundwater hydrology. Construction of the open pit requires lowering the water table in and surrounding the area of the pit in order to establish stable pit walls and dry working conditions. Mine pit dewatering would long-term impacts to the local groundwater flow system and discharge patterns, particularly focused around Crooked Creek. The most intense impacts would be experienced during the period of active mining. The plan for discharge of treated water back into Crooked Creek and pit lake level recovery during Closure would serve to partly reduce impacts from these activities. Effects on groundwater hydrology within the Transportation Corridor and Pipeline components would include small stresses on aquifers

tapped by port and camp water supply wells, and temporary disturbances to shallow groundwater during pipeline construction.

Past and present activities that have affected groundwater hydrology in the analysis area include water supply wells in communities along the Kuskokwim River; at oil and gas facilities, the Beluga power plant, and residential use in western Cook Inlet; and small scale wells or springs associated with cabins and camps along the pipeline route, or mining exploration or placer operations near the project area. Fish habitat, subsistence fishing activities, and other surface water use in Crooked Creek would overlap with the area of flow reductions caused by pit dewatering during the mine life. Impacts associated with these activities include localized changes in groundwater flow patterns, reductions in groundwater in aquifers, and use of streams that are hydraulically connected with groundwater. These past and present actions are expected to continue throughout the Project Area, primarily in and around villages and larger population centers (e.g., Bethel, Crooked Creek, Beluga). Other parts of the project would be located in more remote areas, characterized as having very little development that would substantially draw from groundwater resources.

The implementation of Alternative 2 will impact groundwater in the Project Area during Operations; however, these impacts are not expected to be significant beyond the boundaries of the operational Mine Site. Overall, the incremental contribution of Alternative 2 and impact to groundwater from the project and the past, present and RFFAs would be localized high intensity changes in the vicinity of the pit during the life of the project, because the effects of the project on groundwater are limited to a relatively small area and would be reduced in post-Closure.

4.3.1.6.2 Alternatives 3A, 3B, 4, and 6A

Cumulative effects on groundwater for Alternatives 3A and 4 would be the same as discussed under Alternative 2. There would be slightly more past, present, and future actions contributing to cumulative effects on groundwater in the Tyonek-Beluga area under Alternative 3B (including the Port MacKenzie Option and Collocated Natural Gas and Diesel Pipeline Option), due to additional commercial and residential water supply wells in this area. Alternative 6A would encounter about 1 mile less shallow groundwater along the pipeline route than Alternative 2, resulting in slightly less direct/indirect impacts during construction. The implementation of any of these alternatives would have impacts on groundwater in the Project Area.

4.3.1.6.3 Alternative 5A – Dry Stack Tailings

In addition to the direct and indirect effects discussed under Alternative 2, Alternative 5A would result in modestly more groundwater that would require longer term pumping and treatment in the TSF and SRS area under Option 1 (unlined dry stack). These effects would gradually reach the same as those under Option 2 (lined dry stack) or Alternative 2 after about 200 years. The resulting impact level under Alternative 5A would be the same as impacts from pit dewatering that range from low to high intensity as under Alternative 2.

Past, present, and reasonably foreseeable future actions would be the same as described under Alternative 2.

4.3.1.7 WATER QUALITY

The geographic area considered in the cumulative effects analysis for surface water and sediment quality includes all watersheds affected by the project footprint and potential dust deposition, where project-related and non-project related actions could have additive effects. The distance to watershed boundaries affected by project activities varies from about 5 to 20 miles at the Mine Site and along the mine access road (Figure 3.5-8 in Surface Water Hydrology, and Figure 3.8-7 in Air Quality), up to roughly 100 miles from the project footprint for the Kuskokwim River watershed and other large watersheds crossed by the pipeline (Figures 3.5-11, 3.5-16, and 3.5-17 in Surface Water Hydrology).

The geographic area considered for groundwater quality is the near project vicinity (i.e., within about ½-mile to several miles) where project impacts to groundwater quality could overlap with other past, present, and reasonably foreseeable future actions.

4.3.1.7.1 Geochemistry

In terms of geochemistry, past, present, and future conditions that would contribute to cumulative impacts generally involve subsurface materials that are exposed to air and water as a result of mining activities or natural processes. Weathering reactions that occur when subsurface materials such as rocks and minerals are exposed to air and water can increase the solubility and mobility of certain constituents to the surrounding environment. Since the changes that would occur from geochemical processes are reflected in water and sediment quality, the cumulative effects associated with these changes are discussed under Sections 4.3.1.7.2 and 4.3.1.7.3.

4.3.1.7.2 Surface Water and Sediment Quality

<u>Alternative 2 – Donlin Gold's Proposed Action</u>

Direct and Indirect Effects

Direct and indirect impacts to surface water and sediment quality at the Mine Site could result from geochemical alteration of mined rock and its interaction with air and water, as well as mercury deposition from stacks and fugitive dust. Surface water quality within mine site watersheds would be affected by the creation of the WRF, TSF, and pit lake; however, due to perpetual management and water treatment, untreated water from these facilities would not leave the onsite watersheds. Effects from mine site waters on the environment would be mostly of low intensity, as all water would be treated to meet water quality standards prior to discharge to Crooked Creek. There is a low risk that high intensity impacts to Anaconda and Crooked creeks could result in the event of SRS pump failure and overflow in post-Closure.

Impacts to surface water and sediment quality resulting from atmospheric deposition of mercury would be both low and high intensity. High intensity impacts would be likely to occur at some locations within the Crooked Creek and Donlin Creek watersheds, where the inputs of mercury deposition to water are expected to be the greatest. Water quality is likely to be within regulatory limits on average, but could exceed baseline conditions and EPA chronic criteria in some areas. Impacts to sediment quality in Crooked Creek, and increases in mercury and methylmercury concentrations in sediments, would be of low intensity. Project-related mercury

deposition would result in an estimated 2.5 percent increase in total mercury concentrations in sediment closest to the Donlin Camp, and a 0.2 percent increase at the Bell Creek watershed (SRK 2014a), levels which would be within the range of natural variation. Aquatic systems in the Project Area have low rates of methylmercury production, and net rates of mercury methylation in the environment are not expected to change as a result of project related activities, considering nutrient limitation of mercury methylation processes, rapid rates of natural demethylation processes, and the lack of changes in inputs from wetland and upland systems (ARCADIS 2014). The duration of these impacts would be long-term, as concentrations would be expected to return to pre-activity levels at some time after the completion of the project.

Impacts to surface water and sediment quality from the Transportation Corridor and Pipeline components of the project would be of low intensity. For example, construction activities associated with the Angyaruaq (Jungjuk) Port and Bethel Port (connected action), and barging at critical shallow sections of the river during low water periods, could create low intensity, temporary impacts through increases in turbidity and sediment loads at downstream locations. Soil erosion associated with installation of the natural gas pipeline at river and stream crossings and the clearing of riparian habitat along the pipeline ROW could also contribute to temporary increases in sediment loads in area streams. Extensive BMPs and ESC measures would be identified in the SWPPP (Section 3.2, Soils) and used to reduce the intensity of surface runoff and sediment loading.

Past, Present, and Reasonably Foreseeable Future Actions

Past and present human-induced impacts to surface water and sediment quality have occurred within the analysis area as a result of regional and global sources of mercury, as well as a variety of other smaller scale activities. Elevated concentrations of mercury are a widespread natural feature of surface water and sediment within the Project Area; existing impacts to water quality are expected to continue as a result. Past mining in the area and natural rock weathering have partially contributed to elevated baseline levels of mercury present in surface water and other media in the vicinity of the Mine Site. Placer mining has occurred in several drainages upstream of the Mine Site, including Donlin Creek, Snow Gulch, Queen Gulch, Lewis Creek, and upper Crooked Creek. A loading study of inorganic constituents in Crooked Creek water indicated changes in concentrations as the creek passes through mineralized zones as well as past placer mining areas. Studies of sediment quality in the Kuskokwim River have shown similar trends. Mercury concentrations in sediment tend to be highest in the Kuskokwim River upstream of Crooked Creek in an area of known mineralized zones (Figure 3.7-4, in Water Quality).

Atmospheric mercury originating from outside the Project Area has and will continue to contribute to mercury deposition inside the Project Area (ARCADIS 2014; Environ 2015). Inputs of mercury to the global atmosphere from outside sources, such as coal burning power plants, are expected to continue for the foreseeable future, and would add to the mercury deposition resulting from the activities proposed under Alternative 2. The current rate of mercury deposition to the Crooked Creek and Donlin Creek watersheds from global atmospheric sources is estimated to be 8.4 micrograms per square meter per year ($\mu g/m^2/y$) (Environ 2015). The correlation between atmospheric deposition and mercury concentration in surface water and sediment is expected to be linear, because rates of mercury transformation and transport in

upland / wetland systems and aquatic sediments are not expected to change as a result of project activities.

In the past, activities associated with the Red Devil Mine contributed substantial concentrations of mercury, arsenic, and antimony to the surface water and sediment of Red Devil Creek, a tributary of the Kuskokwim River. As a result of those past actions, Red Devil Creek and a small area of the Kuskokwim River (1,000 feet of the river near confluence with Red Devil Creek) are presently considered impaired waters under the Clean Water Act (CWA) Section 303(d) due to concentrations of mercury, arsenic, and antimony in excess of Ambient Water Quality Criteria (AWQC). However, because this site is located approximately 30 miles upstream of the Donlin Gold Project Area on the Kuskokwim River, it is not expected to add to surface water or sediment impacts resulting from Alternative 2, and therefore would neither increase nor decrease the net effects to these media considered in the cumulative case.

Other than mercury-related actions described above, activities that could contribute to cumulative effects in the analysis area include small-scale placer mining operations, localized construction material production, new roads and airport improvements in southwestern Alaska, oil and gas development, transmission and utility upgrades, pipeline development, climate change, domestic and industrial discharges, and contaminated sites. These actions are expected to continue throughout the proposed analysis area, and would most likely impact water bodies in the immediate vicinity of the activity. The majority of the analysis area is located in remote parts of Alaska, characterized as having very little or no development that could impact surface water or sediment quality. As described above for upper Crooked Creek, small-scale mining operations in other parts of the analysis area could contribute to the amount of rock exposed to geochemical processes or to the amount of suspended sediment from placer operations. Contaminated soils documented near the Kuskokwim River (described in Sections 3.2.2.2.4, Soils, and 4.3.1.2.3 in this chapter) could contribute fuel-related contaminants to the river in the event of natural or man-made bank erosion. Past and current actions related to barging, fuel storage tanks at airports and schools, and military and fuel storage sites near Bethel, Aniak, and Dutch Harbor may have introduced fuel-related contaminants to sediment (RWJ 2008a, 2010a). Diesel range organics (DRO) and residual range organics (RRO) are present below sediment quality guidelines (SQGs) throughout the Kuskokwim River corridor, and toluene and pesticides have been detected in river sediment near Bethel (Table 3.7-15 in Section 3.7, Water Quality). Impacts to surface water or sediment quality from material sites or road developments are expected to be of low intensity; for example, increased turbidity and suspended sediment that would likely settle out before being transported long distances. Climate change effects on precipitation and hydrology could have related effects on water quality concentrations, depending on whether the changes cause increases or decreases in runoff.

Cumulative Effects Conclusion – Surface Water and Sediment Quality

The implementation of Alternative 2 would have direct and indirect impacts on surface water and sediment quality in the Project Area. Past, present, and reasonably foreseeable future actions in the EIS Analysis Area would have effects on surface water and sediment quality, considering the range from small-scale localized suspended sediment increases, to effects from mining operations and global mercury deposition. The intensity of additive, incremental cumulative impacts attributable to Alternative 2 would vary within the Mine Site vicinity, as the addition of mercury deposition from project sources to global sources could result in water and

sediment quality that is likely to be within regulatory limits or natural variation on average, but could exceed water quality criteria for total mercury in some areas. Project-related impacts at the Mine Site would be expected to result in neither increases nor decreases to the cumulative effects on sediment quality associated with rates of mercury methylation in the Project Area. There would be additive incremental cumulative impacts attributable to Alternative 2 along the Transportation Corridor and Pipeline components.

Alternatives 3A and 3B – Reduced Diesel Barging

The direct and indirect effects for Alternatives 3A and 3B (including the Port MacKenzie Option and Collocated Natural Gas and Diesel Pipeline Option), on surface water and sediment quality would be similar to Alternative 2. Barge traffic on the Kuskokwim River would be reduced from 174 under Alternative 2 to 145 under Alternative 3A and 126 under Alternative 3B; there could be slightly fewer effects from contaminated sites along the Kuskokwim; and slightly more effects from pipeline construction and contaminated sites along the Tyonek-Beluga section of Alternative 3B. The relatively small scale of these changes would not alter the conclusions that were reached under Alternative 2. Therefore, either of these alternatives would have impacts to surface water and sediment quality in the vicinity of the Mine Site, and impacts along the Transportation Corridor and Pipeline components.

Past and present actions that affect surface water and sediment quality in the EIS Analysis Area would be similar to Alternative 2, such as mercury deposition from global sources, mining, barging, oil and gas activities, roads and airport developments, and climate change. There could, however, be slightly more cumulative effects from contaminated sites along the Tyonek-Beluga pipeline section. As with Alternative 2, these actions are expected to continue and would have effects on surface water and sediment quality. Overall, the contribution of Alternatives 3A and 3B to the past, present, and future actions would result in cumulative effects on surface water and sediment quality.

Alternative 4 – Birch Tree Crossing Port

Alternative 4 would have direct and indirect impacts on surface water and sediment quality. The 73-mile long BTC Road would be about 46 miles longer than the mine access road under Alternative 2, increasing the number of stream crossings and opportunities for temporary, localized impacts to surface water quality from runoff and sedimentation. Several critical sections upstream of the BTC Port (e.g., Aniak, Holokuk, Upper Oskawalik), where barges would need to be relayed during low water periods, would be avoided under Alternative 4, thereby reducing potential for temporary impacts related to suspended sediments in the Kuskokwim River. These impacts would be small compared to the range of effects for the project as a whole.

Past and present actions that affect surface water and sediment quality in the EIS Analysis Area would be similar to Alternative 2. There would be slightly fewer cumulative effects in the Upper Kuskokwim from barging and mining actions due to the smaller analysis area.

Alternative 5A – Dry Stack Tailings

Direct and indirect impacts to surface water and sediment quality under Alternative 5A would be similar to Alternative 2 with several exceptions. There would be an increase in the volume of treated water discharged to Crooked Creek in Operations. The pit would fill faster under

Alternative 5A, and would likely have greater metals concentrations in surface water. Under both options of Alternative 5A (unlined and lined dry stack), effects on downstream surface water and sediment quality in closure would be the same as Alternative 2, provided SRS water is contained and conveyed to the pit; the main difference between the two options being the amount of time it would take for SRS water to clean up and be decommissioned. The lined option would take about the same amount of time as Alternative 2 (about 10 to 50 years); the unlined dry stack would reach the same seepage rate as the lined option, due to the presence of an impermeable cover blocking infiltration, after about 200 years. Thus, there is a greater risk of SRS pump failure and contaminated water release to the environment in post-Closure under the unlined option. Under both options, there would be increased potential for high intensity impacts to surface water and sediment quality resulting from atmospheric deposition and terrestrial runoff of fugitive dust from the dry stack tailings facility. Impacts from increased deposition of mercury to sediments and the potential for increased rates of mercury methylation would result from the increased levels of fugitive dust under Alternative 5A.

Past, present, and future actions that affect surface water and sediment quality in the EIS Analysis Area would be the same as Alternative 2.

Alternative 6A – Modified Natural Gas Pipeline Alignment: Dalzell Gorge Route

Impacts to surface water and sediment quality under Alternative 6A would be similar to Alternative 2, including effects at the Mine Site and Transportation Corridor, which would not change under this alternative. The Dalzell Gorge alignment of the pipeline would create temporary, localized surface water and sediment quality impacts at crossings of the Happy River and the South Fork of the Kuskokwim River, but would not change the range of direct and indirect surface water quality impacts. Past, present, and future actions that affect surface water and sediment quality in the EIS Analysis Area would be the same as Alternative 2.

4.3.1.7.3 Groundwater Quality

Alternative 2 – Donlin Gold's Proposed Action

Direct and indirect impacts to groundwater quality under Alternative 2 would include localized high intensity effects within the mine site facilities that are not expected to migrate off-site. These effects would result from seepage from the WRF to shallow groundwater that flows toward the pit, and temporary localized outflow of groundwater from the pit into deep bedrock in the first few years of pit filling. Onsite groundwater quality would be reduced during the life of the project and into the post-Closure period, as some seepage from the unlined WRF is expected to continue after reclamation. Impacts outside of the WRF footprint and permanent cone of depression around the pit would be of low intensity, as it would be unaffected by mine contact water. Impacts to groundwater quality would result from the Construction and Operations of the Transportation Corridor and Pipeline components. Overall direct and indirect effects on groundwater quality consider that effective groundwater management would occur at the Mine Site indefinitely, and the low intensity of effects along the Transportation Corridor and Pipeline components.

Past and present impacts to groundwater quality have occurred within the EIS Analysis Area as a result of the presence of natural mineralized bedrock, mining operations, oil and gas development, contaminated sites, and climate change. For example, the concentrations of

certain constituents in groundwater are higher in the vicinity of the Donlin ore body than outside this zone; conditions that are expected to be similar at other mines in the EIS Analysis Area. A number of the contaminated sites identified within ¼ mile of the project footprint (Sections 3.2.2.2.4 and 3.2.2.3.4, Soils) are known to have fuel-contaminated groundwater, such as in Dutch Harbor and the Beluga area, and at localized underground tank sites in villages along the Kuskokwim River. Climate change effects on precipitation could have related effects on groundwater quality, depending on whether the changes cause increases or decreases in recharge. These past and present actions are expected to continue throughout the Project Area and result in localized impacts on groundwater quality, in that some actions and natural conditions result in exceedances of regulatory standards. The majority of the EIS Analysis Area, however, is located in remote areas of Alaska, characterized as having very little or non-existent development that would substantially impact groundwater quality.

The implementation of Alternative 2 would have direct and indirect impacts on groundwater quality in the Project Area; however, no measurable impacts are anticipated beyond the mine site boundaries. Alternative 2 would result in localized additive, incremental, cumulative impacts to the resource from the project from past, present and future actions.

Alternatives 3A and 3B – Reduced Diesel Barging

Alternatives 3A and 3B (including the Port MacKenzie Option and Collocated Natural Gas and Diesel Pipeline Option), would have direct and indirect impacts on groundwater quality. Past, present, and future actions would be similar to Alternative 2. There could also be additional contaminated sites in the Tyonek-Beluga area that have impacted groundwater (Section 3.2.2.3.4, Soils).

Alternative 4 – Birch Tree Crossing Port

Direct and indirect effects on groundwater quality under Alternative 4 would be the same as Alternative 2. Past, present, and future actions would be similar to Alternative 2. There would be slightly fewer contaminated sites in villages along the Kuskokwim River corridor (Figure 3.2-4, in Section 3.2, Soils) that could contribute to cumulative effects on groundwater quality. In addition to the past, present, and reasonably foreseeable future actions discussed under Alternative 2, Alternative 4 would result in additive, incremental, cumulative impacts.

Alternative 5A – Dry Stack Tailings

Direct and indirect impacts to groundwater quality under Alternative 5A would be the same as Alternative 2 in the area of the WRF and pit lake, and the Transportation Corridor and Pipeline components Impacts would also be the same as Alternative 2 for the lined dry stack option under this alternative. Under the unlined dry stack option, tailings seepage could potentially reach groundwater, and though it would be captured by the SRS and conveyed to the pit lake, there is a higher risk of SRS pump failure and possible offsite groundwater migration due to the longer time it would need to operate than the lined option or Alternative 2.

Past, present, and future actions would be the same as Alternative 2. Alternative 5A would result in additive, incremental, cumulative impacts.

Alternative 6A – Modified Natural Gas Pipeline Alignment: Dalzell Gorge Route

Direct and indirect effects on groundwater quality under Alternative 6A would be the same as Alternative 2. Past, present, and future actions would be similar to Alternative 2, as there are few differences in activities between the pipeline routes through the Alaska Range that would affect groundwater quality.

4.3.1.8 AIR QUALITY

4.3.1.8.1 Alternative 2 – Donlin Gold's Proposed Action

The geographic area considered in the cumulative effects analysis for air quality would extend through a wide-reaching EIS Analysis Area (see Section 3.8.3.3.2, Air Quality), including air, land, and water transportation routes and ports. Except for a small portion of the pipeline (which would primarily emit GHGs) located near Denali National Park, the project is not located near a Class I area (see Figure 3.8-1, Air Quality). No components of the project would be located within or near a non-attainment, maintenance, or area with local regulations. With regard to climate change and GHG emissions, the area considered for the cumulative effects analysis is the state of Alaska.

Direct and indirect impacts to air quality would be below permit thresholds and/or meeting regulatory standards for the Construction, Operations, and Closure phases (Table 3.8-14, Air Quality). The duration of impacts would be temporary during the Construction Phase, but would be considered long-term (through the life of the project) during Operations and for post-reclamation activities. There would be emissions above permit thresholds for the Mine Site during the Operations Phase, but the impact would not exceed ambient standards or increments.

Changes to GHG levels and global climate change are considered part of the baseline and direct/indirect effects analysis, as well as a component of the past, present, and future actions considered in cumulative effects. The magnitude of GHG emissions during Construction, Operations, and Closure of all components of this project would be considered low to medium. The maximum duration of impacts would be long-term, with GHG emissions occurring throughout the duration of the project. The highest GHG emissions (associated with the Mine Site) represent between 1 and 10 percent of Alaska annual GHG emissions.

The past and present actions that have influenced air quality within the EIS Analysis Area are described in Table 4.2-1, and discussed in greater length in Section 3.8.2, Air Quality, Affected Environment. The majority of project components associated with Alternative 2 would be located in remote areas of Alaska characterized as attainment/unclassified areas for air quality. Past and present actions are expected to continue, such as existing infrastructure operations, transportation modes, and energy and utility development and upgrades. Reasonably foreseeable future actions were identified in the EIS Analysis Area (see Section 4.2), but these would likely induce minimal cumulative changes to air quality. Relevant future actions for air quality impacts include mineral exploration and mining activities occurring in southwest Alaska; oil and gas exploration and development in Cook Inlet surface, marine, and air transportation developments, such as new roads, bridge rehabilitation, shipping and barging traffic, barging on the Kuskokwim River, and port and airport improvement projects; and transmission upgrades, installations, and maintenance. The proposed Pebble Mine would be

located roughly 175 miles southeast of the Donlin Mine and there could be some potential for effects on air quality. However, given the distance between the two projects, the relatively low level of emissions from both projects which propose using natural gas, and that neither project would be permitted to exceed air quality regulatory standards, the potential for regional cumulative air quality effects would be minimal. Overall, the impacts to air quality from the project and the past, present and future actions are expected to increase air emissions, including GHGs, in the region and the state.

4.3.1.8.2 Alternatives 3A, 3B, 4, 5A, and 6A

The cumulative effects on air quality from all other action alternatives would be similar to Alternative 2, with the exception of Alternative 3B. While GHG emissions would be reduced under Alternative 3A compared to Alternative 2, and Alternative 4 would have a slight increase in GHG emissions during operations of the Transportation Corridor when compared to Alternative 2, these changes would not affect the incremental contribution of the alternatives to climate change cumulative effects. With elimination of cleaner burning natural gas as a fuel for power generation under Alternative 3B, approval of the Pebble Mine could present an additional emission source. However, given the distance between the two projects and that neither project would be permitted to exceed air quality regulatory standards, the potential for regional cumulative air quality effects would be minimal.

4.3.1.9 NOISE AND VIBRATION

4.3.1.9.1 Alternative 2 – Donlin Gold's Proposed Action

The geographic area considered in the cumulative effects analysis for noise and vibration includes the immediate and near-project vicinity (i.e., a 15-mile buffer around project components), shown on Figure 3.9-3, in Section 3.9, Noise and Vibration. This distance is used as a reference distance for cumulative noise impacts because it is considered to be a distance beyond which noise impacts associated with the project would be low or would experience no effect. The distance is also conservative, as the nearest community to the Project Area is approximately 10 miles away.

Construction, Operations, and Closure of the project components under Alternative 2 would result in direct and indirect impacts to noise levels with higher noise levels associated with the Pipeline component Construction Phase. However, most noise and vibration impacts resulting from project components are temporary and intermittent in duration. Impacts would be lower at the Mine Site and Transportation Corridor components due to the distance from the Mine Site to the sensitive receptor (Crooked Creek). Many aspects of the project components and phases do not utilize major ground-borne vibration-causing equipment. Vibration-causing activities would occur intermittently throughout the Construction and Operations phases, primarily associated with pile driving or blasting activities.

The past and present actions that have influenced noise levels within the EIS Analysis Area are described in Table 4.2-1, and discussed in greater length in Section 3.9.3, Noise and Vibration, Affected Environment. The majority of project components associated with Alternative 2 would be located in remote areas of Alaska characterized as having minimal or non-existent development. Baseline ambient noise levels have been estimated, using industry standards, as

rural residential and wilderness ambient. Past and present actions that influence noise and vibration levels are expected to continue, such as existing infrastructure operations, transportation modes (e.g., upriver barging on the Kuskokwim River), and energy and utility development and upgrades. Reasonably foreseeable future actions were identified in the EIS Analysis Area (see Section 4.2), but these would likely induce minimal cumulative changes to noise or vibration levels. By way of example, if cumulative future projects were to double the amount of barge traffic on the Kuskokwim River compared to existing conditions, the resulting noise level increase attributed to barge traffic would only be 3 dBA (A-weighted decibels), a just-perceptible change to the outdoor sound environment as mentioned in Section 3.9.1.1. Relevant future actions for noise and vibration impacts include mineral exploration and mining activities occurring in southwest Alaska; oil and gas exploration and development in Cook Inlet surface, marine, and air transportation developments, such as new roads, bridge rehabilitation, shipping and barging traffic, barging on the Kuskokwim River, and port and airport improvement projects; and transmission upgrades, installations, and maintenance. While some large-scale projects are proposed in the region, they are generally considered to be speculative, and are not considered reasonably foreseeable.

The contribution of Alternative 2 to cumulative effects on noise and vibration levels is considered to have little additional impact from RFFAs, because the magnitude of effect at a given sensitive receptor, such as a community, depends largely on the proximity of cumulative projects that may involve concurrent temporary construction activities or post-construction operations. For illustration purposes, and aside from background sound that already includes aggregate acoustical contribution of natural (e.g., winds, water flows, wildlife) and other man-made (e.g., aviation and surface traffic, industry, commerce, residences) sources, the cumulative noise level at a receiver due to two nearest remote projects (A and B) would be one of the following:

1. The dominant noise emission level from project A;
2. The dominant noise emission level from project B; or,
3. The logarithmic sum of noise from project A and B, which by acoustical principles cannot be more than 3 dBA higher than the noise emission level of the louder project or activity (A or B).

In other words, the cumulative noise effect for such a combination would be no more than 3 dBA and thus a just-perceptible difference. Past and present actions have generally induced impacts within the normal limits and trends of the EIS Analysis Area. Overall, the impact on the resource from the project and the past, present and future actions is not expected to be substantial.

4.3.1.9.2 Alternative 3A – Reduced Diesel Barging: LNG-Powered Haul Trucks

Under Alternative 3A, the cumulative noise and vibration effects would be the same as or similar to those discussed under Alternative 2.

4.3.1.9.3 Alternative 3B – Reduced Diesel Barging: Diesel Pipeline

The cumulative effects for Alternative 3B (including the Port MacKenzie Option and Collocated Natural Gas and Diesel Pipeline Option), would be similar to Alternative 2. Although the intensity of noise levels at the sensitive receptors during construction would be slightly greater

than under Alternative 2, the impacts would be temporary and intermittent in duration. During the operational life of the project, there would be no detectable changes in noise levels at the sensitive receptors.

4.3.1.9.4 Alternative 4 – Birch Tree Crossing Port

Although the port and road configuration would differ compared to Alternative 2, and barge traffic would travel shorter distances on the Kuskokwim River, the cumulative effects for Alternative 4 would be similar to Alternative 2. There would be no detectable changes in noise levels at the sensitive receptors during the life of the project.

4.3.1.9.5 Alternatives 5A and 6A

Under these alternatives, cumulative impacts to noise and vibration levels would be the same as discussed under Alternative 2.

4.3.2 BIOLOGICAL ENVIRONMENT

This subsection describes the contribution of the project and its alternatives to cumulative effects on the biological resources described in Chapter 3, Environmental Analysis.

4.3.2.1 VEGETATION AND NONNATIVE INVASIVE SPECIES

4.3.2.1.1 Alternative 2 – Donlin Gold's Proposed Action

The geographic area considered in the cumulative effects analysis for vegetation includes vegetation that may be directly or indirectly affected by the project, including areas within the project footprint for direct effects plus the adjacent areas within the EIS Analysis Area where indirect effects may occur. As described in Section 3.10, Vegetation and Nonnative Invasive Species, direct and indirect impacts could occur from the project as planned at the Mine Site, Transportation Corridor, and Pipeline components. Direct impacts would occur by removal of vegetation in the project footprint. Removal would be either permanent in the case of some areas that are not planned for revegetation or reclamation, such as the pit lake, or temporary, in areas that are planned for reclamation or areas in which natural revegetation is expected to occur. Indirect impacts to vegetation could occur from vegetation damage by accidental construction impacts or wildland fire or through contamination from fuel or chemical spills; from fugitive dust impacts; from changes in water availability; or from nonnative invasive species (NNIS) introduction or spread from project activities or habitat changes resulting from vegetation removal or damage.

Direct vegetation removal acres for Alternative 2 would be 17,894.6 (9819.3 in the Mine Site, 1093.4 in the Transportation Corridor, and 6981.9 in the Pipeline component). The North Option is expected to impact a similar number of acres as Alternative 2 in the Pipeline component. Additional acres may be impacted in the construction buffer and work areas in both the Mine Site and Pipeline component.

Direct impacts could occur if any rare or sensitive plants were removed within the project footprint through project activities. No populations of confirmed rare or sensitive plant species

are expected to be directly impacted by proposed activities, but increased activity or access may negatively impact habitat that supports rare or sensitive plants.

Past, ongoing, and reasonably foreseeable future actions were identified in the Project Area (see Section 4.2). These include past mining operations as well as mineral exploration and other small-scale placer mining activities; oil and gas exploration and development activities near Cook Inlet; ground-disturbing activities near communities and tributaries including gravel extraction; and seasonal barging to serve villages along the Kuskokwim River. These actions have removed some vegetation and are likely to have resulted in the introduction and spread of NNIS.

The areal extent of impacts to vegetation from these actions is a small proportion of impacted vegetation types compared to the distribution of vegetation types throughout region in the five ecoregions that occur within the EIS Analysis Area. The ongoing or future similar activities would likely induce little overall change to regional vegetation types or the proportion of vegetation types represented in the five ecoregions with the EIS Analysis Area.

Climate change may result in large-scale biome shifts to vegetation. Changes may include an increase in woody vegetation, a loss of wetlands, and a decrease in permafrost, changes in hydrology, and changes in fire regime with potentially greater fire extent or severity. Habitat for NNIS is expected to increase with climate change. Overall, the impacts on vegetation from the project and the past, present and reasonably foreseeable future actions is expected to be measureable, but geographically limited.

4.3.2.1.2 Alternatives 3A, 3B, 4, 5A, and 6A

The contribution to vegetation cumulative effects for all action alternatives is expected to be the same as Alternative 2. There are variations in the number of acres removed per action alternative, aside from Alternative 3A which would have the same number of acres impacted as Alternative 2. Direct vegetation removal acres for Alternative 3B would be 7455.4 acres in the Pipeline component, compared to 6981.9 in Alternative 2. For the Port MacKenzie Option in Alternative 3B, 20.7 fewer acres would be removed. For the Collocated Pipeline Option in Alternative 3B, an additional 211.1 acres would be removed. Direct vegetation removal acres for Alternative 4 would 1791.1 acres removed in the Transportation Corridor, compared to 1093.4 in Alternative 2. Direct vegetation removal acres for Alternative 5 would be range from an additional 2463.0 acres removed in the Unlined Option to 2753.5 in the Lined Option in the Mine Site. Direct vegetation removal acres for Alternative 6A would include an additional 819.6 acres in the Pipeline component.

4.3.2.2 WETLANDS

4.3.2.2.1 Alternative 2 – Donlin Gold's Proposed Action

The geographic area considered in the cumulative effects analysis for wetlands is similar to that of vegetation and includes wetlands that may be directly or indirectly affected by the project, including areas within the project footprint for direct effects plus the adjacent areas within the EIS Analysis Area where indirect effects may occur. Wetland acres impacted in Alternative 2 would be 4,289 acres (4,283 for Alternative 2-North Option) affected by direct impacts, including excavation, fill, and vegetation clearing. There would also be an additional 1,262 acres

with indirect impacts including fugitive dust impacts and dewatering impacts. In the Mine Site, during Construction, there would be 2,728 direct impact acres (1,331 acres for Alternative 2-North Option) and 1,067 indirect impact acres from fugitive dust and dewatering. In the Transportation Corridor, during Construction, there would be 224 direct impact acres and 627 indirect impact acres from fugitive dust. In the Pipeline component, there would be 1,337 direct impact acres during Construction and 525 direct impact acres during Operations. Proportionally, wetlands comprise between 7 percent and 61 percent of ecoregions, and between 12 percent and 62 percent of project-specific wetlands study areas (see Table 3.11-14 in Section 3.11, Wetlands; Michael Baker 2016, Michael Baker 2017). The percent of the Project Area within each ecoregion is low, generally below 1 percent (see Section 3.10, Vegetation and Nonnative Species). Only a small percentage of regional wetlands are expected to be impacted by project activities.

Past, ongoing, and reasonably foreseeable future actions were identified in the Project Area (see Section 4.2). These include past mining operations as well as mineral exploration and other small-scale placer mining activities; oil and gas exploration and development activities near Cook Inlet; ground-disturbing activities near communities and tributaries including gravel extraction; and seasonal barging to serve villages along the Kuskokwim River. These actions have removed some wetlands and introduced or spread NNIS. The ongoing or future similar activities would likely induce minimal overall changes to wetlands in the region, as the proportion of impacted wetlands on a regional scale is extremely small.

The effects of predicted climate change on wetlands under Alternative 2 may increase in later project years due to warming temperatures and altered precipitation patterns, resulting in permafrost loss, vegetation type changes, a general drying trend, and changed fire regime. Fire severity is predicted to increase over time in a warming climate, and the wetland areas along active roads or other operations areas would be most vulnerable to accidental fire. Overall, the impact on wetlands from the project and the past, present and reasonably foreseeable future actions is expected to be measureable, but geographically limited.

4.3.2.2.2 Alternatives 3A, 3B, 4, 5A, and 6A

The contributions to wetland cumulative effects for all action alternatives are expected to be the same as Alternative 2. There are variations in the number acres impacted per action alternative, aside from Alternative 3A which would have the same number of acres impacted. Wetland acres impacted in Alternative 3B would have a total of 4,442 direct impact acres (Port MacKenzie Option, total of 4,433 direct impact acres; Collocated Pipeline Option, 4,489 direct impact acres), slightly more than Alternative 2. Alternative 4 would have a total of 4,629 direct impact acres, greater than Alternative 2, due to the longer mine access road. Alternative 5A would have a total of 4,274 acres for the Unlined Option and 4,282 acres for the Lined Option, similar to Alternative 2. Alternative 6A would have direct impacts to 4,389 acres, slightly greater than Alternative 2.

4.3.2.3 WILDLIFE

The cumulative effects analysis for wildlife includes consideration of effects on non-endangered terrestrial mammals, birds, and marine mammals. ESA-listed species are discussed in Section 4.3.2.5.

4.3.2.3.1 Alternative 2 – Donlin Gold's Proposed Action

The geographic area of consideration for cumulative effects on wildlife extends widely across the EIS Analysis Area and includes habitat and migratory range for mammal and bird populations that use the area where direct and indirect impacts of the project would occur.

Past, ongoing, and RFFAs were identified in the Project Area, including small-scale placer mining and other ground-disturbing activities and access for recreation and subsistence activities (see Section 4.2). These actions have removed or modified some wildlife habitat and cause behavioral disturbance of terrestrial mammals and birds in some adjacent areas. The ongoing or future similar activities would likely induce minimal overall changes to available bird and terrestrial mammal habitats, or use of them, when considering the availability of similar habitat in the region. The existing level of hunting of large mammals, particularly moose, tends to maintain the population near the limit of sustainable harvest. The project activities combined with existing activities and human presence in the vicinity may cause some species of wildlife or birds to avoid areas in which project activities or human presence occurs. However, many species would be expected to habituate to noise, human presence, and other activities. Changes would be expected to be incremental on a regional scale.

Climate impacts over time may result in changes in habitat, such as an increase in woody vegetation, as well as changes in fire regime with potentially greater fire extent or severity. Shifts in wildlife populations may occur due to subsequent habitat changes (changes in food, forage, or shelter, for example), large-scale biome shifts, and precipitation or temperature trend changes.

Past, ongoing, and reasonably foreseeable future actions were identified in the Project Area including commercial fishing, shipping/barging of fuel and supplies, and other marine traffic (see Section 4.2). These actions have provided a level of activity that could adversely affect marine mammals through risk of vessel strikes, behavioral disturbance, and potential fuel spills. In addition, there has been some subsistence hunting of marine mammals in the area. Under Alternative 2, the main types of impact for marine mammals would be behavioral disturbance or risk of injury or mortality from barges or during in-water construction at the ports. The slow speed of the barges would be expected to reduce impacts. Populations of marine mammals are limited in the river where the port construction would occur, reducing impacts. Overall, the impact on wildlife from the project and the past, present and future actions is expected to be geographically or temporality limited within a large area. While the individual impact of the project is measurable, the cumulative effect is still considered to be limited, given the limited area of disturbance over the region.

4.3.2.3.2 Alternative 3A – Reduced Diesel Barging: LNG-Powered Haul Trucks

For Alternative 3A, the contribution to cumulative effects on terrestrial mammals and birds is expected to be similar to Alternative 2. Cumulative effects of Alternative 3A on non ESA-listed marine mammals would be similar to Alternative 2.

4.3.2.3.3 Alternative 3B – Reduced Diesel Barging: Diesel Pipeline

For Alternative 3B (including the Port MacKenzie Option and Collocated Natural Gas and Diesel Pipeline Option), the contribution to cumulative effects on terrestrial mammals and birds is expected to be similar to Alternative 2. Cumulative effects of Alternative 3B (including the

Port MacKenzie Option and Collocated Natural Gas and Diesel Pipeline Option), on non ESA-listed marine mammals would be similar to Alternative 2 and would be derived primarily from port site in-water construction activities and fuel and cargo barge traffic.

4.3.2.3.4 Alternatives 4, 5A, and 6A

The contribution to cumulative effects on terrestrial mammals and birds is the same as described for Alternative 2 for the remaining action alternatives. The contribution of these alternatives to cumulative effects on marine mammals is considered the same as described for Alternative 2.

4.3.2.4 FISH AND AQUATIC RESOURCES

4.3.2.4.1 Alternative 2 – Donlin Gold's Proposed Action

The geographic area of consideration for cumulative effects on fish and aquatic resources extends widely across the EIS Analysis Area and includes habitat and migratory range for populations of anadromous fish and other species that may migrate within the river systems crossed or used by the project and use the waters that may be affected by the project.

Past, ongoing, and reasonably foreseeable future actions were identified in the Project Area (see Section 4.2). These include past mining operations as well as mineral exploration and other small-scale placer mining activities; oil and gas exploration and development activities near Cook Inlet; ground-disturbing activities near communities and tributaries including gravel extraction; seasonal barging to serve villages along the Kuskokwim River; ongoing subsistence and commercial fishing activities and other boating-related traffic along the main river channel; community water supply development; waste disposal; fuel spills; and new roads and airport improvements. Such past and ongoing activities, combined with natural events, have contributed in variable ways to adverse effects on anadromous and resident fish populations and aquatic habitat by altering flow regimes and drainage patterns; diminishing water quality from riverbank erosion, turbidity, and sedimentation; and degrading the extent of productive habitat conditions. In addition, the run size and escapement of certain stocks of salmon (particularly king and chum salmon in Crooked Creek) and, to a certain extent, other anadromous and resident fish populations have diminished in recent years due to a range of factors that are not fully understood by resource managers or the scientific community. The various components of the project (Alternative 2) would result in an incremental increase of impacts of variable intensities that would contribute to the cumulative effects on fish and aquatic resources in the drainages within the Project Area during all three project phases.

The cumulative effects on fish and aquatic resources of the project in combination with those of other past, ongoing, and reasonably foreseeable future projects, are expected to increase over the life of the project. The effects of predicted climate change may increase in later project years due to warming temperatures and altered precipitation patterns. Shifts in fish populations may occur due to subsequent habitat and precipitation or temperature changes, affecting subsistence resources as well.

The adaptive management monitoring measures in Chapter 5, Impact Avoidance, Minimization, and Mitigation, describe a flexible framework for implementing proposed mitigation plans and programs that would:

- Evaluate project-related activities and factors potentially contributing to cumulative impacts;
- Develop new or refine existing proposed measures and plans to address such impacts;
- Implement and monitor these plans based on specific goals, objectives, and performance standards;
- Evaluate results and trends of the implementation program relative to established long-term objectives; and
- Determine mid-course adjustments needed to mitigate project impacts and, where possible, contribute to the restoration of affected resources.

Overall, the impact on fish and aquatic resources from the project and the past, present and future actions is expected to be measurable, but geographically limited.

4.3.2.4.2 Alternatives 3A and 3B – Reduced Diesel Barging

Due to reduced barge traffic under Alternatives 3A and 3B (including the Port MacKenzie Option and Collocated Natural Gas and Diesel Pipeline Option), the contribution to cumulative effects on fish and aquatic resources is expected to be less than Alternative 2.

4.3.2.4.3 Alternatives 4, 5A, and 6A

The contribution to cumulative effects on fish and aquatic resources from any of the remaining action alternatives is expected to be about the same as Alternative 2.

4.3.2.5 THREATENED AND ENDANGERED SPECIES

4.3.2.5.1 Alternative 2 – Donlin Gold's Proposed Action

The geographic area of consideration for cumulative effects on threatened or endangered species extends widely across the EIS Analysis Area and includes habitat and migratory range for populations of listed birds and marine mammals that may migrate within the waters crossed or used by the project and use the waters that may be affected by the project.

Two eider species are listed as threatened, and may be present at the mouth of the Kuskokwim River, in Kuskokwim Bay, and in the Bering Sea, but are not likely to be found upriver more than 56 miles from the coast. Alternative 2 could have direct and indirect effects on threatened or endangered birds through the increase in ocean barge traffic. Although the barge route does not go through eider concentration areas, direct and indirect impacts could potentially include behavioral disturbance from increased barge traffic, injury or mortality from collisions with barges, and habitat changes and/or injury or mortality through contamination from fuel or chemical spills. The overall ESA effects determination in the Biological Assessment is "may affect, not likely to adversely affect" for Steller's eiders and for spectacled eiders (Owl Ridge 2017a, Appendix O).

ESA-listed marine mammals, including pinnipeds (seals, sea lions, and walruses), cetaceans (whales, dolphins, and porpoises), and sea otters occur within the proposed water-based transportation corridor in Kuskokwim Bay and the Kuskokwim River, in the eastern Bering Sea,

and in upper Cook Inlet (see Section 3.14, Threatened and Endangered Species). Past, likely ongoing, and reasonably foreseeable future actions were identified in the Project Area that could induce impacts to these species, including commercial fishing, shipping/barging of fuel and supplies, and other marine traffic (see Section 4.2). These actions have provided a certain level of activity that could adversely affect threatened and endangered marine mammals, including risks of vessel strikes, behavioral disturbance (e.g., avoidance, displacement, disrupted foraging), and potential fuel spills. In addition, there has been and continues to be some subsistence hunting of marine mammals in the area. Although the probability of ship strikes for North Pacific right whales is also low, the impact of such an occurrence would directly impact the species population. Right whale distribution within the designated critical habitat tends to be clustered and driven by prey availability. Recent studies indicate strong site fidelity of right whales to the northeast portion of this area (Clapham et al. 2012; Zerbini et al. 2015), through which the Dutch Harbor to Bethel barge corridor passes. The duration of potential behavioral disturbance, such as displacement, masking, or disrupted feeding, would likely be short, lasting only during the time of barge passage through the area. The number of right whales disturbed with each passage depends on presence and numbers of whales in the area.

The Donlin Gold Project could increase vessel traffic in the Bering Sea by an estimated 0.5 percent (Appendix O, Biological Assessment). This percent calculation, however, was based on the approximately 4,500 large commercial vessels (containerships, bulk carriers, car carriers, tank vessels, and others) that pass through Unimak Pass in the eastern Aleutian Islands while transiting the North Pacific Great Circle Route (TRB 2008). Although some make port in Dutch Harbor, most continue westward across the southern Bering Sea, south of the designated right whale critical habitat. Approximately 1,700 other vessels (80 percent of which were fishing vessels) involved in local trade were tracked in the vicinity of Unimak Pass in 2007 (TRB 2008). Deliveries to bulk fuel facilities in Bristol Bay, Western Alaska, the Northwest Arctic, and North Slope also transit the area (Nuka Research and Planning Group, LLC 2006). It is not possible to discern from available data the number of ships operating in the area of the barge corridor or that might go through right whale critical habitat. Some of these ships do transit to the Port of Bethel, which, as noted in Section 3.23.2.2.2, Transportation, would experience an increase in the number of annual barge receipts. The contribution to cumulative effects on threatened and endangered mammals (either vessel strikes or behavioral disturbance) is considered to be "may affect, not likely to adversely affect" for Steller sea lions, bearded seal, ringed seal, Pacific walrus, beluga whale, humpback whale, fin whale, North Pacific right whale, and northern sea otter (Owl Ridge 2017b, Appendix O). Construction of the Pebble Mine Project would result in the development of a new port facility on the West side of Cook Inlet. If construction of the pipeline associated with the Donlin project coincided with construction and operation of the Pebble mine, there could be a cumulative increase in ship traffic on the west side of Cook Inlet that could potentially affect Cook Inlet beluga whales. The likelihood of overlap of Cook Inlet marine activities associated with the two mines in unknown at this time, but could be moderate over the two year Donlin Mine construction period. Overall, the impact on Threatened and Endangered species from the project and the past, present and future actions is expected to be geographically or temporality limited within a large area. While the individual impact of the project is measurable, the cumulative effect is still considered to be limited, given the limited area of disturbance over the region.

4.3.2.5.2 Alternatives 3A, 3B, 4, 5A, and 6A

The contribution to cumulative effects on threatened and endangered species under any of the other action alternatives is expected to be less than or about the same as Alternative 2. Alternatives 3A and 3B (including the Port MacKenzie Option and Collocated Natural Gas and Diesel Pipeline Option), would reduce the number of barge transits through right whale critical habitat compared to the other alternatives.

4.3.3 SOCIAL ENVIRONMENT

This subsection describes the contribution of the project and its alternatives to cumulative effects on the social environment resources analyzed in Chapter 3, Environmental Analysis.

4.3.3.1 LAND OWNERSHIP, MANAGEMENT, AND USE

4.3.3.1.1 Alternative 2 – Donlin Gold's Proposed Action

The past and present actions that have influenced land ownership, management, and use are described in Section 3.15, Land Ownership, Management, and Use, Affected Environment. Several management plans govern uses of the largely undeveloped area. The geographic extent of reasonably foreseeable future actions that were considered for land ownership was limited to the public and private lands where project components lay. Adjacent lands were also considered for land management and use. The reasonably foreseeable future actions identified are:

- Cook Inlet Area-wide Oil and Gas Lease Sales (oil and gas exploration development).
- Small scale placer mining and exploration (mineral exploration and mining).
- Iditarod trail use, trail system improvements/installation, (tourism, recreation, sport hunting and fishing), which would affect 10.5 miles of the Pipeline ROW.
- The Bering Sea/Western Interior Resource Management Plan current planning effort, which would affect 600 acres of the operations Pipeline ROW (land use planning).

These would likely induce little change to land ownership, management, and use. External actions are estimated within normal limits and trends. With the implementation of Alternative 2, there would be no change to land ownership, beneficial impacts to the management plans of Calista Corporation (Calista) and The Kuskokwim Corporation (TKC), minimal change to state and federal land management, and impacts to land use, primarily associated with use of the cleared ROW after construction (for effects on subsistence uses, see Section 3.21, Subsistence). Since the Mine Site airstrip and access road would not be accessible for public use, there would be no contribution to other potential mining operations in the area. Overall, impacts would include beneficial effects at the Mine Site and within the Transportation Corridor, along with adverse effects from transportation facilities on state lands, and on lands affected by the pipeline. Alternative 2 would have a beneficial and an adverse contribution to cumulative effects to land ownership, management, and use. Overall impact to land ownership from the project and the past, present and future actions would not be noticeable or apparent. There would be some minimal overall impact on land management and use in some areas along the pipeline ROW, around the Mine Site from the project along with past, present and future actions.

4.3.3.1.2 Alternatives 3A and 3B – Reduced Diesel Barging

Under Alternatives 3A and 3B(including the Port MacKenzie Option and Collocated Natural Gas and Diesel Pipeline Option), other direct, indirect, and cumulative impacts associated with the Transportation Corridor and Pipeline components would also be similar or the same as for Alternative 2.

4.3.3.1.3 Alternative 4 – Birch Tree Crossing Port

Although the port and road configuration would change, and barge traffic would travel shorter distances on the Kuskokwim River (compared to Alternative 2), the contribution to cumulative effects on land ownership, management, and use for Alternative 4 would be similar to Alternative 2.

4.3.3.1.4 Alternative 5A – Dry Stack Tailings

All other components for Alternative 5A would be the same as for Alternative 2; therefore cumulative impacts for Alternative 5A would be the same as for Alternative 2.

4.3.3.1.5 Alternative 6A – Modified Natural Gas Pipeline Alignment: Dalzell Gorge Route

The proposed pipeline route would change compared to Alternative 2, and would result in impacts on a longer section of the INHT. Otherwise the cumulative effects on land ownership, management, and use for Alternative 6A would be similar to Alternative 2.

4.3.3.2 RECREATION

4.3.3.2.1 Alternative 2 – Donlin Gold's Proposed Action

Past and present actions relevant to recreation include state and federal land management plans, which are described in Section 3.16.1, Recreation. In addition, Section 3.15.1, Land Ownership, Management, and Use, describes legal structures and land use plans with relevance to recreation resources. The existing recreation setting in the Project Area is generally remote and undeveloped lands which support dispersed recreational activities, such as sport hunting and fishing, travel by snowmachine, hiking, and camping. Past and existing recreation uses are expected to continue, including use of the INHT and shelter cabins.

The geographic scope of cumulative effects to recreation is federal lands, state lands, public easement ROWs, public waterways, and Alaska Native corporation lands used for recreation activities in the vicinity of project components for all phases. Public easement ROWs give access to lands used for recreation, and include R.S. 2477 ROWs, section line easements, Section 17(b) easements, state public access easements, and other encumbrances. TKC and Cook Inlet Region Inc. (CIRI) both have a permit system to allow recreation by non-shareholders on Alaska Native Corporation lands.

The State of Alaska manages the INHT on state lands, and the BLM, as the Trail Administrator for the INHT, has cooperated with the State of Alaska to operate, develop, and maintain portions of the INHT located outside the boundaries of federally administered areas in

accordance with the INHT Comprehensive Management Plan (1986) and as agreed to in the 'Memorandum of Agreement Between the State of Alaska and Bureau of Land Management, U.S. Department of Interior Concerning the Iditarod National Historic Trail' (1987), and pursuant to the requirements of Public Law 90-543 (as amended).

The reasonably foreseeable future actions relevant to recreation resources include:

- Commercial fishing, particularly if commercial fishing in the Kuskokwim Management Area increased competition with recreational anglers.
- Transportation, such as new airport improvements which could improve access for recreationists.
- Energy and utilities, particularly if new installations or upgraded transmission corridors would create attractive paths for recreationists or if renewable energy initiatives and Y-K Delta energy development facilitated recreational lodging developments.
- Subsistence, particularly if competition increases between recreational and subsistence hunters and anglers.
- Tourism, recreation, sport hunting and fishing in the Kuskokwim River watershed, Cook Inlet, and INHT trail use and improvements, such as shelter cabins.
- Land use and planning, including current planning efforts for the BLM Bering Sea / Western Interior Resource Management Plan.
- Climate change trends which may have associated changes in fish and wildlife habitat, which may affect the recreation setting and activities.

Reasonably foreseeable future actions would likely induce minimal changes to recreation including type or level of use, access, or setting. Overall, the impact on recreation from the project and the past, present and future actions is minimal, since most recreation in the project area occurs away from reasonably foreseeable future actions. However, an increase in tourism or competition with subsistence users could increase in other areas. There would be additive incremental impacts to recreation attributable to Alternative 2.

4.3.3.2.2 Alternatives 3A and 3B – Reduced Diesel Barging

The cumulative effects of Alternatives 3A and 3B (including the Port MacKenzie Option and Collocated Natural Gas and Diesel Pipeline Option), on recreation resources would be similar to the impacts outlined for Alternative 2.

4.3.3.2.3 Alternative 4 – Birch Tree Crossing Port

Cumulative effects on recreation resources at the Mine Site, the Transportation Corridor, and within the Pipeline component would be the same as in Alternative 2.

4.3.3.2.4 Alternative 5A – Dry Stack Tailings

Since the changes associated with this alternative would be made within the same Mine Site footprint as Alternative 2, this modification would have the same cumulative effects on

recreation resources as Alternative 2 for the Mine Site, Transportation Corridor, and Pipeline components of the project.

4.3.3.2.5 Alternative 6A – Modified Natural Gas Pipeline Alignment: Dalzell Gorge Route

Overall, Alternative 6A would have similar direct, indirect, and cumulative effects to recreation resources as Alternative 2.

4.3.3.3 VISUAL RESOURCES

Visual resources in the Project Area are described in Section 3.17.2, Visual Resources, Affected Environment. Past and present actions have had minimal influence on the existing condition of the resource throughout most of the Project Area, which remains largely dominated by natural features. Past and present actions are expected to continue, including community infrastructure development, transportation improvements, energy consumption, subsistence activities, and recreation uses, including the re-establishment and designation of the INHT in 1978, and growing use for organized race events, including the Iditarod Trail Sled Dog Race and the Iron Dog snowmachine race. The geographic extent of reasonably foreseeable future actions that were considered to correspond to the area used for the visual analysis in Section 3.17, Visual Resources include:

- Lands located within a 15-mile radius of the proposed Mine Site and proposed pipeline corridor, with emphasis on the modeled viewshed;
- Lands located within 2.5 miles of the Kuskokwim River, extending from Crooked Creek to Bethel; and
- Common flight paths between Anchorage, McGrath, Aniak, and Bethel, and routes associated with the INHT.

The reasonably foreseeable future actions relevant to impacts to visual resources include:

- Oil and gas exploration and development in Cook Inlet, particularly, projects affecting the northwest portion of Cook Inlet;
- Mineral exploration and mining;
- Transportation, including new roads or airport improvements in communities along the Kuskokwim River from Crooked Creek to Bethel;
- Energy and utilities, particularly infrastructure improvements in communities along the Kuskokwim River from Crooked Creek to Bethel;

  Community development/capital improvement projects in communities along the Kuskokwim River from Crooked Creek to Bethel; and
- Tourism, recreation, sport hunting and fishing, particularly improvements to the INHT, and growing use of the trail.

These RFFAs would likely induce minimal changes to visual resources in the Project Area. While some large-scale projects are proposed in the region, they are generally still considered to be speculative, and are not considered to be reasonably foreseeable.

4.3.3.3.1 Alternative 2 – Donlin Gold's Proposed Action

Alternative 2 would have direct and indirect impacts to visual resources in the EIS Analysis Area as summarized in Section 3.17.3.3.5, Visual Resources. The contribution of Alternative 2 to cumulative effects on visual resources would also be from additive incremental impacts. Past, present, and reasonably foreseeable actions are anticipated to be within normal limits and trends. Overall, the impact on the resource from the project and the past, present and future actions would be modest but noticeable.

4.3.3.3.2 Alternatives 3A and 3B – Reduced Diesel Barging

Although the volume of additional barge traffic on the Kuskokwim River would be reduced over the life of the project under either of these alternatives (as compared to Alternative 2), the cumulative effects for Alternatives 3A and 3B (including the Port MacKenzie Option and Collocated Natural Gas and Diesel Pipeline Option), would be similar to Alternative 2.

4.3.3.3.3 Alternative 4 – Birch Tree Crossing Port

Although barge traffic would travel shorter distances on the Kuskokwim River under this alternative (as compared to Alternative 2), the cumulative effects for Alternative 4 would be similar to Alternative 2.

4.3.3.3.4 Alternative 5A – Dry Stack Tailings

The construction, operation, and closure of the project under Alternatives 5A would result in similar cumulative effects to visual resources as described for Alternative 2.

4.3.3.3.5 Alternative 6A – Modified Natural Gas Pipeline Alignment: Dalzell Gorge Route

Although the direct and indirect impacts to the INHT would be greater under this alternative, the cumulative effects for Alternative 6A across all other project components would be similar to Alternative 2.

4.3.3.4 SOCIOECONOMICS

4.3.3.4.1 Alternative 2 – Donlin Gold's Proposed Action

Several socioeconomic indicators for potentially affected communities are described in the Affected Environment Section (3.18.1, Socioeconomics). The geographic area for cumulative effects consideration is the state of Alaska. Effects on smaller geographic scales within the state of Alaska are also considered, with a particular focus on the Y-K region and census areas and boroughs where project components would be located. Table 3.18-1 in Section 3.18, Socioeconomics, lists these communities, census areas, boroughs, and regions within the state of Alaska. Past and present actions have shaped the socioeconomic environment. Population levels, economic sectors, income and unemployment, and revenue in the Project Area are examples of indicators that reflect changes in socioeconomic environment conditions. A significant trend in the last decade is the large decline in Chinook salmon runs on the Yukon

and Kuskokwim rivers, with resulting decline in commercial fishing opportunities. There is little evidence of a categorical transition from a subsistence economy to a cash economy. Instead the concept of a cash-based mixed economy is valid, in recognition of both a level of cash dependency alongside large levels of participation and production in subsistence activities. In this framework, an increase in personal income could lead to enhanced subsistence activities.

The reasonably foreseeable future actions relevant to socioeconomics include:

- Oil and gas exploration and development in Cook Inlet.
- Mineral exploration and mining in Southwest Alaska, the west side of Cook Inlet, and Bristol Bay (Pebble Mine).
- Commercial fishing, particularly the stock status of Kuskokwim River Chinook salmon.
- Energy and utilities, including transmission upgrades or installations, renewable energy initiatives, and energy efficiency initiatives.
- Community development and capital improvement projects, particularly village infrastructure development.
- Subsistence activities.
- Tourism, recreation, sport hunting, and fishing.
- Climate change; particularly the potential effects of long-term climate change on community infrastructure.

Reasonably foreseeable future actions would likely induce minimal changes to socioeconomic characteristics in the Project Area. The Pebble Mine Project is proposed in the Bristol Bay region and entering the permitting and NEPA phase and decisions on approval will be made in the next three years. While the Pebble Project could potentially create state-wide competition for skilled workers, it would be located in a different region and would have little contribution to the regional socioeconomic effects of the Donlin Gold Project. From a state-wide perspective, both projects could create the need for support services and secondary / indirect jobs associated with such services.

Existing economic sectors are likely to continue, with similar trends in employment, income, and sales. These indicators in turn affect population, which drives demand for public infrastructure and services. Residents in the Yukon-Kuskokwim (Y-K) area have the highest energy costs in the nation ($7 to $12 per gallon for diesel heating fuel), and the cost to building public facilities can cost twice per square foot as in Anchorage. Reasonably foreseeable future actions likely would not notably affect these living costs. Persistent declines in Chinook salmon runs could further depress commercial fisheries employment. While commercial fishing is seasonal, it is an important component of the private sector economy of the Y-K region.

Alternative 2 would have beneficial direct indirect impacts to the socioeconomic environment in the Project Area. The beneficial socioeconomic impacts would be realized in the Y-K region. The contribution of Alternative 2 to cumulative effects on socioeconomics is considered additive, and little additional impact is anticipated from reasonably foreseeable future actions. Past and present actions have generally induced impacts within normal limits and trends. Overall, the impact on the resource from the project and the past, present and future actions would be well outside normal variations and trends.

4.3.3.4.2 Alternatives 3A, 3B, 4, and 5A

The cumulative effects for Alternatives 3A and 3B (including the Port MacKenzie Option and Collocated Natural Gas and Diesel Pipeline Option), Alternative 4, and Alternative 5A would all be similar to Alternative 2.

4.3.3.4.3 Alternative 6A – Modified Natural Gas Pipeline Alignment: Dalzell Gorge Route

The cumulative socioeconomic impacts of Alternative 6A would be similar to those discussed under Alternative 2, with some exceptions. As a result of the larger workforce and higher expenditures required to construct a pipeline with additional horizontal directional drilling, Alternative 6A would enhance the beneficial direct and indirect employment, income, and sales impacts during project construction.

4.3.3.5 ENVIRONMENTAL JUSTICE

An Environmental Justice assessment focuses on the possibility that impacts of a proposed action might disproportionately affect minority and low-income communities (see Section 3.19.1, Environmental Justice). Minority and low-income communities in the EIS Analysis Area are described in Section 3.19.2, Environmental Justice. Table 3.19-2 shows ethnicity and poverty levels of the EIS Analysis Area by community, and Table 3.19-3 shows whether a community or region meets minority or low-income definitions for environmental justice. The Y-K region, city of Unalaska, Native Village of Tyonek, and Beluga comprise the minority and low-income communities in the EIS Analysis Area.

Environmental justice analysis is an intersection between several resource topics including socioeconomics, subsistence, and human health. Past and present actions affecting minority and low-income communities related to socioeconomics and described in Section 3.18.1, Socioeconomics, include population levels, economic sectors, income and unemployment, and revenue. Past and present actions related to subsistence and described in Section 3.21, Subsistence, are incorporated into baseline conditions of community harvest patterns (Section 3.21.5). These actions include federal and state regulations (Section 3.21.3), subsistence values and beliefs (Section 3.21.4), and traditional ecological knowledge (Section 3.21.4). Moose declines in Game Management Unit 19 have affected current subsistence harvest practices. Declines in Kuskokwim River Chinook salmon runs have affected commercial and subsistence catches in minority and low-income communities. Past and present conditions for human health described in Section 3.22.3 include social determinants of health, accidents and injuries, exposure to potentially hazardous materials, food and nutrition, diseases, sanitation, and capacity of health services. Communities in the Y-K region fare worse than state averages in many aspects of physical, mental, and social health, but strengths in human health for the Y-K region include high rates of childhood immunizations and physical activity participation in leisure time. The Bethel Census Area also had no clear signs of nutritional deficiencies, and rates better (occurring at lower rates) than state averages include low infant birth weights, alcohol use by pregnant mothers, and divorce.

Reasonably foreseeable future actions relevant to environmental justice and impacts to low-income and minority communities include:

- Oil and gas exploration and development in the Cook Inlet, particularly project affecting the northwest portion of Cook Inlet.
- Mineral exploration and mining in Southwest Alaska and the west side of Cook Inlet.
- Commercial fishing, particularly the stock status of Kuskokwim River Chinook salmon and fisheries in the Bering Sea with a bycatch of Western Alaska-bound salmon.
- Energy and utilities, including transmission upgrades or installations, renewable energy initiatives, and energy efficiency initiatives.
- Community development and capital improvement projects, particularly village infrastructure development.
- Subsistence activities.
- Tourism, recreation, sport hunting, and fishing, particularly if recreational and guided sport hunting and recreational fishing were to increase in the Kuskokwim River area.
- Climate change, particularly effects on ocean-phase salmon population dynamics, terrestrial wildlife and habitat, and the potential effects of long-term climate change on community infrastructure and effected on ocean-phase salmon.

Reasonably foreseeable future actions could induce changes to socioeconomics, subsistence, and human health, which are the elements of consideration to determine an environmental justice concern. Changes in the EIS Analysis Area are anticipated to continue to occur at low levels. Direct and indirect impacts for minority and low-income communities in the Y-K region would be adverse for effects to human health and subsistence, beneficial effects to human health, and beneficial effects from increased employment and income. While there would be beneficial effects from the project, adverse impacts would disproportionately impact minority and low-income populations, and Alternative 2 would raise an environmental justice concern. The contribution to cumulative effects to environmental justice is also considered additive. Overall, the project and the past, present and future actions would have modest but noticeable effects to minority or low-income populations, including Alaska Natives communities.

4.3.3.5.1 Alternatives 3A, 3B, 4, 5A, and 6A

The cumulative effects for Alternatives 3A and 3B (including the Port MacKenzie Option and Collocated Natural Gas and Diesel Pipeline Option), Alternative 4, and Alternatives 5A and 6A would all be similar to Alternative 2, with adverse for effects to human health and subsistence, beneficial effects to human health, and beneficial effects from increased employment and income. There would be a contribution to cumulative effects to environmental justice. Adverse impacts for all alternatives would disproportionately affect minority and low-income communities, raising environmental justice concerns.

4.3.3.6 CULTURAL RESOURCES

4.3.3.6.1 Alternative 2 – Donlin Gold's Proposed Action

The geographic scope of effects to cultural resources includes the draft APE. The final APE will be determined through consultation and will be agreed upon as part of the Programmatic

Agreement development process. The APE is described in Section 3.20.2.1, Cultural Resources; in general terms it includes all project components and buffer areas around each component. The cumulative effects analysis considers a larger area, with a particular focus on the Y-K region.

The Affected Environment for Cultural Resources (Section 3.20.2.2, Cultural Resources) describes the history and prehistory of the area, which includes occupation by Alaska Native groups of Yup'ik and Athabascan descent, as well as immigrant populations of Russian, English, American, and Scandinavian groups. As previously described, the Project Area generally includes numerous prehistoric lithic scatters, a few historic cabins and cabin ruins, ditches, and a prehistoric occupation area. In addition, a portion of the INHT is located within the APE.

Reasonably foreseeable future actions were identified in the EIS Analysis Area; these actions could generate incremental changes to cultural resources, exposing additional sites, or causing disturbance to the sites or their setting. The reasonably foreseeable future actions relevant to cultural resources include:

- Mineral exploration and mining.
- Transportation, including new roads or airport improvements in communities along the Kuskokwim River from Crooked Creek to Bethel.
- Energy and utilities, particularly infrastructure improvements in communities along the Kuskokwim River from Crooked Creek to Bethel.
- Community development/capital improvement projects in communities along the Kuskokwim River from Crooked Creek to Bethel.
- Subsistence activities.
- Tourism, recreation, sport hunting and fishing, particularly improvements to the INHT, and growing use of the trail.

Reasonably foreseeable future actions could induce changes to cultural resources due to physical disturbance or changes to the character or setting of cultural resources. Changes in the EIS Analysis Area are anticipated to continue increasing, but are difficult to access, and so regional changes generally occur slowly. The NHPA Section 106 process would apply to any other projects in the area requiring federal authorization. The direct and indirect effects to cultural resources under Alternative 2 would contribute to cumulative effects to cultural resources. Overall, the impact on cultural resources from the project and the past, present and future actions would have some measurable impacts and loss of integrity to NRHP sites. [Note: This chapter section may be revised after completion of the Human Health Risk Assessment and any needed updates to Section 3.19, Environmental Justice, Section 3.20, Cultural Resources, and Section 3.21, Subsistence].

4.3.3.6.2 Alternatives 3A, 3B, 4, 5A and 6A

The cumulative effects to cultural resources for Alternatives 3A, 3B (including the Port MacKenzie Option and Collocated Natural Gas and Diesel Pipeline Option), 4, 5A, and 6A would be similar to Alternative 2.

Project footprints of Alternatives 3A, and 5A do not vary notably from Alternative 2. While Project footprints would vary from Alternative 2 with the southern pipeline terminus in Alternative 3B, the Birch Tree Crossing Port site in Alternative 4 and the Dalzell Gorge alignment for the natural gas pipeline in Alternative 6A, the number and type of potentially affected cultural resources is very similar to Alternative 2. The pipeline component of Alternative 6A would have greater impacts to the affected portion of the INHT, but the overall impact rating would remain the same as in Alternative 2.

4.3.3.7 SUBSISTENCE

The past and present actions that have influenced subsistence are incorporated into the current baseline conditions described in Section 3.21.5 Community Harvest Patterns. Federal and state regulations with a complex history govern subsistence uses and resources in the region, as described in Section 3.21.3, Subsistence, Regulatory Environment. Changes in subsistence resource abundance and availability have also influenced current harvest practices, particularly the decline of moose in Game Management Unit 19 and the decline of Kuskokwim River Chinook stocks. Sociocultural changes have already and may continue to influence subsistence production, as described in Section 3.21.6.1.3, Subsistence, Potential Socio-cultural Impacts. However, subsistence uses continue in communities and associated traditional use areas throughout the EIS Analysis Area, providing continuity in social organization, identity, and cultural beliefs.

The geographic area of consideration for cumulative effects on subsistence practices extends widely across the EIS Analysis area and includes:

- Habitat and migratory range for subsistence resources such as caribou herd ranges, salmon migratory ranges, and migratory waterfowl ranges.
- The traditional subsistence use areas for communities potentially affected by the project. These areas can be quite extensive, from hundreds to thousands of square miles, as noted in Table 3.21-27, and displayed in maps throughout Section 3.21.5, Community Harvest Patterns.

The reasonably foreseeable future actions relevant to impacts to visual resources include:

- Oil and gas exploration and development in Cook Inlet, particularly, projects affecting the northwest portion of Cook Inlet.
- Mineral exploration and mining.
- Commercial Fishing, including fisheries in the Bering Sea with a bycatch of Western Alaska-bound salmon, and intercept fisheries that take Western Alaska-bound salmon.
- Tourism, recreation, sport hunting and fishing, particularly if recreational and guided sport hunting and recreational fishing were to increase in the Kuskokwim River basis.
- Climate change, particularly as it may affect ocean—phase salmon population dynamics, and terrestrial wildlife and bird habitat.

These reasonably foreseeable future actions would likely induce little change to subsistence resource abundance and availability, access to subsistence resources, competition for

subsistence resources, or sociocultural effects on subsistence uses, except that the factors contributing to decline in Kuskokwim River Chinook stocks represent an adverse impact.

4.3.3.7.1 Alternative 2 – Donlin Gold's Proposed Action

With the implementation of Alternative 2, there would be direct and indirect impacts to subsistence practices and a contribution to cumulative effects on subsistence resources and practices. Overall, the impact on subsistence resources from the project and the past, present and future actions could result in some harvest decrease and slightly increase competition for resources, although there would be minimal impact to access. [Note: This chapter section may be revised after completion of the Human Health Risk Assessment and any needed updates to Section 3.19, Environmental Justice, Section 3.20, Cultural Resources, and Section 3.21, Subsistence].

4.3.3.7.2 Alternatives 3A and 3B – Reduced Diesel Barging

The cumulative effects for Alternatives 3A and 3B (including the Port MacKenzie Option and Collocated Natural Gas and Diesel Pipeline Option), would be similar to Alternative 2. However, these alternatives would have a lower volume of barge traffic on the Kuskokwim River over the life of the project with a reduced potential for impacts to riverine habitat, subsistence resources, and subsistence activities associated with the river. Alternative 3B would have a contribution to cumulative effects to subsistence resources and practices.

4.3.3.7.3 Alternatives 4, 5A, and 6A

The cumulative effects for Alternatives 4, 5A, and 6A would be similar to Alternative 2, with a contribution to cumulative effects to subsistence resources, uses and needs.

4.3.3.8 HUMAN HEALTH

4.3.3.8.1 Alternative 2 – Donlin Gold's Proposed Action

The geographic area for analysis of cumulative effects to human health is the state of Alaska, with a focus on smaller geographic scales, particularly the Y-K region and census areas and boroughs where project components would be located. Table 3.18-1, Socioeconomics, lists these communities, census areas, boroughs, and regions within the state of Alaska.

Health effects categories for potentially affected communities in the EIS Analysis Area are described in the Affected Environment Section (3.22.3). Past and present actions have shaped the human health environment of the Project Area (see Section 4.2). Social determinants of health, accidents and injuries, exposure to potentially hazardous materials, food and nutrition, diseases, sanitation, and capacity of health services are examples of indicators that reflect changes in human health conditions. While Y-K region communities fare worse than the state average in many aspects of physical, mental, and social health, important health strengths include high rates of childhood immunizations in the Yukon-Kuskokwim Health Corporation (YKHC) service area, no clear signs of nutritional deficiencies in the Bethel Census Area, and residents report leisure time participation in physical activities. Rates of low birth weight infants, alcohol use by pregnant mothers, and divorce rates were lower than state averages.

Reasonably foreseeable future actions relevant to human health include:

- Oil and gas exploration and development in Cook Inlet.
- Mineral exploration and mining.
- Commercial fishing, particularly the stock status of Kuskokwim River Chinook salmon.
- Transportation, including new roads or airport improvements in communities along the Kuskokwim River from Crooked Creek to Bethel.
- Energy and utilities, including transmission upgrades or installations, renewable energy initiatives, and energy efficiency initiatives, particularly infrastructure improvements in communities along the Kuskokwim River from Crooked Creek to Bethel.
- Community development and capital improvement projects, particularly village infrastructure development in communities along the Kuskokwim River from Crooked Creek to Bethel.
- Subsistence activities.
- Tourism, recreation, sport hunting, and fishing.
- Climate change, particularly as it may affect community infrastructure and access to subsistence resources.

Reasonably foreseeable future actions would likely induce minimal changes to human health in the EIS Analysis Area. While some large-scale projects are proposed in the region, they are generally still considered to be speculative, and are not considered to be reasonably foreseeable. Existing health trends are likely to continue.

Impacts to human health would be both beneficial and adverse (positive and negative). Benefits to human health would include increased affordability and access to routine and emergency healthcare for acute and chronic conditions, improved food security and increased access to subsistence resources associated with economic benefits generated by the project. Adverse health impacts would be related to potential accidents and injuries, exposure to hazardous constituents, and infectious diseases.

Alternative 2 would have direct and indirect impacts to human health in the EIS Analysis Area. There would be beneficial socioeconomic impacts, and associated human health impacts, realized in the Y-K region. The contribution of Alternative 2 to cumulative effects on human health was considered and little additional impact is anticipated from reasonably foreseeable future actions. Past and present actions have generally induced impacts within normal limits and trends. Overall, the impact on human health from the project and the past, present and future actions would be modest, but noticeable and measurable.

4.3.3.8.2 Alternatives 3A, 3B, 4, 5A, and 6A

The direct and indirect impacts to human health from the implementation of Alternatives 3A and 3B (including the Port MacKenzie Option and Collocated Natural Gas and Diesel Pipeline Option), Alternative 4, Alternative 5A, and 6A would all be similar to Alternative 2. The contribution to cumulative effects on human health would also be the same as Alternative 2.

4.3.3.9 TRANSPORTATION

4.3.3.9.1 Alternative 2 – Donlin Gold's Proposed Action

The Affected Environment for Transportation (Section 3.23.1) describes local and regional transportation systems available in the region. The area is not connected by road to other regions of the state; air and water transportation provide connectivity to other regions. Past and present actions that have influenced the transportation systems include mining, commercial fishing, transportation infrastructure projects, subsistence activities, and recreation activities. Ports and harbors, airstrips, trails, local roads, and community transportation infrastructure have been developed over time to support these activities. State and federal land management plans also influence transportation infrastructure development and maintenance. The existing conditions in the Project Area generally include low population densities spread across broad geographic regions. Existing transportation infrastructure and modes of travel are expected to continue with only local improvements.

The geographic extent of reasonably foreseeable future actions that were considered for transportation was limited to project barge routes, Anchorage airports, and major trails that intersect project components (such as the INHT). The reasonably foreseeable future actions were identified are:

- Shipping through Dutch Harbor (transportation);
- Shipping / barging to Bethel (transportation);
- Upriver barging – Kuskokwim River (transportation);
- Cook Inlet shipping / barging (transportation);
- Port improvements (transportation); and
- Iditarod trail use (tourism, recreation, sport hunting and fishing).

These actions would likely induce little change to modes of transportation used in the region, transportation connectivity with other regions, or transportation demand in the region. While the Y-K Transportation Corridor is in the planning phase, this is not considered to be reasonably foreseeable because it has no appropriation for construction and is not likely to be available during the Construction Phase and early years of the Operations Phase.

Transportation infrastructure has grown incrementally over time, with improvements to ports, airports, and local roads. Alternative 2 would add new transportation infrastructure to the region, but would not change modes of transportation used or connectivity with other regions. There would not be a noticeable increase in ocean barges on the Pacific Ocean; there would be no contribution to cumulative effects.

With the implementation of Alternative 2, existing transportation systems would remain intact. However, the volume of additional barge traffic on the Kuskokwim River over the life of the project would have a noticeable disturbance or displacement of transportation access, mode, or traffic levels. This would cause potential for disturbance and limited displacement of the commercial and non-commercial vessel traffic, approximately 395 average annual commercial vessel trips and 1600 average annual non-commercial vessel trips on the Kuskokwim River. If construction of the Pebble Mine Project were to coincide with construction of the Donlin Gold Project, there could be a cumulative increase in Cook Inlet marine vessel traffic. However, the

contribution of the Donlin Gold Project barges carrying pipeline support material would be minimal. Overall, the impact on transportation from the project and the past, present and future actions may not be measurable or apparent.

4.3.3.9.2 Alternative 3A – Reduced Diesel Barging: LNG-Powered Haul Trucks

The cumulative effects for Alternative 3A would be similar to Alternative 2. The volume of additional barge traffic on the Kuskokwim River over the life of the project would exert noticeable disturbance and limited displacement of other uses, despite a reduced potential for congestion and disturbance of vessel traffic, as compared to Alternative 2.

4.3.3.9.3 Alternative 3B – Reduced Diesel Barging: Diesel Pipeline

The cumulative effects for Alternative 3B (including the Port MacKenzie Option and Collocated Natural Gas and Diesel Pipeline Option), would be similar to Alternative 2. However, the volume of additional barge traffic on the Kuskokwim River over the life of the project may not be measurable or apparent, though there would be a reduced potential for increased congestion and disturbance of vessel traffic, as compared to Alternative 2.

4.3.3.9.4 Alternative 4 – Birch Tree Crossing Port

Although barge traffic would travel shorter distances on the Kuskokwim River under this alternative (as compared to Alternative 2), the cumulative effects for Alternative 4 would be similar to Alternative 2.

4.3.3.9.5 Alternative 5A – Dry Stack Tailings

Since the changes associated with this alternative would be made within the same Mine Site footprint as Alternative 2, this modification would have the same cumulative effects on transportation resources as Alternative 2.

4.3.3.9.6 Alternative 6A – Modified Natural Gas Pipeline Alignment: Dalzell Gorge Route

For the Mine Site, the potential direct, indirect, and cumulative impacts to transportation resources during construction, Operations, and closure under Alternative 6A would be the same as those described under Alternative 2. The extent, duration, and context of all impacts would be the same as for Alternative 2. The discussion under this alternative focuses on differences in the Transportation Corridor and Pipeline under Alternative 6A.

4.3.4 CUMULATIVE EFFECTS AND CLIMATE CHANGE

Future trends in climate change were considered part of the Affected Environment, since this was defined as past, present, and reasonably foreseeable future trends, under the CEQ draft guidance (2014). Section 3.26, Climate Change, describes the definitions and regulatory framework for climate change. The current science regarding climate change effects to date and future trends were described as part of the Affected Environment (Section 3.26.3) for the atmosphere, water, permafrost, vegetation, wetlands, wildlife and Threatened and Endangered Species, fish and aquatic resources, and subsistence. Subsection 3.26.4 on Environmental

Consequences in Section 3.26, Climate Change, discusses effects of the project on climate change (i.e., from emissions of GHG) and effects of climate change on the key resources. This subsection also includes discussion of the potential increase of NNIS based on changes to introduction vectors and to suitable habitat due to climate change.

In this section on cumulative effects and climate change, the discussion focuses on whether other RFFAs would interact with and alter the projected trends in climate change.

4.3.4.1 ALTERNATIVE 1 – NO ACTION ALTERNATIVE

Under the No Action Alternative, the Donlin Gold Project would not be developed, and Donlin Gold would not establish a mine site, develop transportation facilities, or construct a natural gas pipeline in the Project Area. While this alternative would introduce no new GHG emissions, the effects of climate change would still occur based on existing projections. Existing GHG emissions and related climate change effects on various resources would be the same as described in Affected Environment (Section 3.26.3).

The past and present actions that have influenced climate changes within the Project Area are described in Section 4.2.2, Affected Environment. Past actions are expected to continue, such as existing infrastructure operations, transportation modes, and energy and utility development and upgrades. RFFAs for the EIS Analysis Area are identified above in Section 4.2.2, but these would likely induce little additional change to climate change trends. While some large-scale projects are proposed in the region, they are generally still considered to be speculative, and are not considered reasonably foreseeable. Climate change is expected to increase habitat for NNIS in some locations, based on predictive habitat model scenarios using SNAP (Scenarios Network for Alaska and Arctic Planning) data (USFWS 2009b). Increases in population, recreational use, increased trade and travel, and other changes related to RFFAs are recognized as changes that have the potential to increase introduction or spread of NNIS. There would be no incremental contribution from Alternative 1 to cumulative effects related to climate change.

4.3.4.2 ALTERNATIVE 2 – DONLIN GOLD'S PROPOSED ACTION

Section 3.26.4.2, Climate Change, examines direct and indirect effects of climate change and the project to the key resources of the atmosphere, water, permafrost, biological resources, and subsistence.

The past and present actions that have influenced climate changes within the Project Area are described in Section 4.2.2, Affected Environment, above. Past actions are expected to continue, such as existing infrastructure operations, transportation modes, and energy and utility development and upgrades. RFFAs for the EIS Analysis Area are identified above (Section 4.2.2), but these would likely induce little additional change to climate change trends. While some large-scale projects are proposed in the region, they are generally still considered to be speculative, and are not considered reasonably foreseeable. There would be an incremental contribution of Alternative 2 to cumulative effects related to climate change. While the individual impacts of the project are measurable, the cumulative effect is still considered to be limited, given the limited contribution of GHGs from the project over the region, state, or world. Table 3.26-13 provides a summary of the effects of climate change for all Alternatives.

4.3.4.3 ALTERNATIVE 3A – REDUCED DIESEL BARGING: LNG-POWERED HAUL TRUCKS

Section 3.26.4.3 examines direct and indirect effects of climate change and Alternative 3A to the key resources of the atmosphere, water, permafrost, biological resources, and subsistence.

Under Alterative 3A, cumulative impacts related to climate change would be considered similar to Alternative 2.

4.3.4.4 ALTERNATIVE 3B – REDUCED DIESEL BARGING: DIESEL PIPELINE

Section 3.26.4.4 examines direct and indirect effects of climate change and Alternative 3B to the key resources of the atmosphere, water, permafrost, biological resources, and subsistence.

Under Alterative 3B (including the Port MacKenzie Option and Collocated Natural Gas and Diesel Pipeline Option), cumulative impacts related to climate change would be considered essentially the same as discussed under Alternative 2.

4.3.4.5 ALTERNATIVE 4 – BIRCH TREE CROSSING PORT

Section 3.26.4.5 examines direct and indirect effects of climate change and Alternative 4 to the key resources of the atmosphere, water, permafrost, biological resources, and subsistence.

Under Alterative 4, cumulative impacts related to climate change would be considered essentially the same as discussed under Alternative 2.

4.3.4.6 ALTERNATIVE 5A – DRY STACK TAILINGS

Section 3.26.4.6 examines direct and indirect effects of climate change and Alternative 5A to the key resources of the atmosphere, water, permafrost, biological resources, and subsistence.

Under Alterative 5, cumulative impacts related to climate change would be considered essentially the same as discussed under Alternative 2.

4.3.4.7 ALTERNATIVE 6A – MODIFIED NATURAL GAS PIPELINE ALIGNMENT: DALZELL GORGE ROUTE

Section 3.26.4.7 examines direct and indirect effects of climate change and Alternative 6A to the key resources of the atmosphere, water, permafrost, biological resources, and subsistence.

Under Alterative 5, cumulative impacts related to climate change would be considered essentially the same as discussed under Alternative 2.