3.24 SPILL RISK

SYNOPSIS

This section outlines the risks associated with potential spills of five substances proposed for use in the Donlin Gold Project: ultra-low sulfur diesel fuel (diesel) transported in barges, trucks, pipelines and stored in tanks; liquid natural gas (LNG) releases; mercury or cyanide release to the environment during transport; and tailings behind the tailings dam. The impact of mercury released into the air on health and the environment is discussed in Section 3.8, Air Quality. Natural gas releases are also discussed in Section 3.25, Pipeline Reliability and Safety. These substances are not a comprehensive list of all substances proposed for use; they were selected for analysis based on likelihood of a spill, concerns brought up from the scoping period, and potential impacts to the environment. A list of other reagents used in the mine process is presented in Chapter 2. For each of the five substances included in this section, there is a discussion of the regulatory framework, existing response capacity, potential spill frequency and volume, and fate and behavior of the material.

The substances would be regulated by a variety of federal, state, and international standards, described in Section 3.24.1. Diesel storage, transportation, and distribution would be managed according to required plans like Oil Discharge and Prevention Contingency Plans (ODPCPs) and Facility Response Plans (FRPs). LNG is managed by the Pipeline and Hazardous Materials Safety Administration (PHMSA) regulations, cyanide by the International Cyanide Management Code and other state and federal agencies, and mercury by various federal regulations. The safety of the tailings dam would be under authority of the Alaska Department of Natural Resources (ADNR).

During transportation and storage of the materials, Donlin Gold would pre-position response equipment as would be determined in response plans, and personnel would be trained in using it. Donlin Gold would contract to oil spill removal organizations for response to diesel spills, discussed in detail in Section 3.24.2. LNG, cyanide, mercury and tailings are currently not used in the region. As there is no response capability at this time, new plans and response capacities may be required.

An overview of the potential spill sources; projected rates and likelihoods of occurrence; and spill volume by alternative is presented in Section 3.24.3 for each of the five substances. Potential sources of release for diesel, LNG, cyanide and mercury include vessels, storage containers, vehicles, transfer operations, and pipelines. Tailings could be released in the event of a partial dam failure.

Substance behavior if released into the environment is discussed in Section 3.24.4. Behavior is influenced by environmental factors (e.g., current weather or season), the environment onto which the spill occurs, and the physical and chemical properties of the spilled material.

Nine spill scenarios are presented in Section 3.24.5 that summarize potential causes, behavior, and volumes of spills that could occur during the transport and storage of materials, as well as potential impacts to each resource (those analyzed in Sections 3.1 to 3.23) and responses. The scenarios are a representative example of the types of spills that could occur, and do not represent “worst case” possibilities. The focus is on high-consequence, low probability occurrences; the analysis considers a variety of accidental spill types. The impacts described are not part of the project design, but represent upset or system failure. Spill impacts would not occur under Alternative 1, the No Action Alternative, and not all scenarios are applicable to each alternative. If any were to occur, it would likely result in regulatory and punitive action against the project. These conceptual scenarios represent possible sets of potential accidents and include:

Scenario 1: Ocean Barge Rupture at Sea. If an ocean-going barge were damaged, releasing 735,000 gallons of diesel into the ocean, south of the Kuskokwim River.

Scenario 2: River Barge Release. If a river diesel barge were damaged, releasing 37,817 gallons into the Kuskokwim River.

Scenario 3: Tank Farm Release. If a diesel tank were to fail at a tank farm, releasing the contents into secondary containment or during transfer operations, releasing less than 2,000 gallons into the environment.

Scenario 4: Tanker Truck Release. If tanker trucks were to rollover or collide, releasing up to 13,500 gallons into the environment.

Scenario 5: Diesel Pipeline Release. If the diesel pipeline were to have pinhole leaks (releasing less than 100 gallons into the environment) or rupture (releasing 422,000 gallons into the environment).

Scenario 6: Liquefied Natural Gas Release. If there were leaks or ruptures in LNG tanks, releasing up to 55,000 gallons of LNG into the environment, or if a truck accident released 1,150 gallons into the environment.

Scenario 7: Cyanide Release. If cyanide containers were lost or ruptured during transportation, releasing into the environment.

Scenario 8: Mercury Release. If mercury containers were lost or ruptured during transportation, releasing into the environment.

Scenario 9: Partial Tailings Dam Failure. If the tailings dam failed, releasing 2.6 million cubic yards of water or a mixture of water and tailings into Anaconda Creek.

3.24.1 APPLICABLE REGULATIONS AND PLANNING REQUIREMENTS

An Emergency Planning and Community Right to Know Act (EPCRA) plan would be developed and submitted to the State of Alaska with the volumes and locations of hazardous materials on the site. EPCRA requirements vary, depending on the volumes and toxicity of the chemical used at a facility. Once Donlin Gold establishes the volumes and types of hazardous materials at the facility, the appropriate EPCRA requirements will be addressed. All hazardous materials storage will comply with the latest version of the Fire Code.

Reporting a release into the environment would be done according to spill plans and regulatory requirements for the substance.

3.24.1.1 DIESEL FUEL AND OTHER OIL

The Donlin Gold Project and alternatives propose to transport ultra-low sulfur diesel (diesel) fuel to the Mine Site either by barge and truck or via a diesel pipeline. The storage, transportation, and distribution would be managed according to a number of required plans that are needed to comply with state and federal regulations. These plans would be developed, signed, and stamped by a professional engineer registered in the state of Alaska. The primary plans are described below.

Oil Discharge and Prevention Contingency Plan (ODPCP). An ODPCP describes the measures to be taken to prevent a spill, and, in the event of a spill, the response actions, equipment, procedures, and other elements necessary to respond to and effectively manage a response to an oil spill. Operators of a non-crude oil terminal facility with a capacity of 10,000 barrels or greater (including piping) and/or a tank barge that transports oil as cargo (not for its own use) are required to prepare the ODPCP, obtain Alaska Department of Environmental Conservation (ADEC) approval, and submit a renewal every five years. 18 AAC 75.425 describes the requirements for preparing ODPCPs. These requirements apply to the Donlin Gold Project.

AS 46.04.030 requires sufficient oil discharge secondary containment, storage, transfer, and cleanup equipment, personnel, and resources to meet the following response planning standards:

- For a discharge from an oil terminal facility, cleanup or control capacity equal to the capacity of the largest tank within 72 hours,
- For a discharge from a pipeline, cleanup or control capacity for the realistic maximum oil discharge within 72 hours, and
- For a discharge from a tank vessel or barge carrying non-crude oil in bulk as cargo, be able to contain or control 15 percent of the maximum capacity of the vessel or barge or the realistic maximum oil discharge, whichever is greater, within 48 hours and cleanup the discharge within the shortest possible time consistent with minimizing damage to the environment.

Based on these requirements, Donlin Gold, LCC (Donlin Gold) has prepared two ODPCPs for the proposed project:

- Terminal and Tank Farm Oil Discharge Prevention and Contingency Plan (SLR 2012a), and
- Vessel Operations Oil Discharge Prevention and Contingency Plan (SLR 2012b).

These ODPCPs are included as Appendix R and describe the proposed project's pre-deployed equipment planned at Angyaruaq (Jungjuk) Port and the Mine Site tank farm, and discharge and response scenarios. These ODPCPs would be updated and approved by ADEC prior to construction.

Due to a similarity of requirements, ODPCPs can be written as a single purpose document to meet multiple documentation requirements with the appropriate cross-referencing tables. This includes the following plans.

Spill Prevention Control and Countermeasure (SPCC) Plan. The SPCC Plan would be required for any facility which could reasonably be expected to discharge oil in quantities that may be harmful into navigable waters of the United States, per 40 Code of Federal Regulations (CFR) 112. The operator would prepare and provide an SPCC signed by a professional engineer prior to initiation of the project. Information on the potential sources of spills and the equipment and materials available onsite for cleanup would be included. This plan would contain spill prevention measures such as oil storage and transfer guidelines, planned secondary containment to meet the containment requirements, and cleanup procedures (including on-site spill equipment, personnel training and management of associated wastes) if a spill were to occur.

Facility Response Plans (FRP). EPA and the U.S. Coast Guard (USCG) may require an FRP for the storage and transfer facilities. These plans would be prepared and provided to the agencies prior to initiation of the project. FRPs which are required by 33 CFR 154 (USCG) and 40 CFR 112 (EPA) include emergency response action plans, facility information, worst-case spill scenarios, and response training records. USCG covers the section from the connection with the vessel to the first valve within secondary containment; EPA covers the facility from the first valve within secondary containment.

Waste Management Plan. Donlin Gold is in the process of preparing a comprehensive Waste Management Plan prior to the generation of wastes. This plan includes effective mitigation measures, including: waste minimization, product substitution, beneficial reuse, recycling, sampling, analysis, waste characterization, disposal profiling, manifesting, and proper off-site disposal. The Waste Management Plan addresses storage, analysis, labeling, transportation, and disposal of wastes generated during construction, drilling, and operations. Depending on the type of waste, there are numerous regulatory agencies and local government requirements that need to be addressed to maintain compliance, such as EPA, and ADEC (18 AAC 60, Solid Waste). Donlin has previously prepared an integrated waste management plan for normal facility operations; but if needed, a waste management plan specific to the oil spill response would be drafted. Where appropriate, this event-specific plan would be tailored to be consistent with Donlin Gold's integrated waste management plan.

3.24.1.2 LIQUEFIED NATURAL GAS

The Pipeline and Hazardous Materials Safety Administration (PHMSA) has regulatory authority over the LNG facilities proposed. Construction, operation, and maintenance of land-based LNG facilities are subject to the PHMSA regulations codified in 49 CFR Part 193, Liquefied Natural Gas Facilities: Federal Safety Standards. These regulations incorporate many of the requirements of National Fire Protection Association Standard 59A and specify the siting, design, construction, equipment, and fire protection requirements that would apply to the LNG plant.

The LNG liquefaction plant would be subject to inspection during construction and thereafter annually by PHMSA regional staff to ensure that the plant is constructed, operated, and maintained in accordance with the requirements of 49 CFR Part 193. PHMSA is able to enforce these requirements through civil penalties and correction action orders in order to quickly rectify any circumstances that it deems hazardous (PHMSA 2011a).

See Section 3.25, Pipeline Reliability and Safety, for PHMSA regulatory authorities for the proposed pipeline.

3.24.1.3 CYANIDE

Sodium cyanide is a reagent used to extract gold during the mining process. The International Cyanide Management Code (Code) is a voluntary industry code of practice for the use of cyanide in the mining of gold. The Code was developed in 2001 under the auspices of United Nations Environment Program and the International Council on Mining and Metals. The Code's mission statement is "To assist the global gold mining industry in improving cyanide management, thereby minimizing risks to workers, communities, and the environment from the use of cyanide in gold mining, and reducing community concerns about its use."

The Code consists of nine principles and 31 standards of practice that address best management practices (BMPs) for all aspects of the safe use of cyanide by gold mines, including production of cyanide and its transportation to the Mine Site, handling of reagent-strength cyanide, use of cyanide in the gold production process, decommissioning of cyanide facilities, worker safety, worker training, emergency response, independent auditing, and public dialogue. Implementation of the Code is overseen by the International Cyanide Management Institute (International Cyanide Management Institute 2014). The Code requires independent third-party audits and compliance with audit findings is required to continue to be certified by the ICMC. Audit reports are publicly available. The Donlin Gold Project would rely on purchased supplies of sodium cyanide rather than producing it onsite, but all other standards apply.

Sodium cyanide is designated as a hazardous substance in accordance with Title 40 CFR Part 116. The State of Alaska also recognizes cyanide as a hazardous substance and lists appropriate soil cleanup levels (18 AAC 75). This section details the regulations governing the transportation, storage and use of sodium cyanide at the Donlin Gold Project.

Transportation. Transportation of sodium cyanide would comply with agency requirements that would include, but not be limited to, the U.S. Department of Transportation (USDOT), the USCG, the Occupational Safety and Health Administration (OSHA), and the Mine Safety and Health Administration (MSHA). Specifically, sodium cyanide would be transported in accordance with all applicable laws and regulations, including, but not limited to, the following requirements:

- Sodium cyanide would be transported using containers and transporters certified by the USDOT for safe handling.
- Containers would be prepared for shipment according to the requirements of Title 49 CFR Part 172 for the preparation of shipping papers, marking, labeling and placarding.
- Materials would be packaged according to Title 49 CFR 173, 178 and 179.
- Emergency response information would be provided and maintained according to Title 49 CFR 172.
- Personnel involved in the transportation of hazardous materials would be trained according to Title 49 CFR 172.
- Where applicable, Safety and Security Plans would be developed and implemented in accordance with Title 49 CFR 172.
- Transportation of hazardous materials by vessel would be conducted in accordance with Title 33 CFR and Title 49 CFR 176, which includes requirements for general handling, storage, and segregation, port security, and the preparation of a Dangerous Cargo

Manifest, in addition to specific requirements for the various classes of hazardous materials.

Where applicable, international shipments of hazardous materials would be shipped in accordance with the International Maritime Dangerous Goods Code (IMDG Code).

Handling and Storage. Sodium cyanide handling and storage practices and processes would be in accordance with the Code, as developed by the International Cyanide Management Institute, and to all applicable laws and regulations. Sodium cyanide would be stored based on the hazard classifications identified in their material data safety sheets and in compliance with the applicable OSHA or MSHA regulations. For example cyanide would not be stored with incompatible materials (e.g., acids).

Employees handling sodium cyanide would be trained in the appropriate and safe handling of these materials as required by OSHA, MSHA, and/or USDOT based on the duties of the employees. Records of training would be maintained on file according to the applicable regulations. For example, employees working with cyanide would use ventilation and personal protective equipment as appropriate.

3.24.1.4 MERCURY

Naturally occurring, mercury-containing waste materials would be generated during the extraction of gold in the mining process. If mercury containing waste is extracted with the Toxicity Characteristic Leaching Procedure (TCLP) and the leachate exceeds the TCLP mercury criterion, the waste is designated as a characteristic hazardous waste in accordance with Title 40 CFR Part 261. Hazardous wastes are regulated in the state of Alaska under the Resource Conservation and Recovery Act (RCRA) federal regulations contained in Title 40 CFR, Parts 260 to 279. EPA has the authority to administer hazardous waste regulations in Alaska.

This section describes the regulations governing the disposal of mercury waste for the proposed project.

Transportation. Hazardous wastes would be shipped off site to appropriate recycling/disposal facilities in accordance with the applicable rules and regulations. Specifically, mercury hazardous wastes would be transported in accordance with all applicable laws and regulations, including, but not limited to, the following requirements:

- The waste would be sampled, analyzed, characterized, and profiled for recycling/disposal.
- Containers would be prepared for shipment according to the requirements of Title 49 CFR Part 172 for the preparation of shipping papers, marking, labeling and placarding.
- Materials would be packaged according to Title 49 CFR 173, 178 and 179.
- Emergency response information would be provided and maintained according to Title 49 CFR 172.
- Personnel involved in the transportation of hazardous materials would be trained according to Title 49 CFR 172.
- Where applicable, Safety and Security Plans would be developed and implemented in accordance with Title 49 CFR 172.

- Transportation of hazardous materials by vessel would be conducted in accordance with Title 33 CFR and Title 49 CFR 176, which includes requirements for general handling, stowage, and segregation, port security, and the preparation of a Dangerous Cargo Manifest, in addition to specific requirements for the various classes of hazardous materials.

Where applicable, international shipments of hazardous materials would be shipped in accordance with the IMDG Code; however, the sale, distribution, transfer, or export of elemental mercury is prohibited

Shipments would be accompanied by a hazardous waste manifest and the appropriate land disposal restriction (LDR) notification and certification forms where applicable.

Handling and Storage. Hazardous materials would be handled and stored in the workplace according to the U.S. Department of Labor OSHA and MSHA hazard communication standards as detailed in Title 29 CFR 1910.1200 and Title 30 CFR 47.

The requirements for managing hazardous waste are found in the RCRA regulations at Title 40 CFR Parts 260 to 282. The specific requirements that apply to a particular waste depend mainly on the classification of the waste generated and the generator status, which is based on the quantity of waste generated in a month and the total quantity of waste accumulated on site at any one time. The proposed project would maintain an inventory of the volumes of hazardous waste generated each month and the total volume of hazardous waste on site to ascertain its generator status and would comply with the applicable regulations.

The applicable training, inspection, reporting, preparedness, spill prevention, contingency planning, and emergency procedures required by RCRA and ADEC Division of Spill Prevention and Response would be implemented.

3.24.1.5 TAILINGS

Spills of tailings at the mill or from piping to the TSF can occur during mine operations but these would be relatively small and easily contained and cleaned up. However, a spill from the tailings dam, especially the failure of such a structure and the release of wet tailings downstream into the environment, was a concern expressed during scoping and is appropriate for discussion in this section.

In Alaska, dam safety is regulated by the Alaska Department of Natural Resources (ADNR) primarily under Alaska Statute (AS) 46.17 “Supervision of Safety of Dams and Reservoirs” and 18 AAC 93 “Dam Safety.” Enforcement powers granted to ADNR under Dam Safety regulations include requirements for ADNR approval to construct, enlarge, repair, alter, remove, maintain, operate, or abandon a dam or reservoir. ADNR can inspect dams and enter private lands for this purpose without notice if there is reason to believe that a dam or reservoir may be unsafe or presents an imminent threat to life or property. ADNR may order the owner to take action to protect life and property if it determines the dam or reservoir is unsafe, and may take supervisory control of the dam from the owner in emergency situations.

ADNR also has financial assurance requirements associated with dam safety (11 AAC 93.171 and 172), and may enter into cooperative agreements with other state and federal agencies for the purpose of reclamation and bonding of tailings dams in accordance with AS 27.19.060. Financial assurance must be established to pay for costs of reclamation and post-closure monitoring and maintenance, or for breaching a dam and restoring the stream channel and land to natural conditions.

ADNR considers the TSF to be Hazard Class I, which means there is a probable loss of one or more lives if failure were to occur; a potentially significant danger to public health; and probable losses or damage not limited to the owner of the dam. There is also probable loss of or significant damage to waters identified under 11 AAC 195.010(a) as important for spawning, rearing, or migration of anadromous fish.

The ADNR (2005) guidelines contain design requirements for hydrology (inflow flood, precipitation, snowpack); hydraulics (flood routing, spillway, freeboard); stability under a variety of loading conditions; design earthquake levels; seepage analysis; and cold regions factors such as permafrost foundation issues, ice loading, and other cold temperature effects on construction materials and operations. Dry stack tailings dams are regulated by the Alaska Department of Environmental Conservation (ADEC) under their solid waste permitting program (18 AAC 60). However, the primary intent of the dam below the dry stack under Alternative 5A would be to contain operating pond water from flowing into the dry stack, and as such, would likely be regulated under the ADNR dam safety program as Hazard Class II.

Two levels of design earthquakes are required to be addressed by ADNR (2005): 1) an operating basis earthquake (OBE) representing ground motion or fault movement with a reasonable probability of occurrence over the project life, during which dams must remain functional and easily repairable; and 2) a Maximum Design Earthquake (MDE) representing the most severe earthquake that could potentially occur relative to an established acceptable risk level, during which dams must resist collapse, failure, or uncontrolled release. Risk levels for the OBE and MDE are defined in terms of earthquake return period, that is, the frequency with which a certain size earthquake is expected to occur.

For Class I dams, the return period for the OBE is specified as 150 to > 250 years, and for the MDE, the return period is specified as 2,500 years to the return period of the maximum credible earthquake (MCE). For Class II dams, the return period for the OBE is specified as 70 to 200 years, and for the MDE, the return period is specified as 1,000 to 2,500 years. Seismic hazard analyses conducted for the Mine Site relative to these levels are described in Section 3.3.2.1.2, Geohazards and Seismic Conditions.

The ADNR (2005) dam safety guidelines also contain requirements governing different phases of the project life, such as construction plans and construction quality assurance/quality control; operations, maintenance, and repairs; monitoring and inspections; emergency action planning; and closure. Emergency Action Plan (EAP) requirements under 11 AAC 93.164(b) identify specific requirements for dam failure analysis and detailed inundation maps which estimate the extent of downstream flooding in the event of a dam breach. With respect to dam failure analysis, guidance is provided by ADNR (2005) for appropriate levels of engineering evaluation; quantitative dam break models; weather, breach size, and failure mode parameters; flood wave attenuation; considerations for fish habitat; and consideration of potential domino effects of dam failure on other dams located downstream.

3.24.2 EXISTING RESPONSE CAPACITY

In the region of the project, there are no industry operations at the scale of the proposed project. Because the area is remote and little infrastructure exists, the capacity for response to spilled substances is limited. While the statewide capacity for oil spill response is well established, there is minimal capacity to handle a spill of LNG, cyanide, or mercury. These gaps in response capacity would need to be planned for, and new plans created for the project.

3.24.2.1 OIL SPILLS

As noted in Section 3.24.1.1, there are regulations that require spill prevention and response planning for companies that store or transport diesel. As these companies operate in remote areas, response gear is prepositioned as appropriate (e.g., carried on each tank barge, stationed at storage and transfer facilities) that would be used by initial responders in the event of a spill. This response equipment typically includes sorbents, containers, deflective or sorbent booms, pumps, skimmers, and/or skiffs. In some areas companies collaborate to share equipment and responders in order to maximize their ability to respond while keeping costs down. The specific location of spill response equipment and spill plans would be determined as part of the detailed engineering and State of Alaska ODPCP processes. Should a response require additional equipment and/or personnel for recovery or cleanup operations, the contracted oil spill removal organization (OSRO) would be called upon to provide additional resources from their bases in Anchorage, Nikiski, Dutch Harbor, or other locations as appropriate.

3.24.2.1.1 OIL SPILL REMOVAL ORGANIZATIONS

There are several OSROs in Alaska; most with a focus on a single geographic region. There are two OSROs whose coverage includes Western Alaska, the Aleutian Islands, and Cook Inlet; these are described below.

Donlin Gold is a member of Alaska Chadux Corporation (Chadux), the only OSRO that covers Western Alaska and the Aleutians. In the event of a spill, Chadux provides experienced response personnel and equipment for recovery and cleanup operations. They are based in Anchorage; however, they also maintain prepositioned response equipment in several locations around the state, including Dutch Harbor and Bethel. In the event of a spill, personnel would come from Anchorage within 24 hours of notification of a spill. They regularly update their inventory, including absorbent pads, sweeps, and booms, land bladders, towable bladders, tanks, skimmers, rope mops, drums, and harbor, river, and shore seal booms. In addition, the Chadux Anchorage hub has vessels, pumps, and a variety of safety equipment.

Cook Inlet Spill Prevention & Response, Inc. (CISPRI) was created as a response to OPA 90 requirements to serve operators in Cook Inlet, and its focus remains recovery and cleanup operations in the Cook Inlet region. In the event of a spill, they provide experienced response personnel and equipment for recovery and cleanup operations. CISPRI is based in Nikiski, and remains the only OSRO capable of responding to a large or very large spill in Cook Inlet, through their prepositioned response equipment around the Inlet. CISPRI maintains a broad inventory of response equipment.

Chadux and CISPRI both provide spill response training to their clients’ on-site personnel, and can be contracted to provide personnel on-site. This allows for the possibility of a limited but immediate response in the event of a spill.

3.24.2.1.2 UNIFIED AND SUBAREA CONTINGENCY PLANS

The Alaska Federal/State Preparedness Plan for Response to Oil and Hazardous Substance Discharges/Releases, commonly referred to as the Unified Plan, along with the supplementary Subarea Contingency Plans, represents a coordinated and cooperative effort by government agencies to be prepared to respond in the event of a spill. As part of these plans, the EPA, USCG, and ADEC each have prepositioned response equipment around the state, as described in Annex E of the Unified Plan. This equipment may be used to supplement a Responsible Party's response to a spill; however, it is generally reserved for spills where the Responsible Party fails to respond to a spill.

3.24.2.1.3 ALASKA PETROLEUM DISTRIBUTORS & TRANSPORTERS AGREEMENT OF COMPLIANCE

Tank barge operators planning to be engaged in lightering operations in the Western Alaska Captain of the Port Zone must be signatories to the Alaska Petroleum Distributors and Transporters (APD&T) Agreement for Compliance, per USCG Marine Safety Information Bulletin 07-13. As stated in the Agreement's preamble: "Due to the remote operational environment, seasonal operations, and lack of an Oil Spill Response Organization to meet the Oil Pollution Act of 1990 (OPA-90) compliance needs of the operators, the purpose of APD&T was to develop and implement an oil spill response scheme that would meet the OPA-90 requirements as an alternative planning criteria acceptable to the USCG in accordance with 33 CFR 155.1065 (f)." One of the elements in this agreement is a memorandum of understanding regarding the use of tank barges of opportunity to provide temporary storage in support of an oil spill response. Therefore, additional response resources beyond those listed on Chadux's or CISPRI's websites can potentially be brought to bear during a response, especially to a catastrophic discharge.

3.24.2.2 LIQUEFIED NATURAL GAS

LNG is not currently used in the Project Area. Therefore, no plan or capacity for response is presently available for this area. New plans and response capacities could be required for the proposed project.

3.24.2.3 CYANIDE

Cyanide is not presently used or transported in the Project Area. Therefore, no plan or capacity for response is presently available for this area. Donlin Gold has committed to preparing plans to respond to spills, including cyanide, and would have response resources available for the proposed project.

3.24.2.4 MERCURY

Mercury is not presently used or transported in the Project Area. Therefore, no plan or capacity for response is presently available for this area. Donlin Gold has committed to preparing plans to respond to spills, including mercury, and would have response resources available for the proposed project.

3.24.2.5 TAILINGS

This area is not currently being mined in a manner which produces mine tailings; therefore, no plan or capacity for response is presently available for this area. New plans and response capacities would be required for the proposed project, which would be detailed in the EAP required under ADNR dam safety permitting (Section 3.24.1.5). These would involve the extensive use of excavation and earthmoving equipment from the mine itself. As described in BGC (2015n), if a situation arises that requires immediate attention, Donlin Gold would have the necessary equipment, material, labor, and engineering expertise already onsite for mining operations that could be deployed to respond to an emergency immediately.

The specific equipment and supplies would be outlined in the EAP. For example, stockpiles of fine and coarse filter materials, as well as rockfill and transitional rockfill, would be located in the vicinity of the dam to be readily available in an emergency to arrest or retard internal or external erosion of the dam, and plug any erosion channels that may have formed on the dam crest or downstream face. In addition, pumps would be on hand to lower the TSF pond level, utilizing the reclaim system to divert water to the open pit for temporary storage (BGC 2015n).

3.24.3 SPILL FREQUENCY AND VOLUME

This section describes, by alternative, the expected relative rate of occurrence and estimated volumes of spills from the proposed project. The likelihood of a spill is a qualitative assessment based on the rate or frequency of occurrence. The rate of occurrence is a function of several factors, including operating procedures, personnel training and awareness, maintenance, and human error. The relative rates listed below are based on the experience of several personnel with spill background, peer-reviewed and “gray” literature, and reports as referenced. The assessment is a subjective evaluation and the categories are relative to each other in the context of area operations.

3.24.3.1 DIESEL FUEL AND OTHER OIL

3.24.3.1.1 ALTERNATIVE 1 – NO ACTION

Under the No Action alternative, the project would not be developed and none of the materials necessary for the action alternatives would be transported, used, stored, or disposed. Therefore, there would be no additional spill risk under this alternative.

3.24.3.1.2 ALTERNATIVE 2 – DONLIN GOLD’S PROPOSED ACTION

Under Alternative 2, diesel would be used as a primary fuel source for electricity generation for the project until natural gas became available to be used to fuel the power plant at the mine. Diesel would also be the fuel source for the mining haul trucks. The peak annual usage would be expected to be 42.3 Mgal during the Operations Phase of the mine; during the Construction Phase, annual diesel usage would be anticipated to be approximately 7.05 Mgal to 21.15 Mgal. After the closure of the mine, diesel would be used in relatively small amounts by the annual inspection and maintenance crews. As a result, the potential for a spill of any size would be lowest during the Closure Phase and highest during the Operations Phase.

Based on the spills database maintained by ADEC, the Donlin Gold Oil Spill Risk Assessment (ERM 2017c), and Etkin (2006), Table 3.24-1 provides an estimate for the likelihood of diesel spills for this project by source.

Table 3.24-1: Expected Relative Rate of Occurrence for Diesel Fuel Spills from Main Project Sources

Spill Size (US gallons)					
Source	**Very Small < 10**	**Small 10 – 99.9**	**Medium 100 – 999.9**	**Large 1,000 – 100,000**	**Very Large > 100,000**
Storage tanks / Tank farms	High	Medium	Low	Very Low	Very Low
Vessels (Barges)	High	Medium	Low	Very Low	Very Low
Tanker trucks	Very High	Medium	Very Low	Very Low	Would not occur
Pipeline	Very High	High	Low	Very Low	Very Low

Notes:
Probability of Spill: Very high has a probability approaching one, very low has a probability approaching zero.
Source: ERM 2017c; Etkin 2006.

Potential Sources of Spilled Material

Vessels

On-water transportation of diesel would be accomplished by bulk oil tanker to Dutch Harbor, then by double-hulled ocean-going barge from Dutch Harbor to Bethel, which provide added security against oil spills in low impact collisions and groundings (OCIMF 2003). The Donlin Gold Project Plan of Operations, Volume 6 - Transportation Plan indicates planning for deliveries to Bethel of up to 2.94 million gallons of diesel per ocean-going barge. Barges of this size typically have between six and eight compartments that can vary in size. The likelihood of a large spill from a barge going to Donlin is very low for several reasons. The potential effects of severe winter storms and temperatures will be minimized because the season for shipping is limited to the ice-free period on the Kuskokwim River. The risk would be further limited because the barges would be double-hulled, so that even if there is a collision or grounding, the likelihood of breaching the diesel-containing compartments is much lower than for a single-hulled vessel (OCIMF 2003). Spills of more than 10,000 gallons involving a barge transporting petroleum products in Alaska did not occur between January 1995 through July 2013, and because of this a spill of this size is not projected to occur during the life of the Donlin Gold Project (ERM 2017c). Any actions that would occur at Dutch Harbor or the Port of Bethel at the Bethel Yard Dock are not part of the proposed action, and are considered connected actions (see Section 1.2.1, Connected Actions, in Chapter 1, Project Introduction and Purpose and Need).

From 1990 to 2011, only 10 instances of a vessel suffering hull failure, grounding, or sinking were recorded on or in the vicinity of the Kuskokwim River. Eight of the 10 incidences resulted in the release of 20 gallons or less of petroleum products (ARCADIS 2013a). The risk of such a spill would be minimized by the use of double-hulled barges, the implementation of operational procedures that are in compliance with all applicable regulations, and the use of licensed pilots on all tank vessels approaching Bethel. Double-hulled river-going barges would be used between Bethel and Angyaruaq (Jungjuk) Port. Most potential spills are likely to be small or very small. It is possible, although very unlikely, that a large or even a very large spill could result if a vessel carrying a large amount of diesel grounds, sinks, or is otherwise compromised, resulting in a cargo tank being breached and the contents released to the riverine or marine environment. Based on historical spill data, the projected frequency of a spill between 1,000 and 10,000 gallons is greater than the life of the Donlin Gold Project (ERM 2017c). Double-hulled tank vessels provide an additional layer of spill prevention—in the case of hull rupture caused by a grounding or collision, usually the outer hull absorbs the damage and the inner hull remains unharmed with contents intact (NOAA 2014c). The cargo tanks of tank vessels and barges are compartmentalized, which adds additional mitigation in that if one or more cargo compartments are breached, only the cargo in those compartments is released, and not the vessel's whole cargo. The design of the river barges currently incorporates eight cargo compartments in each barge, along with the double hull.

Donlin has committed to using only double-hulled river barges on the Kuskokwim River to further reduce the risk of a spill. In the Donlin Gold Project River Barge and Fleet Operation Plan, each delivery from Bethel to Angyaruaq (Jungjuk) Port would be accomplished by a tow of four specially built double-hulled barges, each barge with a maximum capacity of 336,150 gallons in eight compartments of about 42,000 gallons each. However, the maximum operating capacity will be 95 percent of the maximum capacity: 319,342 gallons per barge (AMEC 2013). The actual operating capacity will generally be lower, as the maximum operating capacity is based upon the maximum draft of the barges during the highest river flows; the draft will be determined individually for each transit upriver, and will likely result in actual operating capacities of 80 percent to 90 percent of the maximum capacity: 268,920 to 302,535 gallons per barge. (Refer to Section 2.3.2.1, Alternatives, and Section 3.23.2.2.2 for barging information).

Oil Spill Risk Assessment Study

In 2014, ERM reviewed ADEC and USCG data, as well as other studies and documents to conduct an oil spill risk assessment for diesel barges along the Kuskokwim River. The assessment looked at the frequency and potential volume of spills by specified modes of transport, cause of spills, spill volumes, likelihood that the cause would result in an incident, and potential receptors. In general, the study found that:

- On average, spills occurring as a result of groundings, collisions/allisions, and equipment failures tend to result in larger spill volumes than other spill causes;
- With the exception of unknown spill causes, human factors, equipment failures, and collisions/allisions are the primary causes for petroleum product barge spills occurring along rivers and around ports;
- Spill volumes from spills occurring in rivers and around ports tend to be similar to spill volumes reported for all spills; and
- Majority of spills resulted in small volumes, less than 50 gallons.

This information was considered in the above discussion, and incorporated in the impact analyses in Section 3.24.6.

Tank Farms

Storage of diesel would occur in tank farms located in Dutch Harbor, Bethel, Angyaruaq (Jungjuk) Port, and the Mine Site and project airstrip. Storage at Dutch Harbor, Bethel, and Angyaruaq (Jungjuk) Port would be used to facilitate the transfer of diesel from one form of transportation to the next; the Mine Site tank farm would be the final storage and distribution point (the diesel would be used for the operation of mining equipment and for power generation). Tanks used for storage at the Mine Site would have a capacity of 2.5 Mgal each, with a combined planned capacity of 37.5 Mgal. The diesel storage tank at Angyaruaq (Jungjuk) Port would have a planned capacity of 2.8 Mgal and would be above the 100 year floodplain and more than 500 feet from the active floodplain. Federal regulations mandate that all storage tanks have secondary containment equal to 110 percent of the total maximum volume of the largest tank in the secondary containment area (SCA). State regulations require an SCA sufficiently sized to accommodate the largest tank "plus enough additional capacity to allow for local precipitation" which may require the SCA to have a capacity greater than 110 percent. Any actions that would occur at Dutch Harbor or the Port of Bethel at the Bethel Yard Dock are not part of the proposed action, and are considered connected actions (see Section 1.2.1, Connected Actions, in Chapter 1, Project Introduction and Purpose and Need).

Data indicates that tank failures are uncommon, and that the volumes released during these occurrences are small relative to the total storage volume of the tanks. Often there is complete recovery in SCAs (ARCADIS 2013a). Most potential spills are likely to be small or very small, and mostly due to a combination of human factors and structural or mechanical factors. It is possible, although very unlikely, that a large or even a very large spill could occur from a storage tank failure, resulting in a spill into the tank farm's impermeable (lined) SCA. The SCA would be designed to contain a minimum of 110 percent of the largest tank.

Vehicles

A fleet of ten 13,500-gallon capacity B-train tanker trucks (with two tanks of approximately 6,750 gallons each) would be used to transport diesel from Angyaruaq (Jungjuk) Port to the Mine Site. There would be an average of 2,424 round trips per year during the shipping season of the Operations Phase, (approximately 22 per day). Research has been conducted into the probability of accidents on a number of different types of roads, but no research has been identified that examines accident rates on controlled access, private industrial roads such as the proposed mine access road (ARCADIS 2013a). Most potential spills would likely be small or very small. It is possible for a medium to large spill (up to 13,500 gallons) to occur in the unlikely event of a rollover or collision that results in a cargo tank being breached and the contents released to the surrounding environment. The risk of a release would be reduced to some degree with provisions made for driver safety through the continued use of BMPs such as travelling at safe speeds. There would be no transport of fuel during winter and trucking would be curtailed during extreme weather events, such as high wind, during the shipping season. The tanker trucks would be equipped with spill response kits, and the drivers would be trained to minimize and contain low-volume spills.

Transfer Operations

Potential spill sources include transfer operations between vessels and tank farms, between tanker trucks and tank farms, and from pipelines to barges, trucks, and tanks. Most potential spills would be likely to be small to very small. It would be possible for a spill to occur due to a combination of human factors and structural or mechanical factors. A spill during a transfer operation to or from a tanker truck would likely result in the diesel being spilled within the tanker truck loading/unloading area equipped with secondary containment. State regulations require the loading/unloading areas to be impermeable and sized to hold the capacity of the largest compartment of the largest tanker truck serviced. The event of a catastrophic discharge from a tanker truck at the transfer area would be very unlikely, but could result in a discharge reaching the surrounding environment. In the event of a transfer failure at the fueling dock, such as from a hose rupture, during a transfer to or from a vessel, diesel may reach water. Operators would be trained to respond to spills during transfer operations.

Fuel storage and vehicle and equipment refueling and lubricating would not take place within riparian areas, closer than 100 feet from waterbodies, or within 500 feet of the active floodplain (generally would be considered the one-year floodplain) of any fish-bearing stream. Fuel storage and refueling areas would have secondary containment, and spill response equipment would be staged as appropriate and as detailed in spill response plans.

Pipelines

Short pipelines are proposed at Angyaruaq (Jungjuk) Port and at the Mine Site to transfer diesel between barges, trucks, and tanks. The potential for spills from these pipelines is covered in the Transfer Operations section above. Releases from the proposed natural gas pipeline would not result in contamination of soil or water and are discussed in Section 3.25, Pipeline Safety and Reliability.

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

Under Alternative 3A, annual diesel usage during the Construction Phase is anticipated to be the same as for Alternative 2; however, during the Operations Phase annual diesel deliveries would be reduced from 42.3 Mgal/year to 13.3 Mgal/year. Under Alternative 3A, a limited amount of diesel would be transported to the Mine Site during the initial Construction Phase to serve as a backup fuel source for electrical generation, and fuel a smaller fleet of equipment during the Operations Phase. This would result in a reduced number of barge trips annually, from an estimated 122 round trips to 83, and reducing the number of tanker truck trips from 2,424 to 932 per season. The decrease in barge volume would reduce the spill risks associated with diesel fuel transport. For this alternative, the potential for a spill of any size is highest during the Construction Phase, reduced for the Operations Phase, and lowest for the post-Closure Phase.

3.24.3.1.4 ALTERNATIVE 3B – REDUCED DIESEL BARGING: DIESEL PIPELINE

Under Alternative 3B, annual diesel usage during the Construction Phase would be anticipated to be the same as for Alternative 2, and the diesel would be barged up the Kuskokwim River as described in Alternative 2. For this alternative, the potential for a spill of any size over the Western Alaska delivery route would only exist during the Construction Phase.

Barge tows on the Kuskokwim River would be reduced, and the diesel storage requirements in Dutch Harbor, Bethel Fuel Terminal, and Angyaruaq (Jungjuk) Port would be eliminated under

Alternative 3B. Diesel fuel shipments (during Operations and Closure) would be routed to Tyonek or Port MacKenzie, and a pipeline segment would run from Tyonek to Beluga or Port MacKenzie to MP 28. The reduction in barge volume would dramatically reduce the spill risks associated with diesel fuel transport using river barge, tank farm storage, and tanker trucks. However, this alternative introduces additional spill risks associated with the transportation of fuel along the pipeline corridor. Any actions that would occur at Dutch Harbor or the Port of Bethel at the Bethel Yard Dock are not part of the proposed action, and are considered connected actions (see Section 1.2.1, Connected Actions, in Chapter 1, Project Introduction and Purpose and Need).

On completion of the diesel pipeline, approximately 120 Mgal of diesel would be delivered to the mine via pipeline from Tyonek or Port MacKenzie; diesel would be delivered to Tyonek or Port MacKenzie by tankers in 12 annual shipments of 10 Mgal. This differs from Alternative 2; with the addition of the pipeline, less fuel is required to be stored at the Mine Site. For the Cook Inlet delivery route there would be an increasing risk for a potential spill during the Construction to Operations Phase, with a diminished risk during the Closure Phase. Additionally, the use of a pipeline would eliminate the need for tanker truck deliveries from Angyaruaq (Jungjuk) Port to the Mine Site (being replaced by occasional tanker truck deliveries from the Mine Site to Angyaruaq (Jungjuk) Port solely to provide fuel for the power generator), thereby potentially reducing the total risk of a potential spill of any size from tanker trucks during the Operations and Closure phases.

Transportation of diesel by pipeline involves risk to the public and the environment in the event of an accident, incident, or an unauthorized action, and subsequent release of diesel. According to PHMSA, the 10-year average for releases from diesel pipelines is as follows in Table 3.24-2:

Table 3.24-2: 10-Year Average for Releases from Diesel Pipelines

Product	Average # of Incidents/yr.	Average Property Damage /year (dollars)	Average Amount Lost/Recovered (gallons)	Miles of Pipeline (miles)
Onshore refined product	132	$52,712,410	15,552 / 7,754	63,633

Source: PHMSA 2013a.

Only half the diesel fuel released from refined product lines is ever recovered. Because of this, the intensity and duration of a release is likely to be higher than Alternative 2 based on the physical and chemical properties of diesel compared to natural gas. The volume of diesel that could be released would be less under the collocated option, because the diameter of the pipeline would be smaller.

The risk of a potential spill of any size from the pipeline would be highest during the Operations Phase, when the pipeline would actively be transporting diesel, and lowest during the Construction and Closure phases, when the pipeline would not be transporting diesel. Generally, pipelines are less prone to large spills compared to trucks and railcars (Furchtgott-Roth 2013).

Operational spills may occur also anywhere along the proposed pipeline, including pump stations and within long runs of straight line pipe. Pipeline operation leaks, drips, and spills could occur due to corrosion, external forces such as thaw settlement, or other causes. Pump station operational leaks can occur due to circumstances similar to pipeline operational leaks, with additional risks related to filter change and pig launching or receiving operations.

Spills from the proposed pipeline, associated pump stations, valves, or pigging facilities could occur during project operations at several general locations including the pipeline right-of-way (ROW), pump stations, and staging areas for major maintenance and other contractor activities. Although leak detection systems would be in place that would automatically shut down the pumps on loss of pressure, some leaks might not be detected by the system for an extended period of time. For example, a pinhole leak could potentially be undetectable for days or weeks, especially if the release volume rate was small. Detection of diesel from small pinhole leaks would most likely occur through visual or olfactory identification, either during regular pipeline aerial inspections, ambulatory patrols, or landowner or citizen observation. Larger leaks/breaks would be detected much quicker. A study calculated that spill volumes for Alternative 3B for pinhole leaks could range from 25,620 to 812,280 gallons while volumes from large leaks could range from 3,360 to 790,020 gallons (Michael Baker Jr., Inc. 2014). The high range estimates would be considered worst case for spill response planning and very unlikely to occur.

Diesel fuel spills could occur during the Operations Phase if a bulk carrier tanker ran aground navigating to the Tyonek or Port MacKenzie facility or during the transfer of the diesel from the tanker to the tank farm. The carrying capacity of the fuel barges is estimated to be 10.5 Mgal of diesel fuel. However, only one or two barge compartments would be expected to fail in a grounding, and transfer facilities would have secondary containment, so the amount that would be spilled would likely be less. These scenarios are unlikely to occur.

Rupture of a tank at the tank farm would have the potential to release a maximum of 2.5 Mgal of diesel (equivalent to the storage capacity of the tank) but would most likely be contained by the secondary containment system.

If this alternative were selected, Donlin would revise the Vessel Operations Oil Discharge Prevention and Contingency Plan (SLR 2012b) and the Donlin Gold Terminal and Tank Farm Oil Discharge Prevention and Contingency Plan (SLR 2012a) to include diesel spill prevention, response activities, and procedures for the tankers delivering diesel to the Port of Tyonek or Port MacKenzie and the tank farm at the proposed Operations Center and Pumping Facility.

3.24.3.1.5 ALTERNATIVE 4 – BIRCH TREE CROSSING (BTC) PORT

Under Alternative 4, the only change from Alternative 2 would be the upriver port and road location to the BTC Port instead of the proposed Angyaruaq (Jungjuk) Port.

The BTC Port would be 69 river miles downriver from the proposed Angyaruaq (Jungjuk) Port, which is a 38 percent decrease in barging river miles. This alternative would allow for the avoidance of the shallowest areas on the barge route, which are upriver of BTC. The transits would be completed more quickly due to the shorter route, but the total number of transits would remain the same because the estimate is based on the number of barges needed to carry a certain amount of fuel in a given time frame. The potential for a spill risk due to a grounding of a river fuel barge is notably reduced (see Section 3.5, Surface Water Hydrology); however, the potential risk for a spill due to accident or collision would not be substantially reduced. The same BMPs would be used.

The BTC Port would require a road of approximately 76 miles for delivery of the fuel to the Mine Site, up from the approximately 30 miles from Angyaruaq (Jungjuk) Port to the Mine Site. Increasing the trucking portion by 2.5 times increases the potential spill risk for a spill of any size by a tanker truck; the same number of tanker truck deliveries of diesel from the port to the Mine Site would still be required (approximately 22 per day, during the 110 day shipping period), and so approximately 20 or more trucks (and operators) would be required in order to accomplish the transfer of diesel to the Mine Site from BTC Port in the same time frame as from Angyaruaq (Jungjuk) Port. This increased risk can be mitigated to some degree with provisions made for driver safety through the continued use of BMPs, making modifications to the design of the route such as allowing for rest stops and maintenance pull off areas, and ensuring no gaps in radio communication along the entire road. An additional consideration would be for greater diesel storage capacity at BTC Port to allow for a longer transfer time, using fewer trucks and/or a lower speed limit. However, lengthening the trucking season would increase the likelihood of weather-related risks, which would increase the chances of truck accidents.

However, it should be noted the incidence is relatively small for refined fuel released by truck in accidents. In Alaska, the following fuel spill incidents (Table 3.24-3) from trucks have been reported to ADEC in the last five years:

Table 3.24-3: Fuel Spill Incidents from Trucks in Alaska (2010-2015)

Year	Location	Volume Spilled (gallons)	Product
2010	Glenn Hwy	9,000	Propane
2010	Glenn Hwy	2,464	Diesel
2010	Parks Hwy	2,540	Diesel
2011	Manley Hot Springs	Rollover – no spill	Diesel
2011	Fairbanks	2,550	Heating Oil
2012	None		
2013	Rampart Airport	2,750	Diesel
2013	Dalton Hwy	3,000	Diesel
2014	Dalton Hwy	2,188	Diesel
2014	Dalton Hwy	2,561	Diesel
2014	Richardson	4,400	Diesel
2014	Wiseman	1,200	Diesel
2015	Dalton Hwy (MP 86)	2,800	Diesel

Source: ADEC 2015b.

The number of releases of fuel from truck accidents averages 2 per year. There is not a good source of information on the number of fuel truck miles in Alaska per year; however, the number is thought to be very substantial. For example, Colville Inc. supplies most of the fuel on the North Slope by driving it from Valdez, Fairbanks, and Anchorage. This is done by using 24 dedicated tractor trailers. In 2011, they logged 1.2 million miles transporting fuel to Prudhoe Bay (Colville, Inc. 2015). Only one spill occurred during that year. As such, their spill rate per mile is very low.

Therefore, because the BTC Road is longer, there is an increased risk of a fuel spill; however, the overall risk remains very small.

Diesel usage for the project would increase slightly due to the additional requirements of trucking; across the life of the project this small increase would likely be insignificant in increasing the potential for a spill of any size.

3.24.3.1.6 ALTERNATIVE 5A – DRY STACK TAILINGS

Alternative 5A evaluates a dry stack tailings method. Under Alternative 5A, annual diesel usage during the Construction, Operations, and Closure phases of the project and the associated spill risk is anticipated to be approximately the same as for Alternative 2.

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

Under Alternative 6A, the natural gas pipeline route would depart to the northwest through Dalzell Gorge from the Alternative 2 alignment at approximately MP 106.5. The route would not otherwise differ from Alternative 2. Under Alternative 6, annual diesel usage during the Construction, Operations, and Closure phases of the project and the associated spill risk is anticipated to be the same as for Alternative 2.

3.24.3.2 LIQUEFIED NATURAL GAS

Analysis of Pipeline and Hazardous Materials Safety Administration datasets indicates that approximately 0.0003 incidents would occur per mile of the proposed natural gas pipeline each year of operation, equating to a potential of 1.9 incidents over the 30-year operational life of the pipeline (ARCADIS 2013a). Because of the unlikelihood and unlikely impacts of escaped natural gas to the environment, that scenario is not discussed in this analysis. Instead, the scenario would be based on a potential release of LNG at the Mine Site.

3.24.3.2.1 ALTERNATIVE 1 – NO ACTION

Under the No Action alternative, the project would not be developed and none of the materials necessary for the action alternatives would be transported, used, disposed of, or stored. Therefore, there would be no spill risk under this alternative.

3.24.3.2.2 ALTERNATIVE 2 – DONLIN GOLD'S PROPOSED ACTION

Alternative 2 would use diesel fuel to power the large haul trucks that would move waste rock and ore from the open pits. Because LNG would not be used under this alternative, there would be no risk associated with LNG spills.

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

Under Alternative 3A, the large haul trucks that would move waste rock and ore from the open pits would use LNG instead of diesel for fuel. This alternative would include the addition of an

LNG Plant and storage tanks. Table 3.24-4 provides an estimate for the likelihood of LNG spills for this project by source.

Table 3.24-4: Expected Relative Rate of Occurrence for LNG Spills from Main Project Sources

Spill Size (Gallons)					
Source	**Very Small < 10**	**Small 10 – 99**	**Medium 100 – 999**	**Large 1,000 – 50,000**	**Very Large > 50,000**
Haul Trucks	High	Medium	Low	Very Low	Would not occur
Storage Tanks	High	Medium	Medium	Very Low	Very Low

Notes:

Probability of Spill: Very high has a probability approaching one, very low has a probability approaching zero.

Because LNG-powered haul trucks are not commercially available at this time, it is unknown how much fuel an LNG-powered truck would carry. Caterpillar is currently in the early stages of development of LNG-powered mining trucks, which will include the Cat 793, 795, and 797 (Caterpillar 2013). The fuel tanks for Caterpillar's existing diesel-powered trucks in the 793, 795, and 797 classes range in capacity from 750 gallons for the Cat 793F, to 1,150 gallons for the Cat 793D (Caterpillar 2010a and 2010b). Therefore, it is assumed that the maximum spill from an LNG-powered truck would be approximately 1,150 gallons.

The eight conceptual storage tanks at the LNG plant would have a capacity of 55,000 gallons of LNG.

Potential Sources of Spilled Material

Haul Trucks

Because LNG-powered haul trucks are not commercially available at this time, no data exist about the rates of accidental LNG release from these vehicles. LNG tanker trucks would not be used in Alternative 3A and these vehicles are not equivalent to LNG-powered haul trucks; however, data on LNG tanker truck incidents were examined in the absence of any data on LNG-powered haul trucks. A summary of LNG tanker truck incidents compiled by CH-IV International through February 2012 shows that since the year 2000, one accident has occurred which resulted in an LNG release and subsequent vapor ignition (CH-IV International 2012).

There is a very low chance that a large LNG release would occur under Alternative 3A; however, frequent but very small to small LNG spills would be more likely to occur. Very small and small LNG spills could result from haul truck accidents, fuel transfer operations, and pinhole leaks from the storage tanks. This alternative would have the same requirements for secondary containment and operator training that would be required with diesel fuel.

Storage Tanks

For Alternative 3A, a 220,000-gallon per day LNG plant would be constructed near the terminus of the gas line at the Mine Site, and the LNG would be stored in a series of tanks. An explosion of an LNG container is a highly unlikely event that is possible only if the pressure relief equipment or system fails completely. If the pressure builds up to the point where the vessel bursts, the resulting explosion is known as a boiling liquid expanding vapor explosion (BLEVE) with the container pieces propelled outward at a very high velocity. There have been no reports in the literature reviewed of any BLEVE occurring with LNG (USDOT 1995).

Leaks and spills from storage tanks are not considered high risk. One of the major provisions at any LNG storage facility is the requirement to provide an impounding area surrounding the container to minimize the possibility of accidental discharge of LNG from endangering adjoining property on important process equipment and structure, or reaching waterways. This requirement would ensure that any size spill from tanks would be fully contained and the risk of any fire damage will be minimized (USDOT 1995; Rath and Krol 2013).

3.24.3.2.4 OTHER ALTERNATIVES

Alternatives 3B, 4, 5A, and 6A would use diesel to power the large haul trucks that would move waste rock and ore from the open pits. Because LNG would not be used under these alternatives, there would be no risk associated with LNG spills.

3.24.3.3 CYANIDE

3.24.3.3.1 ALTERNATIVE 1 – NO ACTION

Under the No Action alternative, the project would not be developed and none of the materials necessary for the action alternatives would be transported, used, disposed of, or stored. Therefore, there would be no spill risk under this alternative.

3.24.3.3.2 ALTERNATIVE 2 – DONLIN GOLD'S PROPOSED ACTION

Under Alternative 2, sodium cyanide would be used to separate gold from the ore. The sodium cyanide would be transported as solid briquettes in 22-ton International Standards Organization (ISO) approved type 2 watertight sparge tank-tainers. The cylindrical tank-tainers would be permanently and prominently marked with appropriate warning labels and hazard markings, and Donlin would comply with the Code as discussed in Section 3.24.1. The average annual usage of sodium cyanide would be approximately 2,618 tons (SRK 2016a); and it would only be used during the production phase of the mine. Based on this prediction, approximately 119 containers would be required per annum.

Sodium cyanide only poses an environmental threat if handled improperly, and must come in contact with water to pose immediate toxic and acute health dangers. The likelihood of a very large cyanide spill is very low to almost non-existent, as the sodium cyanide would be transported as solid briquettes in ISO-approved type 2 watertight sparge tank-tainers that would be dedicated solely to cyanide, and secured to vessels. This is expected to reduce the risk. Table 3.24-5 provides an estimate for the likelihood of cyanide spills for this project by source.

Table 3.24-5: Expected Relative Rate of Occurrence for Cyanide Spills from Main Project Sources

	Spill Size (Tons)				
Source	**Very Small < 0.1**	**Small 0.1 – 4.9**	**Medium 5 – 9.9**	**Large 10 – 22**	**Very Large > 22**
Vessels (Ocean Barges)[1]	Very Low	Very Low	Very Low	Very Low	Very Low
Vessels (River Barges)[2]	Very Low	Very Low	Very Low	Very Low	Very Low
Transfer Operations	Very Low	Very Low	Very Low	Very Low	Very Low
Port Storage	Very Low	Very Low	Very Low	Very Low	Very Low
Vehicles	Low	Very Low	Very Low	Very Low	Very Low
Mine Storage Area	Low	Very Low	Very Low	Very Low	Very Low
Mine Processing Area	Low	Very Low	Very Low	Very Low	Very Low

Notes:

1 Assumes 14 trips per year with the cargo split evenly between each trip (~200 tons per barge); see Table 2.3-8 in Chapter 2, Alternatives.

2 Assumes 64 trips per year with the cargo split evenly between each trip (~75 tons per barge); see Table 2.3-8 in Chapter 2, Alternatives.

3 Probability of Spill: Very high has a probability approaching one, very low has a probability approaching zero.

Potential Sources of Spilled Material

Vessels

An ocean barge would transport solid sodium cyanide in ISO-approved type 2 watertight sparge tank-tainers from Seattle or Vancouver to Bethel. Sodium cyanide is a USDOT Class 6 hazard, of which 9.9 million tons were shipped nationally in 2007 (0.5 percent of all hazard material shipments) (USDOT 2013). Not all Class 6 shipments include cyanide. For all hazardous materials transported in the years 1990, 2000, 2010, 2011, and 2012, there was only one accident-related incident (in 2010) from water transportation. This shows the unlikelihood of a vessel incident carrying Class 6 hazardous materials for the Donlin Gold Project (USDOT 2013).

There would be approximately 12 ocean barge trips per annum and it is assumed that the annual volume of sodium cyanide required would be split evenly between these barges. Consequently, each ocean barge would be carrying approximately 10 tank-tainers per trip, which equates to 220 tons of sodium cyanide. The sodium cyanide tank-tainer would then be transferred from the ocean barges to the Bethel cargo terminal for storage or onto river barges for towing up the Kuskokwim River to Angyaruaq (Jungjuk) Port. There would be approximately 64 river barge trips per annum and it is assumed that the annual volume of sodium cyanide required would be split evenly between these barges. Consequently, each river barge would be carrying approximately one to two tank-tainers per trip, which equates to 22 to 44 tons of sodium cyanide. Crew members would be educated on the substance and trained in proper handling. During the on-water transportation of sodium cyanide it is possible that a tank-tainer could be lost overboard into the ocean or the Kuskokwim River as a result of improperly secured cargo. The potential for losing a tank-tainer overboard is very low to non-existent considering they would be secured to the barge deck. In event that the tank-tainers were lost overboard from the ocean or river barges they would be locatable as each tank-tainer would be tracked during transport. The containers would then be able to be retrieved by salvage divers. The sodium cyanide must come in contact with water to pose immediate toxic and acute health dangers. However, the tank-tainers would be watertight, preventing contact between the solid sodium cyanide briquettes and water, and minimizing the potential for spills.

Transfer Operations

Transfer operations between vessels and the Bethel cargo terminal and Angyaruaq (Jungjuk) Port barge terminal would be a potential spill source. Barges would be loaded and unloaded using shore-based container handlers. The potential source results from the unlikely event that a tank-tainer is dropped into the water during these transfer operations. However, the potential for spills is very low to non-existent because the tank-tainer would be watertight and the solid sodium cyanide would be protected from potential contact with water. Transfer operations would only occur during the shipping season. NICNAS (2010) found that between 1984 and 2010, no reports of incidents occurring during storage or handling prior to transportation to the mine sites were encountered, with the exception of an incident in New Zealand in 2004, which had minor environmental impacts.

Port Storage

Storage of sodium cyanide would occur at Bethel and Angyaruaq (Jungjuk) Port. Tractor-trailer units would transport the tank-tainers to the storage yard, where container handlers would be used to place loads into designated storage locations with secondary containment. A reserved secure and isolated sodium cyanide tank-tainer storage area would be provided where public access is prohibited. The sodium cyanide would be stored in the watertight tank-tainers to minimize the potential for contact of cyanide with water. A potential spill could occur in the very unlikely event that the tank-tainers ruptured. However, the potential release would be contained as the tank-tainers would be located within secondary containment area. The sodium cyanide tank-tainers would not be stored with incompatible materials (e.g., acids, strong oxidizers, metals, moisture, water, and halogens). This potential source would occur during the shipping season.

The storage areas for cyanide would be well ventilated to prevent the build-up of hydrogen cyanide gas and hydrogen cyanide monitoring would be implemented. Personal protective equipment would be available at the port where the sodium cyanide is stored. Spill neutralization and cleanup equipment should also be available at appropriate storage locations, and personnel would be trained in its use. This would include water for cleaning up spills of sodium cyanide solution and shovels for cleaning up spills of solid sodium cyanide. Spill residue would be properly disposed.

The Bethel and Angyaruaq (Jungjuk) ports would be operated according to the applicable laws and regulations to ensure the security of the facilities, protection of the environment, and safe storage, handling and transportation of hazardous materials. Any actions that would occur at Dutch Harbor or the Port of Bethel at the Bethel Yard Dock are not part of the proposed action, and are considered connected actions (see Section 1.2.1, Connected Actions, in Chapter 1, Project Introduction and Purpose and Need).

Vehicles

The sodium cyanide containers would be offloaded at the port terminal and trucked to the mine throughout the barging season. NICNAS (2010) found that incidences of spilled cyanide internationally from 1984 to 2010 were rare, relative to the amount of sodium cyanide that is annually transported. The spill risk during truck transportation is very low to non-existent due to the safeguards at the Donlin Gold access road (design for industrial traffic, dedicated use and low speed limits), and the appropriate containment to prevent a spill if an accident occurred. The sodium cyanide would be transported as dry solid briquettes that would be stored in watertight tank-tainers. Potential spills could occur in the unlikely event of an accident or wildlife collision that results in the tank-tainer rupturing. This event could result in either the dry sodium briquettes being spilled on dry ground or the contents could be spilled on wet ground or surface waters. If solid sodium cyanide is spilled on dry ground, it does not present a danger to people or the environment as long as the sodium cyanide remains dry and is swept up and properly contained for disposal. Spill residues would be properly disposed. Sodium cyanide that comes in contact with water poses immediate toxic and acute health dangers.

Mine Storage Area

Storage of sodium cyanide would occur at the mine. A secure storage area with secondary containment would be constructed, which would include an enclosed structure for the storage of cyanide. The watertight tank-tainers of solid sodium cyanide would be offloaded from the truck using a container handler and stored within the secure storage area. The tank-tainers would be stored within appropriate secondary containment systems designed to contain at least 110 percent of the volume of the largest container within the containment. The secondary containment area would be located on an appropriately designed concrete surface to prevent spill seepage to the subsurface. The potential for spills is very low or low. It is possible, although very unlikely, that there would be a large spill that could result from a tank-tainer rupture resulting in a spill to a secondary containment area. This potential source exists all year round.

Mine Processing Area

Stock cyanide solution would be prepared by connecting the tank-tainers to sparging tanks and circulating process water with sufficient sodium hydroxide content to maintain a pH of around 10 in the enclosed tank-tainer. The briquettes would be dissolved to create a 30 percent sodium cyanide solution. Once the briquettes were completely dissolved, the solution would be transferred to a sparging storage tank. The tanks would be equipped with level measuring gauges to ensure the sparging tanks do not overflow. The sparging system would be controlled from an air-conditioned control room such that the operators could monitor operations without risk of being sprayed by cyanide if there was a system failure. In the event of a leak from the sparging system, the process could be shut down remotely. The sparging system would be a closed system and automated such that the exposure risk to cyanide was minimized and the manual handling greatly reduced. The sparging system (the ISO tank-tainer, sparging storage tank and associated pipelines and pumps) would be stored within appropriate secondary containment systems designed to contain at least 110 percent of the volume of the largest tank-tainer or container within the containment. The secondary containment area would be located on an appropriately designed concrete surface to prevent spill seepage to the subsurface.

The sparging system for cyanide would be well-ventilated to prevent the build-up of hydrogen cyanide gas and monitored during the course of operations. Personal protective equipment would be available. Spill neutralization and cleanup equipment would also be available as appropriate at the mine storage area. This would include water for cleaning up spills of liquid cyanide and shovels for cleaning up spills of solid cyanide. Spill residues would be properly disposed.

The stock cyanide solution would be used in the mine processing area and would be conveyed using pipes and pumps. The potential for spills could result from mechanical failures relating to the pumping system, and is likely to be small. In the unlikely event of a mechanical failure, the spill would be contained within the secondary containment area.

The stock cyanide solution would be used to dissolve the gold in the carbon in leach (CIL) process. The screened CIL tailings from this process would contain cyanide and would be treated by a sulfur dioxide process prior to being discharged to the tailings storage facility to detoxify residual cyanide from the CIL process. Sulfur dioxide would be added at a rate sufficient to reduce the weak acid dissociable (WAD) cyanide levels to <10 ppm. The detoxified cyanide slurry would be discharged to a lined TSF.

3.24.3.3.3 OTHER ALTERNATIVES

Under Alternatives 3A, 3B, 4, 5A and 6A the use of cyanide would be the same as in Alternative 2; spill frequency and volume would also be the same as Alternative 2.

3.24.3.4 MERCURY

3.24.3.4.1 ALTERNATIVE 1 – NO ACTION

Under the No Action alternative, the project would not be developed and none of the materials necessary for the action alternatives would be generated, transported, disposed of, or stored. Therefore, there would be no spill risk under this alternative.

3.24.3.4.2 ALTERNATIVE 2 – DONLIN GOLD'S PROPOSED ACTION

The Kuskokwim Gold Belt is plentiful in naturally occurring mercury and the ore at Donlin Gold is estimated to have an average mercury concentration of 1.7 parts per million. Within the Donlin Gold ore body, mercury is found as a stable sulfide mineral. The mercury sulfide minerals in the ore would be oxidized to yield elemental, divalent and particulate mercury, during mining and processing. Mercury would not be transported to the mine or used in the process, but would be a byproduct recovered in the abatement systems in the autoclave circuits, hot cure tanks, electrowinning process, refinery furnace, and carbon regeneration process. Donlin Gold has committed to preparation of a detailed mercury handling plan that would detail the BMPs and other measures to be taken to reduce the potential for spills and ensure proper response if a spill occurred. This is expected to reduce the risk. Table 3.24-3 provides an estimate for the likelihood of mercury spills for this project by source.

Table 3.24-6: Expected Relative Rate of Occurrence for Mercury Spills from Main Project Sources

	Spill Size (lbs)				
Source	**Very Small < 0.01**	**Small 0.01– 0.9**	**Medium 1 – 2.9**	**Large 3– 50**	**Very Large > 50**
Storage Areas	Low	Low	Very Low	Very Low	Very Low
Vessels	Low	Low	Low	Very Low	Very Low
Trucks	Low	Low	Low	Very Low	Very Low

Notes:
Probability of Spill: Very high has a probability approaching one, very low has a probability approaching zero.

Potential Sources of Spilled Material

Mercury Storage Areas

The mercury collected by the mercury abatement systems would be temporarily stored onsite and then transported offsite for long-term management. During the process mercury would be removed from the gases primarily using condensers and through adsorption on activated carbon. All drums containing mercury-loaded spent carbon would be secured on a pallet, and then contained inside of an intermodal shipping container (a Conex) for transport via truck and barge. The Conex would be secured as necessary to the deck of the barge during transport.

The condensers would produce liquid elemental mercury, which would be collected in specialized USDOT-approved containers, either carbon steel 76-pound flasks or metric tonne containers. Although the amount collected annually would vary from year to year, approximately 11 tons of liquid elemental mercury would be collected on an annual basis. The mercury containers would be dedicated solely to liquid elemental mercury management to avoid any compatibility issues. The sealed mercury containers are designed to withstand the weight and corrosive properties of mercury and provide a very high level of integrity.

The carbon beds in the mercury abatement systems would be monitored to measure loading and ensure that overloading and/or break through does not occur. The spent carbon would be emptied from the bottom of each column into 55-gallon United Nations (UN) and USDOT approved open head bolt ring closure drums. All containers would meet or exceed HM 181 USDOT requirements, United Nations Hazardous Material Shipping Requirements, and EPA packaging requirements. The drums would be used solely to contain spent carbon from the mercury abatement systems. Although the amount of mercury-loaded spent carbon would vary on a year to year basis, approximately 29 tons of spent carbon would be generated annually. The sealed drums that contain the mercury provide a very high level of integrity (Enos 2015).

Partially filled flasks and drums may be stored in accumulation areas within the processing facilities. The completely filled flasks and drums would be moved from the process area to the centralized mercury material storage area. The liquid elemental mercury flasks and spent carbon drums would be shipped offsite as hazardous materials for long-term storage by a federally approved storage facility in accordance with the Mercury Export Ban Act (122 STAT. 4341) once constructed or a permitted RCRA facility.

Accumulation areas - Accumulation areas are temporary collection storage sites for small amounts of mercury up to 55 gallons. Mercury collected at accumulation areas would ultimately be moved to the centralized storage area. In general, the accumulation areas would be secure locations located within the processing facility accessible only by authorized personnel, and designed to handle and contain potential spills. Mercury containers would remain tightly closed at all times except when being filled. The containers would be marked appropriately to identify the content.

Centralized Storage Area - The centralized storage area would be a separate enclosed facility located near the processing facility. It would be designed to handle and contain potential spills, and equipped with adequate monitoring and ventilation systems to limit potential exposure to any mercury vapors. The area would have signage and be secured and accessible only to authorized personnel. At the centralized location, trained personnel would prepare the mercury and required documentation for transport via truck and barge to a permitted storage facility in the U.S. Mercury-filled containers would be transported as soon as practicable, and onsite storage would not exceed legal requirements.

A minimum of weekly inspections would be conducted at the accumulation and centralized storage areas. Inspectors would verify the proper labeling and integrity of each elemental mercury container and activated carbon drum and the overall condition of the areas. Records of inspections would be maintained onsite, including identification of the need for any corrective actions. Specifically, any evidence of damage to or leakage or spills from individual containers or leakage within the areas would be immediately addressed. Access to the accumulation and storage areas would be controlled to limit entry to only authorized employees.

Donlin Gold's handling and storage of mercury materials would be conducted in accordance with the RCRA regulations at 40 CFR Part 260, including requirements for testing, classification, packaging, labeling, training, tracking / recordkeeping, and ultimate management.

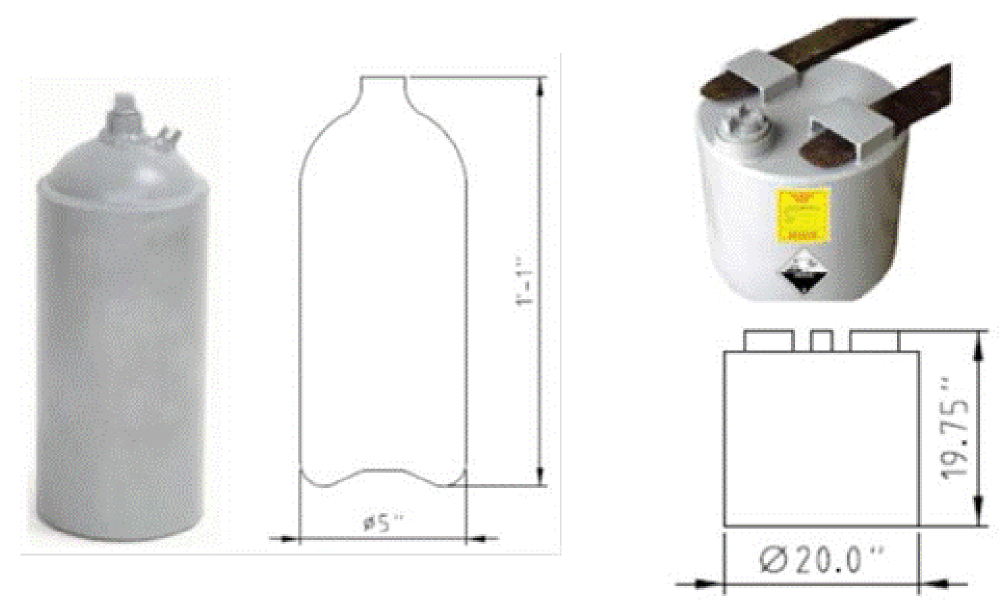
Offsite Transportation

Donlin Gold would transport the elemental mercury and spent carbon containing mercury via barge to an offsite, permitted facility that is permitted to store the materials for an extended period of time. All flasks or 1 metric tonne containers ("pigs") containing liquid elemental mercury would be placed inside of a plastic-lined 55 gallon UN and USDOT approved open head bolt ring closure drums. These drums would then be strapped, or otherwise secured, on a 4-Drum Spill Containment Pallet, and then containerized inside of a "Conex" intermodal shipping container for transport via truck and barge. Figure 3.24-1 shows a typical elemental mercury 76 pound flask, and a typical 1 tonne elemental mercury pig container. Probabilities of a release into the environment from a failed container are proven very low (USDOI 2013b) and may be unprecedented.

Mercury is a USDOT Class 8 hazard class, of which 103.6 tons were shipped nationally in 2007 (5.1 percent of all hazard material shipments). For all hazardous materials transported in the years 1990, 2000, 2010, 2011, and 2012, there was only one accident-related incident (in 2010) from water transportation. This shows the unlikelihood of a vessel incident carrying Class 8 hazardous materials for the Donlin Gold project.

The spill risk during truck transportation is minimal due to the safeguards at the Donlin Gold access road (design for industrial traffic, dedicated use and low speed limits, for example), the relatively limited number of truck trips necessary for mercury transport, and the appropriate containment to prevent a spill if an accident occurred. All mercury containers would be secured to prevent slippage in any direction under the full range of travel conditions, and with appropriate separation from other cargo. In the unlikely event of a spill, the transporters and responders would be trained to properly respond to a mercury spill, and minimize the potential for any impacts to the environment. Spill response equipment would be located at appropriate places of the project site. At the Angyaruaq (Jungjuk) Port, Donlin Gold would verify that all mercury containers that left the Mine Site were accounted for and in good condition. The truck transportation of mercury containers would be scheduled to facilitate immediate transfer from the trucks to barges at the Angyaruaq (Jungjuk) Port. Like all hazardous materials, transfers would be made by trained personnel with spill control, containment, and countermeasure equipment in place.

Figure 3.24-1: Typical Elemental Mercury Containers



Typical Elemental Mercury Container, 76 lb flask

Typical Elemental Mercury Container, 1 tonne pig

For transport via barge, the containers would be appropriately separated from other materials and similar methods would be used to fully secure the containers and provide for secondary containment for the range of conditions expected during transport. Donlin Gold's handling, transportation, and disposal of mercury materials would be conducted in accordance with the RCRA regulations.

Prior to shipment, Donlin Gold would verify that the container labeling is accurate and in good condition. A manifest would be prepared for each shipment that documents the type and weight of material being transported as well as the generation history. The manifest would formally facilitate tracking of the chain-of-custody from the Mine Site through the transportation process, to a permitted storage facility.

3.24.3.4.3 OTHER ALTERNATIVES

Under Alternatives 3A, 3B, 4, 5A, and 6A the generation of mercury as a by-product from the gold-bearing ore processing, and the transportation of the mercury-loaded spent carbon and liquid elemental mercury would be the same as in Alternative 2.

3.24.3.5 TAILINGS

3.24.3.5.1 ALTERNATIVE 1 – NO ACTION

Under the No Action alternative, the project would not be developed and none of the materials necessary for the action alternatives would be generated, transported, disposed of, or stored. Therefore, there would be no spill risk under this alternative.

3.24.3.5.2 ALTERNATIVE 2 – DONLIN GOLD'S PROPOSED ACTION

An Early Stage Failure Modes and Effects Analysis (FMEA) Workshop was conducted in December 2014 to evaluate potential failure causes for the Donlin Gold TSF dam design based on a consensus of opinion from geotechnical experts (SRK 2015a). Unlike other substances discussed in this EIS, the likelihood of occurrence for tailings spills cannot be described by spill volume, as the likelihood of a tailings release is largely independent of spill size. Instead, the risk of a failure is generally assessed based on a number of factors such as siting, dam design, construction, QA/QC practices, water management, and inspections. During the Early Stage FMEA Workshop, the definitions of likelihood shown Table 3.24-7 were used as a tool by participants for rating the risk that both the failure mode and consequence would occur. These definitions were incorporated into the evaluations of likelihood for different failure mode scenarios as described in the following paragraphs.

Table 3.24-7: Likelihood Definitions Used in Early Stage FMEA for Assessing Tailings Dam Failure Risk

Likelihood	Frequency	Probability of Occurrence over 20 Years	Probability of Occurrence in any one Year
Almost Certain	High frequency (more than once every 5 years)	98%	17.8%
Likely	Event does occur, has a history, once every 15 years	75%	6.7&
Possible	Occurs once every 40 years	40%	2.5%
Unlikely	Occurs once every 200 years	10%	0.5%
Very Unlikely	Occurs once every 1000 years	<2%	0.1%

Source: SRK 2015a.

Based on the results of the Early Stage FMEA Workshop, the following tailings dam release, from workshop Scenarios 1 and 4 (SRK 2015a), was selected to evaluate in the EIS (AECOM 2015c):

> An unplanned release of up to two million cubic meters [2.6 million cy] of tailings and contaminated water from the TSF from either a partial breach of the dam and resulting

downstream failure or a liner rupture leads to a sinkhole and outflow of tailings through the underdrain.

These two failure modes were selected for further evaluation and modeling after screening of the Early Stage FMEA scenarios based on likelihood and consequence criteria described in AECOM (2015c). These two represent the largest of the low probability-high consequence failure modes identified in the Early Stage FMEA workshop that met these criteria. Both were characterized as moderately high risk and unlikely to occur, but were considered by the participants to be the most likely ways a significant release of tailings could occur. As the design further evolves and is reviewed and approved by the State Dam Safety Program, these probabilities may drop further.

Several other scenarios examined in the Early Stage FMEA workshop were considered likely to result in some form of seepage, water quality exceedances and/or events that would exceed a regulatory limit. While these would not be desirable, they would also not result in the severe impacts associated with the failure and breach scenarios described above. These lesser scenarios do not need to be analyzed in this EIS because associated impacts would be within the range of the scenario analyzed.

The Early Stage FMEA also identified several modes of catastrophic failure of the TSF dam, all of which were considered very unlikely to occur; that is, conceivable but only in extreme circumstances and given a probability of 1 in 1,000 years (SRK 2015a). These were not carried forward for further analysis in the EIS as they represent "worst-case" spill scenarios. CEQ does not require analysis of such scenarios, instead directing attention to low probability-high consequence events that have a reasonable likelihood of occurrence for detailed analysis (AECOM 2015c). All of these would be mitigated by current design features, as well as additional site investigation and detailed design work prior to construction (Donlin Gold 2015g).

The Early Stage FMEA Workshop ranked Scenarios 1 and 4 as unlikely, with a probability of occurrence once every 200 years, or 0.5 percent in any individual year. Such an event could occur during Construction or Operations of the TSF. The overall objective of the Early Stage FMEA workshop was to identify and evaluate risks associated with the TSF and the Snow Gulch Reservoir, with a view to ensuring that these risks are addressed in the current and future stages of investigation and design. It is anticipated that additional not yet identified design modifications to mitigate risk will be included in the final tailings dam design, and that the probability of such release scenarios would be reduced. Additionally, Donlin Gold has revised their proposed project following the Early Stage FMEA Workshop to reduce the amount of water stored in the TSF during the Operations Phase. Thus, these scenarios are likely much less probable than presented here.

The tailings dam holds back not just fluids, but a slurry of water and tailings (perhaps a 20 to 50 percent solids content). This makes the tailings a viscous fluid resulting in slower flow and sediment deposition during a release than a water reservoir. As such, a breach of the tailings dam may not result in a full release of the contents behind the dam, but could release a significant portion of the contents depending on the speed of the breach development, amount of ponded water, tailings geotechnical characteristics, flow laminarity or turbidity, TSF and downstream topography.

The design of the TSF dam to withstand various causes of dam failure, both during operations and closure, is discussed in Section 3.3.3.2 (Geohazards and Seismic Conditions, Alternative 2). The design was also evaluated in comparison to the Mount Polley Tailings dam which failed in August 2014 (AECOM 2015b). The downstream rockfill dam proposed for the Donlin TSF, with its multiple filter zones, sitting in a narrow valley on bedrock, and water drainage control features (Figure 3.3-6 in Section 3.3, Geohazards and Seismic Conditions), is considered a relatively robust dam design. Additionally, the slope of the downstream face (1.7H:1V), geotechnical boring coverage, and target factor of safety used in Donlin TSF engineering studies (1.5), are more conservative than those documented at Mount Polley (AECOM 2015c; IEEIRP 2015).

Downstream tailings dams like that proposed for this project are less likely to fail compared to centerline or upstream designs (Chambers and Higman 2011). Based on International Commission on Large Dams (ICOLD) statistical data for dam failure, HydroCoop (2013) noted that far fewer failures have occurred worldwide for rockfill dams as compared to earthfill dams. In a benchmarking study of B.C. tailings dam failure frequency, IEEIRP (2015) noted that there were no failures of rockfill dams out of 525 dam-years of active operation for U.S. water dams. Dam height is also known to correlate (inversely) with the frequency of dam failure. Only about 1 percent of 147 tailings dam failures documented worldwide by Rico et al. (2008) have occurred at large dams greater than 300 feet high. Failures of tailings dams with no ponded water after mine closure, like that proposed for the post-Closure TSF, is small compared to dams in active operations with ponded water (IEEIRP 2015).

3.24.3.5.3 OTHER ALTERNATIVES

Alternatives 3A, 3B, 4, and 6A have the same tailings dam and volume of tailings as Alternative 2, therefore release frequency and volume would also be the same as Alternative 2. Alternative 5A would also have the same amount of tailings but would use the dry stack method and would have a lower risk for releases of tailings from the TSF. Alternative 5A would have an operating pond contained by a dam and releases of process affected water are possible. The operating pond dam was not subject to review during the Early Stage FMEA Workshop and possible releases of process affected water under Alternative 5A were not modelled. For the purposes of this EIS, it is assumed that a release from the Alternative 5A operating pond would be similar to the water-only release modelled for the TSF dam for Alternative 2 (see Section 3.24.5.9).

3.24.4 FATE AND BEHAVIOR OF SPILLED MATERIALS

This section discusses how materials behave when released into the environment. Fate and behavior of spilled materials do not change as a result of project components; therefore, the information presented is applicable to all action alternatives.

3.24.4.1 DIESEL FUEL AND OTHER OIL

Although petroleum and motor oil would be transported to the Mine Site, diesel fuel (a light oil) would be transported in the greatest quantity and garnered the most concern from scoping comments. All oil substances would be included in the spill plans (see Section 3.24.1); however, for the purposes of analyzing the spill scenarios laid out below in Section 3.24.5 and 3.24.6, diesel fuel only is discussed in this section and analyzed in scenarios.

3.24.4.1.1 ENVIRONMENTAL FACTORS AFFECTING THE FATE OF SPILLED MATERIALS

The fate and behavior of spilled diesel is affected by many factors, including:

- Weather conditions (e.g., wind, temperature, sunshine);
- Receiving environment of the spill (e.g., river, pond, tundra, roadbed); and
- Properties of the spilled diesel (physical and chemical).

The interactions of these factors affect the behavior of spilled diesel and its impact on the receiving environment. Response actions (or lack thereof) as well as the timeliness of the response can further affect the fate and behavior of the spilled diesel.

<u>Weathering</u>

Spreading, evaporation, and dispersion are the primary weathering processes affecting diesel, and have the greatest impact during the initial stages of a spill. Dissolution, photodegradation, and biodegradation processes can also play a part depending on circumstances.

Spreading. As diesel is spilled, it tends to spread quickly. The increased surface area assists weathering processes that are surface-dependent (e.g., evaporation). Spreading reduces the concentration of diesel at the spill site; however, it increases the area which may be adversely affected by the diesel, although possibly less severely.

Evaporation. Diesel evaporates very quickly; evaporation is the primary process for loss of diesel. In general, small and medium-sized spills evaporate and disperse naturally within a day or less, even in cold water (NOAA 2006). As the diesel evaporates it becomes subject to increased rates of photodegradation.

Dispersion. Diesel that is spilled into water is subject to dispersion. This process increases the surface area of the diesel by breaking it up into fine droplets, allowing for greater susceptibility to the processes of dissolution and degradation. Dispersion is more effective when surface turbulence is increased, as by wind, waves, or currents. This is true even in cold water. Often there is little or no substance on the surface for responders to recover (NOAA 2006).

Adsorption. Diesel is lighter than water, and will not sink and accumulate on the bottom of a river or pond as free oil; however, diesel that has been dispersed into fine enough droplets can adhere to suspended fine-grained sediment, which can then settle out and deposit on basal materials. Basal materials consist of any depositional environment inundated with water that is capable of transporting or depositing impacted fine grained sediment. This would include river bed and bank materials; in river features such as point or longitudinal bars; or similar inter-tidal depositional environments depending on the proximity and size of the release. This process will be less of a factor for small and medium spills, or conditions lacking suspended sediment such as marine environments.

Dissolution. Dissolving in water is not a primary process for diesel, as it floats on the surface. However, to the extent that dissolution does occur in a contained body of water, such as a pond, it increases the toxic effects.

Photodegradation. Photodegradation is the process by which light breaks down a material, and on sunny days can be a major factor in the fate of diesel. Photodegraded petroleum product constituents tend to be more soluble and more toxic than parent compounds and extensive photodegradation, like dissolution, could increase the biological impacts of a spill.

Biodegradation. In areas that have not previously been exposed to diesel, biodegradation by indigenous microorganisms is not likely to be a significant factor in the fate of diesel. Indigenous microorganisms take time to adapt to degrade the diesel, as well as grow to a large enough population to make a noticeable effect. Biodegradation can take longer in colder soils. Bioremediation efforts have shown that in some cases fertilization may increase the speed of establishment and growth of microbial populations, thus enhancing the biodegradation of diesel.

Of these processes, dispersion and evaporation would have the greatest short-term effect on the fate of diesel spills in an aquatic environment. For example, almost all (more than 90 percent) of the diesel in a small spill incident from a barge in marine waters would evaporate or naturally disperse into the water column in a matter of hours or days. On land, diesel quickly penetrates porous sediments. Biodegradation and photo oxidation are longer-term processes that would slowly degrade any remaining diesel in the environment over one to two months, longer if the temperatures are cold (NOAA 2006).

Seasons

The season during which a diesel spill occurs may influence the behavior and impact of a spill, as well as the potential response activities (and success). For this project, transportation of the diesel by vessel will generally be limited to summer months due to restrictions of river draft; summer and fall will see significant transportation of diesel by truck from Angyaruaq (Jungjuk) Port to the Mine Site. Overwinter storage of diesel will occur at the Mine Site, supported by storage at Angyaruaq (Jungjuk) Port.

Summer (Ice-free). Summer is the period in which the Kuskokwim River is ice-free, and regional streams and ponds are open water. The tundra is snow-free, and plant and animal activity is highest. Spills to water would be subject to spreading by wind and wave action, and tundra vegetation would be most likely to be impacted by a spill.

Fall (Freeze-up). Fall is the period when water bodies may begin to freeze over, but the ice cover might advance and retreat daily depending upon weather conditions and river flow volumes. Snow will begin to cover the tundra and migratory birds are moving through the region. Spills to water would be subject to spreading by wind and wave action; however, spreading may be checked and diesel trapped by forming ice, only to be further dispersed when that ice melts and refreezes. Diesel spilled on top of ice may flow through cracks to water below, where it may collect or disperse out of sight.

Winter. In winter, the tundra is snow-covered, and rivers, streams, ponds, and lakes are ice-covered. Snow usually slows the spreading of spilled diesel, although diesel can move underneath the snow to some degree. Depending upon the condition and depth of the snow, and the temperature and volume of the spilled diesel, diesel may still reach the tundra vegetation beneath the snow. Diesel spilled to ice and snow-covered water bodies will likewise be somewhat limited in its ability to spread, although it is possible for diesel to flow to water depending on cracks in the ice, and the volume and temperature of the spilled diesel. In such cases, the diesel should disperse slowly due to the low water levels and low rates of flow in streams and rivers.

Spring (Break-up). Spring is the period in which snow and ice melts and streams and rivers quickly and substantially increase flow volumes. These increased flows cause the Kuskokwim River ice to break up and flow to Kuskokwim Bay. Migratory birds return to the region, and tundra biological activity resumes. Diesel spills to water are likely to become quickly dispersed and difficult to contain or cleanup. The tundra will be wet, and spills to tundra are likely to easily reach open water.

Weather, Water Level, and Winds

Flooding of tundra ponds, lakes, and streams can occur quickly due to snowmelt and/or heavy rains. Increased water levels would result in increased river flow volumes, which may impede response efforts. The increased water levels can facilitate the dispersal of spilled diesel to adjacent areas that might not normally be impacted during drier times. Wind storms may increase the spread of spills, as well as impeding response efforts; however, they would also assist evaporation. High winds would increase wave action in rivers and seas, providing further spreading and weathering of the spilled diesel. Inclement weather in general can be expected to impede response efforts.

3.24.4.2 LIQUEFIED NATURAL GAS

Liquefied Natural Gas (LNG) is natural gas that has been transitioned into a liquefied state by being cooled to minus 259 degrees Fahrenheit through a process known as liquefaction. However, LNG will transition back to a gaseous phase if it is released and comes into contact with warmer air or water (California Energy Commission 2014). Methane, the primary component of LNG, is colorless, odorless, and tasteless. It is non-corrosive and non-toxic but is classified as a simple asphyxiant, possessing a slight inhalation hazard. If breathed in high concentration, oxygen deficiency can result in serious injury or death. Methane has an ignition temperature of 1,000 degrees Fahrenheit and is flammable at concentrations between 5 and 15 percent in air. Unconfined mixtures of methane in air (such as an LNG release that has transitioned back to a gaseous phase) are not explosive. However, a flammable concentration within an enclosed space in the presence of an ignition source can explode.

LNG is less dense than water and will therefore float if an LNG spill comes into contact with water. If a large amount of LNG is spilled on water within a short period of time, the relatively warmer temperature of the water will cause the LNG to rapidly transition to its gaseous phase, a process known as rapid phase transition (RPT). RPT can cause a physical explosion that may be hazardous to nearby people, buildings, or wildlife (California Energy Commission 2014). In addition, if an ignition source is present, the gas-phase natural gas may ignite, leading to a fire or chemical explosion, depending on the concentration of gas present.

3.24.4.3 CYANIDE

Sodium cyanide dilutes quickly in water and thus cannot be cleaned-up using conventional means such as booms, sorbent pads, and skimmers. Because of this, cyanide would be transported in ISO-approved containers designed to minimize the chance of an accidental spill even in the event the container is lost overboard during transportation; the design of these ISO-approved containers effectively provides secondary containment.

Sodium cyanide is generally transported in dry form in individual water tight tank-tainers and it must come in contact with water to pose immediate toxic and acute health dangers. In the event of an accident with release of sodium cyanide into surface waters, all aquatic life in the immediate area would be killed. In flowing streams, the effects would continue downstream until dilution and / or volatilization reduced the cyanide content to nontoxic levels. In a lake, the anticipated impacts would be longer lasting due to the lack of flowing water; however, the overall toxicity would still be relatively short-term.

Although cyanide is highly toxic, the duration of impacts from a release of cyanide would likely be short term. Cyanide is relatively reactive and does not persist in the aquatic environment nor does it bio-accumulate in the food chain.

What is most important environmentally is to prevent cyanide from reaching surface water or ground water. If solid sodium cyanide is spilled on dry ground, it does not present a danger to people or the environment as long as the sodium cyanide remains dry and is swept up and contained for proper disposal.

Hydrogen cyanide in water is subject to the follow processes that will reduce the concentrations in the water:

- Dilution; this is particularly important in moving water.
- Volatilization – This is an important exposure route; the volatilization rate is reduced with high pH water and cool or cold water.
- Complexation – Hydrogen Cyanide forms complexes with 28 different elements.
- Adsorption – Hydrogen cyanide is adsorbed as free or complexed forms onto solid phases of the soil / rock.
- Precipitation – Cyanide complexes from solid metallocyanide precipitates.
- Thiocyanate – Cyanide combines with locally available sulfur to form thiocyanates.
- Oxidation – Cyanide is oxidized to cyanate.

Cyanide is very reactive and short lived in the environment. In the interim before it dissipates via the reaction mechanisms noted previously or is diluted, it is dangerous as hydrogen cyanide gas in the air or in water as a cyanide solution by ingestion or gill absorption.

There are a variety of factors that will complex or destroy cyanide in the environment. Even if the local microbial life is killed, the other mechanisms will destroy or dilute cyanide in groundwater.

3.24.4.4 MERCURY

Mercury is present in the environment as a result of both natural and human activities, and persists in the environment. Mercury is an important pollutant at all scales ranging from global to local. Mercury in its elemental form is a heavy, silvery-white liquid metal at typical ambient temperatures and pressures. When spilled, liquid elemental mercury flows and collects in the same way and locations that water would if spilled. However, due to the volatility of the liquid elemental mercury it partitions strongly to atmosphere in the environment.

Mercury can chemically combine with other elements to form organic (carbon-containing) and inorganic (not containing carbon) compounds. The fraction of organic mercury in the atmosphere is extremely small compared to that of inorganic mercury. Typically inorganic mercury is released into the atmosphere in one of three forms:

1. Elemental mercury vapor
2. Gaseous divalent mercury
3. Particulate mercury

Mercury deposition from the atmosphere can be wet or dry. Wet deposition is the dissolution and removal of mercury by rain and snow. Dry deposition refers to the transfer of mercury to the ground during non-precipitating time periods due to molecular diffusion and settling (dust). The three forms of inorganic mercury have very different physical and chemical characteristics, resulting in large differences in their rates of removal by deposition from the atmosphere, and consequently, in their atmospheric lifetimes.

Elemental mercury vapor has a lifetime of several months to more than a year because of its low reactivity, extremely low solubility in water, and slow deposition rate and hence is transported globally over long distances. In contrast, gaseous divalent mercury, dry deposits rapidly and both gaseous divalent mercury and particulate mercury are efficiently wet deposited (due to high solubility in water) near their sources during rain and snow events; thus, their lifetimes range from a few hours to days.

Mercury emissions are transported through ambient air, and deposited to water and land where humans and wildlife can be exposed. Concentrations of mercury in ambient air are usually low and of little direct concern. Once mercury enters water, either through air deposition or soil runoff, microorganisms such as bacteria transform inorganic mercury in the environment to methylmercury, which can then bio-accumulate in fish and animal tissue. The methylation of mercury is a key step in the entrance of mercury into the food chain.

The volatility of the liquid elemental metal and some of its compounds, in conjunction with its ability to chemically transform under environmental conditions, makes it easily exchangeable across all environmental media including the biosphere where it can bio-accumulate and bio-magnify.

Adverse effects from exposure to mercury differ depending on the form and the route of exposure. The primary route of exposure to elemental mercury is inhalation of its colorless and odorless vapors. The symptoms of acute toxicity following high-level exposure to mercury vapor occur within hours of the exposure. Chronic effects take longer to manifest. Elemental mercury is essentially nontoxic when ingested because virtually none (less than 0.1 percent) is absorbed (Agency for Toxic Substances and Disease Registry [ATSDR] 2014). Dermal exposure or absorption of elemental mercury through the skin is considered a minor exposure route. Methylmercury is commonly found in fresh or salt water fish as a result of bioaccumulation. The most significant exposure pathway for humans and wildlife is considered to be through ingestion of methylmercury. Methylmercury has the highest potential for environmental toxicity relative to inorganic and elemental mercury forms because it is subject to bioaccumulation and biomagnification in higher trophic level organisms. It should also be noted; however, that inhalation of high concentrations of elemental mercury vapor produces toxic effects in humans.

Initially the half-life of ingested elemental mercury is 1-3 days followed by a slower half-life of 2-3 weeks (CDC 2013b).

Liquid mercury pools in soil and water. Care should be taken not to disperse the pools during the cleanup process, as that increases the evaporation rate. Spilled elemental mercury can react in a number of ways as follows; volatilize, oxidize, and move down the soil column. It can also be metabolized into methylmercury by microorganisms.

Mercury will be produced as a by-product at Donlin Gold and will be captured and stored off-site.

3.24.4.5 TAILINGS DAM RELEASE

As described in Section 3.24.5.9, release from the tailings dam could be discharged as either water only, or slurry of water and solids. The potential spill scenario was modeled in these two ways to bracket the range of flow distances, velocities, and depths for the range of possible materials that could spill. Modeling was conducted using FLO-2D, a U.S. Federal Emergency Management Agency (FEMA) approved two-dimensional hydraulic model. This model was selected for application to the Donlin FMEA because of its ability to model both tailings (slurry) and "clear water" flow inundation processes. FLO-2D is a depth-averaged, volume conservation based flood routing model that was developed specifically for the analysis of muddy flows travelling over complex terrain, making it well suited for tailings run-out analysis (BGC 2015n). Model inputs and assumptions are detailed in BGC's memorandum titled Tailings Release Spill Scenarios (BGC 2015n). Due to the large area modeled, the resolution and grid spacing did not capture some of the detailed river bed features; however, the resolution is considered to be adequate for the FMEA (BGC 2015n).

The behavior of a slurry or water only release would be different depending on the season of occurrence as follows:

Slurry (Tailings and Water) Release

Winter: In the winter months, at least some of the released tailings could be excavated and transported back to the tailings facility thereby limiting the impact of the release during the following spring thaw. There would be reduced potential for released tailings to be mobilized by Crooked Creek. Water would not necessarily penetrate underlying materials, and there is some potential that a portion of the contaminated fluids could be recovered.

Summer: The impacted area would likely be much larger because a significant portion of the deposited tailings would be remobilized by Crooked Creek and transported downstream. Impacts from fluids infiltrating soil and groundwater would be difficult to control or remediate. Access by trucks and other large equipment would be difficult on thawed off-road areas.

Water Only Release

Winter: The volume released would be sufficiently high and fast that freezing would not quickly impede the flow. The maximum flow rates of water would be approximately 4.0 percent of flow rates of the Kuskokwim River in the winter months (November to April), resulting in greater potential impacts. Water would not necessarily penetrate underlying materials, and there is some potential that a portion of the contaminated fluids could be recovered.

Summer: The maximum flow rates of water would be approximately 1.8 percent of flow in Kuskokwim River in the summer months (May to October). More water would penetrate the ground surface and infiltrate the subsurface materials, and impacts from fluids on the subsurface would be difficult to control or remediate.

3.24.5 SPILL SCENARIOS

This section summarizes the potential spill or release causes and volume estimates that might result directly or indirectly from the transportation and storage of diesel, LNG, cyanide, mercury, and tailings from behind the dam in Alternative 2. This analysis considers a variety of accidental spills, from minor to catastrophic. These scenarios are conceptual views of the future and represent possible sets of potential accidents. The primary purpose of a scenario is to provide a common basis for the analysis of potential environmental impacts, should future accidents occur. BMPs are given, where appropriate.

Table 3.24-8 shows which alternatives are applicable to each scenario. Scenarios 1 through 5 summarize the potential spill or release causes, behavior, and potential impacts that might result directly or indirectly from the transportation and storage of diesel.

In the Project Area, spills could occur from the diesel pipeline, vessels, trucks, storage tanks (including tank farm infrastructure), and transfer operations. Spills that escape from secondary containment areas and roadbeds, or enter water sources directly, could reach one or more of several habitat types. The habitats present in the operational areas for consideration are wet and dry tundra, tundra ponds, lakes, flowing creeks and rivers (especially the Kuskokwim River, as the primary drainage and transportation corridor), bays (including Captains Bay / Iliuliuk Bay at Dutch Harbor, and Kuskokwim Bay at the mouth of the Kuskokwim River) and ocean (including the Bering Sea). Spills could occur any time during the year for certain operations. However, all on-river transportation of diesel will be limited to the timeframe of approximately June through October due to the seasonal freezing of the Kuskokwim River in winter.

These scenarios do not include fugitive air emissions, which are discussed in Section 3.8, Air Quality, and Section 3.22, Human Health, or incidental spills of other industrial fluids, as they would be used in relatively small quantities, contained, and cleaned quickly.

Table 3.24-9 shows which project components are applicable to each scenario.

Table 3.24-8: Spill Scenarios and Alternatives

Scenario	Alternative						
	1	2	3A	3B	4	5A	6A
1. Ocean Barge Rupture at Sea		X	X	X	X	X	X
2. River Barge Release		X	X	X[1]	X	X	X
3. Tank Farm Release (Angyaruaq, BTC, Mine Site)							
Tank farm tank rupture		X	X	X	X	X	X
Tank farm faulty valve/pipeline leak		X	X	X	X	X	X
Transfer operation line rupture		X	X	X	X	X	X
Transfer operation human error		X	X	X	X	X	X
4. Tanker Truck Release							
Tanker truck rollover		X	X	X	X	X	X
Tanker truck collision		X	X	X	X	X	X
5. Diesel Pipeline Release							
Diesel pipeline pinhole leaks				X			
Diesel pipeline rupture				X			
6. Liquefied Natural Gas Release							
Storage tank pinhole leaks			X				
Fueling trucks			X				
Truck accident			X				
Rupture of a storage tank			X				
7. Cyanide Release							
Lost cargo overboard		X	X	X	X	X	X
Tank-tainer rupture		X	X	X	X	X	X
Vehicle collision		X	X	X	X	X	X
8. Mercury Release							
Lost cargo overboard		X	X	X	X	X	X
Flask, Metric Tonne Container, or drum rupture (mine locations)		X	X	X	X	X	X
Truck accident		X	X	X	X	X	X
9. Partial Tailings Dam Failure							
Tailings and water release (slurry)		X	X	X	X		X
Water only release		X	X	X	X	X	X

Notes:

1 River barge release scenario for Alternative 3B would apply only during the Construction Phase.

Table 3.24-9: Spill Scenarios and Project Components

Scenario	Project Component		
	Mine Site	Transportation	Pipeline
1. Ocean Barge Rupture at Sea		X	
2. River Barge Release		X	
3. Tank Farm Release (Angyaruaq, BTC, Mine Site)			
Tank farm tank rupture	X	X	
Tank farm faulty valve/pipeline leak	X	X	
Transfer operation line rupture	X	X	
Transfer operation human error	X	X	
4. Tanker Truck Release			
Tanker truck rollover		X	
Tanker truck collision		X	
5. Diesel Pipeline Release			
Diesel pipeline pinhole leaks			X
Diesel pipeline rupture			X
6. Liquefied Natural Gas Release			
Storage tank pinhole leaks	X		
Fueling trucks	X		
Truck accident	X		
Rupture of a storage tank	X		
7. Cyanide Release			
Lost cargo overboard		X	
Tank-tainer rupture		X	
Vehicle collision		X	
8. Mercury Release			
Lost cargo overboard		X	
Flask, Metric Tonne Container, or drum rupture (mine locations):		X	
Truck accident		X	
9. Partial Tailings Dam Failure			
Tailings and water release (slurry)	X		
Water only release	X		

Notes:

1 River barge release scenario for Alternative 3B would apply only during the Construction Phase.

3.24.5.1 SCENARIO 1: OCEAN BARGE RUPTURE AT SEA

A very low probability (probability approaches zero), very large volume potential spill scenario could result if an ocean-going diesel barge was damaged. The cause of this hypothetical scenario could be loss of tow during stormy weather, mechanical failure of a tug, or human error and result in grounding of the barge with damage that causes the loss of 75 percent of the diesel in two compartments. For a 2.94 million gallon barge with six equal sized compartments, this scenario would result in a release of 735,000 gallons of diesel. This scenario assumes the barge grounds south of the Kuskokwim River entrance. It is assumed for this scenario that approximately 50 percent of the release would contact the shore. Spills of more than 10,000 gallons involving a barge transporting petroleum products in Alaska did not occur between January 1995 through July 2013 and a spill of this size is not likely to occur during the life of the Donlin Gold Project (ERM 2017c).

Dispersal and evaporation would likely take approximately three to five days; however, heavy winds and waves would reduce that timeframe by speeding up the process. Due to the remoteness of such a spill, response efforts could include overflights to observe the dispersal of the diesel to confirm whether or not shoreline contact is likely and to direct any protection efforts to environmentally sensitive areas. The use of dispersants in not typically considered for response to non-persistent oils.

Potential impacts would include environmental impact to the shoreline and possible contamination of fish, birds, or animals due to contact or ingestion. Also, the possibility of affecting fisheries, which may have immediate economic and subsistence consequences, may also result in potential longer term economic consequences based on loss of fishery reputation.

3.24.5.2 SCENARIO 2: RIVER BARGE RELEASE

A very low probability (probability approaches zero), large volume, potential spill scenario is a grounding or other accident and release of diesel from a laden river tank barge traveling up the Kuskokwim River carrying 302,535 gallons (90 percent of maximum capacity). (While most fuel shipments would be comprised of a tow of four barges, this scenario assumes only one of the barges would be damaged, as it is extremely unlikely that more than one barge would ground or strike another object with enough force to compromise both layers of the hull.) This scenario would be limited to the summer delivery season, when the river is ice free. A barge could potentially suffer damage that breaches the double hull and impacts the compartment seam, allowing two compartments to release their contents to the river (each compartment holding 37,817 gallons at 90 percent capacity). Spills of more than 10,000 gallons involving a barge transporting petroleum products in Alaska did not occur between January 1995 through July 2013 and a spill of this size is not projected likely to occur during the life of the Donlin Gold Project (ERM 2017c). The tug crew would immediately initiate transfer of diesel from the damaged compartments to other compartments on the same and adjacent barges. Approximately 25 percent of the cargo (18,908 gallons) from the damaged compartments could be transferred to the other compartments (limited by the need to retain void space in those cargo compartments to allow for expansion of the diesel). As diesel leaves the ruptured cargo compartments through release to the environment and transfer to other tanks, it eventually would achieve equilibrium with the outside water pressure, resulting in the retention of approximately 25 percent of the diesel in the ruptured cargo compartments. As a result, approximately 50 percent of the cargo would ultimately be released to the river, accounting for

37,817 gallons. Diesel evaporation rates for a low (32°F) and high (55°F) range of temperatures were estimated for a river barge release in the Kuskokwim River. After four days, approximately 39 percent and 59 percent of diesel fuel would be evaporated, respectively (ERM 2017c).

Response efforts by the tug crew would include the placement of containment booms to encircle the barge tow. While diesel would potentially be entrained under the containment boom by the river current, this would slow the dispersion of diesel into the river enough to allow additional response efforts to get underway. Tactics to employ would include diversion booming downstream, and bringing in a skimming platform to recover diesel by skimming diesel from within the boom. While it would take time for the additional response actions to occur, the release would not be instantaneous; it could take 48 hours or more for the entire volume to be released from the damaged compartments. As a result, it is likely that response efforts would succeed in recovery of at least half of the released diesel, approximately 18,908 gallons.

Diesel that would not be recovered would travel downstream, and so further response efforts would be expended primarily on the protection of pre-identified, environmentally sensitive areas in Kuskokwim Bay. Rough weather could limit response activities; however, it would also speed up dispersion of the diesel by wave action. Dispersants would not be used. Within three days there would be no or very little visible diesel sheen remaining (NOAA 2006).

As noted in Section 2.3.4, Alternative 3B would eliminate the barging of diesel fuel after the Construction Phase, eliminating the 58 fuel barge tow round trips per year required under Alternative 2 during the Operations Phase. There would be 64 barge tow round trips per year for cargo. Transport of diesel by tank truck on the mine access road would be the same as Alternative 2 during the Construction Phase but would be reduced by more than 75 percent during operations. This would significantly reduce the likelihood of diesel fuel release scenarios.

Alternative 4 would reduce the barge distance for freight and diesel out of Bethel bound for the Mine Site from 199 miles to Angyaruaq (Jungjuk) Port to 124 miles to BTC, a decrease of 75 miles. This would decrease the risk of a diesel spill occurring from river barges.

3.24.5.3 SCENARIO 3: TANK FARM RELEASE

3.24.5.3.1 TANK FARM TANK RUPTURE

A very low probability (probability approaches zero), large volume (possibly 1 million gallons or more), potential spill scenario is a catastrophic tank failure at a tank farm; this scenario could occur anytime during the year. The entire volume of the tank's contents would be released to secondary containment; recovery would be 100 percent minus any lost to evaporation. Response efforts would involve recovery of free product to another tank (if available) or a tank barge, and returning the secondary containment to original condition. Recovery of free product should be complete within two to three days; recovery and cleanup operations should be complete within seven days.

Impacts include evacuation of nearby homes and businesses due to fumes and potential fire danger. There would be probable economic and legal impacts.

3.24.5.3.2 TANK FARM FAULTY VALVE/PIPELINE LEAK

A high probability, very small volume (less than 10 gallons), potential spill scenario is a mechanical or structural failure at a tank farm (such as a leaky valve seal); this scenario could occur anytime during the year. Any leak would be discovered during the daily visual inspection, and all diesel spilled would be captured within secondary containment. Recovery volume would be 100 percent minus any loss to evaporation; recovery and cleanup operations would be complete within a few hours.

There would be likely little or no impact, including economic.

3.24.5.3.3 TRANSFER OPERATION LINE RUPTURE

A low probability, medium to large volume (100 to 2,000 gallons, depending upon the volume of the hose), potential spill scenario would be failure of a transfer hose during a transfer at a marine facility between a vessel and a tank farm; this scenario would be limited to the summer shipping season, when the river is ice free. Diesel would be released to secondary containment, both on the dock and on the water (barges will be boomed off prior to any transfer operation). On-water recovery may involve sorbents and skimmers; on-shore recovery would involve sorbents and pumping out of secondary containment. On-water recovery would be less than 100 percent due to losses to evaporation and a relatively small quantity of diesel that could escape under the boom if river current causes entrainment. On-shore recovery would be 100 percent minus loss to evaporation, and would be complete within one day.

Impacts would include minimal environmental impact to the shoreline with possible contamination of fish or animals due to ingestion. There would be probable economic and legal consequences.

3.24.5.3.4 TRANSFER OPERATION HUMAN ERROR

A low probability, very small volume (less than 10 gallons), potential spill scenario would occur due to human factors during a transfer operation, resulting in the overfilling of a tanker truck; this scenario could occur during the shipping season (Alternative 2) or longer (Alternative 4). A very small amount would be spilled, and recovery would be 100 percent minus loss to evaporation. Recovery would involve the use of sorbents carried on the truck; response efforts would be immediate and complete within the hour.

There would be likely little or no impact, including economic.

3.24.5.4 SCENARIO 4: TANKER TRUCK RELEASE

3.24.5.4.1 TANKER TRUCK ROLLOVER

A low probability, medium to large volume (up to 13,500 gallons), potential spill scenario is an accident resulting from a tanker truck rollover or major collision; this scenario could occur during the shipping season (Alternative 2) or longer (Alternative 4), although more likely during shipping season. The entire contents of the tanker truck could be released to the environment along the roadbed, including potentially to tundra and water. Recovery would be limited by potential dispersal to running water (e.g., a stream), as well as by evaporation, during the time required to get response equipment to the site. During winter, snow and ice may limit the diesel's ability to initially reach the tundra or water. Response efforts may include (depending on location and receiving environment) sorbent booming, trenching, on-water recovery by boat or shore-based skimmers, snow and ice removal, and in-situ burning. Recovery and cleanup should be complete within seven to 10 days (less in easily accessed locations). Winter responses will require observation during melt and break-up, in case additional recovery and cleanup is required.

Impacts would include damage to tundra vegetation, streams, and possible contamination of animals or fish by ingestion. Also, there are possible impacts to subsistence and fisheries.

Under Alternative 4, the mine access road would increase in length to 75 miles from 30 miles in Alternative 2. This would increase the risk of a diesel release from a tanker truck rollover.

3.24.5.4.2 TANKER TRUCK COLLISION

A low probability, very small volume (less than 10 gallons), potential spill scenario may result from a vehicle collision involving a loaded tanker truck, if the accident causes the tanker truck to start leaking (e.g., from an affected valve); this scenario could occur during the shipping season (Alternative 2) or longer (Alternative 4). A very small amount of diesel would puddle on and be absorbed into the gravel road where it could be captured by sorbents or the contaminated gravel removed. All diesel would be recovered minus any lost to evaporation. Recovery would involve the use of sorbents and shovels which would be carried on the truck; response efforts would be immediate and complete within the hour.

There would be likely little or no impact, including economic.

Under Alternative 4, the mine access road would increase in length to 75 miles from 30 miles in Alternative 2. This would increase the risk of a diesel release from a tanker truck collision.

3.24.5.5 SCENARIO 5: DIESEL PIPELINE RELEASE

3.24.5.5.1 DIESEL PIPELINE PINHOLE LEAKS

A high to very high probability, low volume (less than 99.9 gal) potential spill scenario would result from pinhole leaks from the buried diesel pipeline and related appurtenances that are detected within days. This scenario could occur anytime during the year. Most of these small spills would not reach non-facility land or waterbodies. However, some of the spills could seep into the soil toward groundwater or into nearby waterbodies outside of the ROW. The spills that could reach terrestrial habitats typically would affect a limited area adjacent to the ROW. Even those spills that do reach waterbodies generally would result in a limited impact because of the small volume of diesel involved. Small spills from pinhole leaks would be restricted in geographic extent and would be unlikely to have measureable impacts on resources. Minimal environmental impact to river and stream shorelines, tundra vegetation, and contamination to fish or animals due to ingestion could occur.

A medium to low probability, medium (100-999.9 gal) or large (1,000-100,000 gal) volume potential spill scenario would result if a pinhole leak remained undetected for weeks or months. If the release volume rate from a pinhole leak was small, the leak might not be detected by the leak detection systems. As stated previously, detection of diesel from pinhole leaks would most likely occur through visual or olfactory identification, either during regular pipeline aerial inspections, ambulatory patrols, or landowner or citizen observation. Because pipeline inspections for indications of leaks would only occur twice a year, a pinhole leak could go undetected for weeks or months. Medium and large volume spills would have a high likelihood of seeping into the soil or into nearby waterbodies. Recovery would be limited by potential dispersal to running water (streams, etc.) and by evaporation during the time required to detect the leak and get response equipment to the site. During winter, snow and ice may limit the diesel's ability to initially reach the tundra or water; however, it may also disguise cracks in the ice where diesel is able to rapidly reach tundra or water. Snow and ice may also inhibit detection of spills at river and stream crossings. Response efforts may include (depending on location and receiving environment) sorbent booming, trenching, on-water recovery by boat or shore-based skimmers, snow and ice removal, and in-situ burning. Recovery and cleanup should be complete within seven to 10 days (less in easily accessed locations). Winter responses will require observation during melt and break-up, in case additional recovery and cleanup is required.

Potential impacts would include damage to tundra vegetation, streams, and possible contamination of animals or fish by ingestion. Impacts to subsistence uses could also occur.

3.24.5.5.2 DIESEL PIPELINE RUPTURE

The buried diesel pipeline would traverse a total of 334 miles. The pipeline would hold approximately 42,200 gallons of fuel per mile of line. There are 27 identified stream crossings that would require valves. It is probable that there could be 10-mile or longer stretches without valves. Depending on the nature of the topography, volumes from large ruptures could range from 3,360 to 790,020 gallons (Michael Baker Jr, Inc. 2014). The high range estimates would be considered worst case for spill response planning and very unlikely to occur. Therefore, this scenario evaluates a very low probability, high to very high volume (greater than 100,000 gallons) spill contingency volume of 422,000 gallons or more, resulting from a major rupture or a complete break in the proposed pipeline that releases diesel somewhere along the ROW. This scenario could occur anytime during the year. Causes might include pipeline corrosion or a major earth movement (resulting from slides, an earthquake, or thaw settlement). The actual volumes spilled could vary depending on a number of factors, including:

- Locations, activation methods, and activation delay times for valves;
- The amount of pressure in the line;
- Location of the break; and
- The extent to which the proposed pipeline follows topographic contours, and the location of low spots in the pipeline relative to the break.

A very large spill would be likely to reach both land and adjacent waterbodies, especially if it occurs in the ice-free seasons and near waterbodies. The proximity of the spill to main streams and rivers may be the most important factor in spill scenarios. For those spills that do reach waterbodies, especially flowing streams and rivers, the area of impact generally would be more extensive than for the small spills because of the larger volume of diesel involved. Likewise, the potential for large spills to reach groundwater surfaces is greater than for small spills. Large spills that result from a rupture in a pipeline, for whatever reason, would likely be detected quickly by the SCADA (supervisory control and data acquisition) system; both automatic and manual responses would be quickly activated to stop and isolate the leak.

Potential impacts would include damage to water bodies, wetlands and vegetation, birds, and fisheries, depending on the location. Other resources could be impacted to lesser degrees, and subsistence and economic impacts could be magnified by perception.

3.24.5.6 SCENARIO 6: LIQUEFIED NATURAL GAS (LNG) RELEASE

Scenario 6 summarizes the potential spill or release causes, behavior, and potential impacts that might result directly or indirectly from the site production, storage, and use of LNG. Small LNG spills could result from pinhole leaks from the storage tanks. Fueling the LNG-fueled trucks may also be a source of frequent but very small to small spills. An LNG fueling spill would occur on a hard surface within secondary containment.

An accident involving an LNG-fueled truck would have the potential to release up to the full amount of LNG within the truck's tank. As discussed in Section 3.24.3.2.3, it is assumed that the maximum spill from an LNG-powered truck would be approximately 1,150 gallons.

Rupture of a storage tank at the LNG plant would have the potential to release a maximum of 55,000 gallons of LNG (equivalent to the storage capacity of the tank) into secondary containment. This scenario is unlikely. The storage tanks would be located near the power plant between the waste rock facility and the TSF (see Figures 2.3-1 and 2.3-38) and would not be near any water bodies.

As noted in Section 2.3.3, Alternative 3A would reduce the barging of diesel fuel on the river to a peak of 19 fuel barge tow round trips per year, compared to the peak of 58 required under Alternative 2 during Operations. There would be 64 cargo barge tow round trips per year during Operations, for a total of 83 river barge trips per year during Operations. The LNG operated haul trucks under this alternative would significantly reduce the likelihood of more probabilistic diesel fuel release scenarios (very small to medium releases), since approximately 75 percent of the annual diesel fuel consumed under Alternative 2 is associated with haul truck operation.

3.24.5.7 SCENARIO 7: CYANIDE RELEASE

Scenario 7 summarizes the potential spill or release causes that might result directly or indirectly from the transportation and storage of sodium cyanide.

Sodium cyanide incidents could result from losing the cargo off of a river or ocean barge, transfer operations, tank ruptures, or equipment failure.

It should be noted that if solid sodium cyanide is spilled on dry ground, it does not present a danger to people or the environment as long as the sodium cyanide remains dry and is swept up and contained for proper disposal. Sodium cyanide must come in contact with water to pose immediate toxic and acute health dangers due to the release of hydrogen cyanide gas. Cyanide should be prevented from reaching surface water or groundwater. Sodium cyanide would be transported as solid briquettes in ISO-approved type 2 watertight sparge tank-tainers, and secured to vessels. Individual tank-tainers would be off-loaded from ocean barges at the Bethel Port and stored at the port until transfer to river barges. River barges would transport tank-tainers to the port site, where they would be off-loaded onto tractor-trailers for transport to a secure storage area at the Mine Site. Any actions that would occur at Dutch Harbor or the Port of Bethel at the Bethel Yard Dock are not part of the proposed action, and are considered connected actions (see Section 1.2.1, Connected Actions, in Chapter 1, Project Introduction and Purpose and Need).

3.24.5.7.1 LOST CARGO OVERBOARD

A very low probability (probability approaches zero and may be unprecedented) potential scenario could result if the container was lost overboard from a barge. Sodium cyanide would be transported in watertight tank-tainers designed to minimize the chance of an accidental spill. The tank-tainers would be tracked as they are transported, aiding in relocating containers if they were lost from a barge. Lost tank-tainers would be subject to intense relocation and salvage recovery efforts. Rupture of a container and sodium cyanide contact with water would be considered a worst-case event and extremely unlikely to occur.

All marine carriers involved in handling sodium cyanide would be trained in safe handling and spill response procedures. Personal protective equipment would be available onboard each barge carrying sodium cyanide. The marine carriers would also be certified under the International Cyanide Management Code. Adherence to this code requires that cyanide transporters implement appropriate security, release prevention, training, and emergency response plans and capabilities, and employ adequate measures for cyanide management. The transportation company would also have a contract with a certified and licensed hazardous materials response and cleanup company within Alaska.

3.24.5.7.2 TANK-TAINER RUPTURE

A very low probability (probability approaches zero and may be unprecedented) potential spill scenario may result from the tank-tainers while being transported within the port storage or Mine Site locations. In the unlikely event that the tank-tainer ruptures, the sodium cyanide briquettes could be spilled on dry ground. As long as the sodium cyanide remains dry and is swept up and contained for proper disposal it does not present a danger to people or the environment. If the sodium cyanide briquettes are spilled on wet ground or come into contact with water, the sodium cyanide would dissolve and a cyanide spill could result in the release of hydrogen cyanide gas. The resultant spill would be contained as the tank-tainer would be located in an area that includes secondary containment. The dissolved sodium cyanide would be collected and contained for proper disposal. Any undissolved sodium cyanide briquettes would need to be prevented from further potential contact with the water. All marine carriers and Donlin Gold staff involved in handling sodium cyanide would be trained in safe handling and spill response procedures. The storage areas for cyanide would be well ventilated to prevent the build-up of hydrogen cyanide gas and hydrogen cyanide monitoring would be implemented. Personal protective equipment would be available at the port where the sodium cyanide is stored. Spill neutralization and cleanup equipment would also be available at appropriate storage locations.

3.24.5.7.3 VEHICLE COLLISION

A very low probability (probability approaches zero and may be unprecedented) potential spill scenario may result from a vehicle collision during transport from Angyaruaq (Jungjuk) Port to the mine. Potential spills could occur in the unlikely event of an accident that results in the tank-tainer rupturing. If the sodium cyanide came into contact with water it would dissolve, and a cyanide spill could result. Cleanup would be limited to removing and protecting the undissolved sodium cyanide briquettes from further potential contact with the water. To evaluate impacted soils resulting from an uncontrolled cyanide release, the soil would be tested for free or physiologically available cyanide (i.e., CN) per ADEC 18 AAC 75 requirements using departmental or EPA approved test methods. Impairments above applicable ADEC soil cleanup levels would be excavated, or left in place if below cleanup levels. An alternative approach may include in-situ neutralization (treatment) with calcium hypochlorite if soil in excess of cleanup levels cannot be excavated. Residual impairments would be left to naturally attenuate. Furthermore, residual impairments are not considered to have high bioaccumulation potential in upland terrestrial environments (Section 3.22, Human Health).

If sodium cyanide spills into water, the cyanide would be remediated or allowed to dissipate depending on the spill. A release into water would not be detoxified to avoid adverse impacts to aquatic life. Personal protective equipment would be available as determined in the spill plans, and staff would be trained in safe handling and spill response procedures.

3.24.5.8 SCENARIO 8: MERCURY RELEASE

Scenario 8 summarizes the potential spill or release causes that might result directly or indirectly from the transportation and storage of mercury. An incident or release could occur from a container rupture, transfer operations, or losing cargo overboard from an ocean or river barge. Liquid elemental mercury and spent carbon would be contained in flasks and pigs in a secured area of the Mine Site, then within shipping containers for transport via truck and barge. All containers would be secured as necessary to the decks of barges during transport.

These scenarios do not include fugitive air emissions, which are discussed in Section 3.8, Air Quality, and Section 3.22, Human Health.

3.24.5.8.1 LOST CARGO OVERBOARD

A very low probability (probability approaches zero and may be unprecedented) potential spill scenario may result if a container containing mercury is lost overboard from a barge. In the unlikely event that the cargo is lost overboard a mercury spill could only result if the containers ruptured. However, all mercury shipping containers would be secured to the barges to prevent slippage in any direction under the full range of travel conditions, and with appropriate separation from other cargo. Secondary containment of mercury containers would be provided inside the shipping containers that would prevent slippage in any direction under the full range of conditions expected during transport. Shipping containers lost overboard would be relocated and recovered by salvage specialists.

A spill is unlikely as the sealed flasks, pigs and drums provide a very high level of integrity and it is unlikely that these containers could rupture. Prior to shipment, Donlin Gold would verify that the container labeling is accurate and in good condition. A manifest would be prepared for each shipment that documents the type and weight of material being transported as well as the generation history. The manifest would formally facilitate tracking of the chain-of-custody from the Mine Site through the transportation process, to a permitted storage facility. Complete spill response would be included in a Spill and Emergency Response Plan.

3.24.5.8.2 FLASK, METRIC TONNE CONTAINER, OR DRUM RUPTURE (MINE LOCATIONS)

A very low probability (probability approaches zero and may be unprecedented) potential spill scenario could result from damage to or spillage from the flasks, metric tonne containers, and drums that contain liquid elemental mercury and spent carbon while being stored within the accumulated storage area and the centralized storage areas locations. A container leak is unlikely as the sealed flasks, metric tonne containers, and drums would provide a very high level of integrity and it is unlikely that these containers could be damaged enough to cause a leak.

The accumulation areas would be secured locations located within the processing facility accessible only by authorized personnel, and designed to handle and contain potential spills. The mercury containers would remain tightly closed at all times except when being filled. The containers would be marked appropriately to identify the content. The sealed flasks, pigs and drums alone provide a very high level of integrity. The central storage area would be designed to handle and contain potential spills, and would be equipped with adequate monitoring and ventilation systems to limit potential exposure to any mercury vapors. Spill response equipment would be located appropriately. The area would have signage and be secured and accessible only to authorized personnel.

In the unlikely event that there was a mercury spill from the storage areas either the liquid mercury or the spent carbon would be released from the containers. The liquid elemental mercury would be expected to be collected in the secondary containment. Spilled mercury would be recovered and managed appropriately.

At a minimum, weekly inspections would be conducted at the accumulation and centralized storage areas. Inspectors would verify the proper labeling and integrity of each elemental mercury container and activated carbon drum and the overall condition of the areas. Aisle space would be maintained to allow inspection of each container/drum. Records of inspections would be maintained onsite, including identification of the need for any corrective actions.

3.24.5.8.3 TRUCK ACCIDENT

A very low probability (probability approaches zero and may be unprecedented) potential spill scenario may result from transportation to Angyaruaq (Jungjuk) Port. In the unlikely event that there is an accident and the containers ruptured, a mercury spill (either the liquid mercury or the spent carbon) could result. The liquid elemental mercury and the spent carbon could be released to the land or surface water.

The spill risk during truck transportation is very low due to the safeguards at the Donlin Gold access road (design for industrial traffic, dedicated use and low speed limits, for example), the relatively limited number of truck trips necessary for mercury transport, and the appropriate containment to prevent a spill if an accident occurred. All mercury containers would be secured to prevent slippage in any direction under the full range of travel conditions, and with appropriate separation from other cargo. A spill is unlikely as the containers provide a very high level of integrity and it is unlikely that these containers would rupture. Additionally, the mercury containers would be transported secured to four drum containment pallets. In the event of a spill, the transporters and responders would be trained to properly respond to a mercury spill, and minimize the potential for any impacts to the environment or mine personnel. Specialized equipment (high-efficiency particulate arrestance vacuums) would be used to recover pools of visible mercury. Contaminated soils and water would be remediated. Spill response equipment would be kept at appropriate locations, as stipulated in the spill plans.

3.24.5.9 SCENARIO 9: PARTIAL TAILINGS DAM FAILURE

An inundation study was conducted for the selected release scenario (see Section 3.24.3.5.2) of up to 2.6 million cy to estimate the potential downstream consequences of a partial dam breach due to piping and a liner rupture leading to a sinkhole and outflow of stored material (BGC 2015n). For both of these potential failures, BGC modelled a release of a mixture of process-affected water and tailings, and a release of process-affected water only, to bracket the range of possible materials that could spill. For the purposes of this EIS, it is assumed that a release from the Alternative 5A operating pond would be similar to the water-only release modelled for the TSF dam for Alternative 2. The risk of a failure associated with both the operating pond under Alternative 5A and the TSF under Alternative 2 would be similar.

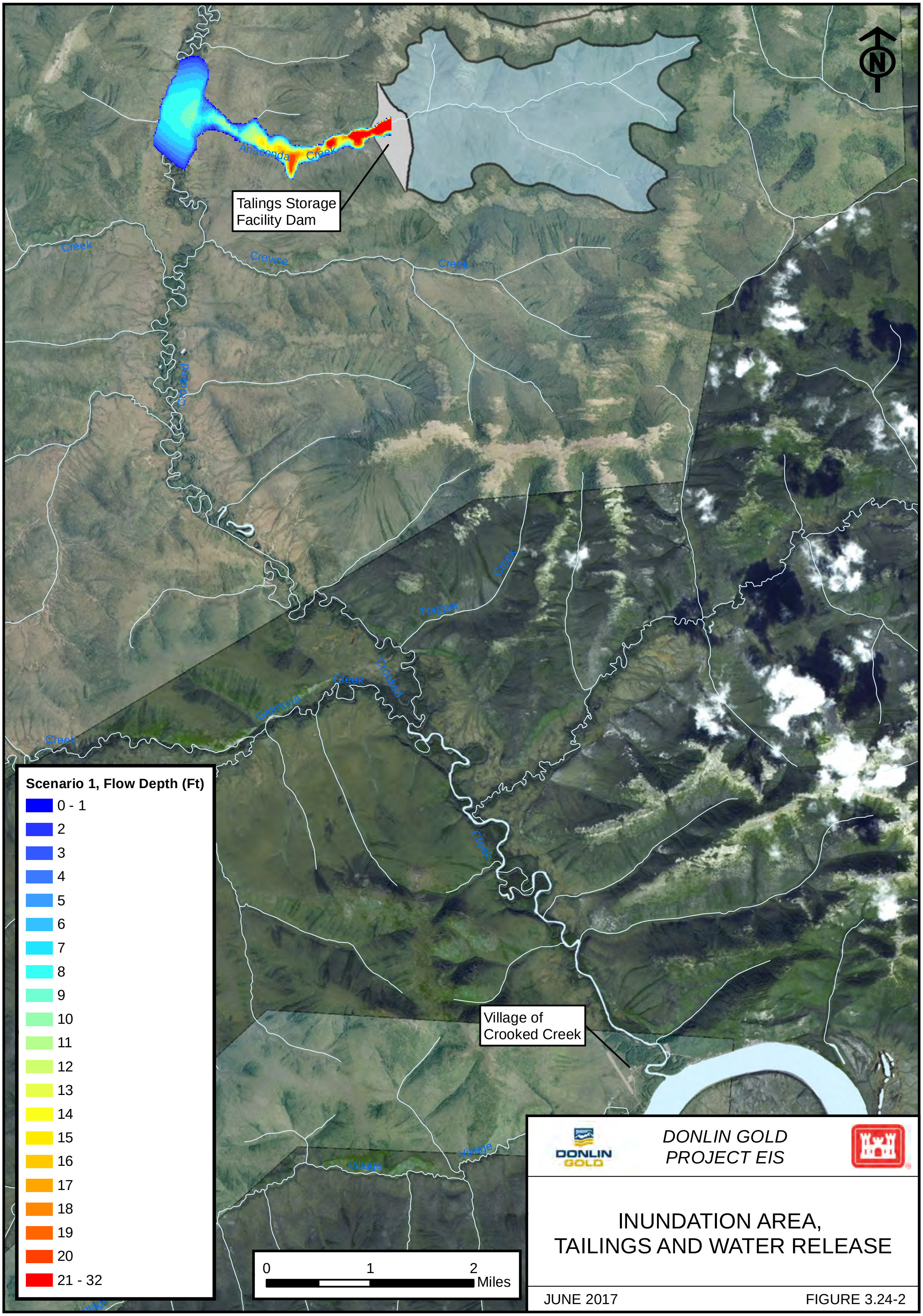
Modelling showed that the partial dam breach release from a piping failure (internal erosion) would be more severe than the liner rupture release (BGC 2015n). Thus, the inundation results analyzed in the EIS are for the partial dam breach release from the piping failure; the liner rupture release is dismissed from further analysis. The modelled flow inundation areas are shown in Figure 3.24-2 and Figure 3.24-4 (Scenarios 1 and 2 from BGC 2015n). Figure 3.24-3 (Scenario 1 from BGC 2015n) shows the deposition depth for a tailings and water release. Total duration time, flow front arrival time and maximum flow depth at the confluence of Anaconda Creek with Crooked Creek and the confluence of Crooked Creek with the Kuskokwim River, are summarized in Table 3.24-10.

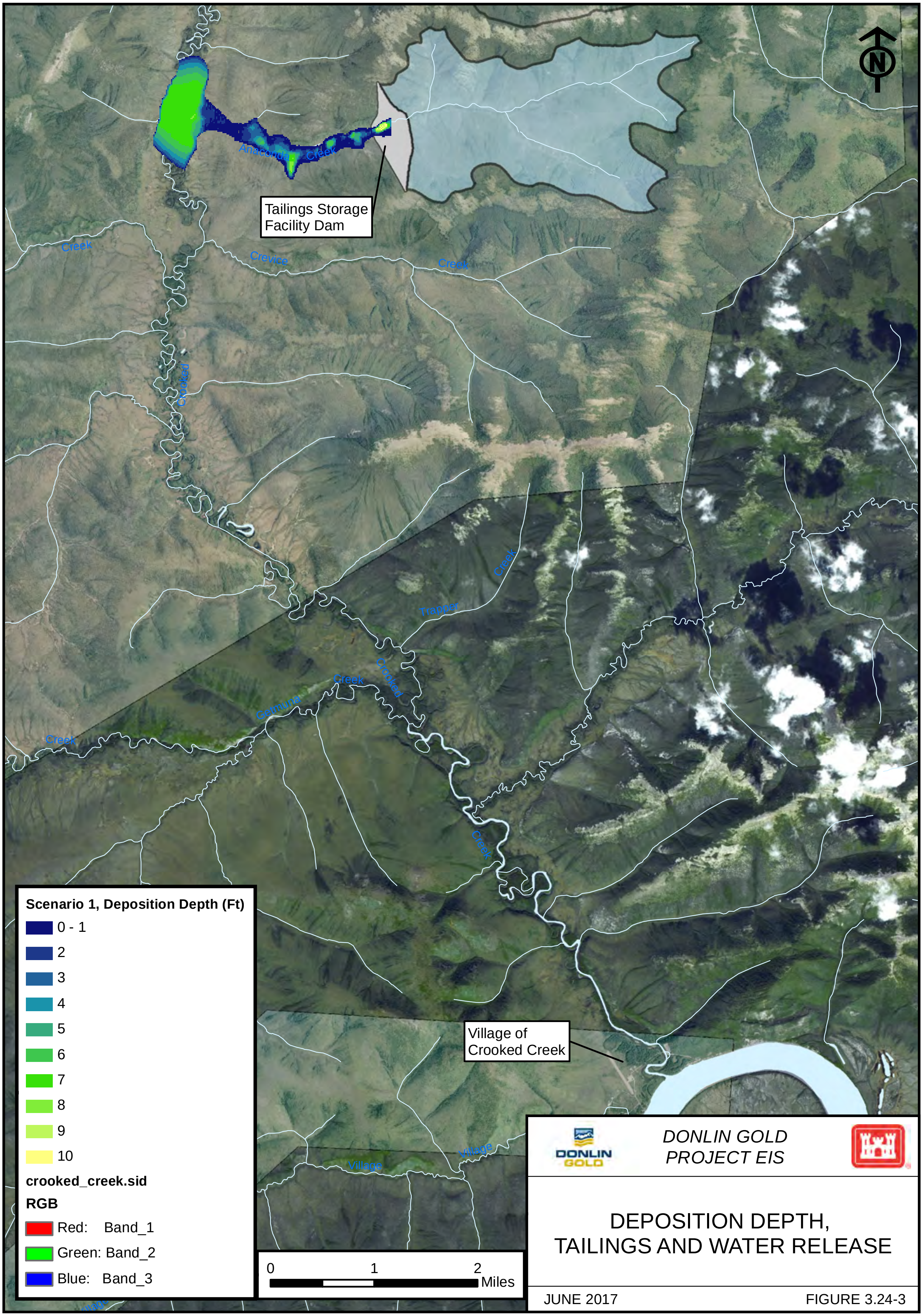
The scenario is intended to facilitate discussion on impacts; the cause of the failures is not detailed, nor are the potential effects of climate change taken into account.

Table 3.24-10: Summary of Modelling Results for Partial Tailings Dam Breach due to Piping Failure

Material Released	Total Duration (hrs.)	Confluence of Anaconda Creek and Crooked Creek (1.6 miles downstream of TSF)		Confluence of Crooked Creek and Kuskokwim River (13 miles downstream of TSF)	
		Front Arrival Time (hrs.)	Maximum Flow Depth (ft.)	Front Arrival Time (hrs.)	Maximum Flow Depth (ft.)
Water and Tailings	5.0	0.6	7.9	-	-
Water Only	>48	0.7	6.8	24.9	1.0

Source: BGC 2015n.


Talings Storage Facility Dam
Anaconda Creek
Crevice Creek
Creek
Crooked
Trapper Creek
Crooked Creek
Getmuna Creek
Creek
Village of Crooked Creek
Village
Scenario 1, Flow Depth (Ft)
0 - 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21 - 32
0 1 2 Miles
N
DONLIN GOLD
DONLIN GOLD PROJECT EIS
INUNDATION AREA, TAILINGS AND WATER RELEASE
JUNE 2017
FIGURE 3.24-2

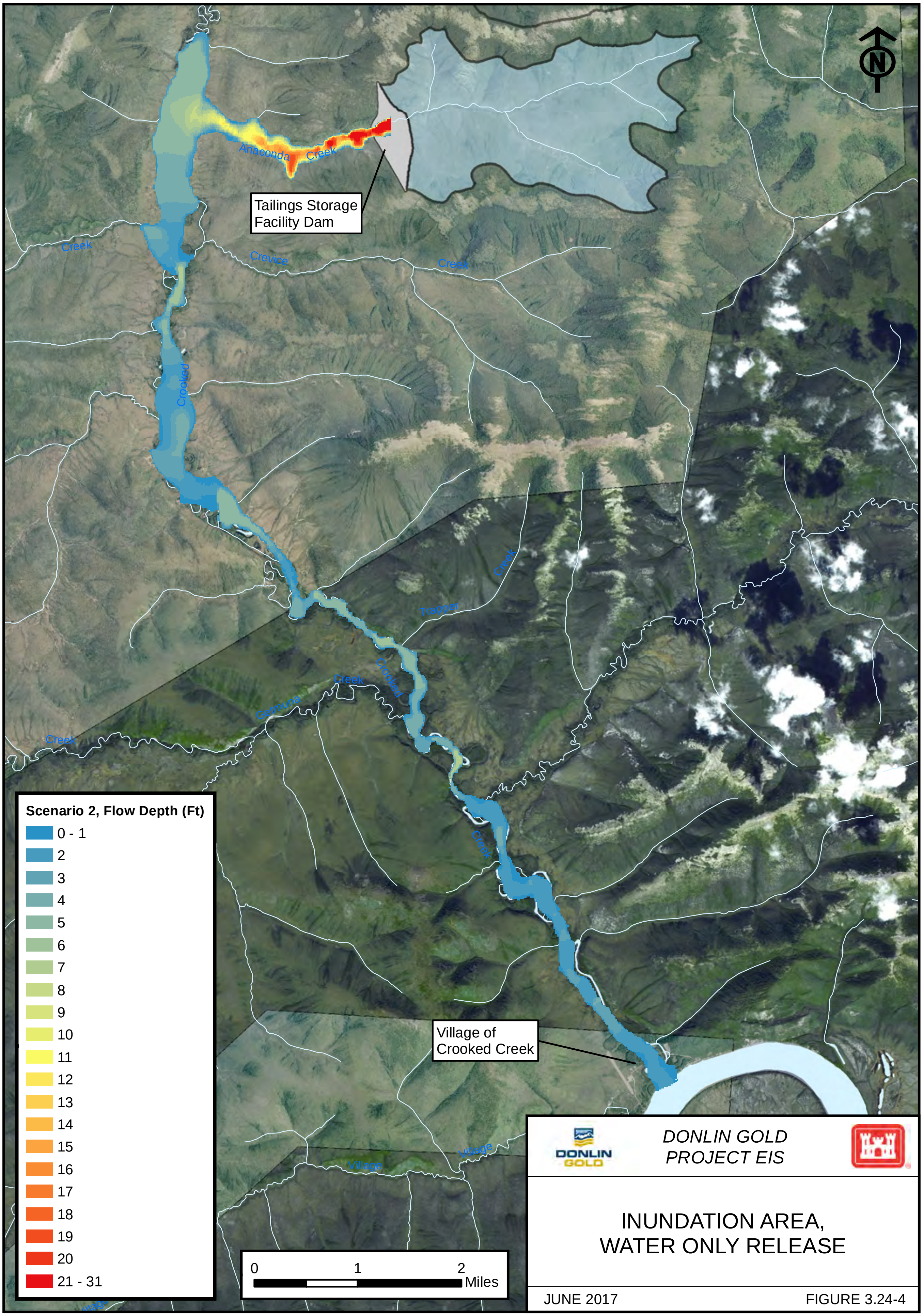


DONLIN GOLD
PROJECT EIS

DEPOSITION DEPTH,
TAILINGS AND WATER RELEASE

JUNE 2017

FIGURE 3.24-3



DONLIN GOLD PROJECT EIS

INUNDATION AREA, WATER ONLY RELEASE

JUNE 2017

FIGURE 3.24-4

3.24.5.9.1 TAILINGS AND WATER RELEASE

For the tailings and water release, the modelled travel distances and deposition of greater than about 1 to 2 feet of tailings extends from the TSF dam toe to the confluence of Anaconda Creek with Crooked Creek, and for about ½-mile both upstream and downstream of the confluence (Figure 3.24-3). Water and suspended solids would be transported downstream to the Kuskokwim River and beyond. If the release were to occur during the summer, Crooked Creek could be temporarily blocked by the deposited tailings, and some of the deposited tailings would then be remobilized by Crooked Creek and transported downstream. Removal of the tailings during a summer release would be difficult due to the flow in Crooked Creek and the challenges of using equipment in the areas along the creek. Should the release occur in the winter, the cone-shaped deposit of tailings could be excavated and transported back to the tailings facility, thereby limiting the impact during the following spring thaw (BGC 2015n). See Tables 3.2-12 and 3.7-33 for chemical composition of the materials that would be in the TSF.

An Emergency Action Plan required by the State of Alaska Dam Safety Program would be available to direct the appropriate response measures. Response measures would include ensuring the safety of mine employees and downstream residents; stabilizing the TSF breach; and implementing remedial actions to minimize impacts to affected resources. Remedial actions would include removing the tailings from the primary depositional area at the Crooked Creek confluence to the extent practicable. The tailings would be excavated using a combination of heavy equipment and hand tools and transported back to the TSF or other designated temporary storage area. Access to cleanup areas in the summer would be difficult due to the lack of roads along Crooked Creek and would likely involve heavy use of helicopters. Access in the winter could likely be accomplished on packed snow trails and removal of deposited material may be more effective because the ground and creek would likely be frozen.

The modelled tailings deposition depths varied from less than 2 feet to 8 feet along Anaconda Creek. The total deposition volumes that may be in Crooked Creek were estimated at approximately 1,300 acre-feet (BGC 2015n). Prediction of tailings deposition thicknesses less than about 1 to 2 feet are limited by the accuracy of the model and existing topographic data.

3.24.5.9.2 WATER ONLY RELEASE

For the water-only release, modelling suggests it would take approximately 24 to 25 hours for the release front to arrive at the confluence of Crooked Creek with the Kuskokwim River with a maximum flow rate of approximately 600 cfs. The predicted flow depth was approximately 1 foot or less at the confluence of Crooked Creek with the Kuskokwim River.

Based on the above observations, the flow discharges impact flow depths and flow velocities in Anaconda Creek, but do not have a significant impact on flow depths and velocities in Crooked Creek. This is because the Crooked Creek floodplain is wide (approximately 0.5 miles) and the bed gradient is very gentle (approximately 0.3 percent) from the confluence of Anaconda Creek to the confluence of Kuskokwim River, resulting in flood attenuation along Crooked Creek.

The maximum flow rates of the water only release would be approximately 4.0 percent of flow rates of the Kuskokwim River in the winter (November to April), and approximately 1.8 percent of flow in Kuskokwim River in the summer (May to October) (BGC 2015n).

Depending on the volumetric sediment concentration of the released tailings, the estimates show that the duration of flow could vary from approximately 6 hours for tailings and water flow, to longer than 48 hours for water flow only. Recovering released water would be difficult in any season.

3.24.6 SPILL SCENARIO IMPACTS

This section examines potential effects of the nine spill scenarios described in Section 3.24.5 under the action alternatives. These scenarios would be non-routine events, which vary from the analyses in Sections 3.1 to 3.23 that analyzed potential impacts under routine operations. Not all spill scenarios are applicable for each alternative, and this is noted when pertinent.

Under Alternative 1, the No Action Alternative, Donlin Gold would not establish a mine site, develop transportation facilities in the proposed Project Area, or construct a natural gas pipeline. Therefore, no direct or indirect effects to any resource would occur as a result of a project-related substance release and are not discussed (see Table 3.24-8).

3.24.6.1 GEOLOGY

The effects of project-related spills on geological and paleontological resources are considered either not applicable or very similar to impacts described for other resource impacts (e.g., soils); as such, spill impacts are not evaluated in depth for geological and paleontological resources in the EIS. Two spill scenarios, Scenario 1 (ocean barge rupture at sea), and Scenario 2 (river barge release), are not applicable to upland resources, and impacts to surficial deposits along shorelines under these scenarios are covered under the sediment quality discussion in Section 3.24.6.7.3, Water Quality. Scenario 6 (LNG Release) would not have any effect on geological or paleontological resources. Impacts to surficial deposits under Scenarios 3 through 9 (tank farm, tanker truck, and diesel pipeline releases, and cyanide or mercury releases) would be the same as those described in Section 3.24.6.2, Soils. Intensity of impacts to bedrock and paleontological resources would be very similar to those described for soils with the following differences:

- While soils and surficial deposits are nearly ubiquitous and would be impacted by almost any release, bedrock (and fossils in the bedrock) is more limited in extent to project areas described under Alternative 2 (Sections 3.1.2.2.1 and 3.1.2.2.2, Geology). Thus, depending on the location of a fuel release, spill impacts to these resources would be the same or less than impacts to soils.
- The presence of shallow bedrock in an area where a spill occurs would impede vertical infiltration into the subsurface. A fuel spill seeping into soils would tend to spread laterally upon reaching a contact between surface geology and unweathered bedrock. Because of this, a large spill of the same volume in an area of shallow bedrock would tend to affect a wider area and shallower depths, than the same size spill in an area of deep soils or surficial deposits where vertical infiltration is rapid.
- If sodium cyanide briquettes come into contact with water, the sodium cyanide would dissolve and a cyanide spill could result.
    - The dissolved sodium cyanide collected in secondary containment and properly disposed of would be considered to have an unmeasurable or unnoticeable impact to bedrock, and the resource would be reduced infrequently due to readily available and immediate response measures and secondary containment.

- Spills of cyanide that get wet on bedrock cannot be excavated; the bedrock would be neutralized (detoxified) in place with calcium hypochlorite. The cyanide already dissolved cannot be recovered and would be left to disperse naturally.

- Mercury would exist either bound to spent carbon or as an elemental liquid in flasks. The spent carbon could be vacuumed from the exposed bedrock and easily cleaned up. Liquid mercury would penetrate the bedrock, and be very difficult to remediate using conventional methods such as excavation. In the event that impacts from medium to large releases reach bedrock and are not readily recovered, impact duration could potentially be up to several seasons until remediation objectives (regulatory limits) are achieved. Mercury is volatile, so such remediation may involve vapor recovery. The geographic extent of impact from this release scenario would be generally limited to the immediate release area. Soil types and soil quality vary in context.
- For a release of tailings and water, the tailings could conceivably be excavated and removed reducing impacts. Impacts from contaminated water would presumably seep into bedrock fractures and could impact a wide area, and remediation would be difficult.

3.24.6.2 SOILS

Some spill scenarios are not applicable to any soil impacts; spill scenario impacts to soil that are considered not applicable to any alternatives include the following:

- Scenario 1 (Ocean Barge Rupture at Sea): This scenario assumes a release to water, and generally does not involve upland soil since any resulting impacts would be limited to ocean waters or intertidal shoreline sediment. Sediment, for purposes of this evaluation, includes basal or shoreline depositional environments that are potentially influenced by annual variations in sea level fluctuations. This discrete environment and active hydraulic mechanisms are unique with respect to continuous erosion, depositional, and transport processes. Impacts to sediment are discussed in Section 3.24.6.7.3, Sediment Quality
- Scenario 2 (River Barge Release): Similar to Scenario 1, this scenario does not involve upland soil since any resulting impact would be limited to in-stream waters or river shoreline sediment. Sediment, for purposes of this evaluation, encompasses the active river channel area typically ranging from peak high and low annual (seasonal) stage fluctuations. Impacts to sediment are discussed in Section 3.24.6.7.3, Sediment Quality.
- Scenario 6 (Liquefied Natural Gas Release): Although a natural gas release can be toxic to atmospheric receptors, impacts to soil are considered non-existent due to the low boiling point of natural gas / methane (-260 degrees Fahrenheit), which means that it dissipates rapidly into the atmosphere.

For all applicable spill scenarios impacting soil, contingency plans are required to mitigate and respond to such circumstances. With the exception of Alternative 1 (No Action), a SPCC plan would be required for all other alternatives where applicable. The SPCC plan would detail measures to prevent, respond, contain, report, and cleanup releases inherent to the final action(s) selected. If necessary, this may include regulatory required post-Closure characterization activities or continued mitigation and / or management measures to achieve specific site objectives with regulatory oversight.

3.24.6.2.1 ALTERNATIVE 2 – DONLIN GOLD'S PROPOSED ACTION

In addition to the scenarios listed above, Scenario 5 (diesel pipeline release) does not apply to the proposed action, and is not analyzed for soils impacts.

Scenario 3: Tank Farm Release

Releases associated with the range of potential spills under this scenario would result in limited quantities of affected soils with concentrations either above or below regulatory levels, requiring minimal remediation / excavation due to small volume human error transfers. Soil impacts from a large tank farm release are considered unlikely due to a very low probability of occurrence and secondary containment infrastructure designed to be capable of capturing a catastrophic-sized release. Similarly, secondary containment at the tank farms and dock would capture releases from other Scenario 3 sources, with the exception of human error fuel transfers. Releases attributed to human error fuel transfers could result in small release volumes (less than 10 gallons) potentially covering areas of surface soil encompassing several square feet, which would be addressed through immediate response and recovery efforts. If necessary, appropriate remediation measures would be capable of readily removing limited soil volumes in excess of regulatory limits.

In terms of impact duration, soils would be expected to return to pre-activity levels after the spill event. The extent or scope of impacts from small release areas would be limited to the immediate source area. In context, soil types associated with scenario-based release areas are prevalent beyond potentially impacted areas, but soil chemical quality is governed by regulation.

Scenario 4: Tanker Truck Release

The intensity of impacts to soil from these events would range from small volume, tanker truck collision to medium volume, low probability truck rollover. Small spills would be limited to roadbed materials and addressed / recovered immediately per the SPCC plan. Although medium spills could potentially impact soils adjacent to the roadbed, they would be limited in close proximity to the point of release. Limited excavation and removal of shallow impacted soils above regulatory limits would likely be required; however, immediate response and cleanup efforts would minimize further migration of soil impacts through containment and recovery. Post-rehabilitation efforts would likely include limited landscape contouring and revegetation measures.

Impact duration is generally infrequent under more probabilistic small spill scenarios due to readily available and immediate response measure alternatives. In the event that impacts from medium to large releases reach soil depths not readily accessible by heavy equipment, impact duration could potentially be up to several seasons until remediation objectives (regulatory limits) are achieved. The geographic extent of impact from this release scenario would be generally limited to the immediate release area. As described under Scenario 3, soil types and soil quality vary.

Scenario 7: Cyanide Release

A very low probability potential scenario could result if the sodium cyanide container was lost overboard from a barge. There would be no potential impact to soils in such scenario.

In terms of intensity, if the sodium cyanide briquettes come into contact with water, the sodium cyanide would dissolve. The dissolved sodium cyanide would be collected and contained in secondary containment and properly disposed. Therefore, spills at the marine terminal or the mine facility would have impacts to soils and soils would be expected to return to pre-activity levels after the spill event due to readily available and immediate response measures and secondary containment.

A very low probability potential spill scenario may result from a vehicle accident during transport from Angyaruaq (Jungjuk) Port to the mine. Small spills would be limited to roadbed materials and addressed / recovered immediately per the SPCC plan. Limited excavation and removal of shallow impacted soils above regulatory limits would likely be required; however, immediate response and cleanup efforts would minimize further migration of soil impacts through containment and recovery. Post-rehabilitation efforts would likely include limited landscape contouring and revegetation measures.

Cyanide is highly mobile in soil, and can be converted to hydrogen cyanide and other compounds that evaporate out of soil by microbial processes. However, high concentrations can be toxic to the micro-organisms that convert it into evaporative forms, resulting in persistent concentrations that can find its way to groundwater. If the area cannot be excavated, the soil would be neutralized (detoxified) in place with calcium hypochlorite. If the sodium cyanide came into contact with water it would dissolve; and dissolved cyanide cannot be recovered, and would be left to disperse naturally.

In the event that impacts from medium to large releases reach soil depths not readily accessible by heavy equipment, impact duration could potentially be up to several seasons until remediation objectives (regulatory limits) are achieved. The geographic extent of impact from this release scenario would be generally limited to the immediate release area. Soil types and soil quality vary in context.

Scenario 8: Mercury Release

In the unlikely event that the cargo is lost overboard, a mercury spill could only result if the containers ruptured, which is not part of this scenario.

In the unlikely event that there was a mercury spill from the storage areas either the liquid mercury or the spent carbon would be released from the containers. The liquid elemental mercury or spent carbon would collect in the secondary containment, be recovered, and managed appropriately.

A low probability potential spill scenario may result from transportation to Angyaruaq (Jungjuk) Port from the Mine Site. In the unlikely event that there is an accident and the containers ruptured, a mercury spill (either the liquid mercury or the spent carbon) could result. The liquid elemental mercury and the spent carbon could be released to the land or surface water. In the event of a spill, the transporters and responders would be trained to properly respond to a mercury spill, and minimize the potential for any impacts to the environment or mine personnel.

Such an event is likely to involve only a small amount of spent carbon with mercury impacting a relatively small area of soil. Contaminated soils and water would be remediated. Spill response equipment would be located at appropriate locations as detailed in the spill plans. Limited excavation and removal of shallow impacted soils above regulatory limits would likely be required. Post-rehabilitation efforts would likely include limited landscape contouring and revegetation measures. Soils would be expected to return to pre-activity levels after the spill event due to readily available and immediate response measure alternatives, and the ease of cleaning up a solid, as opposed to a liquid, spill. The geographic extent of impact from this release scenario would be generally limited to the immediate release area. As described under Scenario 3, soil types and soil quality vary in context.

Elemental mercury is a liquid, much heavier than water. If spilled on the soil it would be expected to migrate downward. However, there may be complicating factors to this scenario. In warm temperatures mercury can vaporize, leaving the spill location. During cold temperatures the ground would be frozen, retarding downward migration or volatilization.

Mercury-contaminated soils would be remediated with the intent of cleaning up to levels that will be protective of human health and the environment and consistent with soil cleanup levels.

The intensity of impacts to soil from such a release would range from small volume spill on frozen soils to medium volume spill on thawed soils. Small spills would be limited to roadbed materials and addressed / recovered immediately per the SPCC plan. Although medium spills could potentially impact soils adjacent to the roadbed, they would be limited in close proximity to the point of release. Limited excavation and removal of shallow impacted soils above regulatory limits would likely be required; however, immediate response and cleanup efforts would minimize further migration of soil impacts through containment and recovery. Post-rehabilitation efforts would likely include limited landscape contouring and revegetation measures. Mercury spilled in water would not impact soils, and the impacts of such a spill are discussed below in Section 3.24.6.7, Water Quality.

Soils would generally be expected to return to pre-activity levels at the completion of the spill under more probabilistic small spill scenarios due to readily available and immediate response measure alternatives. In the event that impacts from medium to large releases reach soil depths not readily accessible by heavy equipment, impact duration could potentially be up to several seasons until remediation objectives (regulatory limits) are achieved. The geographic extent of impact from this release scenario would be generally limited to the immediate release area. Soil types and soil quality vary in context.

Scenario 9: Partial Tailings Dam Failure

The two TSF release scenarios discussed in Section 3.24.5.9 would cause significant impacts to undisturbed soils located downstream of the TSF dam toe. Physical processes and chemical attributes unique to each scenario would result in different types of post-release impacts. Physical impacts would be derived from a variety of mechanisms resulting in alteration of the pre-existing landscape; these would predominantly be associated with erosion (scour) and deposition. Chemical impacts to soil would be derived from the tailings and water (supernatant or porewater) released from the TSF.

Based on a screening review of analyte concentrations for TSF tailings compared to ADEC (2017b) soil cleanup level guidelines, identified analytes of concern include antimony, arsenic, and thallium (Table 3.24-11). Although mercury would not be present in tailings at levels exceeding soil cleanup guidelines, it was included in this review based on general project concerns regarding mercury, and comparatively elevated concentrations in tailings pond water that could potentially affect downstream soils. All other evaluated analytes and associated concentrations in TSF tailings or water were well below listed ADEC soil cleanup levels. Chromium concentrations in tailings were compared to ADEC chromium III guidelines only and did not exceed these; chromium VI rarely occurs naturally (e.g., in rock from which tailings are derived), and most chromium VI compounds are manufactured products (e.g., paint and stainless steel industries) (IARC 2012).

Tailings water and ADEC groundwater cleanup levels are also included in Table 3.24-11 for the purpose of comparison to solids concentrations, and to identify potential contaminated water impacts to soils. However, dam release impacts to surface and groundwater quality are addressed separately in Section 3.24.6.7.

Table 3.24-11: Media and Analytes of Concern for Soil Impacts from TSF Release Scenarios

Parameter	Tailings Solids: Feasibility Plot (Phase 2) Final Tailings Filtrate 2007[1] (mg/kg)	Tailings Water:		ADEC Soil Cleanup Levels		ADEC Groundwater Cleanup Levels[5] (mg/L)
		TSF Pond Water[2] (mg/L)	Tailings Porewater, Buried Tailings[2] (mg/L)	Human Health Pathway[3] (mg/kg)	Migration to Groundwater Pathway[4] (mg/kg)	
Antimony	120	0.022	1.1	41	3.6	0.006
Arsenic	910	3.3	15	8.8	0.20	0.00052
Mercury	0.7	10	10	30/10[6]	3.9/180[6]	0.0057/0.002[6]
Thallium	0.9[7]	0.00041	0.00041	1.0	0.19	0.0002

Notes:

1. Values from Appendix H – Analysis of Mine Site Geochemistry, Table H-2.
2. Values from Appendix H – Analysis of Mine Site Geochemistry, Table H-8.
3. 18 AAC 75: Method Two, Under 40-inch Zone, Human Health (ADEC 2017b).
4 18 AAC 75: Method Two, Under 40-inch Zone; migration to groundwater soil cleanup level (ADEC 2017b).
5. 18 AAC 75: Table C Groundwater Cleanup Levels (ADEC 2017b).
6. Mercury guidelines are shown as mercuric chloride/methylmercury.
7. Exceeds migration to groundwater pathway only.

Abbreviations:

ADEC = Alaska Department of Environmental Conservation
DOC = Dissolved organic carbon
mg/kg = milligrams per kilogram
mg/L = milligrams per liter
Shaded cell = Tailings concentration exceeds ADEC soil cleanup level(s).
Lightly shaded cell = Constituents in tailings water also exceed ADEC groundwater cleanup level.

As shown in Table 3.24-11, predicted concentrations of arsenic and antimony in TSF tailings exceed human health soil cleanup levels. Since a TSF release could transport these constituents in either tailings or tailings water to downstream soils, and leach or infiltrate to groundwater, exceedances of soils migration to groundwater and groundwater cleanup levels were also considered to be indicative of potential chemical impacts to soils. Migration to groundwater soil cleanup levels are applicable if the potential exists for leaching of contaminants to groundwater, where they might result in concentrations above groundwater cleanup levels. With the exception of mercury, all analytes exceed soil cleanup levels for the migration to groundwater pathway. All listed concentrations in TSF pond and porewater would also exceed ADEC groundwater cleanup levels.

Tailings and Water Release Scenario

Physical Impacts

The total release volume of 1,620 acre-feet of slurry would have solids concentration of 50 percent (sediment) in the scenario used for this evaluation. The slower flowing solid-water mixture would be released over a five hour period (Enos 2015). The two-dimensional model (FLO-2D) used to perform the quantitative impact analysis and evaluate the muddy release over complex 3D terrain, resulted in deposition throughout the tailings run (see Figure 3.24-2). The tailings are assumed to deposit at a slope of about three degrees, and extend approximately two miles downgradient of the TSF in the Crooked Creek drainage. Maximum flow depths of greater than 20 feet throughout the release are limited to within a half mile of the TSF in the Anaconda Creek drainage, and progressively diminish to two feet in depth at the furthest release extent in Crooked Creek. Varying depths of tailings deposition would be anticipated throughout the entire flow inundation area which range from two to 10 feet in depth. The most prominent area of tailings deposition is the tailings run out terminus at the confluence of Anaconda Creek and Crooked Creek which coincides with the largest depositional volume of 1,300 acre-feet, and maximum depositional depth of 10 feet. The total areal extent of soil disturbance by inundation or deposition would be approximately 1,700 acres under this scenario.

Physical impacts to soil primarily include scouring and depositional processes. Erosion and scouring would be most prevalent throughout the Anaconda Creek drainage at locations where channelized flow and corresponding velocities are most significant. Flows would far exceed any historical flow conditions within the drainage, as described in Section 3.5, Surface Water Hydrology. Although the Anaconda Creek channel is incised and relatively deep, the bed and bank materials are comprised primarily of sand and silt and would be very susceptible to erosion under the release scenario evaluated. With the exception of several discrete areas, tailings deposition in the Anaconda drainage is anticipated to be thin and spatially distributed throughout the inundation area (Figure 3.24-2). High energy erosional processes are likely to result in significant changes to the Anaconda Creek morphology that would include increase in cross sectional area (vertical and horizontal scouring); abrupt vertical gradients in closer proximity to the release area; and intermixing of post depositional tailings with pre-existing sand and silt substrates. A depositional regime would progressively increase towards the confluence of Anaconda and Crooked creeks.

The confluence of Anaconda and Crooked creeks is the most significant area where soil impairment would result from 1,300 acre-feet of deposited tailings. This area represents the largest volume and areal extent of source material over pre-existing soils. In-stream (i.e., Crooked Creek) substrates predominantly consisting of coarse gravel to medium cobbles would be directly overlain or inundated with fine tailings in and immediately downstream of the primary depositional area. Elevated flows through deposited tailings mixtures could remobilize significant quantities of deposited tailings downstream. Additional discussion regarding physical alterations to stream morphology and fish habitat are presented in Sections 3.24.6.5 and 3.24.6.13 (Surface Water Hydrology and Fish and Aquatic Resources, respectively).

Seasonal conditions at the time of the release could also influence the severity of physical soil impacts. Modeled inputs were based on mean summer flow conditions; a frozen river bed; and roughness value (Manning's n-value) representative of dense brush. Scouring and depositional impacts (extent) to soil may be appreciably reduced in winter months due to frozen soil; snow cover; and low annual flow conditions in Crooked Creek. Conversely, a release during peak flow conditions would result in a greater inundation area, and distribution of remobilized tailings downstream of the Crooked Creek confluence (Section 3.5, Surface Water Hydrology).

Chemical Impacts

Chemical impairments of consideration to soil under this scenario would include those from antimony, arsenic, and thallium concentrations in TSF sediment; and mercury in TSF water. Concentrations of antimony and arsenic in deposited tailings would be significantly higher than applicable soil cleanup levels shown in Table 3.24-11. Elevated concentrations of arsenic and antimony (and to a lesser extent, thallium) in TSF water would also exist. It is also possible that elevated concentrations of mercury in TSF water could result in soil impairments above the migration to groundwater cleanup levels. Elevated mercury concentrations would primarily be associated with interstitial porewater entrained in saturated or moist soils located in the post release affected area. Further discussion of mercury impacts to water from this release scenario are presented in Section 3.24.6.7, Water Quality.

If not removed, the tailings and entrained porewater are considered a "source material" from which leachate and impairment to surrounding soils, surface water, and groundwater would be derived. Soil impacts from arsenic and antimony would be more prolonged than mercury, since tailings (solids) represent a residual ongoing source material for these metals. Soil impairments from elevated concentrations of mercury in interstitial porewater would be comparatively shorter in duration based on aqueous mechanisms (i.e., flux) associated surface infiltration (e.g., meteoric water), surface water, and groundwater transport processes. Soil impairments would largely be limited to the depositional extent of TSF tailings shown on Figure 3.24-1 which covers approximately 1,700 acres. Impairments would include vertical migration of leachate constituents to underlying soils (where present), and transport of tailings (downstream) as sediment from in river processes and/or from erosional run-off within receiving Anaconda Creek and Crooked Creek drainages. Soils underlying, and potentially downgradient of deposited TSF sediment would become impaired from tailings leachate or runoff. If left undisturbed, the soil impairments from antimony and arsenic are considered indefinite based largely on the high concentration and fate of these metals in the tailings. Tailings mixtures transported as sediment within the Crooked Creek drainage and subsequent impacts are further addressed in Sections 3.24.6.5, Surface Water Hydrology, and Section 3.24.6.7, Water Quality.

Follow-up restoration work would be performed concurrently with stabilization, recovery and remediation efforts. This would include drainage and channel reconstruction and restoration along Anaconda and Crooked creeks. Erosion and sediment control measures may include seeding of approved vegetation for surface stabilization, in addition to other SWPPP countermeasures. Where appropriate, construction sedimentation ponds within the drainage could also minimize the downstream transport of tailings. In addition to a post release monitoring program, point specific removal and transport of tailings would also be conducted as needed based on preliminary investigation findings.

Summary

In terms of intensity, both physical and chemical impacts to soil from this scenario would alter pre-existing soil conditions in the release inundation area. Immediate and long-term response efforts and natural processes would facilitate restoration of physical impacts; however, complete removal of antimony and arsenic enriched tailings from the inundation area is unlikely to be possible. Residual source material (tailings) could indefinitely impair some soils above baseline conditions, although impacts to soil from mercury would likely be shorter in duration. For these reasons, irreversible impacts on soil character / quality may occur. The extent or scope of soil impacts would extend beyond the Project Area. Although impacted soils are considered types commonly found throughout the region, physically and chemically impaired soils could indirectly result in impairments to resources protected by legislation in context.

Water Release Only Scenario

For reasons similar to the tailings and water mixture scenario described previously, physical impacts to soil would be most significant in the Anaconda Creek drainage. For evaluation purposes, it is assumed that most of the soils within Anaconda drainage inundation area (Figure 3.24-3) will be subjected to some degree of physical impairment ranging from complete removal to sediment deposition. The extent of impacts is assumed to affect approximately 250 acres of soil and sediment in the Anaconda Creek drainage.

Physical impacts to soil at the confluence of Crooked Creek and Anaconda Creek would likely include both erosional losses and deposition of coarser grained materials beyond the active stream channels, followed by finer materials. Physical impacts downstream of the confluence would likely diminish with distance; however, this would largely be influenced by natural creek flows at the time of the release, and localized channel characteristics along the reach to the Kuskokwim River. Based on historical Crooked Creek discharge measurements in closest proximity to the confluence with Anaconda Creek (upstream of Crevice Creek), long-term average daily discharges seasonally range from approximately 100 cfs to 250 cfs. A maximum average daily discharge of 880 cfs was recorded in late August of 2006. The 2-year and 5-year flood magnitude for the Crooked Creek watershed is 783 cfs, and 1,284 cfs, respectively. With the exception of brief peak flood events, total discharge under this release scenario would likely be well within the range of historical flow conditions.

Chemical impairments to soil under this scenario could occur from elevated concentrations of constituents in TSF water (Table 3.24-11). Factors mitigating TSF water (chemical) impacts to soil include a release predominantly consisting of tailings pond water with dissolved constituents less likely to adhere to soil particles, and dilution from Crooked Creek at the time of the release. Similar to the tailings and water release scenario, elevated concentrations would primarily be associated with interstitial porewater entrained in saturated or moist soils located in the post release affected area. Scenario-based modeling showed that affected soils would be greatest near the release source (i.e., TSF). This is where dilution from Crooked Creek flow is greatest, and inundated areas would reach higher bank areas and adjacent uplands. Impacted soil extents would generally diminish downstream as flows progressively become confined within the Crooked Creek drainage that extends to the Kuskokwim River. Soil impacts derived from contaminants in TSF water would be mostly temporary due to aqueous mechanisms and transport processes (described above for the tailings and water release scenario); however, the duration of impact could extend through the life of the project.

Similar to the tailings and water release scenario, follow-up restoration work would be performed concurrently with stabilization, efforts. This may include drainage and channel reconstruction and restoration along Anaconda Creek, and to a lesser extent Crooked Creek (where identified). A post release monitoring program would be implemented to evaluate both physical and chemical impacts to soil, and guide any additional restoration and remediation activities based on the preliminary investigation findings.

In summary, both physical and chemical impacts to soil from this scenario would be less than a release of tailings and water. Physical erosional losses would be most prevalent in the Anaconda Creek drainage because it lacks the capacity to convey a sustained release volume of 600 cfs. In terms of intensity, scouring processes in the Anaconda Creek drainage are likely to result in irreversible erosional losses. Depending on the extent of erosional losses and the success of restoration and rehabilitation efforts in the Anaconda drainage and confluence with Crooked Creek, the duration of physical impairments would vary and may result in irreversible impacts. Although the areal distribution of chemical impairments to soil are potentially greater under this scenario due to the longer inundation extent downstream of the TSF release, the duration of chemical impairment is not considered indefinite like the persistent arsenic and antimony concentrations attributed to tailings under the combined release scenario. The extent of physical disturbance downstream of the Crooked Creek confluence would be limited to discrete portions of the project area due to drainage characteristics and subsequent flood attenuation processes, but the extent of chemical impacts would potentially extend throughout the project area due to the potential distribution of impaired soils largely confined to the Crooked Creek drainage. Although impacted soils are considered types that are commonly found throughout the region, physically and chemically impaired soils could indirectly result in impairments to resources protected by legislation in context.

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

In addition to the scenarios listed above, Scenario 5 (diesel pipeline release) does not apply to Alternative 3A, and is not analyzed for soils impacts. Impacts under Scenarios 7, 8, and 9 (cyanide, mercury, and tailings releases) for Alternative 3A would be the same as those discussed under Alternative 2.

Scenarios 3 and 4: Tank Farm or Tanker Truck Releases

Under Alternative 3A, an uncontrolled release of LNG would not affect soils, since it would dissipate into the atmosphere, provided that no ignition source triggers an explosion before the LNG dissipates. Although the probability of small to medium diesel spills under this alternative is inherently reduced through less diesel usage, impacts to soils under Alternative 3A are generally the same as those described for the proposed action, as some tank farm infrastructure and tanker truck traffic would still be required under this alternative.

3.24.6.2.3 ALTERNATIVE 3B – REDUCED DIESEL BARGING: DIESEL PIPELINE

Under Alternative 3B, five spill scenarios are applicable to soils, three of which (Scenarios 7, 8 and 9, cyanide, mercury, and tailings releases) would have the same impacts as Alternative 2. Spill scenarios applicable to riverine sediment and surface water bodies under this alternative are addressed in Sections 3.24.6.5, Surface Water Hydrology, and 3.24.6.7, Water Quality.

Scenarios 3 and 4: Tank Farm and Tanker Truck Releases

Impacts to soils under these resources would be the same as described under Alternative 2, as some tanks and tanker truck traffic at the mine, mine access road, and Angyaruaq (Jungjuk) Port would still be required under Alternative 3B. In addition, the tank farm at Tyonek Port would add a potential release source under Scenario 3. Although the probability of spills would be inherently reduced at the Angyaruaq (Jungjuk) Port and Mine Site through less diesel storage and transfer, the probability of spills would be increased at Tyonek Port; thus, impacts to soils would generally be the same as described for Alternative 2.

Scenario 5: Diesel Pipeline Release

Alternative 3B represents an increased risk of uncontrolled releases from diesel conveyance and handling during pipeline operation and closure compared to natural gas.

Because only half the fuel released from refined product lines would be recovered, the duration and scope of a release to soil would be likely to be much more significant than a natural gas release under Alternative 2. The chronic release of diesel from a pinhole leak could eventually result in a medium to large release to surrounding soils over the service life of the pipeline.

The potential for soil quality impacts during closure and termination activities of the diesel pipeline would be higher under Alternative 3B in than for the natural gas pipeline described under Alternative 2. Anticipated pipeline decommissioning activities would include draining and handling of large quantities of residual liquid fuel mixtures in accordance with industry practices using approved state and federal guidance and planning documents. Uncontrolled releases during pipeline closure would most likely result in very small to small spill volumes due to controlled conditions and standardized industry pipeline abandonment practices.

Intensity of impacts associated with small to large diesel pipeline releases would be affected by several variables that would influence the distribution of soil impacts (i.e., duration, topography, soil types, and seasonal conditions). This is largely based on the availability and success of current petroleum hydrocarbon remediation alternatives (e.g., excavation, thermal treatment, in-situ treatment) and post-restoration practices (e.g., surface stabilization, native species re-vegetation) in similar environments throughout Alaska.

Small releases would be addressed immediately. Large releases to soil have the potential to be longer in duration until applicable regulatory limits are achieved through active remediation or natural attenuation. The duration of a diesel release is not considered irreversible due to the degradation of hydrocarbons through natural attenuation processes.

The geographic extent of soil contamination from any diesel pipeline release scenario could range from several square feet to several acres. Refer to Sections 3.24.6.7.1 and 3.24.6.7.2 for analysis of spills that also reach surface water or groundwater. Releases are anticipated to be distributed locally from the point source due to vertical infiltration of surrounding soils, and would be limited to discrete portions of the pipeline where release sources exist. Frozen soil conditions can be significantly less conducive to subsurface infiltration in comparison to thawed conditions, and are more likely to reduce the extent of impacts and improve overall remediation success.

As described under Alternative 2 Scenario 3, soil types and soil quality vary in context.

3.24.6.2.4 ALTERNATIVE 4 – BIRCH TREE CROSSING (BTC) PORT

In addition to the scenarios listed above, Scenario 5 (diesel pipeline release) does not apply to Alternative 4, and is not analyzed for soils impacts. Impacts under Scenarios 3, 7, 8, and 9 (tank farm, cyanide, mercury, and tailings releases) for Alternative 4 would be the same as those discussed under Alternative 2.

Scenario 4: Tanker Truck Release

The BTC Road would be approximately 2.5 times longer than the mine access road proposed under Alternative 2. The increased tanker truck transport distance would inherently increase the probability of a tanker truck release. In addition, equipment usage during operation and construction of the temporary ice road along Crooked Creek valley would also slightly increase the potential for a spill. However, the risk remains generally low, and the scope and type of potential impacts that are likely to occur are the same as those described for Alternative 2.

3.24.6.2.5 ALTERNATIVE 5A – DRY STACK TAILINGS

In addition to the scenarios listed above, under Alternatives 5A spill Scenarios 5 and 9 (diesel pipeline, and water and tailings release) are not applicable and have not been analyzed for impacts to soils.

Impacts under Scenarios 3, 4, 7, 8, and 9 (tank farm, tanker truck, cyanide, mercury, and water only tailings releases) for Alternatives 5A would be the same as those discussed under Alternative 2. The water only tailings release (TSF) under this Alternative would be limited to the operating pond based on design differences between Alternative 2. The operating pond release scenario would have comparable impacts using the same Alternative 2 discharge constraints in addition to common Alternative infrastructure locations and downstream discharge receptors (i.e., Anaconda Creek and Crooked Creek drainages). Alternative 2 water only tailings release impacts to soil are described in Section 3.24.6.2.1.

3.24.6.3 GEOHAZARDS AND SEISMIC CONDITIONS

The effects of project-related spills on geohazards are considered not applicable, as spills would not impact geohazards; rather geohazards could cause or exacerbate spills or spill cleanup. The role of geohazards in potentially causing spills (e.g., surface faults causing pipeline rupture, or tsunamis causing tank failure) are incorporated into the analysis of effects of Section 3.3, Geohazards and Seismic Conditions, and the potential impact of these events on other resources are addressed in individual resource sections.

3.24.6.4 CLIMATE AND METEOROLOGY

Climate pertains to long-term weather conditions and is characterized by meteorological parameters listed in Section 3.4.1, Climate and Meteorology, such as temperature, solar radiation, barometric pressures, wind speed, relative humidity, or precipitation. A change to these parameters is referred to as global climate change. These parameters are influenced by natural (e.g., mountains, oceans, solar impacts) and anthropogenic (e.g., land use) features. In the event of a release of diesel, LNG, cyanide, or mercury, no direct or indirect effects to climate or meteorological resources would occur.

3.24.6.5 SURFACE WATER HYDROLOGY

The effects of project-related spills on surface water hydrology are not considered applicable; rather, surface water hydrology could exacerbate spills or spill cleanup efforts. The discussions below examine the potential impacts surface water hydrology could have on uncontrolled releases. This contrasts with Section 3.5 which examines potential effects of project alternatives on surface water hydrology under routine operations.

3.24.6.5.1 ALTERNATIVE 2 – DONLIN GOLD'S PROPOSED ACTION

Under the proposed action, two spill scenarios do not apply and are not analyzed for surface water hydrology impacts. These include Scenario 5 (diesel pipeline release) and Scenario 6 (LNG release).

Scenario 1: Ocean Barge Rupture at Sea

The spread of a large volume (up to 735,000 gallons) spill of diesel fuel from an ocean-going barge during the summer shipping season would be influenced primarily by ocean currents between Dutch Harbor and Bethel. The spreading of diesel fuel over the sea surface would begin as soon as the fuel is spilled. Dispersal and evaporation would take approximately three to five days; however, the rate of spreading would depend upon the viscosity and composition of the spilled fuel, the ambient temperature, and the environmental conditions (wind, waves, and ocean currents) present at the time and location of the spill.

Scenario 2: River Barge Release

A river barge release of diesel fuel into the Kuskokwim River would be highly impacted by surface water hydrology. Spreading of diesel fuel over the river surface would begin as soon as the fuel is spilled. The rate of spreading and the area of the sheen would depend upon the viscosity and composition of the spilled fuel, the rate of release, the ambient temperature, and the environmental conditions (wind, waves, and river velocities) at the time and location of the spill.

Diesel fuel that is not recovered from a barge release would travel downstream; the rate of spread would be influenced by wind, wave, and velocities present at the time of the release. Under average flow conditions during the open-water season, the velocity of the Kuskokwim River averages 6 feet/second (4.1 miles/hour). However, evaporation and dilution would limit the extent of water quality impacts resulting from a diesel spill in the main stem of the Kuskokwim River. Physical and chemical properties of diesel fuel are substantially different than those of crude oil insofar as diesel evaporates and disperses faster and more completely. Diesel evaporation rates for a low (32°F) and high (55°F) range of temperatures were estimated for a river barge release in the Kuskokwim River. After 4 days, approximately 39 percent and 59 percent of diesel fuel would be evaporated, respectively (ERM 2017c).

Scenario 3: Tank Farm Release

In the unlikely event that diesel was released into the environment, factors influencing the impacts of a spill would include the location of the spill and proximity to streams and drainage features, stream velocities, and the volume of diesel released. Diesel spilled into moving water such as a creek or stream could be rapidly transported downstream and distributed over an area of up to several miles in length before the commencement of containment and recovery activities.

Scenario 4: Tanker Truck Release

The impacts of a spill from a tanker truck on other resources could be affected by surface water hydrology. Factors influencing the impacts of a spill would include the location of the spill and proximity to streams and drainage features, stream velocities, and the volume of diesel released. Diesel spilled into moving water such as a creek or stream could be rapidly transported downstream and distributed over an area of up to several miles in length before the commencement of containment and recovery activities.

Scenario 7: Cyanide Release

In the unlikely scenario of a container ruptured and a release occurring in a tributary stream, attenuation processes including evaporation, dilution, and chemical reaction would limit the effects to a discrete area and would make the duration of impacts short. Other factors influencing the impacts of a potential cyanide release would include the location of the release and proximity to streams and drainage features, stream velocities, and the amount of cyanide released. Cyanide that has already dissolved cannot be recovered and would be left to disperse naturally, which would likely be completed by the time cleanup could be initiated.

Cyanide stored and used on site in a liquid form would be contained within primary and secondary spill containment structures and would be cleaned up prior to release to the environment. Thus, there would be no direct or indirect impacts to surface water hydrology as a result of a cyanide release.

Scenario 8: Mercury Release

Secondary containment would prevent a mercury release to surface water. In the unlikely scenario of a mercury container rupture and a release occurring in a tributary stream, attenuation processes including evaporation, dilution, and chemical reaction would limit the effects to a discrete area and would make the duration of impacts short. Other factors influencing the impacts of a potential mercury release would include the location of the release and proximity to streams and drainage features, stream velocities, and the amount of mercury released.

Mercury and mercury-waste stored at the Mine Site or transported out of state for storage or disposal present a very low potential for contacting surface water as a result of numerous containment and safety system associated with handling the product. Liquid mercury is a viscous fluid, and would not travel far from the spill site, unless the spill occurred directly into a surface water body. Dissolved mercury onto land surface adjacent to surface water bodies would not travel far because of natural attenuation mechanisms, particularly adsorption into surface soil. Cleanup methods, including physical removal of contaminated soils would keep the duration of impacts short. Thus, there would be no direct or indirect impacts to surface water hydrology as a result of a mercury release.

Scenario 9: Partial Tailings Dam Failure

Release-induced changes to surface water hydrology and flows would result in varying adverse physical impacts. Surface water chemical impacts are presented in Section 3.24.6.7.1 (Surface

Water Quality), and chemical impacts to soil and sediment are presented in Section 3.24.6.2.1 (Soils). Both release scenarios would affect flows in the Anaconda Creek drainage located immediately downgradient of the TSF point of release (toe), followed by the Crooked Creek drainage, and to a lesser extent the Kuskokwim River confluence.

Tailings and Water Release Scenario

The scenario would involve the release of 1,620 acre-ft. of slurry consisting of 50 percent solids (sediment) over a 5-hour period. The release would occur from the toe of the TSF. Modeling of maximum flow and tailings deposition depths are presented in Figure 3.24-2 and Figure 3.24-3 respectively. Maximum flow depths greater than 20 feet are anticipated within the Anaconda Creek drainage in closest proximity to the TSF. Flow depths would progressively decrease as the tailings spread out toward the confluence of Anaconda Creek and Crooked Creek, most prominent at the toe of the release. The total volume of deposition at the Anaconda Creek and Crooked Creek confluence is estimated to be approximately 1,300 acre-feet. Deposition depths would range from 10 feet at the A / C confluence, and progressively thin to 2 feet at the furthest depositional extents both upstream and downstream.

Changes to surface water flow would be greatest in the Anaconda Creek drainage, where typical flow conditions are significantly less than those resulting from a TSF release. Average monthly discharges from Anaconda Creek between June and September ranges from 2.1 cfs to 21.6 cfs, with a maximum daily discharge of 78 cfs recorded in July of 2003. Significant scouring and erosion would occur in the Anaconda drainage from the Tailings Dam release scenario described above. The post-release stream character would be more linear (less sinuous), with a wider and deeper channel. A TSF release during frozen winter months may result in comparatively less erosion; however, significant changes would still be anticipated.

Intermixed tailings and eroded materials would be deposited in the wide floodplain of Crooked Creek at the confluence with Anaconda Creek. Heavier particles would settle first in close proximity to the drainage confluence, and would progressively gradate to finer materials with distance and reduced flow velocities. Deposition depths of 8 to 10 feet would extend across much of the Crooked Creek floodplain at the Anaconda Creek confluence. The deposit would form a dam that would be likely to temporarily block flow in Crooked Creek.

If a release were to occur during winter months, flow conditions would be more favorable for initial response and recovery efforts. Tailings would be excavated and transported to the TSF, and accumulated water behind the temporary dam could be discharged within historic (seasonal) flow variations. Limited flow data from the month of December indicates discharges ranging from 16 cfs to 32 cfs, which are foreseeably manageable flow volumes given the availability of Mine Site equipment and resources. Seasonally low flow conditions would also minimize tailings remobilization downstream and allow installation of erosion and sediment control measures. At a minimum, this scenario would result in the brief loss of flow contribution above this watershed location.

A controlled release of accumulated water behind the temporary dam during summer months would be less manageable during high flow conditions. Long term average daily discharges in Crooked Creek seasonally range from approximately 100 cfs to 250 cfs near the confluence. A maximum average daily discharge of 880 cfs was recorded in late August of 2006, and the 2-year and 5-year flood magnitude for the Crooked Creek water shed is 783 cfs, and 1,284 cfs, respectively. If left undisturbed, flow contribution to Crooked Creek above the temporary dam would be blocked until a new channel was established. Flow would likely resume (skirt) along the north side of the valley where deposits are likely to be thinner and finer grained.

Flow volumes associated with the uncontrolled release of water behind the temporary dam would depend on a variety of conditions which include, but are not limited to, stream channel development through the unconsolidated tailings mixture, Crooked Creek flows at the time of TSF release, and water volume behind the temporary dam. The progressive release of water through a newly established channel could potentially result in flood conditions well above historic seasonal variations. Elevated flows through the tailings mixture would remobilize a significant portion of deposited tailings downstream. Stream channel erosion and migration would continue to mobilize tailings downstream until equilibrium is eventually achieved through stream restoration measures and natural processes.

If a significant portion of the deposited tailings mixture was remobilized downstream (Crooked Creek), alteration of the low gradient, sinuous drainage would be most apparent in proximity to the tailings run out at the Anaconda Creek confluence. Coarser materials would settle first, and finer fractions would reach the confluence with the Kuskokwim River 13 miles downstream. Stream bed aggradation from the influx of tailings mixtures would likely result in appreciable channel instability and subsequent migration. Alteration of the stream channel morphology would diminish downstream; however, the extent would largely depend on a variety of physical conditions controlling the influx of remobilized tailings mixtures. Various physical surface water parameters (e.g., turbidity) and elevated concentrations of chemical constituents (metals) in non-recoverable tailings mixtures would likely result in indefinite impairments to surface water quality (Section 3.7, Water Quality).

In addition to initial response efforts to be specified in an Emergency Action Plan required by the State of Alaska Dam Safety Program, a controlled release of accumulated water minimizing tailings remobilization could be performed to the extent safely practicable. Alternatives may include, but not be limited to, temporary channel reconstruction, flow diversion, tailings excavation, and construction of sedimentation ponds. Initial response efforts would largely depend on the suitability of working surfaces capable of supporting heavy equipment.

In terms of intensity, flows in the Anaconda drainage would be far greater than historical flood capacities, likely resulting in scouring and significant erosional losses. A temporary run out at the dam at the Crooked Creek confluence would result in the blockage of upstream flow and water accumulation. A controlled release of accumulated water during winter months would be likely; however, an uncontrolled release of accumulated water well above historical seasonal variations could potentially occur during open-water conditions. In terms of impact duration, flows would equilibrate to pre-release conditions after a channel is re-established through the unconsolidated tailings mixture via natural processes or initial response measures. Flows would be disrupted throughout the Crooked Creek drainage below the temporary dam.

Water Release Only

A release of 1,620 acre-feet of water at a flow rate of 600 cfs would far exceed any historical flow capacity in the Anaconda drainage extending to the Crooked Creek confluence located 1.6 miles downstream. Scenario-specific distribution modeling of maximum flow depths are presented in Figure 3.24-4. A prolonged release lasting more than 48 hours would result in significant scouring and erosion which would adversely alter the pre-existing drainage character.

Open water flows seasonally range from approximately 100 cfs to 250 cfs near the Crooked Creek confluence, and the two-year and five-year flood magnitude for the Crooked Creek water shed is 783 cfs, and 1,284 cfs. Based on these values, it is highly probable that an additional influx of 600 cfs to the Crooked Creek drainage would be within the range of a two to five year flood event. All flow would be limited to the active stream channel and wide, gentle sloping floodplain. A 600 cfs discharge during winter months, however, would be far greater than average seasonal flows which typically range from 16 to 32 cfs during the month of December.

Eventual discharge to the Kuskokwim River would result in an approximate four percent flow increase (Kuskokwim River) during winter months, and a flow increase of approximately 1.8 percent during summer months. The induced changes in Kuskokwim River flow are considered negligible based on comparatively substantial year round flow volumes.

In summary, flows in the Crooked Creek drainage during open-water conditions are likely to be within historical range of seasonal variability; however, a winter release would significantly exceed winter flow conditions. Flow within the Anaconda Creek drainage would be well beyond historic variations for all seasonal conditions. For these reasons, the intensity would be that there would be flow changes to one or more receiving drainages. In terms of duration, flow from the TSF release would cease sometime after 48 hours. The extent or scope of effects would range from discrete portions of the project area during a winter release (i.e., Anaconda drainage) to potentially throughout the project area during a summer release (i.e., Crooked Creek drainage). Depending on resources (e.g., fish) indirectly affected from seasonally dependent outcomes in flow changes, the context of impacts could affect Essential Fish Habitat (EFH) with regulatory protection. EFH is regulated under the Magnuson-Stevens Act that supports spawning, rearing, and migration of anadromous fish.

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

Under Alternative 3A, Scenario 5 (diesel pipeline release) is not applicable, and has not been analyzed for effects to surface water hydrology impacts. The likelihood of Scenarios 1 through 4 (ocean or river barge, tank farm, tanker truck, releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Impacts under Scenarios 7 and 8 (cyanide, and mercury releases) for Alternative 3A would be the same as those discussed under Alternative 2.

Scenario 6: Liquefied Natural Gas (LNG) Release

Under Alternative 3A, an uncontrolled release of LNG would not affect surface water hydrology, as the LNG released would dissipate into the atmosphere, provided that no ignition source triggers an explosion before the LNG dissipates.

3.24.6.5.3 ALTERNATIVE 3B – REDUCED DIESEL BARGING: DIESEL PIPELINE

Under Alternative 3B, Scenario 6 (LNG release) is not applicable and has not been analyzed for surface water hydrology impacts. The impacts under Scenarios 1 and 2 (ocean or river barge releases) would be shifted relative to Alternative 2; however, the impacts would be the same types as discussed under Alternative 2. The likelihood of Scenarios 3 and 4 (tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Scenarios 7, 8, and 9 (cyanide, mercury, and tailings releases) would have the same impacts as discussed under Alternative 2.

Scenario 5: Diesel Pipeline Release

Alternative 3B represents risk of uncontrolled releases from diesel conveyance and handling during pipeline operations and closure. The length of the pipeline, remoteness of the areas traversed by the pipeline, and the number of planned stream crossings would contribute to the risk of spill impacts being influenced by surface water hydrology. Additionally, these factors could encumber response efforts in the event of an unplanned release. The additional 19 miles of diesel pipeline from Tyonek to MP 0 of the pipeline corridor under this alternative would create six more stream/river crossings than under Alternative 2. The duration and scope of a pipeline release into surface water is likely to be greater than Alternative 2 based on the physical and chemical properties of diesel compared to natural gas, the volume and rate of the release, and on the surface water conditions at the release site.

Under Alternative 3B, there are several potential modes of failure that could result in unplanned releases of diesel fuel from the pipeline, each of which could be impacted by surface water hydrology, depending upon the specific location of the release. It is likely that diesel fuel from a medium or large volume spill from the diesel pipeline would reach nearby waterbodies along the pipeline ROW. The geographic extent of impacts resulting from a catastrophic diesel pipeline failure would depend on the location of the rupture relative to isolation valves and surface water resources. For example, in the event of a rupture immediately adjacent to a fast moving river, impacts would be rapidly distributed to downstream locations and could affect hydraulically connected waters if the position of isolation valves is insufficient to control the rate of diesel release to the environment in a timely fashion. Response efforts could also be encumbered by the length of the pipeline and its remote location relative to response facilities. During the winter months, snow and ice may limit the diesel's ability to initially reach surface water resources; however it could also inhibit detection of spills at river and stream crossings.

The potential for surface water hydrology to influence spill impacts during closure and termination activities of the diesel pipeline is greater under Alternative 3B in comparison to Alternative 2. Anticipated pipeline decommissioning activities would include draining and handling of large quantities of residual liquid fuel mixtures in accordance with industry practices using approved state and federal guidance and planning documents. Uncontrolled releases during pipeline closure would most likely result in small spill volumes due to controlled conditions and standardized industry pipeline abandonment practices. Risks of impacts caused by diesel fuel spills or leaks would be reduced by spill response planning, construction of protective and alerting systems, and operational practices designed to avoid, minimize or identify leaks and spills as early as possible.

3.24.6.5.4 ALTERNATIVE 4 – BIRCH TREE CROSSING (BTC) PORT

Under Alternative 4, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to surface water hydrology. Impacts under Scenarios 1, 3, 7, 8, and 9 (ocean barge, tank farm, cyanide, mercury, and tailings releases) for Alternative 4 would be the same as those discussed under Alternative 2.

<u>Scenario 2: River Barge Release</u>

The risk of a river barge release would be somewhat lower under Alternative 4 because of the 38 percent reduction in river-barging miles from Alternative 2, and the avoidance of shallow areas between BTC Port and Angyaruaq (Jungjuk) Port that would not be traveled under Alternative 4. Potential surface water hydrology influences on spill-related impacts would be similar to those discussed under Alternative 2.

<u>Scenario 4: Tanker Truck Release</u>

Under Alternative 4, the BTC Road would be 76 miles long, which is about 2.5 times the length of the Alternative 2 mine access road. Preliminary field reconnaissance of the BTC Road indicates that the road would cross 40 streams. Of these, 8 would require bridges and 32 would require culverts. Additional drainage features (such as intermittent or ephemeral drainages) may exist along the route that would require installation of a culvert to convey flow; however, additional reconnaissance during final design would be required to identify these types of features. Under Alternative 4, the risk of a tanker truck release would be amplified because of the increased one-way haul distance of 76 miles, as compared to 30 miles under Alternative 2.

3.24.6.5.5 ALTERNATIVE 5A – DRY STACK TAILINGS

Under Alternative 5A, Scenarios 5, 6, and 9 (diesel pipeline, LNG, and water and tailings releases) are not applicable and have not been analyzed for impacts to surface water hydrology.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and water only tailings releases) for Alternative 5A would be the same as those discussed under Alternative 2.

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

Under Alternative 6A, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to surface water hydrology.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 6A would be the same as those discussed under Alternative 2.

3.24.6.6 GROUNDWATER HYDROLOGY

3.24.6.6.1 ALTERNATIVE 2 – DONLIN GOLD'S PROPOSED ACTION

Under the proposed action, two spill scenarios do not apply and are not analyzed for groundwater impacts. These include Scenario 5 (diesel pipeline release) and Scenario 6 (LNG release).

<u>Scenario 1: Ocean Barge Rupture at Sea</u>

An ocean barge rupture at sea could affect shallow groundwater resources in shoreline zones if diesel fuel came ashore. The impacts would be limited to areas directly contacted by seawater as a result of high tides, storm surges, or wave action, because dispersed emulsions and dissolved hydrocarbons could infiltrate permeable beach deposits and infiltrate to a shallow near-shore water table. In terms of intensity, impacts would be such that groundwater flow systems are maintained and changes in water quantities are within historic seasonal or minimal variation. Resources would be reduced infrequently and would be expected to return to pre-activity levels after the spill. The extent or scope of impacts would be limited to discrete portions of the project area.

Scenario 2: River Barge Release

In context, a river barge release could affect shallow groundwater resources in shoreline areas if diesel fuel came ashore. The impacts would be limited to areas directly contacted by impacted river water as a result of currents, wave action, or fluctuating river levels because dispersed emulsions and dissolved hydrocarbons could infiltrate permeable sand or gravel bar deposits and infiltrate to a shallow water table; there is no particular context.

Scenario 3: Tank Farm Release

A tank farm release at Angyaruaq (Jungjuk) Port or at the Mine Site would be contained within a lined, impermeable secondary containment structure that would prevent infiltration to groundwater and discharge to surface waters. Spill response would remove the spilled fuel prior to any potential overtopping event caused by precipitation or other event. Thus, there would be no direct or indirect impacts to groundwater resources as a result of a tank farm release.

Scenario 4: Tanker Truck Release

Tanker truck release scenarios occur on the mine access road, most of which is located on uplands, with varying distances to watercourses. In some areas, especially areas where permafrost is absent, fuel from a release large enough to flow into the road ditch or nearby tundra could infiltrate through porous material and percolate to the water table. Spills that occur during frozen conditions (late fall, winter, and early spring) would be less likely to reach the water table due to the presence of ground ice and frozen soils. As a result of the anticipated fuel spill response and cleanup activities that would take place, the amount of fuel that would infiltrate is likely to be a small fraction of the overall amount of the spill or leak. Fuel that does infiltrate and percolate to the water table, however, could be difficult or impossible to remove completely, resulting in highly discrete (unless near a surface water body), but potential impacts that last through the life of the project.

Scenario 7: Cyanide Release

Cyanide would be transported to the Mine Site in solid form in sealed containers via barge and truck. Even if one or more containers ruptured, and a spill occurred in a watery environment, little or no cyanide would encounter groundwater. Natural attenuation processes of evaporation, dilution and chemical reaction would limit effects to a discrete area and would make the duration of impacts infrequent. Potential secondary impacts to the biosphere from groundwater contamination would generally be limited to microorganisms found in the subsurface.

Cyanide stored and used on site in a liquid form would be contained within primary and secondary spill containment structures and would be cleaned up prior to a release to the environment. Thus, there would be no direct or indirect impacts to groundwater resources as a result of a cyanide release.

Scenario 8: Mercury Release

Mercury and mercury-wastes stored at the Mine Site or transported out of state for storage or disposal present a very low potential for contacting groundwater as a result of numerous containment and safety systems associated with handling the product. Liquid mercury is a viscous fluid and would not travel far from the spill site. Dissolved mercury in groundwater would also not travel far because of natural attenuation mechanisms, particularly adsorption onto soil or aquifer materials. Cleanup methods, including physical removal of contaminated soils would groundwater to return to pre-activity levels after the spill event.

Scenario 9: Partial Tailings Dam Failure

In terms of intensity, a partial release of dam tailings could temporarily affect the physical hydrology of shallow groundwater in the Crooked Creek floodplain and Kuskokwim River shoreline areas, in locations where the flood elevation is substantially higher than normal (Figure 3.24-2 and Figure 3.24-3), causing water to flow into shallow alluvial deposits. The maximum increase in water elevation under this scenario is predicted to be about 7 to 8 feet at the confluence of Anaconda and Crooked creeks, and about 1 foot at the confluence of Crooked Creek and the Kuskokwim River (Table 3.24-10). An increased flood elevation of 1 foot near Crooked Creek village would not affect flow in the aquifer used by village drinking water supply well, as it is sited on a hill about 60 feet above Crooked Creek and Kuskokwim River. The source water protection area for the well extends up the hill to the northwest and would not intersect the path of a tailings water flood in Crooked Creek floodplain (Figure 3.6-6).

Impacts to groundwater flow patterns would be limited to areas directly contacted by the release flood. Effects on groundwater quality from metals leaching from the tailings, infiltrating permeable sand or gravel bar deposits, and reaching shallow water table, are described in Section 3.24.6.7.2 (Groundwater Quality). Most impacts on groundwater hydrology are expected to last up to a few days longer than the duration of the release event, and subsiding after creek levels return to normal. A small amount of water table mounding could occur within the thicker parts of the tailings deposit in Anaconda and Crooked creeks, with localized groundwater flow directed radially away from the deposit, which could last for the duration of cleanup activities.

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

Under Alternative 3A, Scenario 5 (diesel pipeline release) is not applicable and has not been analyzed for effects to groundwater resources. The likelihood of Scenarios 1 through 4, ocean or river barge, tank farm and tanker truck releases) occurring would be greatly reduced due to a decrease in barge activity; however, the impacts would be the same types as discussed under Alternative 2. Scenarios 7, 8, and 9 (cyanide, mercury, and tailings releases) for Alternative 3A would have the same impacts on groundwater hydrology as Alternative 2.

Scenario 6: Liquefied Natural Gas (LNG) Release

An occurrence of pinhole leaks in LNG storage tanks, an accident involving an LNG-fueled truck, or the rupture of a storage tank at the LNG plant could occur at the Mine Site. If released, LNG dissipates readily, so it would not infiltrate the soil or the water table. Thus, there would be no direct or indirect impacts to groundwater resources as a result of an LNG release.

3.24.6.6.3 ALTERNATIVE 3B – REDUCED DIESEL BARGING: DIESEL PIPELINE

Under Alternative 3B, Scenario 6 (LNG release) is not applicable and has not been analyzed for effects to groundwater resources. Scenarios 7, 8, and 9 (cyanide, mercury, and tailings releases) for Alternative 3B would have the same impacts on groundwater hydrology as Alternative 2.

Scenarios 1 and 2: Ocean and River Barge Releases

The impacts to groundwater resources in the event of an ocean or river barge release under Alternative 3B would be the same as those discussed under an Alternative 2, except for the following:

- The ocean barge route ends at Tyonek during the Operations and Closure phases of the project, changing the location of potential nearshore shallow groundwater impacts, but not the level of potential effects; and
- River barging would only occur during the Construction Phase, which would reduce the probability of spill impacts to shallow groundwater along the shoreline.

Scenarios 3 and 4: Tank Farm or Tanker Truck Releases

Impacts under these resources would be the same as described under Alternative 2, as some tanks and tanker truck traffic at the mine, mine access road, and Angyaruaq (Jungjuk) Port would still be required under Alternative 3B. In addition, the tank farm at Tyonek Port would add a potential release source under Scenario 3. Although the probability of spills would be inherently reduced at the Angyaruaq (Jungjuk) Port and Mine Site through less diesel storage and transfer, the probability of spills would be increased at Tyonek Port; thus, impacts would generally be the same as described for Alternative 2.

Scenario 5: Diesel Pipeline Release

The impacts to groundwater resources in the event of a diesel pipeline release would be dependent on the volume and rate of the release and on the groundwater conditions at the release site. In areas where the pipeline is constructed on shallow bedrock or permafrost, the infiltration of diesel fuel to groundwater would be limited by the relatively low permeability of the bedrock or frozen materials. In areas where the pipeline is constructed on unfrozen alluvial gravels and sands, diesel fuel would be expected to flow vertically downward until it reaches the water table and then "pancake" out to form a lens of diesel fuel floating on the water table. Removal and restoration of impacted groundwater is possible, but the deeper that the water table is and the larger the spill, the more difficult the operation is. The natural attenuation of a fuel-impacted groundwater body is normally a very long process because the mechanisms of attenuation, including dissolution, dilution, dispersion, biodegradation, sorption, and vaporization are typically very slow processes.

Because most of the diesel pipeline would be buried, a leak that is too small to trigger a response from the leak detection technology could leak for many months before being detected. A leak of this type could create a pool of floating diesel on the water table that could extend for several tens of feet in each direction from the leak before it accumulated to sufficient thickness or extent to surface and be noticeable by visual or olfactory identification. The diesel could create a pool in a closed depression near the leak, emanate from the land surface as a seep, or discharge to nearby wetlands or surface waters (Fetter 2001). In terms of intensity, if the leak goes undetected for long enough and occurs in a vegetated area, it could kill or stress vegetation in the vicinity of the leak. Should a pool of diesel form on the water table from a very small to medium-sized leak, it would likely persist for decades; however, the impact would likely be limited to discrete portions of the project area near the spill.

A large to very large leak or spill would also have the potential to infiltrate to groundwater, especially in areas that are not underlain by shallow bedrock or permafrost, or if the remote location or environmental conditions (e.g., weather, deep snow, flooding, avalanche, landslide, or other conditions) preclude a rapid emergency response. While the immediate flow of diesel could reach surface waters (including wetlands) and potentially be contained and cleaned up in an expedited manner, a large pool of subsurface diesel could be more persistent. However, through source removal, remediation, and use of sorbents and booms (if fuel seeps out into surface water bodies), even a very large spill to groundwater could be substantially contained. Residual dissolved diesel constituents entering surface water bodies would likely be attenuated through natural processes to acceptable levels. The intensity of impacts to groundwater would be expected to be lower than direct impacts of a large spill or leak on surface water resources (see Section 3.24.6.5, Surface Water Hydrology); however, it may take longer to cleanup.

Risks of impacts caused by diesel fuel spills or leaks could be reduced by spill response planning, construction of protective and alerting systems, and operational practices designed to avoid, minimize or identify leaks and spills as early as possible. Potential impacts to groundwater from a large or very large spill could be minimized by long-term groundwater monitoring, contaminant source removal, and groundwater remediation, if needed.

3.24.6.6.4 ALTERNATIVE 4 – BIRCH TREE CROSSING (BTC) PORT

Under Alternative 4, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to groundwater resources. Impacts under Scenarios 7 through 9 (cyanide, mercury, and tailings releases) for Alternative 4 would be the same as those discussed under Alternative 2.

Impacts to groundwater resources in the event of a diesel release (Scenarios 1 through 4; ocean or river barge, tank farm or tanker truck releases) under Alternative 4 would be the same as those discussed under Alternative 2, with the following exceptions:

- The risk of a river barge grounding would be somewhat lower under Alternative 4 because of the 38 percent reduction in river-barging miles from Alternative 2, and the avoidance of shallow areas between BTC Port and Angyaruaq (Jungjuk) Port that would not be traveled under Alternative 4; and
- The risk of a tanker truck release would be increased because the one-way haul distance would be 76 miles, as compared to 30 miles under Alternative 2. The land and water area that could potentially be exposed to risks from a tanker truck release under

Alternative 4 would be approximately 2.5 times larger than those exposed under Alternative 2 as a result of the longer BTC Road.

3.24.6.6.5 ALTERNATIVE 5A – DRY STACK TAILINGS

Under Alternative 5A, Scenarios 5, 6, and 9 (diesel pipeline, LNG, and water and tailings releases) are not applicable and have not been analyzed for impacts to groundwater resources.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and water only tailings releases) for Alternative 5A would be the same as those discussed under Alternative 2.

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

Under Alternative 6A, Scenario 5 (diesel pipeline release) and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to groundwater resources.

Impacts under fuel release Scenarios 1 through 4, and 7 and 8 (ocean or river barge, tank farm, tanker truck, cyanide, and mercury releases) for Alternative 6A would be the same as those discussed under Alternative 2.

3.24.6.7 WATER QUALITY

The effects of project-related spills on geochemistry are considered not applicable, as a fuel spill or LNG release would not affect ongoing geochemical processes occurring at the Mine Site, and geochemical alterations of mine rock would not cause or exacerbate spills or spill cleanup.

3.24.6.7.1 SURFACE WATER QUALITY

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

Under the proposed action, two spill scenarios do not apply and are not analyzed for surface water quality impacts. These include Scenario 5 (diesel pipeline release) and Scenario 6 (LNG release).

Scenario 1: Ocean Barge Rupture at Sea

In terms of intensity, a large volume (up to 735,000 gallons) spill of diesel fuel from an ocean-going fuel barge at sea during the summer shipping season would result in impacts to marine surface water quality over a relatively large area. When spilled on water, diesel oil spreads very quickly forming a thin film of rainbow and silver sheens. Spreading of the diesel fuel over the sea surface would begin as soon as the fuel is spilled. The rate of spreading would depend upon the viscosity and composition of the spilled fuel, the ambient temperature, and the environmental conditions (wind, waves, and ocean currents) present at the time and location of the spill. Diesel oil is much lighter than water (specific gravity of diesel is between 0.83 and 0.88, compared to 1.03 for seawater), and it is not possible for diesel to sink and accumulate on the seafloor unless adsorption occurs with sediment (NOAA 2014a). A small fraction of the spilled fuel dispersed in the water column by wave action could adhere to fine-grained suspended sediments, leading to subsequent deposition of contaminated sediment on the seafloor. This process would be more likely to occur near river mouths where high concentrations of fine-grained sediments are carried in by rivers, and would be less likely to occur in open marine settings. Some of the spilled diesel that may be dispersed by wave action would form droplets that are kept in suspension and moved by ocean currents.

Because petroleum-derived diesel is composed of about 75 percent saturated hydrocarbons, and 25 percent aromatic hydrocarbons (ATSDR 1995), during the initial phase of the spill the most relevant applicable water quality standards would likely be those related to concentrations of total aqueous hydrocarbons and visible surface sheen, rather than standards related to total aromatic hydrocarbons. However, the composition of the spilled diesel in the water would change over time as lower molecular weight hydrocarbon compounds would tend to evaporate faster than those with higher molecular weights. Concentrations of total aqueous hydrocarbons in the water column would likely exceed the 15 µg/L threshold specified by the most stringent Ambient Water Quality Criteria (AWQC) over a relatively large area for a period of several days (ADEC 2012d). Likewise, the sheen resulting from a large diesel spill at sea would be sufficient to exceed water quality regulatory limits for petroleum hydrocarbons in marine waters over a relatively large area (ADEC 2012d). In terms of intensity, there would be widespread exceedances of the applicable water quality standards.

Due to the low density of diesel fuel relative to that of sea water, impacts would be confined to the upper layers of the water column, and the duration of the impacts to surface water quality would be limited by physical (evaporation) and mechanical (natural dispersion and dissolution) processes. The duration of impacts to surface water quality would be limited primarily by the rapid evaporation of diesel fuel, and natural dispersion processes where wave action leads to the formation of micron-sized droplets that are diluted to concentrations below the threshold values (Zervopoulou et al. 2011). Dispersal and evaporation would likely take approximately 3 to 5 days; however, rough weather and wave action would reduce that timeframe.

In summary, a large spill of diesel would affect surface water quality by increasing the concentrations of hydrocarbons in the upper layers of the water column in a large area to levels that greatly exceed background concentrations. The impacts to surface water quality resulting from the release would be sufficient to exceed water quality regulatory limits and baseline ranges. Due to the volume of diesel fuel considered under this scenario, the impacts would likely extend beyond the area of the spill; marine currents and transport processes would likely spread impacts to adjacent waters. The duration of the impacts to surface water quality would be limited to several days due to evaporation and natural dispersion processes. If the spill were to occur in open ocean water (highly unlikely), then the surface water resources impacted would be considered common in context. Due to the intensity and extent of impacts to surface water quality resulting from a fuel spill, the impacts would depend on the specific location and timing of the spill, and the efficacy of response and cleanup efforts.

Scenario 2: River Barge Release

In terms of intensity, the release of diesel fuel to the Kuskokwim River as the result of a river barge release would result in impacts to surface water quality at the site of the release and downstream locations in the Kuskokwim River. Concentrations of total aqueous hydrocarbons in the water column would likely exceed the 15 µg/L threshold specified by the most stringent AWQC over a relatively large area (ADEC 2012d). Likewise, the sheen resulting from a large diesel spill in the Kuskokwim River would be sufficient to exceed water quality regulatory limits for petroleum hydrocarbons in freshwater over a relatively large area (ADEC 2012d).

When spilled on water, diesel oil spreads very quickly forming a thin film of rainbow and silver sheens. Spreading of the diesel fuel over the river surface would begin as soon as the fuel is spilled. Release over time would result in a long narrow sheen, which would extend downstream for distances of up to several miles. The rate of spreading and the area of the sheen would depend upon the viscosity and composition of the spilled fuel, the rate of release, the ambient temperature, and the environmental conditions (wind, waves, and river flow rate) at the time and location of the spill. Evaporation and dilution would ultimately limit the extent of water quality impacts resulting from a diesel spill in the main stem of the Kuskokwim River. It is important to note that the physical and chemical properties of diesel fuel are substantially different than those of crude oil insofar as diesel evaporates and disperses faster and more completely compared to heavier petroleum products such as crude oil.

Response efforts would focus on the protection of sensitive resources along the river banks, and preventing the ingress of spilled diesel to low energy areas of the river, where retarded natural weathering processes could result in accumulation of spilled fuel and longer-term impacts to water quality. In the main stem of the river, rapid evaporation and dilution would limit the duration of impacts to a period of several days.

In terms of intensity, a river barge release would result in impacts to surface water resources because the effects would be sufficient to exceed regulatory limits for hydrocarbons in surface water. The duration of effects would be limited to a period of several days due to naturally occurring evaporation and dissolution processes. The impacts resulting from spilled diesel in the Kuskokwim River would extend downstream over distances of up to several miles beyond which natural processes would attenuate the impacts to below regulatory threshold levels. It is worth noting that if a spill were to occur during the salmon fishing season, then the perception of water quality impacts by salmon fishers and other resource users could potentially extend far beyond the area affected by actual water quality impacts resulting from spilled diesel. The context would be the cultural and economic importance of the Kuskokwim River as a shared resource. Overall, the impacts to surface water quality in the Kuskokwim River resulting from a river barge release would depend on the specific location and timing of the spill, and the efficacy of response and cleanup efforts.

Scenario 3: Tank Farm Release

For the scenarios involving accidental releases from the tank farm that are captured in secondary containment, there would be no impact to surface water quality.

There could be impacts to surface water quality from releases as a result of transfer line rupture or human error during diesel fuel transfer operations. Depending on the location of the release relative to the shoreline, some of the diesel could be released directly to the water resulting in high-intensity impacts to surface water quality due to exceedances of the AWQC governing acceptable concentrations of total aqueous hydrocarbons in natural waters. The geographic extent of such impacts would be limited by the presence of secondary containment systems, such as containment booms, which would be deployed prior to any fuel transfer operation over water (SLR 2012a). Some fraction of the spilled diesel would evaporate from the surface of the water and the remainder would be recovered using sorbent materials and skimmers (SLR 2012a). In terms of impact duration and extent, spilled material would be recovered immediately following the release and would be contained within a small area adjacent to the area of release. In terms of context, impacts would affect areas of ordinary water quality or where there is an abundance of water resources.

In summary, although there would be impacts to surface water quality, the impacts to surface water quality resulting from an unplanned release of diesel as a result of transfer line rupture or human error during diesel transfer operations would result in the spilled material being completely contained and recovering within a short period of time (hours to days).

Scenario 4: Tanker Truck Release

An accident resulting in a tanker truck rollover or collision could potentially release up to 13,500 gallons of diesel fuel to the environment. Intensity of impacts would depend on the specific location of the accident, proximity to surface water resources, and the volume of diesel released to the environment the impacts to surface water resources. Concentrations of total aqueous hydrocarbons in surface water could exceed the applicable water quality regulatory limits. The response to a tanker truck release could be hampered by several factors that would impede recovery of the spilled material. For example, diesel spilled into moving water such as a creek or stream could be rapidly transported downstream and distributed over an area of up to several miles in length before the commencement of containment and recovery activities. However, the geographic extent of impacts associated with such a release would not be likely to extend beyond a discrete portion of the Project Area. In addition, a substantial fraction of the spilled diesel would evaporate before it could be recovered from the surface of the water. The duration of the impacts would include time for concentrations of total aqueous hydrocarbons would return to below threshold levels specified by the most stringent applicable water quality criterion (15µg/L; ADEC 2012a) within a period of several days following the accidental release. Impacts would be considered to exceed the AWQC. In context, response efforts associated with a tanker truck release would focus on the protection of sensitive resources, such as fish-bearing streams, wetlands, and waterfowl habitat. In most cases, smaller volume releases would result in lower levels of impacts; releases occurring away from surface water resources would be unlikely to have any impacts on surface water quality provided that response and cleanup efforts are successful.

Scenario 7: Cyanide Release

If waterproof containers were recovered without rupturing, there would be no direct impacts of the cyanide on surface water resources.

In the event that cyanide is released to flowing water, the cyanide would be rapidly diluted and would flow downstream. Cyanide degrades rapidly in surface waters at near neutral pH. Although cyanide is toxic to many living organisms at low concentrations, infrequent acute impacts would occur over a relatively small area due to the effects of dilution, dispersion, and natural degradation processes occurring within the river. The most stringent applicable numeric water quality criterion for cyanide in fresh water is the Criterion Chronic Concentration of 5.2 µg/L (4-day average) measured as WAD cyanide or equivalent for protection of aquatic life (ADEC 2008a).

A very low probability potential spill scenario may result from a vehicle collision during transport from Angyaruaq (Jungjuk) Port to the mine. In terms of intensity, if solid sodium cyanide briquettes were spilled from a tank-tainer directly to surface water, then impacts to surface water resources would occur as the concentrations of cyanide in the water at the location of the spill would exceed the applicable numeric water quality criterion for cyanide. In the case of flowing waters, such as rives or streams, the effects of a cyanide release would rapidly decrease with distance from the spill and the intensity of impacts would decrease as the concentrations of cyanide in the water decrease to levels below the applicable water quality standards. If cyanide is released to non-flowing waters, such as stagnant lakes or wetlands, concentrations of cyanide in excess of the applicable criterion could persist over longer time scales (e.g., months); however, the geographic extent of such impacts would be limited to the area of the non-flowing water body to which the cyanide is released.

Scenario 8: Mercury Release

Due to the spill prevention measures and emphasis on safe handling practices considered under Alternative 2, any inadvertent release of mercury to surface water is very unlikely.

In the unlikely event that cargo is lost overboard from a barge, the mercury containers would rapidly sink to the bottom of the river and would become embedded in the riverbed. Due to the high density of mercury (~13.5 g/cm^3) relative to water (~1.0 g/cm^3), mercury-filled containers would be very heavy and unlikely to move very far from the site of the cargo loss, be recovered by salvage specialists, and impacts from mercury to surface water would not occur. It should be noted that due to the high density of liquid mercury, containers would be heavy and special protocols would be needed for retrieving containers dropped in the water.

A very low probability potential spill scenario could result from damage to or spillage from the flasks, metric tonne containers, and drums that contain liquid elemental mercury and spent carbon while being stored within the accumulated storage area and the centralized storage areas locations. Any release of mercury from these areas would be managed by secondary containment systems and would not be expected to influence the quality of surface water in the mine facilities area, the pipeline area, or the transportation corridor.

A low probability mercury spill scenario may result from transportation to Angyaruaq (Jungjuk) Port. In the unlikely event that there is an accident and the containers ruptured, a mercury spill (either the liquid mercury or the spent carbon) could result. In terms of intensity, the liquid elemental mercury and the spent carbon could be released to the land or surface water. An unplanned release of concentrated liquid mercury directly to surface water would likely result in concentrations of total mercury in the water in excess of the 12ng/L most stringent applicable water quality standard (ADEC 2008a, 2012a). In the extremely unlikely event that liquid elemental mercury is spilled to surface water, it would sink and form a pool on the bottom of the water body. Depending upon the bottom composition, some fraction of the spilled mercury would become embedded in the sediment, where it would interact with organic material in the sediment and it would likely persist in various forms over timescales of years to decades. Depending on local flow velocities and other hydrodynamic factors in the vicinity of the mercury spill, some of the spilled mercury would be transported downstream. In the Kuskokwim River, for example, we would expect a localized persistent 'hotspot' in the immediate vicinity of the spilled mercury, and concentrations of mercury in the water and sediment would decrease to below the applicable threshold values over spatial scales of meters due to the diluting and dispersing effects of the flowing water. The situation would be similar in non-flowing water. Mercury concentrations would likely exceed the applicable threshold values over a small area adjacent to the location of the release. The impacts would likely persist for years to decades in non-flowing water due to the lack of dilution and dispersion in such situations; however, spill response and clean-up efforts would be simplified and likely more efficient in non-flowing water relative to flowing water. The duration of impacts to surface water resulting from an unplanned release of mercury could persist throughout the operational period of the project and concentrations of mercury in the water would return to pre-activity levels at some time after the completion of the project. The effects would affect only discrete portions of the Project Area in close proximity to the spill would be affected. The affected resources would vary in context.

Scenario 9: Partial Tailings Dam Failure

In the very unlikely event of a spill resulting from a partial tailings dam failure, the impacts to surface water, groundwater, and sediment resources would be inextricably linked, and the impacts to these resource types would be driven by common impact producing factors. Due to the dependence of impacts to surface water, groundwater, and sediment quality on these common factors, the impacts to these resource types are analyzed together below, in order to preclude redundancy.

Water quality impacts resulting from partial tailings dam failure scenarios are generally limited to chemical evaluation and comparison to water quality standards. Physical impacts resulting in potential changes to surface water hydrology and flow regimes are presented in Section 3.24.6.5.1 (Surface Water Hydrology); and chemical and physical impacts to soil are presented in Section 3.24.6.2.1 (Soils).

Released media would include TSF tailings (solids) and / or water. Water quality impacts would vary based on chemical attributes unique to each media, and would also depend on seasonally dependent physical and chemical conditions at the time of release. Concentrations of analytes expected to exceed the most stringent Applicable Water Quality Criteria (AWQC) in TSF pond water and pore-water in buried tailings are summarized in Table 3.24-12 below. It should be noted, however, that water and tailings contained in the TSF would not be considered waters of the State of Alaska or waters of the U.S. for Clean Water Act purposes.

Multiple analytes in TSF water will exceed the concentrations specified by the most stringent water quality criteria. Although any intentional discharge of TSF water under planned mine operations would be sufficiently treated to comply with APDES requirements, an uncontrolled release of untreated TSF water would potentially result in adverse effects to water quality resulting from contribution (loading) of analytes to receiving waters. A total of seven analytes in TSF water exceed the concentrations specified in the most stringent AWQC by an order of magnitude or greater. These include sulfate, antimony, arsenic, iron, manganese, molybdenum, and mercury. Analyte concentrations in TSF water with the greatest water quality standards disparity include mercury, arsenic, and potentially antimony. However, the high mercury levels would be addressed through process plant design that would include a dosage facility to allow chemical addition to precipitate mercury as a stable mercury sulfide compound that would remain with the tailings solids in the TSF (SRK 2017b).

Representative concentrations of analytes in final plant tailings solids are summarized in Appendix H, Table H-2. Values corresponding with the Phase 2 pilot testing in Table H-2 are considered most representative of combined ore types that would be processed through the process facilities.

Table 3.24-12: Tailings Pond Water and Pore-Water Quality in Buried Tailings for Regulated Analytes of Concern

Parameter	Units	AWQC	Solubility Constrained	Tailings Pond Water	Buried Tailings – Process DOC
Major Constituents					
pH	S. U.	6.5-8.5[1]	X	6.5	5.8
Fluoride	mg/L	1[2e]	X	2	2
Sulfate	mg/L	250[1]	X	5,800	4,400
Metals					
Antimony	µg/L	6[2d]	X	22	1,100
Arsenic	µg/L	10[2d]	X	3,300	15,000
Cadmium	µg/L	0.64[2a,b]		0.73	0.73
Iron	µg/L	1,000[2b]	X	4.4	98,000
Manganese	µg/L	50[2f]	X	2,000	2,000
Molybdenum	µg/L	10[2e]		230	230
Selenium	µg/L	4.6[2b]		42	42
Mercury	ng/L	12[2b]		10,000[3]	10,000[3]

Notes:

All tailings pond water and pore-water concentrations are "dissolved" and should be used as "average" annual.
AWQC:

1 18 AAC 70. ADEC, Alaska Water Quality Standards. Amended as of April 8, 2012, maximum drinking water levels.
2 Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances. Amended through December 12, 2008. Most stringent criteria used. Criteria are expressed in terms of dissolved metal in the water column, except for aluminum and mercury, which are in terms of total recoverable metal.
2a Aquatic life for fresh water hardness-dependent criteria. A hardness of >400 mg/L was used for all calculations. For aluminum,
if pH≥7.0 and hardness ≥50, then 750 µg/L.
2b Aquatic life for fresh water (chronic) criteria.
2c Aquatic life for fresh water (acute) criteria.
2d Drinking water primary maximum contaminant levels.
2e Irrigation water criteria.
2f Human health criteria for non-carcinogens (for consumption of water + aquatic organisms).
2g Aquatic life for fresh water (chronic) criteria based on pH and temperature when early life stages of fish are present.
3 Hatch 2015a; Donlin 2015, personal communication (RE: Hg in TSF pond water email from Gene Weglinski to Nancy Darigo, Aug 26, 2015).

Source: SRK 2015a.

Analysis of the TSF tailings reported elevated concentrations of multiple constituents, of which arsenic, antimony, and lead are most notable (SRK 2017b). Although the tailings filtrate results provide a relative comparison of analyte concentrations in TSF solids, meteoric water mobility procedure (MWMP) test results are more representative of potential chemical impacts to surface water under the tailings mixture release scenario. The MWMP test results are used to determine the nature and quantities of soluble constituents that may be washed from tailings materials under natural precipitation conditions (e.g., rainfall, snowmelt). In the unlikely event of a partial tailings dam failure, tailings deposited downgradient of the TSF would represent a large quantity of source material that could be capable of releasing chemical constituents to surface water receptors over relatively long timescales (e.g., up to decades). Specific MWMP test results for the 2007 Phase 2 pilot-plant transitional final tailings are summarized in Table 3.24-13 and Table 3.24-14, respectively.

Table 3.24-13: 2007 Phase 2 Pilot Plant Transitional Tailings Solids MWMP Species Results

Parameter	Unit	AWQS[1]	Leachate	1st DI Rinse	2nd DI Rinse	3rd DI Rinse	4th DI Rinse
TSS	mg/L	--	5	3	2	3	2
TDS	mg/L	--	2,900	2,820	2,370	1,160	1,440
pH	units	6.5-8.5[1]	6.85	6.86	6.83	6.65	7.06
Alkalinity	mg/L as $CaCO_3$	--	28	32	35	20	27
Acidity	mg/L as $CaCO_3$	--	<2	<2	<2	<2	<2
Conductivity	µS/cm	--	2,960	2,770	2,350	1,390	1,440
Carbonate	mg/L as $CaCO_3$	--	<2	<2	<2	<2	<2
HCO_3	mg/L as $CaCO_3$	--	28	32	35	20	27
OH	mg/L as $CaCO_3$	--	<2	<2	<2	<2	<2
F	mg/L	--	0.45	0.50	0.47	0.30	0.27
$NH_3^+NH_4$	as N mg/L	--	0.8	0.4	0.1	<0.1	0.2
CN(T)	mg/L	--	0.04	0.012	0.014	0.018	0.031
CN (F)	mg/L	--	--	--	--	--	--
CNWAD	mg/L	0.0052[1]	<0.01	<0.005	<0.005	<0.005	<0.007
CNO	mg/L	--	--	--	--	--	--
CNS	mg/L	--	--	--	--	--	--
Cl	mg/L	0.23[2]	3.2	<2	<2	<2	<2
SO_4	mg/L	250	2,000	1,900	1,500	850	1,600
NO_2	as N mg/L	--	8.63	3.54	1.27	0.38	1.84
NO_3	as N mg/L	--	<0.5	<0.5	<0.5	<0.05	0.16

Notes:

1 Alaska water quality standards
2 Aquatic life criteria for fresh waters (chronic)

Source: SRK 2017b; Table 4-5.

The standard MWMP result is from the first deionized (DI) water rinse; however, additional rinses were performed to evaluate response to additional rinsing from natural precipitation. Analytes with reported values above drinking and aquatic life standards in the first MWMP rinse include sulfate, chloride, arsenic, manganese, antimony and molybdenum. Concentrations of mercury in the MWMP rinse water were below the numeric criterion specified for protection of human health, and at or below the most stringent AWQC of 12 ng/L for protection of aquatic life in fresh water (chronic). Although reported concentrations of molybdenum are below the AWQC by the third rinse, concentrations of sulfate, arsenic, manganese and antimony persist at levels above their respective AWQC.

The controlled MWMP test results are indicative of chemical conditions and trends that could be induced from a TSF tailings release; however, additional kinetic cell testing profiles for constituents of concern (i.e., sulfate, arsenic, manganese, and antimony) are also available for comparison. Kinetic cell testing profiles of final tailings were performed to evaluate acid generation and metal solubilization (and transport) characteristics. The tests involve subjecting the tailings to periodic leaching and collection of leachate for analysis. Available data indicated no adverse acid generation trends (SRK 2017b). The release of arsenic from 2007 Phase 1 final tailings stabilized in the 0.10 to 0.15 mg/L range after 65 weeks of testing. Antimony release was stable throughout testing at less than 0.05 mg/L. The leachate test results indicate both metals will persist well above their respective AWQC.

Kinetic testing (humidity cell) of leachate for sulfate concentrations in 2007 Phase 1 final tailings (MWMP test material) show a declining trend from 310 mg/L to eventual stabilization at approximately 100 mg/L. Sulfate concentrations in leachate dropped below the AWQC standard of 250 mg/L after week five of testing (SRK 2017b). The results imply that adverse sulfate contribution in leachate from deposited tailings at levels above those specified in AWQC could be comparatively short in duration.

Tailings and Water Release

The 1,620 acre-feet of slurry mixture released from the toe of the TSF under this scenario would have a solids concentration of 50 percent, and would be released over a five hour period. Tailings solids would be deposited throughout the entire inundation zone shown in Figure 3.24-2; however, approximately 1,300 acre-feet would be deposited at a terminal run-out located at the Anaconda Creek and Crooked Creek confluence. Deposition of tailings solids in the Anaconda Creek drainage would primarily result in depths of 2 feet or less, but would be as great as 8 feet in thickness in discrete areas. Deposition depths at the tailings run-out would be as great as 10 feet. The total areal extent of tailings deposition under this scenario is approximately 1,700 acres.

Varying quantities of previously undisturbed native materials (soil and water) would be intermixed with the tailings slurry by erosional processes during the release. Seasonal conditions (frozen) at the time of the release would likely influence the degree of intermixing; however, some appreciable dilution of the tailings mixture would occur. The released solids and water mixture would result in adverse impacts to surface water quality; however, the duration and intensity of impacts associated with dissolved constituents in entrained TSF water would likely be less severe in comparison to the potentially prolonged adverse impacts to water quality associated with leachate from the released tailings solids. The released mixture is assumed to have a constant sediment concentration by volume of approximately 50 percent, which represents fully consolidated tailings at the end of operations (BGC 2015n). Based on the composition of the tailings in the facility, it is assumed that most of the TSF water would be retained interstitially during tailings deposition.

Table 3.24-14: 2007 Phase 2 Pilot Plant Transitional Tailings Solids MWMP Dissolved Metals Results

Parameter	Unit	AWQS[1]	Leachate	1st DI Rinse	2nd DI Rinse	3rd DI Rinse	4th DI Rinse
Ag	mg/L	--	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Al	mg/L	--	<0.01	<0.01	0.02	0.02	0.01
As	mg/L	0.01[2]	0.463	0.506	0.500	0.412	0.402
B	mg/L	--	0.160	0.158	0.0736	0.0207	0.0316
Ba	mg/L	2[2]	0.0160	0.0185	0.0189	0.0131	0.0428
Be	mg/L	0.004[2]	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Bi	mg/L	--	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Ca	mg/L	--	528	512	555	326	378
Cd	mg/L	0.005[2]	0.000083	0.000061	0.000043	0.000017	0.000045
Ce	mg/L	--	<0.00007	<0.00007	<0.00007	<0.00007	<0.00007
Co	mg/L	0.050[6]	0.00665	0.00584	0.00362	0.00150	0.00189
Cr	mg/L	0.1[2]	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cs	mg/L	--	0.0004	0.0003	0.0002	<0.0001	<0.0001
Cu	mg/L	0.20[6]	0.0078	0.0052	<0.003	0.0015	0.0036
Fe	mg/L	1[4]	0.03	0.05	0.02	<0.01	0.03
Ga	mg/L	--	0.00002	0.00005	0.00004	0.00005	0.00006
Ge	mg/L	--	0.00015	0.00015	0.00008	0.00004	0.00005
Hf	mg/L	--	0.000098	0.0000048	0.000061	0.000018	0.00002
Hg	mg/L	0.00005[3]	0.00001	0.00001	0.000007	0.000005	0.000003
In	mg/L	--	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
K	mg/L	--	17.2	15.9	11.5	5.16	4.70
La	mg/L	--	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
Li	mg/L	[6]2.5	<0.002	<0.002	<0.002	<0.002	<0.002
Mg	mg/L	--	140	122	52.9	8.72	5.58
Mn	mg/L	[3]0.05	3.27	3.14	2.06	0.870	0.966
Mo	mg/L	[6]0.010	0.0368	0.0309	0.0115	0.00268	0.00477
Na	mg/L	--	85.5	38.5	1.76	0.34	0.69
Nb	mg/L	--	0.000002	0.000006	<0.000001	<0.000001	<0.000001
Ni	mg/L	[2]0.1	0.0142	0.0122	0.0073	0.0033	0.0185
Pb	mg/L	[6]0.05	0.00022	0.0036	0.0008	0.00056	0.0002
Rb	mg/L	--	0.00933	0.00795	0.00484	0.00239	0.00186

Table 3.24-14: 2007 Phase 2 Pilot Plant Transitional Tailings Solids MWMP Dissolved Metals Results

Parameter	Unit	AWQS[1]	Leachate	1st DI Rinse	2nd DI Rinse	3rd DI Rinse	4th DI Rinse
Re	mg/L	--	<0.0002	<0.0001	<0.0001	<0.0001	<0.0001
Sb	mg/L	[2]0.006	0.0393	0.0448	0.0431	0.0239	0.0222
Se	mg/L	[4]0.005	0.004	0.003	<0.001	<0.001	<0.001
Si	mg/L	--	2.87	3.56	3.52	1.83	2.03
Sn	mg/L	--	0.00014	0.00032	0.00035	0.00035	0.00045
Sr	mg/L	--	1.90	1.86	1.82	0.0941	0.0003
Ta	mg/L	--	0.000013	0.000008	0.00001	0.00004	0.000001
Te	mg/L	--	<0.00003	<0.00006	<0.00003	<0.00003	<0.00003
Th	mg/L	--	0.000841	0.000519	0.000634	0.000042	0.00149
Ti	mg/L	--	0.0003	0.0006	0.0003	0.0003	0.0003
Tl	mg/L	[3]0.0017	0.000058	0.000046	0.00002	0.000004	0.00001
U	mg/L	--	0.00119	0.00177	0.000978	0.000565	0.000956
V	mg/L	[6]0.10	0.00025	0.00041	0.00030	0.0006	0.00059
W	mg/L	--	0.00019	0.00024	0.00023	0.00011	0.00016
Y	mg/L	--	0.000010	0.000013	0.000008	0.000005	0.000009
Zn	mg/L	[6]2.0	0.008	0.007	0.004	0.003	0.010
Zr	mg/L	--	0.00014	0.00007	0.00032	0.00023	0.00003

Notes:

1 Alaska water quality criteria
2 Drinking water primary max. contaminant levels
3 Human health criteria for non-carcinogens (for consumption of water + aquatic organisms)
4 Aquatic life criteria for fresh waters (chronic)
5 Aquatic life criteria for free cyanide shall be measured as WAD cyanide or equivalent
6 Stockwater + irrigation water criteria
7 Acute, freshwater ammonia criteria based on pH - criteria not available for pHs <6.5
-- = N/A

Source: SRK 2017b; Table 4-6.

Some TSF water could be expelled over a relatively short period through dewatering of the tailings mixture during initial deposition and settlement. This would cause an abrupt influx of partially diluted TSF water to the Crooked Creek drainage. The extent of dispersion would be impeded since the tailings deposit at the Anaconda Creek confluence would temporarily dam Crooked Creek flow (Figure 3.24-2). Much of the expelled TSF water would likely remain within the drainage until flow resumed with stream channel re-establishment. Initial post depositional flow in the Crooked Creek drainage would likely result in acute loading of dissolved TSF water constituents in surface water that would progressively diminish to a relative point of stabilization with continued flushing. It is anticipated that certain dissolved constituents in TSF water would temporarily exceed AWQC throughout the entire drainage to the Kuskokwim River. These would include sulfate, antimony, arsenic, iron, manganese, molybdenum, mercury, and potentially selenium pending dilutional processes.

Prolonged chemical impacts to surface water would largely be attributed to dissolution of constituents from tailings solids released in the event of tailings dam failure. Such impacts would be driven by meteoric and surface water leachate from deposited tailings source material, and tailings redistributed within the drainage from erosional processes. A variety of variables would influence chemical impacts derived from tailings leachate, including exposure of meteoric and surface water to tailings mixtures, and dilution from Crooked Creek flows.

Limited Crooked Creek flow data from the month of December indicates discharges range from 16 cfs to 32 cfs. Long term (open water) average daily discharges in Crooked Creek seasonally range from approximately 100 cfs to 250 cfs near the confluence of Anaconda Creek. Although analyte concentrations from tailings dissolution in surface water are anticipated to diminish with distance downstream of the tailings deposit, certain analytes would exist throughout the entire Crooked Creek drainage at concentrations above AWQC at any seasonal average flow condition. Concentrations of sulfate, arsenic, antimony, manganese, and potentially molybdenum in surface water all would exceed their respective AWQC based on MWMP test results. With the exception of dissolved manganese, pre-existing analyte concentrations (arithmetic average) in Crooked Creek are in compliance with the most stringent AWQC (Table 3.7-4, Section 3.7, Water Quality).

It is anticipated that dissolved sulfate and molybdenum concentrations would fall below applicable water quality standards within a short period of time (several years or less) based on MWMP and kinetic test results with continued flushing of Crooked Creek flow and meteoric water. Arsenic and antimony would likely persist above AWQC in the Crooked Creek drainage after mine closure for an indefinite period of time. This is based on reported concentrations in tailings source materials, and available kinetic test results. Manganese would also persist above the AWQC; however, dissolved concentrations should progressively diminish over time approaching pre-release conditions above the AWQC.

Seasonal conditions at the time of the release and response measures would significantly influence chemical impacts to surface waters. Low winter flow conditions in Crooked Creek would result in limited redistribution of tailings materials; limited intermixing (exposure) of surface water and deposited tailings mixtures; and imperceptible meteoric water contribution. Frozen conditions would also be more favorable for recovery and transport of tailings materials to the TSF; installation of erosion and sediment control measures; and implementation of Crooked Creek channel reconstruction and flow redistribution (diversion) controls during initial response activities. Winter flows in Crooked Creek are foreseeably manageable to temporarily by-pass accumulated water behind the deposited tailings dam given the availability of Mine Site equipment and resources. Winter remediation and restoration success would primarily depend on the amount of time available between shoulder seasons (e.g., freezeup and breakup).

A release during open-water months (summer) would result in greater impacts to surface water quality as initially described. A controlled release of accumulated water behind the temporary dam during summer months would be less manageable during high flow conditions. Significant quantities of tailings material would be re-mobilized and distributed throughout the Crooked Creek drainage from stream channel re-establishment (down cutting, erosion, and channel migration) through the unconsolidated tailings mixture. This process would continue until equilibrium is eventually achieved through stream restoration measures, natural processes, or other mitigation activities.

In the event of a summertime tailings release, initial remediation and restoration efforts would include the removal of deposited tailings to the extent practicable. Restoration and recovery efforts would be prioritized in select areas to minimize tailings re-distribution from channelized flow and erosional run-off. Construction of sedimentation ponds could also minimize the downstream distribution of tailings materials. Initial response efforts would largely depend on the suitability of working surfaces capable for supporting heavy equipment. For this reason the initial tailings recovery would likely span at least one winter season for a summer release scenario.

Since a significant quantity of tailings are expected to be re-distributed downstream within the Crooked Creek drainage during a summer release, fluctuations in water quality are anticipated in response to seasonal changes in flow conditions. Temporally abrupt loading events would be most severe during post release flood conditions that would re-mobilize tailings materials within the drainage, and erosional run-off. Loading of fine suspended tailings sediment during all seasonal flow conditions would progressively diminish over time as the stream re-establishes equilibrium with continued flow. At a minimum, adverse water quality impacts in the Crooked Creek drainage would meet the criteria for a Category 5 impaired waterbody per Section 303 (d) of the Clean Water Act (CWA). The listing could potentially persist throughout mine closure, but this would largely depend on timing of the release relative to the period of mine operation. Depending on the success of remediation and restoration efforts, adverse physical and chemical impacts to water quality in the Crooked Creek drainage could potentially persist for decades.

In the event of a tailings dam failure as described here, appreciable water quality impacts are anticipated to occur downstream at the Kuskokwim River confluence with Crooked Creek. The intensity, duration, and extent of such impacts at the Kuskokwim River would depend on a whether the release occurred during summer or winter. The intensity and extent of adverse impacts resulting from a winter release would be less than those associated with a summertime tailings release, despite lower flow conditions in the Kuskokwim River in winter. This is primarily attributed to flow volume disparities between Crooked Creek and the Kuskokwim River, and favorable initial response conditions previously described for a winter release scenario. Comparison of USGS mean monthly discharge measurements from Crooked Creek and the Kuskokwim River (at Crooked Creek) indicates that dilution would be greatest during the month of February, and least during the month of May. The Kuskokwim River mean monthly discharge is approximately 295 times greater than the flow of Crooked Creek in February, to approximately 63 times greater in May (Table 3.24-15).

Table 3.24-15: USGS Mean Monthly Discharge Comparison (Crooked Creek and Kuskokwim River)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Kuskokwim River											
13,300	11,800	10,800	16,100	81,800	79,800	67,000	74,000	67,300	46,100	22,900	15,900
Crooked Creek[1]											
50	40	35	226	1,290	604	445	569	644	357	133	72
Relative TSF Water Release Volume (600 cfs) Contribution to Combined Monthly Flow Values											
4.5%	5.1%	5.5%	3.7%	0.7%	0.7%	0.9%	0.8%	0.9%	1.3%	2.6%	3.7%

Notes:
All values shown are in cubic feet per second (cfs)
1 Crooked Creek flows approximately 10 miles downstream of Station CCAC.
Source: USGS 2013b: http://waterdata.usgs.gov/nwis/uv/?site_no=15304010).

Greater quantities of tailings sediment and dissolved constituents are anticipated to reach the Kuskokwim River confluence from a summer release relative to a winter release scenario. Analyte specific trends and corresponding water quality exceedances in Crooked Creek are similarly anticipated in the immediate downstream mixing zone at the confluence; however, dilution from Kuskokwim River flow is anticipated to limit the downstream extent of water quality exceedances. The extent of the AWQC exceedances downstream of the confluence would progressively diminish over time; but would fluctuate with variations in Crooked Creek sediment transport and chemical loading (flow), and dilution from the Kuskokwim River. Dissolved concentrations of analytes exceeding their respective water quality standard in Crooked Creek are anticipated to be within acceptable or near baseline levels within several hundred feet or less downstream of the Kuskokwim River confluence, as evidenced by the kinetic test results and USGS river discharge data.

In summary, surface water impacts exceeding applicable water quality standards would extend from the Anaconda Creek and Crooked Creek drainages to the Kuskokwim confluence. Mitigation measures are not likely to address the complete removal of all tailings source materials deposited in the Crooked Creek drainage. In terms of intensity, dissolved arsenic and antimony concentrations above AWQC could potentially persist on a seasonal basis after Closure. The duration and extent of impacts would vary dramatically depending on whether the release occurred during summer or winter. Tailings recovery and initial response measures during a winter release could potentially remove a sufficient quantity of the released tailings source material to minimize the duration of impacts to surface water quality. A summer release, however, could potentially result in irreversible adverse impacts to surface water quality resulting from deposition of large quantities of non-recoverable tailings. Surface water impairment above AWQC would extend from the Anaconda Creek and Crooked Creek drainages to the Kuskokwim confluence. Kuskokwim River flow is anticipated to sufficiently dilute chemical loading from Crooked Creek to below applicable Water Quality Standards (WQSs) downstream. The context would largely depend on the non-recoverable volume of tailings (source material) unique to a winter or summer release scenario, and the subsequent spatial distribution of the tailings solids deposited downstream of Crooked Creek and high water areas.

Water Release Only

A total of 1,620 acre-feet of water at a flow rate of 600 cfs would be released for a period of 48 hours or longer under this scenario from the toe of the TSF. The estimated time for the flow front to reach the Kuskokwim River confluence was determined to be 24 to 25 hours at a maximum flow rate of 600 cfs. Dissolved analyte concentrations in released TSF water with corresponding AWQC are summarized in Table 3.24-16. A total of seven analytes in TSF water are anticipated to exceed their respective AWQC by an order of magnitude or greater. These include sulfate, antimony, arsenic, iron, manganese, molybdenum, and mercury. Analyte concentrations in TSF water with the greatest WQS disparity include mercury, arsenic, and potentially antimony. With the exception of dissolved manganese, pre-existing analyte concentrations (arithmetic average) in Crooked Creek are all below their respective AWQC (Table 3.7-4, Section 3.7, Water Quality).

Table 3.24-16: Potential Kuskokwim River Analyte Exceedances

Analyte	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Kuskokwim River at Crooked Creek												
Sulfate		X	X									
Antimony[1]	X	X	X	X	X	X	X	X	X	X	X	X
Arsenic	X	X	X	X	X	X	X	X	X	X	X	X
Iron[1]	X	X	X	X						X	X	X
Manganese	X	X	X	X							X	X
Molybdenum	X	X	X									
Mercury	X	X	X	X	X	X	X	X	X	X	X	X
Lower Kuskokwim River[2]												
Sulfate												
Antimony	X	X	X	X	X	X	X	X	X	X	X	X
Arsenic	X	X	X	X	X	X	X	X	X	X	X	X
Iron	X	X	X	X							X	X
Manganese	X	X	X	X								X
Molybdenum												
Mercury	X	X	X	X	X	X	X	X	X	X	X	X

Notes:

1 The evaluation is based on the highest dissolved analyte concentration shown in Table 3.24-12. Concentrations in tailings pond water is substantially lower than buried tailings process DOC; likely resulting in a final mixed concentration that is well below water quality standards from any seasonal Kuskokwim River dilution.

2 Lower Kuskokwim River flow conditions assume a general 30% increase in total flow from mean monthly discharges reported at Crooked Creek.

Source: USGS (2013b: http://waterdata.usgs.gov/nwis/uv/?site_no=15304010).

Seasonal conditions at the time of the release would influence the severity of impacts to surface water quality under this scenario; flow conditions in Crooked Creek and the Kuskokwim are likely to be the most important variables. Dilution from Anaconda Creek flow is generally considered imperceptible since year-round flow conditions are comparatively small relative to a peak TSF discharge of 600 cfs. Based on the values shown in Table 3.24-16, dilution from Crooked Creek and Kuskokwim River flows (near Crooked Creek) is greatest during the months of May through October (summer), and least during October through April (winter). Dilution from Kuskokwim River flow would also progressively increase downstream of the Crooked Creek confluence. Based on review and comparison of average daily Kuskokwim River flows from other monitoring sites located downstream of Crooked Creek, flow volumes generally increase an additional 30 percent on the lower Kuskokwim River relative to those measured at the Crooked Creek confluence (Section 3.5, Surface Water Hydrology).

Since an additional influx of 600 cfs to the Crooked Creek drainage would reasonably be within the range of a two to five year flood event, all flow would be limited to the active stream channel and the wide, gentle sloping floodplain (if any). Imperceptible dilution of dissolved analyte concentrations in TSF water would exist at a flow rate of 600 cfs in Crooked Creek. Most of the AWQC exceedances summarized in Table 3.24-16 would exist within the Crooked Creek drainage throughout the release. Exceptions may potentially include pH and cadmium during elevated summer flow conditions in summer months.

The duration of impacts to Crooked Creek water quality would depend on the TSF release period and flow rate, and seasonal flow conditions in Crooked Creek. Since the TSF release period is generally considered temporary based on modeled assumptions (i.e., total release volume and flows), it is not anticipated to persist for greater than 48 hours. A release during the winter could potentially result in comparatively longer impacts than a summer release. This is largely attributed to less flushing and dilution, and potential entrainment of contaminants in ice. Although much of the floodplain would be frozen during a winter release, thawed bed substrate materials would also be capable of TSF water infiltration. Dissolved analyte concentrations in excess of AWQC resulting from a winter release would likely persist throughout some portion of the following open-water season (summer). Water quality exceedances would progressively diminish with continued flushing from summer flow conditions. Gaining stream conditions typically associated with open-water months would also flush impaired porewater and groundwater downstream to the Kuskokwim River. For these reasons, the duration of adverse impacts to water quality are anticipated to drop below AWQC threshold concentrations within one to several years.

Anticipated water quality exceedances at the Kuskokwim River and Crooked Creek confluence, and the lower Kuskokwim River are summarized in Table 3.24-16. This evaluation is based on review and comparison of seasonal mean monthly flows for the Kuskokwim River and Crooked Creek (monthly total) and dilution factors for dissolved analyte concentrations in TSF water at a flow rate of 600 cfs.

Based on the comparative evaluation summarized in Table 3.24-16, a TSF release at any time of the year could potentially result in dissolved concentrations of arsenic and mercury above AWQC beyond the mouth of the Kuskokwim River on a temporary basis. Dissolved concentrations of antimony may similarly exceed AWQC; however, this is considered unlikely since the highest dissolved value was used for evaluation purposes. Antimony concentrations in tailings pond water are expected to be approximately 50 times less than in buried tailings pore water. Mixing of the two water types during a release would further dilute concentrations of antimony dissolved in tailings pore water. The same rationale is applicable to reported iron concentrations in TSF water.

The downstream extent of remaining analytes that could potentially exceed AWQC varies with seasonal flow conditions and subsequent dilution. With the exception of arsenic, mercury, and potentially antimony, no other analytes are anticipated to exceed AWQC from May through September. The least amount of dilution is expected during the months of January through March, coinciding with the largest number of analytes present at concentrations in excess of those specified in AWQC.

The duration of water quality impacts to the Kuskokwim River drainage would largely depend on the TSF release period and flow rate. The release is anticipated to have a peak discharge of 600 cfs. Based on a total release volume of 1,620 acre-feet, a peak rate of discharge could not be sustained over a period lasting more than 48 hours (32.6 hours); therefore flow would be less at times throughout the release period. As the rate of TSF water influx decreases, relative dilution becomes greater. Water quality in the Kuskokwim River drainage would be reduced infrequently based on the modeled assumptions and continuous flushing and dilution from Kuskokwim River flow.

In summary, chemical impacts to surface water quality from a TSF water only release scenario are comparatively less than those of tailings and water mixture. Intensity is attributed to the adverse surface water quality impairments in relation to AWQC that could potentially extend downstream to the mouth of the Kuskokwim River. Depending on seasonal flows (dilution) and subsequent flushing in the Crooked Creek, the duration of impacts would likely range from summer to winter. Regardless of the season, adverse impacts to the Kuskokwim River drainage (downstream) would be considered infrequent due to dilutional processes. The context of impacts is that temporary impairments could potentially impact resources considered valuable from a socioeconomic perspective, or result in loss of resources protected by legislation.

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

Under Alternative 3A, Scenario 5 (diesel pipeline release) is not applicable and has not been analyzed for effects to surface water quality. The likelihood of Scenarios 1 through 4 (ocean or river barge, tank farm, and tanker truck releases) occurring would be greatly reduced due to a decrease in barge activity; however, the impacts would be the same types as discussed under Alternative 2. Scenarios 7, 8, and 9 (cyanide, mercury, and tailings releases) for Alternative 3A would have the same impacts on surface water hydrology as Alternative 2.

Scenario 6: Liquefied Natural Gas (LNG) Release

Under Alternative 3A, an occurrence of pinhole leaks in LNG storage tanks, an accident involving an LNG-fueled truck, or the rupture of a storage tank at the LNG plant could occur at the Mine Site. If released, LNG dissipates readily, so it would not infiltrate surface water. Thus, there would be no direct or indirect impacts to surface water resources as a result of an LNG release.

Alternative 3B – Reduced Diesel Barging: Diesel Pipeline

Under Alternative 3B, Scenario 6 (LNG release) is not applicable and has not been analyzed for effects to surface water quality. The likelihood of Scenarios 1 through 4 (ocean or river barge, tank farm, and tanker truck releases) occurring would be greatly reduced due to a decrease in barge activity; however, the impacts would be the same types as discussed under Alternative 2.

Scenarios 7, 8, and 9 (cyanide, mercury, and tailings releases) for Alternative 3B would have the same impacts on surface water quality as Alternative 2.

Scenarios 1 and 2 would have similar water resource impacts as described in Alternative 2, except that under Scenario 1 the ocean barge route ends at Tyonek during the operations and Closure phases of the project, and under Scenario 2, river barging would only occur during the Construction Phase of the project.

Scenario 5: Diesel Pipeline Release

The diesel pipeline associated with Alternative 3B poses substantial risks to surface water quality due to the potential for unplanned releases of diesel fuel from the buried pipeline to surface water resources. The 334-mile length of the pipeline, the remoteness of the areas traversed by the pipeline, and the 27 planned stream crossings would contribute to the risk of impacts to surface water resources and would encumber response efforts in the event of an unplanned release.

Under Alternative 3B, there are several potential modes of failure that could result in unplanned releases of diesel fuel from the pipeline, each of which could impact surface water resources to varying degrees depending upon the specific location of the release, the rates and total volume of the release, and the efficacy of response efforts. A scenario involving pinhole leaks from the pipeline would result in relatively slow rates of release. Pinhole leaks could go undetected for weeks or months resulting in medium and large volume spills that would have a high likelihood of impacting surface water resources. Recovery would be limited by potential inputs of diesel to moving water and by the amount of time required to detect the leak and mobilize response equipment to the site. In terms of intensity, a pinhole leak in close proximity to a stream or other surface water body would result in impacts because concentrations of total aqueous hydrocarbons would likely exceed the applicable water quality criterion of 15µg/L (ADEC 2012d). In most instances, the impacts would be confined to a discrete portion of the pipeline corridor; however, undetected leaks in close proximity to moving water could result in distribution of impacts over a wider geographic area and adverse effects to hydraulically connected waters could occur outside of the project footprint. In most instances, the impacted surface water resources would be the context; however the context may vary if the leak were to occur in close proximity to less abundant surface water resources such as fish bearing streams or waterfowl habitat. The duration of such impacts could persist for weeks or months.

A catastrophic failure involving diesel pipeline rupture resulting from slides, an earthquake, or thaw settlement would potentially result in severe consequences to surface water resources. In terms of intensity, a pipeline rupture resulting in a release of up to 422,000 gallons of diesel fuel would very likely result in impacts to surface water resources as applicable water quality standards would be exceeded in water bodies in the vicinity of the spill. The geographic extent of impacts resulting from a catastrophic diesel pipeline failure would depend on the location of the rupture relative to isolation valves and surface water resources. For example, in the event of a rupture immediately adjacent to a fast moving river, impacts would be rapidly distributed to downstream locations and could affect hydraulically connected waters if the rate of diesel release to the environment is not controlled in a timely fashion. The duration of impacts to surface water resources resulting from pipeline rupture would be infrequent because concentrations of hydrocarbons in surface water would be expected to return to below the 15 µg/L threshold specified by the most stringent applicable water quality criterion (ADEC 2012d) at some point within the project lifetime as a result of response efforts and relatively rapid natural weathering processes including evaporation. Although some fraction of the released hydrocarbons would initially be expected to partition into sediment and groundwater, and subsequently contribute to hydrocarbon concentrations in surface water, it is assumed that response and cleanup efforts would be sufficient to maintain surface water quality within the specified regulatory limits following the completion of the project.

The intensity, extent or scope, and the context of impacted resources would depend primarily upon the rates and total volume of diesel released, the specific location of the release, and the efficacy of response efforts. Response efforts would be encumbered by the length of the pipeline and its remote location relative to response facilities. Low-volume spills resulting from pinhole leaks in the pipeline would result in discrete impacts, whereas very large diesel spills would likely result in impacts beyond the area of the spill. The context of the impacted resources would depend primarily on the specific location of the spill. Relative to the natural gas pipeline described under Alternative 2, the diesel pipeline described under Alternative 3B poses substantial additional risks to surface water resources.

Alternative 4 – Birch Tree Crossing (BTC) Port

Under Alternative 4, spill Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to surface water quality. The likelihood of Scenario 2 (river barge release) occurring would be greatly reduced, and the likelihood of Scenario 4 (tanker truck release) would be increased; however, the impacts of either would be the same types as discussed under Alternative 2. Impacts under Scenarios 1, 3, 7, 8, and 9 (ocean barge, tank farm, cyanide, mercury, and tailings releases) for Alternative 4 would be the same as those discussed under Alternative 2.

Alternative 5A – Dry Stack Alternatives

Under Alternative 5A, Scenarios 5, 6, and 9 (diesel pipeline, LNG, and water and tailings releases) are not applicable and have not been analyzed for impacts to surface water quality.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and water only tailings releases) for Alternative 5 would be the same as those discussed under Alternative 2.

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

Under Alternative 6A, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to surface water quality.

Impacts under fuel release Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 6A would be the same as those discussed under Alternative 2.

3.24.6.7.2 GROUNDWATER QUALITY

Alternative 2 – Donlin Gold's Proposed Action

Under the proposed action, two spill scenarios do not apply and are not analyzed for groundwater quality impacts. These include Scenario 5 (diesel pipeline release) and Scenario 6 (LNG release).

Scenario 1: Ocean Barge Rupture at Sea

Grounding of an ocean-going fuel barge could potentially release up to 735,000 gallons of diesel fuel to the sea. Due to the low density of diesel fuel relative to water, the vast majority of the spilled material would spread on the sea surface forming a sheen that would be attenuated by natural weathering processes over timescales of days and would not pose any threat to groundwater resources. The spilled material would not sink or pool on the seafloor to any appreciable extent. The potential for impacts to groundwater resources would depend on the specific location of the release, the volume of material released, and environmental conditions (e.g., wind, waves, and ocean currents) at the time and location of the incident; if a very large amount of diesel was released in a nearshore area then some potential would exist for limited impacts to surficial (shallow) unconfined groundwater resources along the shoreline (Kuan et al. 2012). Such impacts could occur as a result of diesel contacting the shoreline at high tide, then percolating into porewater and surficial groundwater at low tide. The extent or scope of such impacts to groundwater would be limited to discrete parcels of surficial groundwater. Due to the high volatility and relatively fast evaporation of diesel fuel, the duration of the impacts would be infrequent, and the impacted resources have an abundance of surficial groundwater resources in and around potentially affected areas.

In summary, impacts to groundwater quality are unlikely to occur as a result of a diesel spill in the open ocean. Under certain, albeit rare, combinations of conditions the potential would exist for infrequent and geographically discrete impacts to affect unconfined surficial groundwater resources in coastal area (i.e., any water that is present in the pore spaces of sediments or soils at or near the riverbank), such impacts could occur because the concentrations of hydrocarbons in the water could exceed the water quality regulatory limits in context.

Scenario 2: River Barge Release

A river barge release could result in impacts to groundwater quality at certain sites along the banks of the Kuskokwim River in close proximity to the site of the diesel release. As a result of the diesel release, a long narrow sheen would extend downstream on the surface of the Kuskokwim River for distances of up to several miles. Response efforts would focus on the protection of sensitive resources along the river banks, and preventing the ingress of spilled diesel to low energy areas of the river, where slower weathering and transport processes would result in accumulation of spilled fuel and greater potential for impacts to groundwater quality. The vast majority of the spilled fuel would either flow downstream with the river water or evaporate to the atmosphere. It is likely that a very small fraction of the spilled diesel fuel would contact the river banks and a subfraction of that fuel could affect unconfined surficial groundwater resources along the riverbanks (any water that is present in the pore spaces of sediments or soils at or near the riverbank). Intensity would be based on concentrations of diesel range organics in the groundwater which would not approach the 1.5 mg/L groundwater cleanup level specified by ADEC at 18 AAC 75. The effects would be unlikely to extend beyond the span of the project, and they would affect only discrete portions of the transportation corridor, specifically areas along the Kuskokwim River banks. In context, groundwater resources are relatively abundant in the areas considered for this analysis.

Scenario 3: Tank Farm Release

For the scenarios involving accidental releases from the tank farm that are captured by secondary containment, there would be no impact to groundwater quality.

Failure of a transfer hose during a transfer operation between a vessel and a tank farm would release a medium to large volume of diesel (100 to 2,000 gallons, depending upon the volume of the hose). Depending on the location of the release relative to the shoreline, some of the diesel could be released to soil and then percolate to surficial groundwater near the Angyaruaq (Jungjuk) facility resulting in discrete impacts to groundwater quality. In terms of intensity, the majority of the spilled fuel would be isolated from groundwater resources by secondary containment, and concentrations of diesel range organics in the groundwater would be unlikely to exceed the 1.5 mg/L groundwater cleanup level specified by ADEC at 18 AAC 75. The extent or scope of such impacts would be limited by the presence of secondary containment systems both at the tank farm and on the dock. On-shore recovery would involve sorbents and pumping out of secondary containment (SLR 2012a). In terms of duration, the majority of the spilled material would be recovered immediately following the release and would be contained within a small area adjacent to the area of release In terms of context, impacts would affect usual, ordinary, or abundant resources that are not depleted.

Scenario 4: Tanker Truck Release

Depending upon the specific location of the tanker truck release, proximity to groundwater resources, and the volume of diesel released to the environment, the intensity of impacts to groundwater resources could result in concentrations of diesel range organics in groundwater that exceed the 1.5 mg/L groundwater cleanup level specified by ADEC at 18 AAC 75.

On land, diesel quickly penetrates porous soils, and could contaminate groundwater resources in the vicinity of the release. Diesel fuel does not penetrate permafrost and frozen soils to the same extent as unfrozen matrices, and if the spill were to occur in winter, or in an area where permafrost forms a barrier between the spilled material and groundwater resources, then the spill would be less likely to result in substantial impacts to groundwater resources.

The extent or scope of impacts associated with such a release would not be likely to extend beyond a discrete portion of the Project Area. In addition, a substantial fraction of the spilled diesel would be recovered by response and cleanup efforts including sorbents and removal of contaminated soils. The duration of the impacts would be such that total aqueous hydrocarbons would return to below threshold levels specified by the applicable water quality criterion as a result of response and cleanup efforts occurring during the span of the project. Response efforts associated with a tanker truck release would focus on the protection of sensitive resources, such as fish-bearing streams, wetlands, and waterfowl habitat. Provided that spilled fuel is excluded from such sensitive areas, the context of impacts would affect usual, ordinary, or abundant resources that are not depleted or protected by legislation.

In summary, the intensity of impacts to groundwater resources resulting from a tanker truck release would be considered to exceed the AWQC. In most cases, smaller volume releases would result in lower levels of impacts; releases occurring away from groundwater resources would be unlikely to have any impacts on groundwater quality provided that response and cleanup efforts are successful. The available response and cleanup resources would greatly exceed the capacity required to manage any unplanned release of diesel fuel from a tanker truck.

Scenario 7: Cyanide Release

The release of cyanide from a tank-tainer rupture or vehicle collision would not be expected to have any substantial effects on groundwater quality. The solid phase material poses relatively little risk to groundwater resources, but cyanide that becomes dissolved in water could potentially enter the aquifer in small quantities as a result of infiltration from surface water resources or bank storage effects along rivers. In the unlikely event that groundwater is impacted by cyanide as a result of tank-tainer rupture or vehicle accident, the intensity of impacts to groundwater resources would potentially result in concentrations of cyanide in the groundwater that could exceed regulatory limits. The extent or scope of such impacts would affect only a small area adjacent to the site of the cyanide release. The duration of effects would be such that concentrations of cyanide in the groundwater would be attenuated to levels below the threshold regulatory limits as a result of dilution and dispersion processes.

Scenario 8: Mercury Release

An unplanned release of liquid mercury to land or water could adversely affect the quality of groundwater in areas near the release. Due to its high density and liquid form at ambient temperatures, spilled mercury could enter the water table where concentrations of total mercury could exceed the applicable water quality criterion for mercury. Under oxidizing conditions some of the mercury would form complexes with dissolved organic matter, and elemental mercury Hg(0) would oxidize to form Hg(II) complexes, with ionic mercury remaining mobile in the groundwater system. Other fractions of the spilled mercury would sorb to surface soils and subsoils and would not be present in the groundwater. Where anoxic conditions are present and sulfate reduction is an important terminal electron accepting process, mercury methylation could occur. Additionally, under reducing conditions, sulfides may precipitate removing mercury from the aqueous phase. The duration of the impacts to groundwater would be such that concentrations of mercury in the groundwater could remain elevated for the duration of the project and would return to background levels at some point following the completion of the project. In most instances spilled mercury would remain in relatively close proximity to the area where it was released. The context of impacts would vary from usual, ordinary, or abundant resources to resources considered depleted or shared within the locality or region.

Scenario 9: Partial Tailings Dam Failure

In the very unlikely event of a spill resulting from a partial tailings dam failure, the impacts to surface water, shallow groundwater, and sediment resources would be inextricably linked, and the impacts to these resource types would be driven by common impact-producing factors. For that reason, the discussion presented under Section 3.24.6.7.1, Surface Water Quality, is relevant to shallow groundwater quality.

As described in Section 3.24.6.6.1, Groundwater Hydrology, the maximum increased flood elevation of 1 foot predicted near Crooked Creek village (Table 3.24-10) would not affect the aquifer used by village drinking water supply well, as it is sited on a hill about 60 feet above Crooked Creek and Kuskokwim River. The source water protection area for the well extends up the hill to the northwest, and would not intersect the path of a tailings water flood in Crooked Creek floodplain (Figure 3.6-6).

Impacts to shallow groundwater along the Crooked Creek floodplain resulting from released solids would potentially persist over decadal time scales, whereas impacts resulting from the water only scenario would likely diminish over timescales of weeks. The water would naturally drain from the Crooked Creek watershed to the Kuskokwim River, where it would be diluted with river water to the extent that the Kuskokwim River would be compliant with the most stringent applicable water quality criteria. Prolonged chemical impacts to shallow groundwater within the Crooked Creek floodplain would largely be attributed to dissolution of constituents from tailings solids released in the event of tailings dam failure. The most substantial impacts to shallow groundwater quality would be primarily driven by the persistence of the released tailings solids in the environment, the efficacy of response and clean-up efforts, and the volume and spatial distribution of the released tailings solids material considered "non-recoverable." Refer to Sections 3.24.6.6.1 and 3.24.6.7.1 for further discussion.

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

Under Alternative 3A, Scenario 5 (diesel pipeline release) is not applicable and has not been analyzed for effects to groundwater quality. The likelihood of Scenarios 1 through 4 (ocean or river barge, tank farm, and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Scenarios 7, 8, and 9 (cyanide, mercury, and tailings releases) for Alternative 3A would have the same impacts on groundwater quality as Alternative 2.

Scenario 6: Liquefied Natural Gas (LNG) Release

The LNG releases described under Scenario 6 are not expected to result in any impacts to groundwater resources because the LNG would be released to the air and would not dissolve in the water under the ambient conditions. While it is possible for methane to dissolve in groundwater at substantial concentrations under certain conditions, when water containing dissolved methane comes into contact with air, the methane quickly escapes from the water into the atmosphere. Thus the spilled material would be expected to remain in the gas phase, and would not result in any impacts to groundwater resources. With no direct impacts to surface water quality or groundwater quality, the LNG releases described under Scenario 6 are not expected to result in any impacts to groundwater quality.

Alternative 3B – Reduced Diesel Barging: Diesel Pipeline

Under Alternative 3B, Scenario 6 (LNG release) is not applicable and has not been analyzed for effects to groundwater quality. The likelihood of Scenarios 3 and 4 (tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Scenarios 7, 8, and 9 (cyanide, mercury, and tailings releases) for Alternative 3B would have the same impacts on groundwater quality as Alternative 2.

Scenarios 1 and 2 would have similar groundwater resource impacts as described in Alternative 2, except that under Scenario 1 the ocean barge route ends at Tyonek during the operations and Closure Phases of the project, and under Scenario 2, river barging would only occur during the Construction Phase of the project.

Scenario 5: Diesel Pipeline Release

The diesel pipeline associated with Alternative 3B poses substantial risks to groundwater quality due to the potential for unplanned releases of diesel fuel from the pipeline to groundwater. The 334-mile length of the pipeline and the remoteness of the areas traversed by the pipeline would contribute to the risk of impacts to groundwater resources and would encumber response efforts in the event of an unplanned release.

Under Alternative 3B, there are several potential modes of failure that could result in unplanned releases of diesel fuel from the pipeline, each of which could impact groundwater resources to varying degrees depending upon the specific location of the release, the rates and total volume of the release, and the efficacy of response efforts. A high-probability scenario involving pinhole leaks from the pipeline would result in relatively slow rates of release. However, because pipeline inspections for indications of leaks would occur only twice a year, pinhole leaks could go undetected for weeks or months resulting in medium and large volume spills that would have a high likelihood of impacting groundwater resources. In terms of intensity, pinhole leaks would likely result in concentrations of diesel range organics that likely exceed the 1.5 mg/L groundwater cleanup level specified by ADEC at 18 AAC 75. In most instances, the extent or scope of impacts would be confined to a discrete portion of the pipeline corridor. In most cases, the context of impacts would affect usual, ordinary, or abundant resources not depleted or protected by legislation. However the context of the impacted resources could potentially affect depleted or shared resources within the locality or region if the leak were to occur in close proximity to groundwater used as a source of drinking water. The duration of such impacts could be such that impacts to groundwater quality resulting from an undetected pipeline leak could persist beyond the duration of the proposed project.

A catastrophic failure involving diesel pipeline rupture resulting from slides, an earthquake, or thaw settlement would potentially result in severe consequences to groundwater resources. A pipeline rupture resulting in a release of up to 422,000 gallons of diesel fuel would very likely result in impacts to groundwater resources as concentrations of hydrocarbons specified by the most stringent AWQC would be exceeded. The extent or scope of impacts resulting from a catastrophic diesel pipeline failure would be limited to a discrete portion of the pipeline corridor.

Response efforts would be encumbered by the length of the pipeline and its remote location relative to response facilities. Relative to the natural gas pipeline described under Alternative 2, the diesel pipeline described under Alternative 3B poses substantial additional risks to groundwater resources which should be carefully considered in any comparison of the alternatives.

Alternative 4 – Birch Tree Crossing (BTC) Port

Under Alternative 4, spill Scenario 5 (diesel pipeline release), and Scenario 6 (LNG Release) are not applicable and have not been analyzed for impacts to groundwater quality. The likelihood of Scenario 2 (river barge release) occurring would be greatly reduced due to shorter barge distances, and the likelihood of Scenario 4 (tanker truck release) would be increased; but the impacts of either would be the same as those discussed under Alternative 2. Scenarios 1, 3, 7, 8, and 9 (ocean barge, tank farm, cyanide, mercury, and tailings releases) for Alternative 4 would be the same as those discussed under Alternative 2.

Alternative 5A – Dry Stack Tailings

Under Alternative 5A, Scenarios 5, 6, and 9 (diesel pipeline, LNG, and water and tailings releases) are not applicable and have not been analyzed for impacts to groundwater quality.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and water only tailings releases) for Alternative 5A would be the same as those discussed under Alternative 2.

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

Under Alternative 6A, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to groundwater quality.

Impacts under fuel release Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 6A would be the same as those discussed under Alternative 2.

3.24.6.7.3 SEDIMENT QUALITY

Alternative 2 – Donlin Gold's Proposed Action

Under the proposed action, two spill scenarios do not apply and are not analyzed for sediment quality impacts. These include Scenario 5 (diesel pipeline release) and Scenario 6 (LNG release).

Scenario 1: Ocean Barge Rupture at Sea

Impacts to sediment quality resulting from an ocean barge release would depend heavily upon the specific location of the spill. As described in Section 3.24.5.1, the density of diesel fuel is much lower than that of water, and it is not possible for diesel to sink and accumulate on the seafloor unless adsorption occurs with sediment suspended in the water column (NOAA 2014a). This process would be more likely to occur near river mouths where high concentrations of fine-grained sediments are carried in by rivers, and would be less likely to occur in open marine settings. Response efforts would focus on excluding the spilled fuel from river mouths and other sensitive areas. Provided these response efforts are effective, the intensity of impacts to sediment quality may not be measurable or noticeable. In terms of context, impacts would affect areas of ordinary sediment quality or where there is an abundance of sediment resources. A small fraction of the spilled fuel dispersed in the marine water column by wave action could adhere to fine-grained suspended sediments, leading to subsequent deposition of contaminated sediment on the seafloor. The duration of effects could persist for decades on the seafloor environment in low energy areas, and the extent or scope of impacts could affect areas throughout the EIS Project Area due to spreading of the diesel on the ocean surface and transport of contaminated sediments by ocean currents. In summary a small fraction of spilled diesel would partition into marine sediments and the potentially wide area over which those sediments would be dispersed.

Scenario 2: River Barge Release

Impacts to sediment quality would result from adsorption of the spilled diesel onto suspended sediment particles in the water column and subsequent deposition of contaminated sediment in the main stem of the Kuskokwim River and within the Kuskokwim River delta. Depending on the specific location of the release and the volume of material released, the intensity of impacts could be such that concentrations of diesel range organics exceed sediment quality guidelines. The extent or scope of impacts would vary spatially according to the concentrations of diesel and suspended sediment in the water and the contaminated sediments would be deposited in low energy areas of the riverbed and delta, thus impacts to sediment quality could potentially extend beyond the immediate Project Area. The intensity of impacts would decrease over time as the contaminated material would be dispersed by natural sediment transport processes, and concentrations of diesel range organics in the sediments would be attenuated by natural processes such as biodegradation and chemical oxidation over timescales of years or decades. Higher intensity impacts would diminish during the lifespan of the project, but detectable levels of diesel range organics could persist in sediments beyond completion of the project. Due to the importance of the Kuskokwim River and delta for fisheries and other economic and cultural uses, the context of impacts would affect sediment resources considered valuable in the region. Overall, the level of impacts to sediment quality resulting from a river barge release would depend on the specific location and timing of the spill, and the efficacy of response and cleanup efforts.

Scenario 3: Tank Farm Release

Provided that secondary containment systems are effective then there would be no impacts to sediment quality as a result of a release at a tank farm.

Impacts to sediment quality could result from the accidental release of diesel to the Kuskokwim River from the rupture of transfer line while offloading a fuel barge at the Angyaruaq (Jungjuk) Tank Farm. The material released to the water would be contained with sorbent booms and would be immediately recovered using sorbent pads and skimmers. Because the density of diesel fuel is much lower than that of water, most of the spilled diesel would remain on the surface of the water and partitioning into sediments would be minimal over the timeframe required for response and cleanup. The extent or scope of impacts would be concentrated in the area immediately adjacent to the tank farm. In terms of intensity, it is possible that local concentrations of diesel range organics could exceed sediment quality guidelines. The contaminated sediments would be dispersed by natural sediment transport processes, and concentrations of diesel range organics in the sediments would be attenuated by natural processes such as biodegradation and chemical oxidation over timescales of years or decades. Impacts would diminish during the lifespan of the project, but detectable levels of diesel range organics could persist in sediments beyond completion of the project. The context of impacts would affect areas of ordinary sediment quality or where there is an abundance of sediment resources. In summary, impacts to sediment quality resulting from a hose rupture at the tank farm would have limited geographic distribution of impacts with potential to control the occurrence of impacts using effective response and cleanup methods.

Scenario 4: Tanker Truck Release

Impacts to sediment quality from a tanker truck release would depend entirely on the specific location of the accident and the proximity to sediment resources. Due to the relatively low dipole moment of the organic molecules that comprise diesel fuel, the spilled material would preferentially associate with soils and other organic substances in the terrestrial environment. The physical and chemical impacts of fuel released to the terrestrial environment away from surface water resources are described in Section 3.24.6.2, Soils. Potential impacts to aquatic sediments would occur primarily as a result of spilled material that enters surface water and is subsequently adsorbed onto sediment particles, or as a result of contaminated soils that erode into the water. In the unlikely event that the entire contents of the tanker truck (up to 13,500 gallons) are spilled directly into surface waters, the impacts to sediment quality could be high intensity over a relatively small area. As previously described, the probability of occurrence for such an event is very low at any location. For the case of a release directly to surface water the probability decreases even further because the release would have to occur at or very near surface water. In terms of intensity, concentrations of diesel range organics in sediment would likely exceed sediment quality guidelines over a discrete portion of the project area. In terms of context, impacts would affect areas of ordinary sediment quality or where there is an abundance of sediment resources. The duration of impacts would likely be such that concentrations of diesel range organics in the sediment would decrease to below threshold levels during the span of the project, detectable concentrations of diesel in the sediment could persist for years or decades.

Smaller volume spills, or spills that occur on land away from aquatic resources would decrease the intensity and extent of the impacts to sediment quality relative to a large volume spill to the water. Response and recovery efforts would also decrease the overall levels of impacts to sediment quality.

Scenario 7: Cyanide Release

Impacts to sediment quality from an inadvertent cyanide release would depend entirely on the specific location of the accident and the proximity to sediment resources. Cyanide released as solid-phase sodium cyanide briquettes would pose relatively little risk to sediment resources. In the event that cyanide becomes dissolved in water the cyanide would be likely to stay in the dissolved phase and therefore would not impact sediment resources. Concentrations of cyanide in sediments would remain low. Depending upon the specific location of the cyanide release, it is possible that concentrations of cyanide in sediment porewater could exceed the applicable water quality criterion; however, because of their high solubilities in water, most cyanide compounds would not be strongly absorbed onto sediments or suspended solids. Any impacts to sediment quality resulting from spilled sodium cyanide would be limited to the areas immediately adjacent to the site of the spill, and the duration of impacts to sediment would be such that concentrations of cyanide in the sediment would be rapidly attenuated as a result of dilution and dispersion processes.

Scenario 8: Mercury Release

An unplanned release of liquid mercury to land or water could adversely affect the quality of sediment in areas near the release. Due to its high density and propensity for complexation with organic material, a substantial fraction of the released mercury would collect in sediments where it could be transformed by abiotic redox reactions as well as biologically mediated mercury methylation reactions driven by sulfate reducing bacteria. The mercury could also be distributed to other areas as a result of sediment transport processes and the ultimate fate of the spilled mercury would depend on the relative rates of the transformation reactions and transport processes. Methylation would potentially increase the bioavailability of the spilled mercury and would also accelerate the rates of mercury transport away from the area of the spill. Although there are no enforceable regulations related to mercury concentrations in sediment, the sediment quality guidelines (SQGs) often serve as benchmark values for making comparisons to the concentrations of contaminant levels in sediments at sites under evaluation for various reasons (Buchman 2008). Preliminary screening levels for mercury contamination in sediment have been suggested by the National Oceanic and Atmospheric Administration (NOAA). Although they do not represent sediment quality standards, these guidelines suggest that the Threshold Effects Level for mercury in freshwater sediment is 174 µg/kg (dry weight), the Probable Effects Level is 486 µg/kg (dry weight), and the Upper Effects Threshold is 560 µg/kg (dry weight) (Buchman 2008). If elemental mercury was inadvertently released directly to land or water, it is likely that concentrations of total mercury in the sediments could exceed the thresholds specified in the SQGs. The duration of such impacts would be such that concentrations could persist beyond the duration of the project. The extent or scope of impacts could be transported away from the location of the initial spill but within discrete portions of the project area. The intensity of effects would attenuate rapidly over distance from the spill location. The context of impacts would vary and may affect areas from low to high sediment quality. The affected sediment resources would be considered common to important in context. Overall, impacts to sediment quality resulting from an unplanned release of mercury would occur only if a mercury container ruptured and there was a release to water.

Scenario 9: Partial Tailings Dam Failure

In the very unlikely event of a spill resulting from a partial tailings dam failure, the impacts to surface water, groundwater, and sediment resources would be inextricably linked, and the impacts to these resource types would be driven by common impact producing factors. For that reason, the discussion presented under Section 3.24.6.7.1, Surface Water Quality, is relevant to sediment quality. Impacts to surface water, groundwater, and sediment quality resulting from released solids would potentially persist over decadal time scales, whereas impacts resulting from the water only scenario would likely diminish over timescales of weeks. The water would naturally drain from the Crooked Creek watershed to the Kuskokwim River, where it would be diluted with river water to the extent that the Kuskokwim River would be compliant with the most stringent applicable water quality criteria. Prolonged chemical impacts to surface water, groundwater, and sediment resources within the Crooked Creek watershed would largely be attributed to dissolution of constituents from tailings solids released in the event of tailings dam failure. The most substantial impacts to surface water quality, groundwater quality, and sediment quality would be primarily driven by the persistence of the released tailings solids in the environment, the efficacy of response and clean-up efforts, and the volume and spatial distribution of the released tailings solids material considered “non-recoverable.” Refer to Section 3.24.6.7.1 for further discussion.

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

Under Alternative 3A, Scenario 5 (diesel pipeline release) is not applicable and has not been analyzed for effects to sediment quality. The likelihood of Scenarios 1 through 4 (ocean or river barge, tank farm, tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Scenarios 7, 8, and 9 (cyanide, mercury, and tailings releases) for Alternative 3A would have the same impacts on sediment quality as Alternative 2.

Scenario 6: Liquefied Natural Gas (LNG) Release

Under Alternative 3A, an occurrence of pinhole leaks in LNG storage tanks, an accident involving an LNG-fueled truck, or the rupture of a storage tank at the LNG plant could occur at the Mine Site. If released, LNG dissipates readily, so it would not infiltrate surface water. Thus, there would be no direct or indirect impacts to sediment quality resources as a result of an LNG release.

Alternative 3B – Reduced Diesel Barging: Diesel Pipeline

Under Alternative 3B, Scenario 6 (LNG release) is not applicable and has not been analyzed for effects to groundwater quality. The likelihood of Scenarios 3 and 4 (tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Scenarios 7, 8, and 9 (cyanide, mercury, and tailings releases) for Alternative 3B would have the same impacts on sediment quality as Alternative 2.

Scenarios 1 and 2 would have similar water resource impacts as described in Alternative 2, except that under Scenario 1 the ocean barge route ends at Tyonek during the operations and Closure phases of the project, and under Scenario 2, river barging would only occur during the Construction Phase of the project.

Scenario 5: Diesel Pipeline Release

The diesel pipeline associated with Alternative 3B poses substantial risks to water quality due to the potential for unplanned releases of diesel fuel from the pipeline to water resources. Similar risks would also apply to sediment quality. The 334-mile length of the pipeline, the remoteness of the areas traversed by the pipeline, and the 27 planned stream crossings would contribute to the risk of impacts to aquatic sediment resources and would encumber response efforts in the event of an unplanned release.

A catastrophic failure involving diesel pipeline rupture resulting from slides, an earthquake, or thaw settlement would potentially result in severe consequences to sediment quality. In terms of intensity, pipeline rupture resulting in a release of up to 422,000 gallons of diesel fuel would very likely result in sediment quality guidelines for diesel range organics being exceeded in the vicinity of the spill. The extent or scope of impacts resulting from a diesel pipeline release would depend on the location of the release relative to isolation valves and water resources. A complete list of rivers and streams crossed by the proposed pipeline, including drainage area and peak-discharge estimates for select recurrence intervals, is included in Table 3, Appendix G. Examples of streams and creeks that could lead to the impacts described in this section include tributaries of Windy Fork and Sheep Creek. For example, in the event of a rupture immediately adjacent to a fast moving river, impacts would be rapidly distributed to downstream locations and could affect hydraulically connected areas; the geographic distribution of impacts would therefore extend throughout the EIS Project Area or outside the project footprint. The duration of impacts to sediment quality resulting from pipeline rupture would potentially be such that concentrations of hydrocarbons in sediments could persist for years or decades as a result of slow natural weathering and degradation processes in subarctic sediments. In terms of context, impacts would affect areas of ordinary sediment quality or where there is an abundance of sediment.

The intensity, extent or scope, and the context of impacted resources would depend upon the rate and total volume of diesel released, the specific location of the release, and the efficacy of response efforts. Response efforts would be encumbered by the length of the pipeline and its remote location relative to response facilities. Low-volume spills resulting from pinhole leaks in the pipeline would result in discrete extent impacts, whereas very large diesel spills would likely result in impacts potentially throughout the EIS Analysis Area. Relative to the natural gas pipeline described under Alternative 2, the diesel pipeline described under Alternative 3B poses substantial additional risks to sediment quality which should be carefully considered in any comparison of the alternatives.

Alternative 4 – Birch Tree Crossing (BTC) Port

Under Alternative 4, spill Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to sediment quality. The likelihood of Scenario 2 (river barge release) occurring would be greatly reduced due to shorter barging distances, and the likelihood of Scenario 4 (tanker truck release) would be increased; however, the impacts of either would be the same types as those discussed under Alternative 2. Scenarios 1, 3, 7, 8, and 9 (ocean barge, tank farm, cyanide, mercury, and tailings releases) for Alternative 4 would be the same as those discussed under Alternative 2.

Alternative 5A – Dry Stack Tailings

Under Alternative 5A, Scenarios 5, 6, and 9 (diesel pipeline, LNG, and water and tailings releases) are not applicable and have not been analyzed for impacts to sediment quality.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and water only tailings releases) for Alternative 5A would be the same as those discussed under Alternative 2.

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

Under Alternative 6A, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to sediment quality.

Impacts under fuel release Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 6A would be the same as those discussed under Alternative 2.

3.24.6.8 AIR QUALITY

There would be air emissions associated with spills; for example, fugitive volatile organic compound emissions associated with a diesel spill and the tailpipe emissions of criteria pollutants from the response equipment. Many variables associated with unplanned events, such as ambient temperatures and surface characteristics of the spill, would affect the quantity of the emissions. As a result, quantities of air pollutants would be difficult or impossible to estimate with any degree of accuracy. In terms of intensity, there are no permit thresholds for fugitive (for the Donlin Gold Project) or mobile emissions that would occur in a spill scenario.

3.24.6.8.1 ALTERNATIVE 2 – DONLIN GOLD'S PROPOSED ACTION

Evaporation of diesel fuel would generate primarily Volatile Organic Compounds (VOCs) and Hazardous Air Pollutants (HAPs) (Bureau of Ocean Energy Management [BOEM] 2012). The quantity of emissions would depend on the amount of fuel spilled and on factors that affect the evaporation rate. For example, the evaporation rate would increase with temperature, amount of exposed surface area, and time of exposure. Exposed surface area would increase if the spill spreads out over a large area or is subject to wind or wave action. Lighter compounds (including benzene, toluene, ethylbenzene, and xylenes (BTEX), and hexane, which are both HAPs) may evaporate in a matter of hours depending on the size of the spill and weather, while heavier compounds would take longer. Ambient concentrations eventually return to pre-spill conditions within a relatively short period of time (BOEM 2012).

In-situ burning would generate products of combustion (carbon monoxide, oxides of nitrogen, sulfur dioxide, PM, and black smoke). Ambient air quality would return to pre-burn conditions relatively quickly (BOEM 2012). Even when in-situ burning is not a proposed cleanup measure, diesel is highly combustible, although it requires a high flash point to ignite. In the unlikely event that a diesel spill ignites, it would result in emissions of criteria pollutants.

Under the proposed action, two spill scenarios do not apply and are not analyzed for air quality impacts. These include Scenario 5 (diesel pipeline release) and Scenario 6 (LNG release).

Scenario 1: Ocean Barge Rupture at Sea

An ocean barge release could result in a diesel fuel spill of up to 735,000 gallons. Due to the remote location, response efforts would include overflights during the dispersal period. As previously stated, emissions of criteria pollutants and greenhouse gasses (GHGs) from the response equipment for this type of action cannot be estimated with certainty.

The duration of air quality impacts would be infrequent and return to pre-activity levels at the completion of the activity. The extent or scope of impacts would be extend outside the project footprint, and the context would affect only attainment/unclassified areas. A

Scenario 2: River Barge Release

After accounting for the effectiveness of booming and skimming operations under this scenario, the remaining fuel would likely evaporate. Increases in emissions of criteria pollutants and GHGs from the response equipment would be almost nonexistent, as the tugs and vessels are used for normal operations.

Air quality would return to pre-activity levels quickly. The extent or scope of impacts would occur within the Project Area, and the context would affect only attainment/unclassified areas.

Scenario 3: Tank Farm Release

Recovery under this scenario would range from one hour to three days, and it is expected that very little of the spilled diesel fuel would evaporate in this time due to the limited surface area of the secondary containment. Except for the transfer operation line rupture (which would occur in summer), the scenarios could occur at any time of year, with colder temperatures reducing the evaporation rate and the rate of VOC emissions.

The duration of air quality impacts would be infrequent and return to pre-activity levels at the completion of the activity. The extent or scope of impacts would be limited to areas within the Project Area. The context would affect only attainment/unclassified areas.

Scenario 4: Tanker Truck Release

Recovery of diesel fuel from a tanker truck rollover could be difficult as the fuel could disperse to a stream, tundra, or water. It is possible the entire spill volume would evaporate. In-situ burning may be used.

The duration of air quality impacts would be infrequent and return to pre-activity levels at the completion of the activity. The extent or scope of impacts would be limited to discrete portions within the Project Area, and the context would affect only attainment/unclassified areas.

Scenario 7: Cyanide Release

Because sodium cyanide must come in contact with water to cause environmental impacts, a potential release of dry briquettes would not usually be expected to have any air quality impacts.

If it does come into contact with water or acid, it dissolves and parts will volatize into hydrogen cyanide gas, which could build up in enclosed areas such as the port storage and mine processing areas. The gas is highly toxic and could be quickly fatal to a human. These areas would be well-ventilated to prevent gas buildup and hydrogen cyanide monitoring would be conducted.

A potential release into the outdoor air could occur as a result of tank rupture. If the tank ruptures and the sodium cyanide combines with water or acid, some of it could volatilize. The gas would dissipate rapidly, and the duration of air quality impacts would be infrequent and return to pre-activity levels as the gas dissipates. The extent or scope would affect air quality within discrete portions of the Project Area. The context would affect only attainment/unclassified areas. There are no permit thresholds for cyanide, thus the intensity of impacts would not exceed regulatory standards.

Scenario 8: Mercury Release

A potential release into the outdoor air could occur as a result of a 76-pound or metric tonne container rupture of liquid elemental mercury. Portions of the mercury could volatilize into the atmosphere. Liquid elemental mercury is highly volatile and partitions quickly to the atmosphere.

The flux of vapor from a given mass of spilled elemental mercury depends on the temperature of the mercury (from surrounding surface and air temperature), the surface area, and conditions of the mercury exposed to the air (degree of oxidation) (Winter 2003). In an example of an extremely conservative outdoor rupture scenario where all of a metric tonne (2,200-pound) mercury container is spilled and spreads until the pool is at its capillary depth of 0.14 inches, the spilled area would be approximately of 220 ft^2 (based on a liquid mercury density of 13.56 g/cm3), which is equivalent to a circle about 17 feet across. The U.S. Department of Energy

(USDOE) (2011) provides an estimated rate of mercury evaporation, based on a wind speed of 10 mph and ambient temperature of 68ºF, of about 14 pounds/day. Based on the same conditional assumptions, less than 1 percent of the spilled liquid mercury from a metric tonne container would evaporate to the air over one day. If it takes a week to clean up the spill, roughly 4 percent of the mercury would evaporate to the air.

Mercury can combine chemically with other elements to form organic or inorganic mercury. There is relatively little organic mercury in the environment compared to inorganic mercury. Inorganic mercury can be released to the atmosphere as Hg^{II}, or Hg_P. These forms have different physical and chemical characteristics, thus have very different atmospheric lifetimes.

Elemental mercury vapor may remain in the atmosphere for more than a year, although it would disperse from the spill area. The Hg^{II} and Hg_P would typically wet deposit in a matter of days (depending on rain and snow events). Thus air quality impacts would be infrequent and return to pre-activity levels as the gas dissipates. The extent or scope would vary from affecting discrete areas of air quality to affecting air quality potentially throughout the EIS Analysis Area. The context would also vary from affecting attainment/unclassified areas to affecting EPA Class I areas or areas with poor air quality. There are no permit thresholds for mercury, thus the intensity of impacts would not exceed regulatory standards.

Scenario 9: Partial Tailings Dam Failure

With the exception of mercury, neither a tailings and water nor water only release would discharge substances that could evaporate and contribute direct or indirect impacts to air quality. The deposited tailings could release mercury in a gaseous phase, however. The extent of this effect would be similar to that described in Environ (2015) for the tailings beach, which is a small portion of overall mercury particulate and gaseous emissions at the Mine Site, but a large portion of gaseous-only emissions. In the event of the tailings and water release, the amount of tailings exposed to air would expand by 1,300 acres, as there would still be a tailings beach left in the TSF. This is roughly double the size of the maximum tailings beach in the late Operations Phase. As the tailings beach comprises more than 90 percent of gaseous mercury emissions at the Mine Site (Environ 2015), this spill scenario could temporarily double the amount of these emissions until remediation is complete. As with the tailings breach, spent mercury in the tailings mixture would include a mercury suppressant that would help prevent the escape of mercury into the air.

Gaseous mercury emissions from the water portion of the slurry release, or from the water-only release, are expected to be imperceptible due rapid transport and dilution of the initial flood, as compared to the stationary TSF pond during normal operations.

Metals in fugitive dust, including mercury as well as others of concern, such as arsenic and antimony (Section 3.2.3.2.4, Soil), could be mobilized during remediation of the tailings deposit. The extent of mercury in air in both gaseous and particulate forms would be similar to that shown on Figure 3.8-5 (Section 3.8, Air Quality) for the Mine Site during normal operations, with a slight bulge in contours to the southwest due to the expanded tailings deposit at the Anaconda-Crooked Creek confluence. It is expected that control of fugitive dust during remediation would include planned mitigation measures similar to those described for normal mine operations, such as water trucks and suppressants when necessary (Section 3.2.3.2.4, Soils).

Impacts to air quality from both gaseous and particulate emissions from the tailings release deposit would be similar to those of the Mine Site during normal operations (Section 3.2.3.2.4, Soils, and 3.8.3.3.1, Air Quality).

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

Under Alternative 3A, Scenario 5 (diesel pipeline release) is not applicable and has not been analyzed for effects to air quality. The likelihood of Scenarios 1 through 4 (ocean or river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Scenarios 7, 8, and 9 (cyanide, mercury, and tailings releases) would have the same impacts on air quality as those discussed under Alternative 2.

Scenario 6: Liquefied Natural Gas (LNG) Release

When LNG is released, it transitions to a gaseous state upon contact with warmer air or water. Air emissions would consist primarily of methane, which is a potent GHG.

Small LNG releases could occur from pinhole leaks from the storage tanks or during fueling of the LNG-fueled trucks. A release of up to 55,000 gallons of LNG could occur from an LNG tank rupture. The duration would be infrequent and returning to pre-activity levels at the completion of the activity. The extent or scope of impacts would be limited to discrete portions of the Project Area. The context would affect only attainment / unclassified areas.

3.24.6.8.3 ALTERNATIVE 3B – REDUCED DIESEL BARGING: DIESEL PIPELINE

Under Alternative 3B, Scenario 6 (LNG release) is not applicable and has not been analyzed for impacts to air quality. Impacts under Scenarios 1 through 3 (ocean or river barge, tank farm releases) would be shifted relative to Alternative 2; however, the impacts would be the same types as discussed under Alternative 2. Scenarios 7, 8, and 9 (cyanide, mercury, and tailings releases) would have the same impacts on air quality as Alternative 2.

Scenario 4: Tanker Truck Release

Alternative 3B eliminates the need for frequent tanker truck deliveries from Angyaruaq (Jungjuk) Port to the Mine Site during the Operations Phase. Instead, there would be an occasional tanker truck delivery in the opposite direction (from the Mine Site to Angyaruaq [Jungjuk] Port) to provide fuel for the generators at the port. Therefore, the occurrence of a spill would be less likely than under Alternative 2. However, should a spill occur, the overall impacts to air quality from a tanker truck release would be similar to the impacts described under Alternative 2.

Scenario 5: Diesel Pipeline Release

A pinhole leak in the pipeline could release up to 100,000 gallons of diesel fuel if the leak is undetected for weeks or months. If the leak is undetected for such a long period of time, much of the diesel would evaporate. Upon discovery, response efforts could include in-situ burning. Emissions of criteria pollutants and GHGs from the response equipment would likely be low on an annual basis. The duration would be infrequent and return to pre-activity levels at the completion of the activity. The extent or scope of impacts would be limited to discrete portions of the Project Area. In terms of context, impacts would affect only attainment/unclassified areas.

A pipeline rupture could release 422,000 gallons or more. The duration would also infrequent and returning to pre-activity levels at the completion of the activity. The extent or scope of impacts would be limited to discrete portions of the Project Area. In terms of context, impacts would affect only attainment/unclassified areas.

3.24.6.8.4 ALTERNATIVE 4 – BIRCH TREE CROSSING PORT

Under Alternative 4, spill Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to air quality. Scenarios 7, 8, and 9 (cyanide, mercury, and tailings releases) would have the same impacts on air quality as Alternative 2.

Impacts to air quality in the event of a diesel release under Alternative 4 for Scenarios 1 through 4 (ocean or river barge, tank farm, and tanker truck) would be the same as those discussed under Alternative 2, with the following exceptions:

- The risk of a river barge grounding would be somewhat lower under Alternative 4 because of the 38 percent reduction in river-barging miles from Alternative 2, and the avoidance of shallow areas between BTC Port and Angyaruaq (Jungjuk) Port that would not be traveled under Alternative 4; and
- The risk of a tanker truck release would be increased because of the longer one-way haul distance of 76 miles, as compared to 30 miles under Alternative 2.

3.24.6.8.5 ALTERNATIVE 5A – DRY STACK TAILINGS

Under Alternative 5A, Scenarios 5, 6, and 9 (diesel pipeline, LNG, and water and tailings releases) are not applicable and have not been analyzed for impacts to air quality.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and water only dam failure) for Alternative 5A would be the same as those discussed under Alternative 2.

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

Under Alternative 6A, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to air quality.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 6A would be the same as those discussed under Alternative 2.

3.24.6.9 NOISE AND VIBRATION

3.24.6.9.1 ALTERNATIVE 2 – DONLIN GOLD'S PROPOSED ACTION

Under the proposed action, two spill scenarios do not apply and are not analyzed for noise impacts. These include Scenario 5 (diesel pipeline release) and Scenario 6 (LNG release).

Scenario 1: Ocean Barge Rupture at Sea

Scenario 1 would be a potential diesel fuel spill resulting from the damage of an ocean-going fuel barge at sea. Under this scenario, dispersal and evaporation would likely take 3 to 5 days. During this time period, an increased number of take-offs and landings of fixed-wing aircraft and helicopters would occur around Dutch Harbor and Bethel. Intermittent noise impacts generated from these activities would have little or no lasting effect on any noise sensitive receptor. The duration of these impacts would last only a few days, would be limited to discrete portions of the Project Area at the sensitive receptor, and would impact usual or ordinary resources. However, if a major spill occurred close to the shoreline, overflight observations of the spill could have a higher intensity impact to sensitive receptors within communities.

Scenario 2: River Barge Release

The grounding and release of diesel from a single laden river tank barge traveling up the Kuskokwim River to the Angyaruaq (Jungjuk) Port would create infrequent noise impacts associated with tug boats used in containing the spill in the river, vehicles transporting the spill response and recovery crew and equipment, and spill cleanup and recovery operations. Sensitive receptors along the Kuskokwim River are shown in Table 3.9-26 (Section 3.9, Noise and Vibration), the nearest being the community of Upper Kalskag, located approximately 475 feet from the river's edge. In terms of intensity, the intermittent noise impacts generated from response operations equipment would be readily detectable at the nearest sensitive receptor., would impact usual or ordinary resources, and limited to discrete portions of the Project Area at the sensitive receptor. Diesel that would not be recovered within the first few days would travel downstream, so further response efforts would be enlisted. In this case, additional downstream sensitive receptors (Table 3.9-26 in Section 3.9, Noise and Vibration) could also experience some brief, discrete noise impacts associated with response efforts. In summary, noise impacts to the sensitive receptor associated with this scenario would be primarily due to impacts resulting from the proximity of the sensitive receptor to the location of the spill.

Scenario 3: Tank Farm Release

Scenario 3 is a potential diesel spill at a tank farm. The spill and subsequent response effort would be limited to the immediate vicinity of the spill site – either the Mine Site, a tank farm at Angyaruaq (Jungjuk) Port, or in Bethel. Noise sources would include vehicles transporting the spill response and recovery crew and equipment, and spill cleanup and recovery operations; under this scenario, recovery and cleanup operations should be completed within seven days. The nearest noise sensitive receptor from the Angyaruaq (Jungjuk) Port site and from the Mine Site would be Crooked Creek, located 5.94 miles from the Angyaruaq (Jungjuk) Port site, and 9.15 miles from the Mine Site. Infrequent noise impacts generated from response activities would have little or no lasting effect at these noise sensitive receptors; and noise levels at the receptor locations would be comparable to natural sounds. The duration of these impacts would last only a few days, would be limited to discrete portions of the Project Area at the sensitive receptor, and would impact usual or ordinary resources. Any actions that would occur at Dutch Harbor or the Port of Bethel at the Bethel Yard Dock are not part of the proposed action, and are considered connected actions (see Section 1.2.1, Connected Actions, in Chapter 1, Project Introduction and Purpose and Need).

Scenario 4: Tanker Truck Release

A small volume potential spill scenario may result from a vehicle collision involving a loaded tanker truck. Response efforts would involve materials that were carried on the tanker truck and the response would be immediate and complete within the hour. Given the relatively short timeframe of this geographically discrete and procedure-specific activity, there would be no anticipated noise-related impacts to the surrounding environment as a result of this scenario.

A larger volume potential spill scenario may result from a tanker truck rollover. Recovery efforts should be complete within seven to 10 days. The nearest sensitive receptor to the mine access road would be the community of Crooked Creek, located 5.93 miles away.

Intermittent noise impacts generated from response activities would have little or no lasting effect at the noise sensitive receptor; and noise levels at this receptor location would be comparable to natural sounds. The duration of these impacts would last only a few days, would be limited to discrete portions of the Project Area at the sensitive receptor, and would impact usual or ordinary resources.

Scenario 7: Cyanide Release

Because spill response and cleanup efforts to address cyanide spills would not involve loud noise generating equipment or vehicles, overall noise impacts would be considered imperceptible and no vibration impacts would be expected from this activity.

Scenario 8: Mercury Release

Spill response and cleanup efforts to address mercury spills would not involve loud noise generating equipment or vehicles. Therefore, overall noise impacts due to mercury spill would be imperceptible and no vibration impact would be expected from this activity.

Scenario 9: Partial Tailings Dam Failure

Scenario 9 is a potential partial tailings dam spill. The spill and subsequent response effort would be limited to the immediate area of the spill site; the Mine Site, Anaconda Creek, upper Crooked Creek, and to a lesser extent, the Kuskokwim River for monitoring activities. Noise sources would include increased air traffic, vehicles transporting the spill response and recovery crew and equipment, and spill cleanup and recovery operations. The nearest noise sensitive receptor from Anaconda Creek and from the Mine Site would be Crooked Creek, located 9.15 miles from the Mine Site at the mouth of Crooked Creek. Infrequent noise impacts generated from response activities would have little or no lasting effect at these noise sensitive receptors. With the exception of increased air traffic, noise levels at the receptor locations from remediation activities would be comparable to natural sounds. The duration of these impacts would last only during response, would be limited to discrete portions of the Project Area at the sensitive receptor, and would impact usual or ordinary resources.

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

Under Alternative 3A, Scenario 5 (diesel pipeline release) is not applicable, and has not been analyzed for effects to noise. The likelihood of Scenarios 1 through 4 (ocean or river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Impacts under Scenarios 7, 8, and 9 (cyanide, mercury, and tailings releases) for Alternative 3A would be the same as those discussed under Alternative 2.

Scenario 6: Liquefied Natural Gas (LNG) Release

Under Alternative 3A, small LNG spills could result from pinhole leaks from storage tanks or fueling the LNG-fueled trucks. Larger spills could result from an accident involving an LNG-fueled truck that could release up to the full amount of LNG within the truck's tank. Noise sources would mainly come from vehicles transporting the spill response and recovery crew and equipment, and spill cleanup and recovery operations. The nearest sensitive receptor would be the community of Crooked Creek, located 5.93 miles away.

If a spill were to occur, the impacts would be the same as those discussed under Scenario 4 of Alternative 2.

3.24.6.9.3 ALTERNATIVE 3B – REDUCED DIESEL BARGING: DIESEL PIPELINE

Under Alternative 3B, spill Scenario 6 (LNG release) is not applicable and has not been analyzed for effects to noise. Scenarios 7, 8, and 9 (cyanide, mercury, and tailings releases) would have the same impacts on noise as Alternative 2.

Impacts under Scenarios 1 and 2 (ocean or river barge releases) would be shifted relative to Alternative 2, and the likelihood of Scenarios 3 and 4 (tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2.

Scenario 5: Diesel Pipeline Release

The diesel pipeline release (either a pinhole leak or a pipeline rupture) portrayed under this scenario could occur anytime during the year, and could occur anywhere along the 334-mile buried pipeline route. Noise impacts under this spill scenario would result from vehicles transporting the spill response and recovery crew and equipment, and spill cleanup and recovery operations. Response efforts would use surface (if in the winter) and air transportation to reach the spill site. The nearest sensitive receptor to the pipeline alignment would be the community of Tyonek, located 0.44 miles from the pipeline alignment.

Response efforts for a pinhole leak could vary in intensity and may be readily detectable at the nearest sensitive receptor, depending on how quickly the leak had been detected. If the pinhole leak had gone undetected for weeks or months, the recovery effort would be much greater than those contained within the pipeline ROW. Noise levels would range from barely detectable to readily detectible at the sensitive receptor. Noise impacts would be limited to discrete portions of the Project Area at the sensitive receptor (Tyonek), and affect usual or ordinary resources. The duration of changes to noise levels would last several days during the cleanup period, and intermittent as response-related equipment is operated (e.g., aircraft overflights). For a larger pipeline rupture, response efforts would create more readily detectible changes to noise levels at the sensitive receptor.

3.24.6.9.4 ALTERNATIVE 4 – BIRCH TREE CROSSING (BTC) PORT

Under Alternative 4, spill Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to noise. Impacts under Scenarios 1, 2, 3, 7, 8, and 9 (ocean or river barge, tank farm, cyanide, mercury, and tailings releases) for Alternative 4 would be the same as those discussed under Alternative 2.

Scenario 4: Tanker Truck Release

The BTC Port road would be approximately 2.5 times longer than the road proposed under Alternative 2. The increased tanker truck transport distance would inherently increase the probability of a tanker truck release. In addition, equipment usage during operation and construction of the temporary ice road along Crooked Creek valley would also increase the probability of a release. However, while the risk of a diesel release increases under this alternative, the anticipated changes in noise levels at the sensitive receptor (Aniak) under the given tanker truck scenarios are generally the same as those described for Alternative 2.

3.24.6.9.5 ALTERNATIVE 5A – DRY STACK TAILINGS

Under Alternative 5A, Scenarios 5, 6, and 9 (diesel pipeline, LNG, and water and tailings releases) are not applicable and have not been analyzed for impacts to noise.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and water only tailings releases) for Alternative 5A would be the same as those discussed under Alternative 2.

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

Under Alternative 6A, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG Release) are not applicable and have not been analyzed for impacts to noise.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 6A would be the same as those discussed under Alternative 2.

3.24.6.10 VEGETATION

3.24.6.10.1 ALTERNATIVE 2 – DONLIN GOLD'S PROPOSED ACTION

Under the proposed action, two spill scenarios do not apply and are not analyzed for vegetation impacts. These include Scenario 5 (diesel pipeline release) and Scenario 6 (LNG release).

Scenario 1: Ocean Barge Rupture at Sea

A spill at sea under this scenario would affect primarily marine vegetation, but could also impact shoreline vegetation. Light oils such as diesel fuel are moderately volatile and can leave a residue of up to one-third of the amount spilled after several days, and can leave a film on intertidal resources that has the potential to cause long-term contamination (USFWS 2004b). While some toxic substances in an oil spill evaporate quickly, meaning that exposure to the most toxic substances are reduced with time and limited to the initial spill area, non-lethal toxic effects can be more subtle and often longer lasting. For example, aquatic life on reefs and shorelines would be at risk of being smothered by oil that washes ashore. Vegetation can also be poisoned slowly by long-term exposure to oil trapped in shallow water or on beaches (EPA 1999b). One impact of oil spills on plants lies with its coating effect. In order to produce food and energy, a plant must be able to carry out gas exchange with the environment. The coating of oil on the leaves of plants prevents the stomata or pores from receiving carbon dioxide from the air. The result would be slow growth and eventual death of plants.

Floating oil can contaminate algae and other marine plants. Marine algae and seaweeds respond variably to oil, and oil spills may result in die-offs for some species. Algae may die or become more abundant in response to oil spills. Although oil can prevent the germination and growth of marine plants, most vegetation, including kelp, appears to recover after cleanup (USFWS 2004b). Oil spills can have an indirect effect on plants through water contamination. A spill could potentially kill algae and plankton. Some animals may also perish with direct contact. If plants and animals die, the amount of ammonia and nitrites in the water increases. Conversely, levels of dissolved oxygen and pH levels decrease. Eventually, the changes in water chemistry can create a toxic environment for both plants and animals, becoming ecological dead zones.

It is assumed that due to the remoteness of such a spill, response efforts could be limited. Overflights would likely be conducted to observe the dispersal of the diesel, to confirm whether or not shoreline contact is predicted, and to direct any protection efforts to environmentally sensitive areas. With 50 percent of the spill assumed to impact the shore, this scenario could be expected to have an impact on shoreline vegetation within the area where the tides and waves carry the diesel onto shoreline vegetation. The extent would be within the vicinity of tidal and wave action along the affected shoreline.

Intensity of impacts would depend on location and size of a spill. The duration would be expected to last as long as the oil persisted in the environment. The extent would affect the immediate vicinity of the spill, and would be limited to a narrow fringe along the shore where the spill would potentially touch the shore. There is no particular context for vegetation unless rare or sensitive plants were to be confirmed to occur in the vicinity, although this is unlikely given that only a small fringe along the shore would be expected to be potentially impacted.

Scenario 2: River Barge Release

A spill on the Kuskokwim River could affect both aquatic and shoreline vegetation in the vicinity, as well as downstream of the spill. In terms of intensity, vegetation could be damaged or killed from the coating effect or through degradation of water quality. Spill response activities could damage adjacent shoreline vegetation by trampling or crushing from increased vehicle and human activity. Intensity of impacts would depend on location and size of a spill. The duration would be last only as long as the fuel persists in the environment. The extent affect the immediate vicinity of the spill and potentially downstream, and there is no particular context for vegetation unless rare or sensitive plants were to be confirmed to occur in the vicinity.

Scenario 3: Tank Farm Release

In the event of a release of diesel from a tank farm, intensity of impacts on vegetation would be that all diesel spilled would be captured within secondary containment. Recovery would be 100 percent minus loss to evaporation, and cleanup would be complete within hours to a few days. There are expected to be no impacts since the spill would be retained in secondary containment.

Scenario 4: Tanker Truck Release

A release of diesel from a tanker truck rollover or collision could occur and would involve a volume of diesel up to 13,500 gallons. At most, the entire contents of the tanker truck could be released to the environment along the roadbed, including potentially to vegetation and any adjacent open water. Recovery would be limited by potential dispersal to running water (e.g., a stream), as well as by evaporation during the time required to get response equipment to the site. During winter, snow and ice may limit the diesel's ability to initially reach the vegetation or water; however, it may also disguise cracks in the ice where diesel is able to rapidly reach vegetation or water.

Impacts would include damage to adjacent terrestrial vegetation and possible contamination of adjacent aquatic vegetation. Additionally, impacts also could include potential longer term contamination of the growth medium (soils) and therefore longer term impacts to plants.

Impacts to vegetation would vary in intensity and include above and below ground vegetation removal that may not be reclaimed. The duration of impacts would last only as long as the fuel persists in the environment; diesel would be expected to dissipate relatively rapidly. The extent or scope of impacts would affect the immediate vicinity of the spill. There is no particular context for vegetation unless rare or sensitive plants were to be confirmed to occur in the vicinity.

Scenario 7: Cyanide Release

If there was a tank-tainer spill at a storage site or the Mine Site, the resultant spill would be contained, as the tank-tainer would be located in an area that includes secondary containment. There would be no effect on vegetation.

If a truck carrying cyanide tank-tainers had an accident on the road, a tank-tainer rupture could result. If the cyanide briquettes spilled on dry ground, there would be no effect on vegetation. If the sodium cyanide came into contact with water, it would dissolve, and a cyanide release would result. If the cyanide came into contact with water, then both aquatic and terrestrial vegetation could be adversely affected. Cyanide can inhibit respiration and affect a plant's ability to absorb nutrients from soil, in some cases causing plant death. In smaller concentrations, cyanide can diminish new growth and can affect germination of seeds (ATSDR 2006). Shifrin et al (1996) report that the phytotoxicity of cyanide complexes is directly related to the amount of free cyanide evolved.

Cyanide is highly mobile in soil, meaning that it has high potential to affect plants and other organisms in soil rather than being bound up by soil particles. At low concentrations, soil micro-organisms convert cyanide into hydrogen cyanide and other compounds that evaporate out of soil. At high concentrations, however, cyanide is toxic to the micro-organisms that convert it into evaporative forms, meaning that cyanide not only remains in soil where it can damage plants but also can find its way to groundwater.

The intensity, extent, and context of effects on vegetation from a release of cyanide would be the same as described above for Scenario 4, Tanker Truck Release. The duration of impacts would depend on the persistence of cyanide in the environment, which could vary depending on the concentration level of the spill.

Scenario 8: Mercury Release

If mercury containers are lost overboard and recovered, or released in storage areas into secondary containment, no effects on vegetation would occur. A low probability potential spill scenario may result from transportation to Angyaruaq (Jungjuk) Port. In the unlikely event that there is an accident and the containers ruptured, a mercury spill (either the liquid mercury or the spent carbon) could result. The liquid elemental mercury and the spent carbon could be released to the land or surface water. Under this scenario, mercury could come into contact with plants (terrestrial species if the spill was on land, or aquatic species if the mercury got into a watercourse). Mercury is variably toxic to plants. Exposure to mercury can reduce photosynthesis, transpiration rate, water uptake, chlorophyll synthesis, and seed viability (Azevedo and Rodriguez 2012). The intensity, duration, extent, and context of impacts on vegetation from a mercury release would be similar to those described above for Scenario 7, Cyanide Release.

Scenario 9: Partial Tailings Dam Failure

An analysis of the effects of the tailings spill scenarios on Wetlands is found in Section 3.24.6.11. The impacts on vegetation are drawn from that analysis. The disturbance processes discussed in the wetland analysis would impact vegetation through:

- Removal or burial of native soils;
- Removal or burial of vegetation and propagules;
- Reduced soil nutrient availability resulting in delayed regrowth; and
- Exposure to soil conditions (pH) or chemical contaminants that may reduce or prevent vegetation growth.

The effects on vegetation would be primarily from deposition of tailings and eroded material, although riparian vegetation could be removed by the flood of materials as it moved down Anaconda Creek. The approximate acres impacted per aggregated vegetation type are estimated in Table 3.24-17 and Table 3.24-18 for the two scenarios (see Section 3.10, Vegetation and Nonnative Invasive Species, for a detailed description of aggregated vegetation types). Analysis is based on preliminary vegetation classification work done by 3PPI (2014b). Over half the affected vegetation would be forested.

In terms of intensity, vegetation would be impacted by the depth and type of materials spilled, and the rate of movement for riparian vegetation locations. The duration would be expected to be permanent, although some locations would experience native vegetation regrowth in places. The extent would affect the area of the spill. There is no particular context for vegetation unless rare or sensitive plants were to be confirmed to occur in the vicinity.

Table 3.24-17: Acres of Vegetation Affected in the Tailings and Water Scenario

Aggregated Type	Approximate Area (Acres)
Forested - Evergreen	285
Forested - Deciduous/Mixed	81
Scrub Shrub	60
Herbaceous	26
Other Land Cover	21
Total:	473

Source: 3PPI 2014b

Table 3.24-18: Acres of Vegetation Affected in the Water Only Scenario

Vegetation Type	Approximate Area (Acres)
Forested - Evergreen	553
Forested – Deciduous/Mixed	597
Scrub Shrub	175
Herbaceous	164
Other Land Cover	152
Total:	1641

Source: 3PPI 2014b

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

Under Alternative 3A, Scenario 5 (diesel pipeline release) is not applicable, and has not been analyzed for effects to vegetation. The likelihood of Scenarios 1 through 4 (ocean or river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Impacts under Scenarios 7, 8, and 9 (cyanide, mercury, and tailings releases) for Alternative 3A would be the same as those discussed under Alternative 2.

Scenario 6: Liquefied Natural Gas (LNG) Release

If released, LNG would transition back into a gaseous phase and if unconfined would not be explosive. In that case no impacts to vegetation would be expected. If a large quantity of LNG was spilled on vegetation, the intense cold would kill at least the above-ground parts of plants encountered before the LNG transitioned back to a gaseous state. In the very unlikely event that a large amount of LNG is spilled on water within a short period of time and there was an ignition source, an explosion could occur and nearby vegetation could catch fire. However, the LNG that would be used at the Mine Site would be stored and used in areas with little vegetation.

In summary, there would be no effects on vegetation from a release of LNG unless it caused surrounding vegetation to freeze. In this case, vegetation would be removed both above and below ground without reclamation. However, these impacts would be limited to the area of the spill. If an explosion and fire occurred, effects would vary in intensity and duration if vegetation was burned, depending on how long it takes the vegetation cover to regrow. The extent be in the immediate vicinity of the spill/fire. There is no particular context for vegetation unless rare or sensitive plants were to be confirmed to occur in the vicinity.

3.24.6.10.3 ALTERNATIVE 3B – REDUCED DIESEL BARGING: DIESEL PIPELINE

Under Alternative 3B, spill Scenario 6 (LNG release) is not applicable and has not been analyzed for effects to vegetation. Scenarios 7, 8, and 9 (cyanide, mercury, and tailings releases) would have the same impacts on vegetation as Alternative 2.

Impacts under Scenarios 1 and 2 (ocean or river barge releases) would be shifted relative to Alternative 2, and the likelihood of Scenarios 3 and 4 (tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2.

Scenario 5: Diesel Pipeline Release

A high to very high probability, low volume (less than 99.9 gal) potential spill scenario would result from pinhole leaks from the buried diesel pipeline that are detected within days. Because most of these small spills would not reach beyond the immediate vicinity of the pipeline or waterbodies they would have little effect on vegetation. Small spills from pinhole leaks would be restricted in geographic extent and would be unlikely to have measureable impacts on vegetation.

A medium to low probability, medium (100 to 999.9 gal) or large (1,000 to 100,000 gal) volume potential spill scenario would result if a pinhole leak remained undetected for weeks or months. Medium and large volume spills would have a high likelihood of seeping into the soil, sitting above permafrost layers, or moving into nearby waterbodies. Recovery would be limited by potential dispersal to running water (streams, etc.) and by evaporation during the time required to detect the leak and get response equipment to the site. Potential impacts would include damage to vegetation, potentially including rare or sensitive plants known to occur along the pipeline route.

In terms of intensity, large areas of both terrestrial and aquatic vegetation could be damaged. In terms of extent, a very large spill would be likely to reach both land and adjacent waterbodies, especially if it occurs in the ice-free seasons and near waterbodies. For those spills that do reach waterbodies, especially flowing streams and rivers, the area of impact would be more extensive. Large spills from a rupture in a pipeline would likely be detected quickly by the SCADA system; both automatic and manual responses would be quickly activated to stop and isolate the leak, in terms of duration, although impacts could persist until the diesel dissipates. In context, there are several documented occurrences of rare or sensitive plants along the proposed pipeline route that could potentially be affected by such a spill.

3.24.6.10.4 ALTERNATIVE 4 – BIRCH TREE CROSSING PORT

Under Alternative 4, spill Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to vegetation. The likelihood of Scenario 4 (tanker truck release) occurring would be greatly reduced due to shorter barge distances, but the impacts would be the same as those discussed under Alternative 2. Impacts under Scenarios 1, 2, 3, 7 through 9 (ocean or river barge, tank farm, cyanide, mercury, and tailings releases) for Alternative 4 would be the same as those discussed under Alternative 2.

3.24.6.10.5 ALTERNATIVE 5A – DRY STACK TAILINGS

Under Alternative 5A, Scenarios 5, 6, and 9 (diesel pipeline, LNG, and water and tailings releases) are not applicable and have not been analyzed for impacts to vegetation.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and water only tailings releases) for Alternative 5A would be the same as those discussed under Alternative 2.

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

Under Alternative 6A, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG Release) are not applicable and have not been analyzed for impacts to vegetation.

Impacts under fuel release Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 6A would be the same as those discussed under Alternative 2.

3.24.6.11 WETLANDS

3.24.6.11.1 ALTERNATIVE 2 – DONLIN GOLD'S PROPOSED ALTERNATIVE

Under the proposed action, two spill scenarios do not apply and are not analyzed for wetland impacts. These include Scenario 5 (diesel pipeline release) and Scenario 6 (LNG release).

<u>Scenario 1: Ocean Barge Rupture at Sea</u>

In this scenario a very large volume of diesel fuel (735,000 gallons) could spill from an ocean-going fuel barge. Failures of this type often involve grounding of the barge with spillage. Sensitive shoreline habitats could be affected and would be the focus of shoreline protection. Diesel fuel reaching shoreline marshes and intertidal wetlands would likely kill vegetation and associated micro and macro fauna, and it could overwhelm or eliminate most wetland functions. The severity of potential impacts to estuarine and marine wetlands would depend on the amount of diesel reaching the wetlands and the sensitivity of the affected shoreline wetlands.

Intensity of impacts would depend on location and size of a spill. The duration would be expected to last as long as the oil persisted in the environment. The extent would affect the immediate vicinity of the spill, and would be limited to a narrow fringe along the shore where the spill would potentially touch the shore. In context, wetlands have varying functions but no specific protective designations.

Scenario 2: River Barge Release

In this scenario grounding or other accidents could cause a large release; most unrecovered diesel would likely travel downstream with relatively little impact to shorelines and riverine wetlands. Wind and wave action could transport some of the unrecovered diesel into riverine wetlands where it may damage wetland vegetation. Diesel fuel kills vegetation similar to contact herbicides, with the short-chain and aromatic hydrocarbons causing the most damage by penetrating and destroying cell membranes, causing tissues to die (Walker et al. 1978; McKendrick 1999). If the contacted tissues are vital to the plant's survival, then the entire plant may die; if not, only the affected tissues may die. Long-chain fractions coat the surface of leaves and stems preventing normal gas exchange and, if sufficient area of the plant is covered, the plant may die (McKendrick 1999).

Because diesel floats on water, a band around the stems of shoreline emergent vegetation and any floating leaves may come in contact with diesel, although roots would be unlikely to be contacted. Herbaceous vegetation is most vulnerable to damage from diesel fuel, and contact with the stems may be sufficient to kill the whole plant (Walker et al. 1978). Shrubs have a protective bark layer and perennating buds that are typically elevated above the soil or water surface, protecting the vital cambium and buds from diesel contact (McKendrick 1999). Diesel oil is readily and completely degraded by naturally occurring microbes, in time frames of one to two months; diesel fuels are unlikely to penetrate saturated riverine wetland soils, and most of the unrecovered spill would evaporate or be dispersed downriver (Walker et al. 1978; Kershaw 1990; Bay 1997; McKendrick 1999). Shoreline cleanup efforts in peat shorelines would be difficult and would potentially cause additional damage to shoreline vegetation (NOAA 2007). Diesel oil is readily and completely degraded by naturally occurring microbes, under time frames of one to two months. Mechanized equipment would do more harm than good to shoreline vegetation in the unlikely event of a diesel spill. Diesel oil is not very sticky or viscous, compared to black oils. When small spills do strand on the shoreline, the oil tends to penetrate porous sediments quickly but also tend to be washed off quickly by waves and tidal flushing. Therefore, peat shorelines would likely be allowed to recover naturally, in which case the oil effects would last longer, but the shoreline habitat would recover faster than if cleanup actions were applied.

Intensity of impacts would depend on location and size of a spill. The duration would be last only as long as the fuel persists in the environment. The extent affect the immediate vicinity of the spill and potentially downstream. In context, wetlands have varying functions but no specific protective designations.

Scenario 3: Tank Farm Release

Potential spills could arise from a tank rupture, faulty valve or pipeline leak, transfer operation line rupture, or transfer human error. In the tank rupture scenario the large potential volume of spilled diesel fuel (1 million gallons or more) would be contained in secondary containment and would be recovered with no discharge to wetlands. Small volume spills (less than 10 gallons) resulting from the failure of a tank valve would also be contained and recovered with no discharge to wetlands. During a transfer operation line rupture, a medium to large volume of diesel fuel (100 to 2,000 gallons) could leak from a transfer hose at the dock in Dutch Harbor, Bethel, or Angyaruaq (Jungjuk). The spill would be 100 percent recovered with sorbents with no discharge to wetlands. A release during a fuel transfer due to operator error could result in a small volume of diesel fuel (less than 10 gallons) spilling from an overfilled tanker truck. The spill would be recovered with sorbents carried on the truck, and there would be 100 percent recovery with no discharge to wetlands. There are expected to be no impacts since the spill would be retained in secondary containment.

Scenario 4: Tanker Truck Release

In this scenario a medium to large volume of diesel fuel (up to 13,500 gallons) could be released primarily during the summer shipping season along the road between the port and the Mine Site during a tanker truck rollover. Although much of the road crosses uplands, it also crosses areas with flat, slope, and riverine wetlands including primarily evergreen forested, evergreen scrub shrub and deciduous scrub shrub wetlands that could be damaged by a large diesel spill. Diesel fuel on wetland vegetation would kill the vegetation on contact. Experimental applications of diesel fuel at a rate of 10 and 12 liters/m^2 on tundra vegetation resulted in reduction in live cover to a few percent or all vegetation died (Walker et al. 1978; Bay 1997). Mosses showed a delayed response to diesel application in heath habitats (Bay 1997). Recovery was generally better in moist and wet habitats than in dry habitats, but effects remained after 10 years with reductions to several percent live cover with the exception to mosses that returned to 53 percent cover in wet fen habitats (Bay 1997). Diesel fuel spray on wetland and upland forest vegetation would kill leaves of deciduous trees and shrubs and ground cover vegetation on contact. The surface contact effects of diesel fuel on evergreen trees, shrubs, and sub-shrubs like Labrador tea may have less impacts as the waxy coatings may delay penetration. While diesel is toxic to wetland flora and fauna in high concentrations, lower concentrations may have little effect. At lower concentrations engineered wetlands have been used successfully to decrease the concentrations of diesel, cyanide, and mercury in aquatic systems (Kadlec and Knight 1996; Palmroth et al. 2002; Weis and Weis 2004; Gessner et al. 2005; Imfeld et al. 2009).

Most spill impact studies in Alaska have addressed effects of North Slope crude oil spills on arctic tundra vegetation and interior black spruce forests (Jenkins et al. 1978; Walker et al. 1978; Kershaw 1990; Collins et al. 1994; McKendrick 1999). Studies that have evaluated both crude and diesel oil spills usually find that diesel is more toxic to vascular plants and mosses and that damage is usually reduced by wetter conditions (Hutchinson and Freedman 1978; Walker et al. 1978; Holt 1987; Bay 1997). Drier soils allow the fuel to penetrate to the root zone; diesel will remain at the soil saturation level. Where diesel fuel penetrates soils it damages root tissues on contact, and it creates hydrophobic soils which limits water availability to plants (McKendrick 1999). Soil water relations remain impaired until microbes degrade the oil, which in turn imbalances carbon:nutrient ratios as microbes increase to decompose the hydrocarbons (McKendrick 1999). The increased microbial activity can deprive vascular and non-vascular plants of vital nutrients (McKendrick 1999). Diesel fuel that reaches the roots of trees would likely kill the trees although it may take several years for death to be apparent (Collins et al. 1994).

Cleanup would be completed within seven to 10 days and would include sorbent, trenching, on-water recovery, snow and ice removal, and in-situ burning. Because diesel fuel causes contact damage to wetland vegetation, limiting the spread of the spill and preventing the diesel from penetrating the soil would limit damages. Burning is generally used after other methods of removal have been applied to remove as much of the spilled product as possible (Cater 2010). An experimental burn of a wet polygon trough after an experimental oil spill in Prudhoe Bay found that all vegetation was dead within the burned area a year after the burn; that vegetation had not recovered after five years, but had recovered completely after 24 years (McKendrick 1999). If diesel pools in wetlands, burning could create sufficient heat to allow the diesel to penetrate the root zones and could cause permafrost melting (Cater 2010). Burning the polygon trough did not cause permafrost melting in the arctic (McKendrick 1999); but oil spills and fires in interior boreal forest habitats with warmer permafrost will likely cause melting and subsidence (Collins et al. 1994; Post 1996).

A very small volume of diesel fuel (less than 10 gallons) could leak from a damaged valve during a collision; the spill would be contained on the road and recovered using sorbents with no discharge to wetlands.

Impacts to wetlands would vary in intensity and include above and below ground vegetation removal that may not be reclaimed. The duration of impacts would last only as long as the fuel persists in the environment; diesel would be expected to dissipate relatively rapidly. The extent or scope of impacts would affect the immediate vicinity of the spill. In context, wetlands have varying functions but no specific protective designations.

Scenario 7: Cyanide Release

Potential impacts from cyanide spills in wetlands depend on the concentrations and potential dilution effects. Should a container be punctured and the sodium cyanide contents come in contact with water, hydrogen cyanide gas would be released and pose immediate toxic and acute health dangers. In this case, an area evacuation should be conducted. Only trained emergency responders with the proper personal protective equipment (PPE) should address a sodium cyanide spill.

In wetlands, aerobic and anaerobic microbes can destroy cyanide, which may lessen the effects of cyanide in general in wetland ecosystems. Natural processes may be insufficient to treat cyanide in the event of a spill; flow-through treatment wetlands in temperate regions have been used to reduce total and free cyanide during a seven day detention by 56 and 88 percent, respectively (Gessner et al. 2005). Certain wetland plants such as willows can ingest and metabolically degrade cyanide (Gessner et al. 2005); however, elevated cyanide can inhibit plant respiration, and at lower concentrations, effects include inhibition of germination and growth (Eisler and Wiemeyer 2004). In general, plants are less sensitive to concentrations of cyanide that are lethal to animals. Adverse effects on aquatic plants are unlikely at concentrations that cause acute effects on most fish and invertebrates (Eisler and Wiemeyer 2004). Cyanide would likely kill wetland fauna. Flow-through treatment wetlands in temperate regions have been used to reduce total and free cyanide during a seven day detention by 56 and 88 percent, respectively (Gessner et al. 2005).

The intensity, extent, and context of effects on wetlands from a release of cyanide would be the same as described above for Scenario 4, Tanker Truck Release. The duration of impacts would depend on the persistence of cyanide in the environment, which could vary depending on the concentration level of the spill.

Scenario 8: Mercury Release

Potential impacts from mercury spills in wetlands depend on the concentrations and potential dilution effects. Uptake of mercury is plant specific in bryophytes, lichens, and wetland plants (Patra and Sharma 2000). In freshwater aquatic vascular plants uptake rate depends on the plant species, seasonal growth-rate changes, and the form of the metal ion (Patra and Sharma 2000). Mercury affects photosynthesis by replacing magnesium and breaking down the photosynthesis reaction, and at low concentrations mercury also interferes with microbial degradation reactions (Patra and Sharma 2000). Toxic effects may include reduced seed germination, reduced seedling vigor, chromosomal abnormalities, reduced growth (root, stem, leaf area, and dry-matter production), foliar injury, reduced chlorophyll and phytomass (Patra and Sharma 2000).

Wetlands may act as sources or sinks of metals. Studies of sources of methylmercury in boreal forest ecosystem wetland catchments determined that these catchments acted as sources. Upland catchments were primarily sinks (St. Louis et al. 1996). Wetland plants may export up 50 percent of mercury within a wetland, with retention level related to mercury sequestration variation within above- or below-ground plant structures by species (Weis and Weis 2004). At non-injurious levels, other studies have reported mercury removal at a rate of about 17 percent within temperate wetlands (Kadlec and Knight 1996). Developing techniques have successfully removed mercury from wetland systems through treatment with metal based salts (Ackerman et. al 2015). The intensity, duration, extent, and context of impacts on wetlands from a mercury release would be similar to those described above for Scenario 7, Cyanide Release.

Scenario 9: Partial Tailings Dam Failure

Burge and Cuervo (2015) identified three categories of physical disturbance that affected vegetation and wetlands after a tailings dam failure that released a slurry of tailings and water:

- Erosion, removal of native vegetation and exposure of native materials;
- Erosion followed by deposition, deposited materials left at the surface with no underlying native soils or vegetation; and
- Deposition, deposited materials overlying intact native vegetation and soils with little or no evidence of prior erosion.

These disturbance processes would impact wetlands through:

- Removal or burial of native wetland soils;
- Removal or burial of wetland vegetation and propagules;
- Reduced soil nutrient availability resulting in delayed regrowth;
- Exposure to soil conditions (pH) or chemical contaminants that may reduce or prevent wetland vegetation growth; and
- Altered hydrologic flow patterns (Andrusiak et al. 2015).

Erosion is expected to be greatest where flow depths are modeled to be highest, near the release point and within the Anaconda Creek valley (Figure 3.24-2 and Figure 3.24-4). Erosion from the water only spill would still occur, although erosion may be reduced compared to the more viscous slurry of water and tailings. Erosion would also be expected to be reduced in winter because of frozen soils, although if the flow also transports large chunks of ice, vegetation damage may not be reduced. Eroded materials would be deposited as water velocity slows, and broken vegetation would be deposited in strand lines as floodwaters recede. Deposition of eroded materials would increase where flow depths are lower or where flow is impeded such as at stream meanders or at the confluence of Anaconda and Crooked creeks for both the tailings and water slurry and for the water only spill.

Interpreting erosion and deposition disturbance as described by Burge and Cuervo (2015) to potential wetland impacts as described by the BGC (2015n) modeled spills based on flow depth: erosion may primarily occur at flow depths of 10 feet or higher; erosion and depositions may primarily occur at flow depths of less than 10 feet to 3 feet; and deposition may primarily occur at flow depths of less than 3 feet. Wetland types are based on preliminary vegetation classification work done by 3PPI (2014b), which overestimated percent wetlands as all mosaic wetland areas were classified as 100 percent wetlands. Based on this interpretation and the modeled spills, an approximate 446 acres of wetlands would be disturbed by the slurry of tailings and water, with 64 percent of these wetlands within the spill trajectory affected by the combination of erosion and deposition (Table 3.24-19). For the water only spill an estimated 1,487 acres of wetlands would be disturbed, with 58 percent of these wetlands affected primarily by deposition (Table 3.24-20).

Table 3.24-19: Piping Failure – Tailings and Water: Preliminary Calculation of Wetland Categories by Maximum Flow Depth

Wetland Type	Flow Depth (acres)			Approximate Impact Area (acres)	Area[1] (%)
	Erosion (≥ 10 ft)	Erosion and Deposition (≥ 3 ft to < 10 ft)	Deposition (< 3 ft)		
Evergreen Forested Wetlands	25.3	40.0	6.9	72.2	15%
Deciduous Forested Wetlands	0	0	0.3	0.3	<1%
Mixed Forested Wetlands	0.2	60.3	5.1	65.6	14%
Evergreen Scrub Shrub Wetlands	67.6	124.4	29.2	221.2	47%
Deciduous Scrub Shrub Wetlands	18.9	37.3	5.7	61.9	13%
Herbaceous Wetlands	0.2	21.6	2.3	24.2	5%
Ponds	0	1.1	0.2	1.3	<1%
Rivers	0	17.8	1.9	19.7	4%
Intermittent Streams (miles)	0.1	0.0	0	0.1	2%
Perennial Streams (miles)	2.1	1.5	0.3	6.7	1%
Uplands	4.6	1.6	0.5	6.7	1%
Area (acre)	116.8	304.1	52.2	473.2	NA
Wetland Area (%, acre)	25%	64%	11%	445.4	94%

Notes:

1 Proportion of total study area by wetland category. Note that mosaic classes calculated as 100% wetlands overestimate the wetland area proportion.

NA = Not Applicable 0 = None 0.0 = < 0.1

Source: 3PPI et al. 2014b, BGC 2015n

Table 3.24-20: Piping Failure – Water Only: Preliminary Calculation of Wetland Categories by Maximum Flow Depth

Wetland Type	Flow Depth (acres)			Approximate Impact Area (acres)	Area[1] (%)
	Erosion (≥ 10 ft)	Erosion and Deposition (≥ 3 ft to < 10 ft)	Deposition (< 3 ft)		
Evergreen Forested Wetlands	25.6	83.6	158.8	267.9	15%
Deciduous Forested Wetlands	0	16.4	36.7	53.1	3%
Mixed Forested Wetlands	0.2	147.6	263.2	411.0	23%
Evergreen Scrub Shrub Wetlands	69.8	159.7	180.7	410.2	23%
Deciduous Scrub Shrub Wetlands	19.7	69.8	175.9	265.4	15%
Herbaceous Wetlands	0.2	30.0	49.5	79.7	4%
Ponds	0	4.2	6.3	10.5	1%
Rivers	0	49.4	117.3	166.7	9%
Intermittent Streams (miles)	0.1	0	0.3	0.4	6%
Perennial Streams (miles)	2.2	2.0	2.9	7.1	94%
Uplands	4.4	2.9	104.9	112.2	6%
Area (acre)	119.8	563.7	1,093.2	1,776.6	NA
Wetland Area (%, acre)	8%	34%	58%	1,487.2	84%

Notes:

1 Proportion of total study area by wetland category. Note that mosaic classes calculated as 100% wetlands overestimate the wetland area proportion.

NA = Not Applicable 0 = None 0.0 = < 0.1

Source: 3PPI et al. 2014b, BGC 2015n

Deposition of tailings and eroded materials would be expected to increase where flow depths are lower or where flow is impeded such as at meander bends or at the confluence of Anaconda and Crooked creeks (Figure 3.24-2). Alluvial forest vegetation, especially cottonwoods and willows are adapted to periodic flooding and deposition of sediments and woody debris. Thick deposits of tailings materials, however, prevent infiltration of water from the surface and limit air exchange in the root zone (Adrusiak et al. 2015). Soil pH may be altered and soil nutrient availability would likely be decreased due to deposition of tailings (Adrusiak et al. 2015). Interpreting potential wetland disturbance from the BGC (2015n) modeled spill based on deposition depth: deposition of less than 0.5 foot was considered light burial; deposition of 0.5 foot to less than 3 feet was considered moderate burial; and deposition of 3 feet or more was considered heavy burial (Table 3.24-21). An approximate 442 acres of wetlands would be covered by tailings, with 52 percent of these wetlands affected by heavy burial with three feet or more of tailings (Table 3.24-21).

Cleanup efforts would focus on removal of tailings and return to the TSF. Some impairment of wetland functions would be likely to persist beyond cleanup. Burial or fill of wetlands and waters in the Anaconda Creek, and Crooked Creek watersheds would alter or remove their capacity to provide hydrologic, biogeochemical, and biological functions. An approximate total of 3.9 miles of streams would be directly affected by tailings deposition, including 3.8 miles of perennial streams and 0.1 mile of intermittent streams (Table 3.24-21; 3PPI et al. 2014).

Table 3.24-21: Piping Failure – Tailings and Water: Preliminary Calculation of Wetland Categories by Burial Depth

Wetland Type	Burial Depth (acres)			Approximate Impact Area (acres)	Area[1] (%)
	Light (< 0.5 ft)	Moderate (≥ 0.5 ft to < 3 ft)	Heavy (≥ 3 ft)		
Evergreen Forested Wetlands	9.9	27.8	34.1	71.7	15%
Deciduous Forested Wetlands	0	0.3	0	0.3	<1%
Mixed Forested Wetlands	0.3	5.0	60.3	65.6	14%
Evergreen Scrub Shrub Wetlands	46.7	86.6	85.0	218.3	47%
Deciduous Scrub Shrub Wetlands	9.5	22.0	30.1	61.6	13%
Herbaceous Wetlands	0.4	2.1	21.7	24.2	5%
Ponds	0.1	0.1	1.1	1.3	<1%
Rivers	0.1	1.8	17.8	19.7	4%
Intermittent Streams (miles)				0.1	3%
Perennial Streams (miles)				3.8	97%
Uplands	2.1	2.0	1.6	5.8	1%
Area (acre)	69.0	147.9	251.7	468.5	NA
Wetland Area (%, acre)	15%	33%	52%	441.7	94%

Notes:

1 Proportion of impact area by wetland category. Note that mosaic classes were calculated as 100% wetlands, which overestimated the wetland area proportion at the time of analysis using 3PPI 2014 data.

NA = Not Applicable 0 = None 0.0 = < 0.1

Source: 3PPI et al. 2014, BGC 2015n

In terms of intensity, wetlands would be impacted by the depth and type of materials spilled, and the rate of movement for riparian vegetation locations. The duration would be expected to be permanent, although some locations would experience native vegetation regrowth in places. The extent would affect the area of the spill. In context, wetlands have varying functions but no specific protective designations.

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

Under Alternative 3A, Scenario 5 (diesel pipeline release) is not applicable, and has not been analyzed for effects to wetlands. The likelihood of Scenarios 1 through 4 (ocean or river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Impacts under Scenarios 7 and 8 (cyanide and mercury releases) for Alternative 3A would be the same as those discussed under Alternative 2.

Scenario 6: Liquefied Natural Gas (LNG) Release

Small spills that would be unlikely to reach wetlands could occur from pinhole leaks in storage tanks or during truck fueling. While non-toxic to vegetation, the temperature of LNG would freeze wetland vegetation on contact. The extent of damage from contact with vegetation would be influenced by the extent of the spill and for some plants may depend on the season. Snow cover would likely provide some protection for ground and low-shrub cover, such that spills to vegetation in summer would likely cause more damage to these vegetation layers.

3.24.6.11.3 ALTERNATIVE 3B – REDUCED DIESEL BARGING: DIESEL PIPELINE

Under Alternative 3B, spill Scenario 6 (LNG release) is not applicable and has not been analyzed for effects to wetlands. Scenarios 7 and 8 (cyanide and mercury releases) would have the same impacts on wetlands as Alternative 2.

During the Construction Phase, impacts from Scenarios 1, through 4 (ocean or river barge, tank farm and tanker truck releases) would be the same as Alternative 2, but after the diesel pipeline is in operation much of the risk of diesel and other oil spills from barging and trucking described under Alternative 2 would be shifted from the Kuskokwim River to Cook Inlet and to the diesel pipeline route. Diesel handling spill scenarios would shift from Dutch Harbor, Bethel, and the Kuskokwim River to Tyonek, Cook Inlet, and the diesel pipeline route. However, if a release did occur, impacts to wetlands would be the same types as discussed under Alternative 2. During construction at the mine and prior to completion of the diesel pipeline some requirements for barge fuel deliveries would remain, however, and spill impact descriptions in Alternative 2 would apply. Because diesel would be primarily delivered by pipeline, the risk of accidents would be reduced, but there would be new risks of spills from the pipeline.

Scenario 5: Diesel Pipeline Release

Most pipeline leaks would be expected to occur in uplands because about 73 percent of the pipeline ROW is upland and 27 percent is wetland. Small spills would be expected to remain within the ROW, but could move along the groundwater surface or collect at the top of the permafrost active layer. Diesel components in the soil may be slow to degrade, and extensive contact with plant roots would cause plant death (Collins et al. 1994). Recovery, cleanup, and repair would likely require excavation of the pipeline, which would require removal of any vegetation cover and would disturb the soil.

3.24.6.11.4 ALTERNATIVE 4 – BIRCH TREE CROSSING (BTC) PORT

Under Alternative 4, spill Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to wetlands. The likelihood of Scenarios 2 and 4 (river barge and tanker truck release) occurring would be higher, but the impacts would be the same as those discussed under Alternative 2. Impacts under Scenarios 1, 3, 7, and 8 (ocean barge, tank farm, cyanide, and mercury releases) for Alternative 4 would be the same as those discussed under Alternative 2.

3.24.6.11.5 ALTERNATIVE 5A – DRY STACK TAILINGS

Under Alternative 5A, Scenarios 5, 6, and 9 (diesel pipeline, LNG, and water and tailings releases) are not applicable and have not been analyzed for impacts to wetlands.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and water only tailings releases) for Alternative 5A would be the same as those discussed under Alternative 2.

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

Under Alternative 6A, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to wetlands.

Impacts under Scenarios 1 through 4, and 7 and 8 (ocean or river barge, tank farm, tanker truck, cyanide, and mercury releases) for Alternative 6A would be the same as those discussed under Alternative 2.

3.24.6.12 WILDLIFE

3.24.6.12.1 TERRESTRIAL MAMMALS

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

Under the proposed action, two spill scenarios do not apply and are not analyzed for terrestrial mammal impacts. These include Scenario 5 (diesel pipeline release) and Scenario 6 (LNG release).

Scenarios 1 through 4: Ocean or River Barge, Tank Farm, or Tanker Truck Releases

Potential fuel spills on land would likely be limited to roads, workpads, and ROWs during the Construction Phase and would most likely be very small (less than 10 gallons) or small (10 to 100 gallons) spills of diesel. Such spills would likely be contained and cleaned up relatively quickly and, given their occurrence on gravel areas with high levels of human and vehicle disturbance, would be unlikely to pose a risk of contamination for terrestrial mammals. Scenarios such as fuel truck accidents, where spills could reach terrestrial habitats adjacent to the road, ROW, or pad, are expected to occur rarely but could involve larger volumes of fuel (up to 13,500 gallons) spills. Such accidents could cause injury and mortality for any terrestrial mammals that happened to be in the impact zone, but this would most likely involve small numbers of small mammals such as voles and shrews. Such serious accidental spills would be addressed immediately by cleanup and safety crews. Contaminated areas could be cordoned off while cleanup operations were completed. It is unlikely that additional terrestrial mammals would be exposed to the spill area due to the high level of disturbance and safety measures taken at the site.

However, such large spills would be more likely to seep into groundwater or escape into nearby water bodies (streams, rivers, and ponds). A similar situation could arise from potential spills that occur directly into water, such as from fuel barges traveling on the Kuskokwim River. As a result of such rare events, if they occurred, terrestrial mammals could be exposed to diesel on the surface of these water bodies, especially those like beavers and moose that spend substantial amounts of time in water and shoreline habitats. The physiological effects of hydrocarbon ingestion or inhalation by terrestrial mammals is rarely studied, except with laboratory animals intentionally exposed to various compounds, and most research in the field has been conducted on birds and marine mammals. Although a number of severe effects have been documented in water birds and marine mammals exposed to crude oil spills, the potential for exposure to more volatile diesel fuel and the abilities of different species to sense contaminated waters and avoid them is not known.

Terrestrial mammals could also be exposed by consuming contaminated organisms. Potential effects on terrestrial mammals from eating contaminated fish or other aquatic animals or vegetation are also poorly known and would likely depend on many exposure variables, including the type of contaminant, quantity and duration of the exposure, and physiological condition of the animal. It is possible that a large diesel spill could have serious physiological effects on any terrestrial mammals that are sufficiently exposed to the spill, but the mechanisms for that exposure, the numbers of each species involved, and the resulting effects on the survival or reproductive capacities of those animals cannot be predicted. For terrestrial mammals that might be so exposed, the numbers are expected to be small and too few for population-level effects.

Spill response activities, including countermeasures such as deflection and containment, in-situ burning, and waste management, may affect terrestrial mammals through disturbance and exposure to toxic substances. When in proximity to in-situ burning, terrestrial mammals could be adversely affected directly through exposure to smoke or ingestion of burned residues (USFWS 2015). Inhalation of in-situ burn smoke would likely result in short-term respiratory distress. Individuals may also be affected by wildlife protection measures including hazing and pre-emptive capture and relocation activities designed to prevent animals from encountering the contaminated area. Capture and handling of wildlife can increase exposure to infectious diseases, and animals exposed to contaminants may have suppressed immune function (USFWS 2015). Typical spill response actions are expected to be relatively small in scale, with impacts limited to the vicinity of the spill site, and would therefore affect a limited number of terrestrial mammals.

Scenario 7: Cyanide Release

Tank-tainers lost overboard from an ocean or river barge that were recovered without rupturing would have no effect on terrestrial mammals.

If a release were to occur at a storage site at the Mine Site, the resultant spill would be contained, as the tank-tainer would be located in an area that includes secondary containment. There would be no effect on terrestrial mammals.

If a truck carrying cyanide tank-tainers had an accident on the road, a tank-tainer rupture could result. If the spilled cyanide briquettes spilled on dry ground, there would be no effect on terrestrial mammals. If the sodium cyanide came into contact with water, it would dissolve; and the resulting hydrogen cyanide would be highly toxic to all wildlife that came into contact with the hydrogen cyanide. The concentrations and extent would depend on the quantity of cyanide spilled into the water and the volume of water. Even a spill in a puddle or rain could release toxic Hydrogen Cyanide gas. Initial isolation of the spill site from unprotected people or animals would be 0.1 mile for a small spill or 0.2 mile for a larger spill, and the downwind protection zone would be 0.1 to 0.2 mile for daytime or 0.2 to 0.9 mile for night. Cleanup would be limited to removing and protecting the undissolved sodium cyanide briquettes from further potential contact with the water. Spill residue would be properly disposed. The cyanide already dissolved cannot be recovered and would be left to disperse naturally, which would likely be completed by the time cleanup could be initiated. If the cyanide came into contact with water, then both aquatic and terrestrial mammals could be adversely affected. Although cyanide reacts readily in the environment and degrades or forms complexes and salts of varying stabilities, it is toxic to many living organisms at very low concentrations. Fish and aquatic invertebrates are particularly sensitive to cyanide exposure. Cyanide has low persistence in the environment and is not reported to be accumulated or stored in any mammals. There is no reported biomagnification of cyanide in the food chain.

Scenario 8: Mercury Release

In the unlikely event that there was a mercury spill in the storage areas either the liquid mercury or the spent carbon would be released from the containers and collected in secondary containment. Spilled mercury would be recovered and managed appropriately. Terrestrial mammals may be affected by sublethal concentrations of mercury that reduce overall fitness or by reduction of food supply if organisms they feed on are affected by the mercury. Generally, mercury accumulates up aquatic food chains so that organisms in higher trophic levels have higher mercury concentrations. At the top trophic levels are (piscivorous) fish-eating species, such as humans, bald eagles, cormorants, herring gulls, bears, river otters, and mink. The larger species prey on fish that occupy high trophic levels, such as pike and burbot, which in turn feed on smaller "forage" fish. Smaller piscivorous wildlife (e.g., kingfishers, ospreys) tend to feed on the smaller forage fish, which in turn feed on zooplankton or benthic invertebrates. Zooplankton feed on phytoplankton and the smaller benthic invertebrates feed on algae and detritus. Thus, mercury is transferred and accumulated through several trophic levels. This bioaccumulation puts the higher level piscivorous species at greatest risk of mercury exposure.

The EPA’s Mercury Study Report to Congress (EPA 1997b) describes that the effects of mercury on birds and mammals include death, reduced reproductive success, impaired growth and development and behavioral abnormalities. Sublethal effects of mercury on birds and mammals include liver damage, kidney damage, and neurobehavioral effects. Quantification of these effects is not possible due to the high number of variables involved. A low probability potential spill scenario may result from truck transportation of mercury containers to Angyaruaq (Jungjuk) Port. In the unlikely event that there is a truck accident and the containers ruptured, a mercury spill (either the liquid mercury or the spent carbon) could result. The liquid elemental mercury and the spent carbon could be released to the land or surface water. If elemental mercury is spilled, some of it would be emitted as gaseous mercury, which could be highly toxic to animals. However, with all the expected activity at the site of an accident and cleanup, few, if any, terrestrial mammals would be expected to be exposed to it. There would be no loss of food supply. If spilled mercury escapes cleanup efforts, it would be subject to natural methylation processes and would add incrementally to the mercury levels in background and air depositions, thus increasing the chronic exposure of aquatic biota and fish and, since it bioaccumulated, it would also increase exposure to fish-eating animals.

Scenario 9: Partial Tailings Dam Failure

An analysis of the effects of the tailings spill scenarios on Wetlands is found in Section 3.24.6.11, and the effects on Vegetation are found in Section 3.24.6.10. The disturbance processes discussed in the wetland analysis would impact wildlife habitat through:

- Removal or burial of native soils;
- Removal or burial of vegetation;
- Reduced soil nutrient availability resulting in delayed regrowth;
- Alteration of stream morphology and aquatic habitat in Anaconda Creek and Crooked Creek; and
- Elimination or burial of aquatic invertebrate communities and other prey species important to the diet of some wildlife species.

More than 360 acres of forested habitat and 60 acres of shrub habitat could be affected by the tailings and water scenario; or about 1,150 acres of forested habitat and 175 acres of shrub habitat could be affected by the water-only scenario. Aquatic habitat effects could range from about 21 acres to about 150 acres, depending on the scenario.

In addition to habitat effects, wildlife that might be in the path of the flood of materials would be subject to drowning, burial or other direct effects. Effects could include exposure to soil conditions (pH) or chemical contaminants that may be toxic.

Species most affected would be ones that spend most of their time in the aquatic or riparian areas, such as water birds, otters, and voles. The area affected would not contain whole populations of any of the wildlife species.

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

Under Alternative 3A, Scenario 5 (diesel pipeline release) is not applicable and has not been analyzed for effects to terrestrial mammals. The likelihood of Scenarios 1 through 4 (ocean or river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Scenarios 7, 8, and 9 (cyanide, mercury, and tailing releases) for Alternative 3A would have the same impacts on terrestrial mammals as Alternative 2.

Scenario 6: Liquefied Natural Gas (LNG) Release

Under this scenario, an LNG release would occur at the Mine Site. With the level of human activity at the site, terrestrial mammals would not be expected to come to within a close enough vicinity to be affected by an LNG release.

Alternative 3B – Reduced Diesel Barging: Diesel Pipeline

Under Alternative 3B, spill Scenario 6 (LNG release) is not applicable and has not been analyzed for effects to terrestrial mammals. Impacts under Scenarios 1 and 2 (ocean or river barge releases) would be shifted relative to Alternative 2, and the likelihood of Scenarios 3 and 4 (tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Scenarios 7 through 9 (cyanide, mercury, and tailings releases) would have the same impacts on terrestrial mammals as Alternative 2.

Scenario 5: Diesel Pipeline Release

Under Alternative 3B, a very large spill (greater than 100,000 gallons) would be a very unlikely event that could not be cleaned up quickly and would probably involve some contamination of groundwater and surface waters. Depending on where and when such an event occurred, it could cause injury and mortality for a number of terrestrial mammals, especially small mammals that cannot flee the area quickly. However, after a response was mounted to stabilize and repair the damage, the area would be subject to a great deal of human activity and substantial disturbance that would effectively inhibit terrestrial mammals from entering the area, thus minimizing the potential for exposure. The spill area may take a long time to recover and would represent a loss of habitat. The value and extent of that habitat loss would depend on the extent of the spill, its location, and the success of remediation efforts.

Alternative 4 – Birch Tree Crossing (BTC) Port

Under Alternative 4, spill Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to terrestrial mammals. The likelihood of Scenario 4 (tanker truck release) occurring would be greatly reduced; however, the impacts would be the same as those discussed under Alternative 2. Impacts under Scenarios 1, 2, 3, 7 through 9 (ocean or river barge, tank farm, cyanide, mercury, and tailings releases) for Alternative 4 would be the same as those discussed under Alternative 2.

Alternative 5A – Dry Stack Tailings

Under Alternative 5A, Scenarios 5, 6, and 9 (diesel pipeline, LNG, and water and tailings releases) are not applicable and have not been analyzed for impacts to terrestrial mammals.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and water only releases) for Alternative 5A would be the same as those discussed under Alternative 2.

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

Under Alternative 6A, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to terrestrial mammals.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 6A would be the same as those discussed under Alternative 2.

3.24.6.12.2 MARINE MAMMALS

Alternative 2 – Donlin Gold's Proposed Action

Under the proposed action, two spill scenarios do not apply and are not analyzed for marine mammal impacts. These include Scenario 5 (diesel pipeline release) and Scenario 6 (LNG release).

Scenario 1: Ocean Barge Rupture at Sea

Most studies on the effects of hydrocarbon contamination on marine mammals pertain to crude oil spills (Garshelis and Johnson 2013; Geraci and St. Aubin 1988; Geraci 1990; Matkin et al. 2008; St. Aubin 1990), although some of the effects of the lighter constituents of crude oil may be comparable to diesel fuel contamination. Highly refined petroleum products such as gasoline, diesel, and kerosene tend to evaporate from the water very quickly, even during winter months (USFWS 2015). Direct impacts of fuel spills on marine mammals may include sublethal effects from ingestion, irritation of eyes, mucous membranes, and the respiratory system, neurological disorders and liver damage, and impaired thermoregulation (St. Aubin 1990). Geraci and St. Aubin (1988) note an event that occurred in 1970 that described seals in Alaska as having "a glazed look in their eyes" and appearing disoriented after coming in contact with a light diesel fuel spill. Cetaceans are more likely to experience impacts through inhalation or ingestion, as their epidermis acts as an effective barrier to noxious substances found in petroleum, including gasoline (Geraci 1990). Indirect impacts could include contamination of prey resources and foraging habitat.

The marine mammals along the Bering Sea ocean barge corridor include minke whales, beluga whales, killer whales, harbor porpoises, and Dall's porpoises. Although gray whales occur in the eastern Bering Sea, they are generally only there during migration prior to and after the proposed shipping season, so they are unlikely to be encountered or impacted by spills occurring along the barge corridor between Dutch Harbor and Bethel. Small and very small spills are unlikely to impact most cetaceans, as they are highly mobile with large ranges relative to the small area that would be affected and short time period over which dispersion or evaporation would occur. In terms of intensity, these impacts would cause changes in behavior that may not be noticeable, with no noticeable incidents of injury or mortality. The duration of impacts would occur for a brief, discrete period lasting up to the duration of the Construction Phase. The extent or scope would be limited to the vicinity of the project footprint. In terms of context, legislative protection exists for all marine mammals under the Marine Mammal Protection Act (MMPA). In the event of a large or very large spill in the vicinity of cetaceans, injury is more likely to occur such that the intensity would involve detectible injuries, although the duration of the event-causing injury would be discrete. The extent or scope would depend on the breadth of the spill and area over which it dispersed. Few pinnipeds would be affected by an ocean barge rupture at sea, since major haulouts in or near Bristol Bay are well beyond the barge corridor. If a rupture were to occur nearer to Kuskokwim Bay and currents and winds dispersed the fuel shoreward prior to evaporation, some seals could encounter fuel and experience brief (up to 4 years), but noticeable physical effects in discrete areas of the spill or fuel dispersal range. Potential impacts of an ocean barge rupture on non-threatened or endangered marine mammals would depend on the size and location of a spill, proximity to marine mammals, and wind and weather conditions.

Spill response activities, including countermeasures such as deflection and containment, in-situ burning, and waste management, may affect marine mammals through disturbance and exposure to toxic substances. When in proximity to in-situ burning, terrestrial mammals could be adversely affected directly through exposure to smoke or ingestion of burned residues (USFWS 2015). Inhalation of in-situ burn smoke would likely result in short-term respiratory distress. Individuals may also be affected by wildlife protection measures including hazing and pre-emptive capture and relocation activities designed to prevent animals from encountering the contaminated area. Capture and handling of wildlife can increase exposure to infectious diseases, and animals exposed to contaminants may have suppressed immune function (USFWS 2015). Typical spill response actions are expected to be relatively small in scale, with impacts limited to the vicinity of the spill site, and would therefore affect a limited number of marine mammals.

Scenario 2: River Barge Release

A diesel fuel spill due either to grounding or collision on the Kuskokwim River could result in the same type of effects on marine mammals as described above for an ocean barge rupture. Small or very small spills are most likely to occur and would likely be contained and/or disperse and evaporate fairly quickly. Pinnipeds, primarily harbor/spotted seals, would have to be at the spill site at the time of occurrence to incur physical effects derived from breathing or ingesting the fuel. Although of low probability of occurrence, a large or very large spill would have a correspondingly greater footprint, potentially moving downstream from the spill site toward Kuskokwim Bay. In such an instance, the potential for a seal to contact diesel increases, as does the possibility of consuming fish contaminated by the fuel.

The frequency of occurrence of pinnipeds in the lower Kuskokwim River (11-68 sightings of harbor/spotted seals per year, 2007-2009) is variable and generally low; occurrence further diminishes upriver. Harbor porpoises and belugas are rare in the Kuskokwim River, and killer whales have never been seen in the river. The potential for direct contact with diesel fuel, were a spill to occur in the Kuskokwim River, is low. If such were to occur, the intensity would range from imperceptible to detectible without population effects. The duration of both the event and the effects would not last longer than the span of the Construction Phase. The extent or scope would be limited to the vicinity of the project footprint (but ranging from the spill location to some distance down river with a larger spill). In terms of context, any impacted marine mammal species are protected under the MMPA.

Scenario 3: Tank Farm Release

Spills at storage tanks at the Mine Site would have no effect on marine mammals. Storage tanks at Dutch Harbor, Bethel, and Angyaruaq (Jungjuk) Port would be used for transferring diesel among forms of transportation (e.g., from ocean barge to river barge and river barge to truck). All storage tanks would have secondary containment equal to a minimum of 110 percent of the total maximum volume of the largest tank. Only in the extremely unlikely event of simultaneous failure of secondary containment of multiple tanks would diesel be released to the surrounding environment. Under such circumstances, and if contamination of the surrounding environment includes nearby marine or riverine waterways, small numbers of marine mammals could encounter diesel from a tank farm release. However, since it is assumed that a diesel spill would be contained and recovered, it would not spread to adjacent waters, resulting in little chance for marine mammals to contact the diesel fuel. The intensity of impacts of a tank farm release on marine mammals would not likely be noticeable, last only as long as the recovery and cleanup operations, and limited to the immediate area of the spill. In terms of context, any impacted marine mammal species are protected under the MMPA. Any actions that would occur at Dutch Harbor or the Port of Bethel at the Bethel Yard Dock are not part of the proposed action, and are considered connected actions (see Section 1.2.1, Connected Actions, in Chapter 1, Project Introduction and Purpose and Need).

Scenario 4: Tanker Truck Release

Fuel spills resulting from a tanker truck incident are unlikely to affect marine mammals. The on-land release, small to very small volume for most spills, and the on-board spill response kits further minimize potential for impact to waterways. Furthermore, marine mammal sightings are rare as far up the Kuskokwim River as Angyaruaq (Jungjuk) Port. Since a spill emanating from a tanker truck is not likely to affect areas used by marine mammals in the Project Area, there would be no anticipated effects of such a spill on marine mammals.

Scenario 7: Cyanide Release

None of the transport scenarios for cyanide would release cyanide into the environment where marine mammals may occur. Therefore, no effects from cyanide would be expected. If a cyanide tank-tainer was lost in the water where marine mammals occur, the container would likely remain intact and the substance not released into the water. The activity associated with recovering the container may temporarily disrupt the behavior of marine mammals if they were present during that time.

Scenario 8: Mercury Release

None of the transport scenarios for mercury would release mercury into the environment where marine mammals may occur. Therefore, no effects from mercury would be expected. If a mercury container was lost in the water where marine mammals occur, the activity associated with recovering may have behavioral impacts on individuals if they were present during that time.

Scenario 9: Partial Tailings Dam Failure

Spills resulting from a partial tailings dam failure are unlikely to affect marine mammals. A water only spill could potentially reach the Kuskokwim River; however, it would rapidly be diluted, and marine mammal sightings are rare as far up the river as Angyaruaq (Jungjuk) Port. Since a spill emanating from a tailings dam is not likely to affect areas used by marine mammals in the Project Area, there would be no anticipated effects.

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

Under Alternative 3A, Scenario 5 (diesel pipeline release) is not applicable, and has not been analyzed for effects to marine mammals. The likelihood of Scenarios 1 through 4 (ocean or river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Impacts under scenarios and 7 through 9 (cyanide, mercury, and tailings releases) for Alternative 3A would be the same as those discussed under Alternative 2.

Scenario 6: Liquefied Natural Gas (LNG) Release

Under this scenario, an LNG release would occur at the Mine Site and marine mammals would not be affected by an LNG release.

Alternative 3B – Reduced Diesel Barging: Diesel Pipeline

Under Alternative 3B, spill Scenario 6 (LNG release) is not applicable and has not been analyzed for effects to marine mammals. The likelihood of Scenarios 2 through 4 (river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same as Alternative 2. Impacts under Scenarios 7 through 9 (cyanide, mercury, and tailings releases) for Alternative 3B would have the same impacts on marine mammals as Alternative 2.

Scenario 1: Ocean Barge Rupture at Sea

Under this alternative, a diesel pipeline from Tyonek to the Mine Site would eliminate diesel fuel barging up the Kuskokwim River during the Operations and Closure phases, but not during the Construction Phase, which would remain as under Alternative 2. During Construction, the potential for an ocean barge rupture and spill along the Western Alaska delivery route from Dutch Harbor to Bethel and resulting effects on marine mammals would be the same as discussed under Alternative 2.

During the Operations and Closure phases, diesel would be delivered by ocean-going vessel to an expanded fuel dock at Tyonek, resulting in an increased spill risk from ocean barge rupture for the Cook Inlet delivery route under Alternative 3B. In the event of such an occurrence, the impacts would be as described above under Alternative 2. Harbor seals occur in the area, although major haul-outs are south of the proposed barge route. In the event of small or very small spills, the intensity of changes in behavior may not be noticeable and population level effects are not expected to be detectable. Impacts would not last longer than the span of the Construction Phase and would be limited to the vicinity of the project footprint. In terms of context, any impacted marine mammal species are protected under the MMPA. In the event of a large or very large spill in the vicinity of marine mammals, injury is more likely to occur, such that the detectible injuries could occur, although the duration of the event causing injury would be discrete. The extent or scope would depend on the breadth of the spill and area over which it dispersed. Potential impacts of an ocean barge rupture on non-threatened or endangered marine mammals would depend on the size and location of a spill, proximity to marine mammals, and wind and weather conditions.

Scenario 5: Diesel Pipeline Release

The proposed diesel pipeline would begin in Tyonek and connect to Beluga, after which it would cross the Beluga River. Spills occurring along this segment of the pipeline route, particularly where it crosses the river, could impact marine mammals. Pipeline leak detection technology may identify a leak and shut down flow quickly, but containment and cleanup response can vary. The proximity of this segment of the pipeline to Beluga and Tyonek should facilitate intense response efforts once a leak is detected. The intensity and extent of impact depend on the time of year, size of the spill, and how quickly it disperses. Harbor seals forage at the mouth of the Beluga River during summer months and could either be directly impacted by skin or nasal contact with the spilled diesel or indirectly impacted if prey species are contaminated. In terms of intensity, impacts could range from imperceptible to detectible, depending on the season, presence of and numbers of seals, duration would likely occur during a discrete event, the extent generally limited to the area near to the spill, although the impact zone depends on the size of the release, time to detection, season, and weather conditions. The context for marine mammals is that all marine mammals are protected by the MMPA.

Alternative 4 – Birch Tree Crossing (BTC) Port

Under Alternative 4, spill Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to marine mammals.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 4 would be the same as those discussed under Alternative 2.

Alternative 5A – Dry Stack Tailings

Under Alternative 5A, Scenarios 5, 6, and 9 (diesel pipeline, LNG, and water and tailings releases) are not applicable and have not been analyzed for impacts to marine mammals.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and water only tailings releases) for Alternative 5A would be the same as those discussed under Alternative 2.

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

Under Alternative 6A, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to marine mammals.

Impacts under fuel release Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 6A would be the same as those discussed under Alternative 2.

3.24.6.12.3 Birds

Alternative 2 – Donlin Gold's Proposed Action

Under the proposed action, two spill scenarios do not apply and are not analyzed for bird impacts. These include Scenario 5 (diesel pipeline release) and Scenario 6 (LNG release).

Impacts under Scenarios 7 through 9 (cyanide, mercury, and tailings releases) for Alternative 2 would be the same as those discussed under terrestrial mammals, except that birds that use affected wetland areas may also be affected by sublethal concentrations of mercury that reduce overall fitness or by reduction of food supply if organisms they feed on are affected by the mercury. Because mercury generally bioaccumulates up the food chain through ingestion of fish, piscivorous bird species, such as bald eagles, kingfishers, and cormorants would be at greatest risk of mercury exposure. The EPA's Mercury Study Report to Congress (EPA 1997b) describes that the effects of mercury on birds include death, reduced reproductive success, impaired growth and development and behavioral abnormalities. Sublethal effects of mercury include liver damage, kidney damage, and neurobehavioral effects. Quantification of these effects is not possible due to the high number of variables involved.

It is important to note that diesel is considered "light" oil, and the effects will differ from "heavy" oils such as crude oil. Light oils are more acutely toxic than heavy, and also less sticky with a tendency to be washed off more quickly. Under fuel release Scenarios 1 through 4, the bulk of research that has been done on birds encompasses all types of oil, and so the discussion of scenario impacts does as well.

Scenario 1: Ocean Barge Rupture at Sea

Since diesel floats, the animals most affected by oil spills are animals like seabirds that are found on the sea surface or on shorelines if the oil comes ashore. During most oil spills, seabirds are harmed and killed in greater numbers than other kinds of creatures (NOAA 2014b).

The types of birds most affected by an oil spill at sea are those that spend a majority of their time on the surface of the water such as gulls, geese, ducks, auks, grebes, terns, and loons. If the oil reaches shore, shorebirds and songbirds may be affected, as well as any birds that use contaminated habitats. Migratory birds may be affected if critical migration staging, foraging or resting areas are contaminated, especially if the spill occurred during a season of high migratory bird use. Birds that feed in contaminated areas, such as raptors and piscivorous birds, can also be adversely affected.

The assessment of oil spill impacts to migratory birds is based on a combination of risk factors, such as probability of a spill, spill size, spill duration, weather conditions, and effectiveness of oil spill response (Stehn and Platte 2000). Spills of more than 10,000 gallons involving a barge transporting petroleum products in Alaska did not occur between January 1995 through July 2013, and a spill of this size is not projected to occur during the life of the Donlin Gold Project (ERM 2017c). If such a spill were to happen, dispersion would depend on the winds, wave action, and currents. The prevailing winds in summer are NE, E, and SE. The strong blows are from the same directions. That means that the spill, if it occurred in Kuskokwim Bay and if uncontained, could disperse in the direction of Kuskokwim Shoals, an area heavily used by eiders and other sea birds. Depending on the winds, the diesel could reach the area within a few hours to a day or two. The wind and waves would also cause the oil to evaporate and disperse in the water more rapidly, and within 3 to 5 days or less the volume of oil at the surface could be reduced by up to two-thirds.

The following description of the short- and long-term effects of oil spills on birds is summarized from USFWS (2004b) and EPA (EPA 1999b). Note that it does not differentiate between crude oil and lighter oils such as diesel fuel, and so it is difficult to know which effects would not be relevant.

Oil harms wildlife through physical contact, poisoning through ingestion or inhalation, and destruction of food sources or habitat, and can cause long-term reproductive problems. Physical contact with oil destroys the insulation value feathers, causing birds to die of hypothermia or lose buoyancy. In cold climates, a 1-inch diameter oil drop can be enough to kill a bird (NOAA 2014b). Heavily oiled birds can lose their ability to fly and their buoyancy; causing drowning.

In an effort to clean themselves, birds ingest and inhale oil. Ingestion can kill animals immediately, but more often results in lung, liver, and kidney damage and subsequent death. Birds constantly preening to remove oil, or unable to fly due to the oil, would be more vulnerable to predators.

Floating oil and oil dispersed in the water can contaminate algae, fish eggs, and the larvae of various invertebrates. Fish that feed on these organisms can subsequently become contaminated and then larger animals in the food chain, including birds, may consume contaminated organisms and be sickened or die.

In the long-term, oil ingestion has been shown to suppress the immune system, cause organ damage, skin irritation and ulceration, damage to the adrenal system, and behavioral changes.

Damage to the immune system can lead to secondary infections that cause death, and behavioral changes may affect an individual's ability to find food or avoid predators. Oil can also affect animals in non-lethal ways such as impairing growth and reproduction, and from the loss of important habitat.

The spill under this scenario (735,000 gallons released and half of it headed toward shore) would take place during the summer shipping season when large numbers of waterbirds (waterfowl, seabirds, shorebirds, etc.) use Kuskokwim Bay for spring staging, and then may nest on adjacent shoreline and upland areas. If birds came into contact with spilled diesel, individuals could be killed, sickened, lose food and habitat, or experience reproductive problems. If the spill spreads to shore, nesting birds may be affected. Eggs coated by diesel would suffocate. If females ingest diesel before laying eggs, the shells may be too thin, or chicks may be malformed. Later in the summer many birds may be molting in the vicinity of the barge route in Kuskokwim Bay and would be more vulnerable to adverse impacts due to their temporary inability to fly.

Numerous foraging areas of regional or global importance for sea ducks, seabirds, breeding seabird colonies, as well as areas important for migratory shorebirds are located in the Bering Sea and the Gulf of Alaska, although most are far enough away from the barge route that they would not be affected because the diesel would disperse and evaporate or winds and currents would take it elsewhere. The coastal area from the mouth of the Kuskokwim River to the south side of Nelson Island is the most important area for fall staging shorebirds on the west coast of North America. It supports hundreds of thousands, if not millions, of shorebirds, including virtually the entire North American-breeding population of bar-tailed godwits. A spill in one of these areas during the time when large numbers of birds are present could affect a large proportion of certain bird populations.

Many bird populations can recover following a one-time mortality event (e.g., a localized oil spill) if the fraction of the total population killed remains small. However, as the fraction killed becomes higher, the severity of population impact can increase above that expected by a simple proportional change (Stehn and Platte 2000). Disruption of social behavior, loss of mates, competition with other species, or increased predation, may prevent or extend the time before population recovery. Declining populations or populations with a limited capacity for growth would be at greater risk. All loons, eiders, and other seaducks have a relatively low capacity for population growth (Stehn and Platte 2000). The effect of spills on federally listed Steller's and spectacled eiders is discussed in Section 3.24.6.14.1.

An ocean barge rupture would have impacts on birds which would vary in intensity as it could affect large numbers of birds (species described in Section 3.12, Wildlife, under the heading Marine Waters) and the effects would be noticeable. The duration would also vary, depending on what proportion of the population is affected. The extent of effects would generally limited to the immediate area of the spill, but if migratory bird populations were affected, the effects could extend to populations distant from the EIS Analysis Area. There is no particular legal context for impacts aside from species that are ESA-listed, although some species may be identified as species of conservation concern (see Section 3.12, Wildlife; Section 3.14, Threatened and Endangered Species; and also addressed in Section 3.24.6.14.1).

Spill response activities, including countermeasures such as deflection and containment, in-situ burning, and waste management, may affect birds through disturbance and exposure to toxic substances._When in proximity to in-situ burning, birds could be adversely affected directly through exposure to smoke or ingestion of burned residues (USFWS 2015). Inhalation of in-situ burn smoke would likely result in short-term respiratory distress. Individuals may also be affected by wildlife protection measures including hazing and pre-emptive capture and relocation activities designed to prevent birds from encountering the contaminated area. Capture and handling can increase exposure to infectious diseases, and animals exposed to contaminants may have suppressed immune function (USFWS 2015). Typical spill response actions are expected to be relatively small in scale, with impacts limited to the vicinity of the spill site, and would therefore affect a limited number of birds.

Scenario 2: River Barge Release

A release of diesel from a river barge caused by either grounding on the Kuskokwim River or a collision on the river or at the Angyaruaq Port, would affect any birds that encountered the spill in the same ways described above for an ocean spill but would also affect adjacent shoreline birds and habitat. Containment and cleanup activities could also affect birds through the increase in human activity. Diesel would spread downstream, potentially reaching Kuskokwim Bay. The river shoreline habitat in the vicinity of the spill would be adversely affected by vegetation damage both from the spill and subsequent cleanup. The barges would travel through the Yukon Delta National Wildlife Refuge, which was created to protect and maintain internationally significant waterfowl and shorebird populations. As described in Section 3.12, Wildlife, the Kuskokwim River area provides habitat for 26 Species of Concern; many of which breed there in exceptionally high densities making the habitat along the barge route of regional importance to these species' populations. In particular, species such as rusty blackbird, solitary sandpiper, dunlin, and short-tailed dowitcher are known to nest near water in the area and feed in shallow water, which increases their risk of exposure to any spills.

The most severe impacts would occur to birds that are not able to leave the area immediately, such as juveniles from nearby nests and molting (temporarily flightless) birds. Twenty-one species that were observed in the Project Area are known to nest along shorelines (see Section 3.12, Wildlife, for details on bird demographics) including tundra swans, ducks, geese, sandpipers, loons, phalaropes, and grebes. Residual contamination that enters the food chain could affect raptors such as bald and golden eagles, osprey, and northern harriers that may eat contaminated fish or small mammals. While a number of birds could be affected by a larger spill, there are no known concentrations of birds along the river that could experience population-level effects from a single spill event.

The impacts of a river barge release on birds would vary in intensity as effects are likely to be noticeable. The duration would depend on what proportion of the population was affected. The extent of effects would generally limited to the immediate area of the spill, but if migratory bird populations were affected, the effects could extend to populations distant from the EIS Analysis Area. There is no particular legal context for impacts aside from species that are ESA-listed, although some species may be identified as species of conservation concern(see Section 3.12, Wildlife; Section 3.14, Threatened and Endangered Species; and also addressed in Section 3.24.6.14.1).

Scenario 3: Tank Farm Release

A small number of birds in the vicinity of the tank farms located at the Angyaruaq (Jungjuk) Port and the Mine Site may be affected by a tank farm rupture, leak or operational line rupture.

However, because the secondary containment would provide 100 percent recovery, the effects would be limited to brief disturbance from fumes, potential fire danger, and an increase in human activity in the area. Birds may be temporarily displaced from adjacent habitat. Because it is assumed that the spill would be contained and recovered, there would be no spread to adjacent habitat and therefore little chance for birds to come into contact with the diesel. The number and type of birds present in the affected area depends on the time of year of the spill, but even during migration or breeding season (when more birds are present) the numbers of birds affected would be small.

In terms of intensity, the impacts of a tank farm release on birds would not likely be noticeable. The duration would last only as long as the recovery and cleanup operations. The extent or scope of effects would be limited to the immediate area of the spill. There is no particular legal context for impacts aside from species that are ESA-listed, although some species may be identified as species of conservation concern (see Section 3.12, Wildlife; Section 3.14, Threatened and Endangered Species; and also addressed in Section 3.24.6.14.1).

Scenario 4: Tanker Truck Release

A release of diesel from a tanker truck rollover or collision may affect a small number of birds in the immediate vicinity of the accident, and small areas of adjacent habitat. If diesel dispersed to a nearby stream, the effects could spread further and affect aquatic birds such as spotted sandpipers, American dippers, and mergansers. Response efforts, including increased human activity, could disturb birds causing them to temporarily avoid the area. If birds were nesting in roadside vegetation that became oiled, nests and/or eggs and young could be killed. Species known to occur in the area and nest close to the ground include fox sparrows, common redpolls, and dark-eyed juncos. Because the area affected would be small, the number of birds to ingest oil or contaminated food would be small.

The number and type of birds present in the affected area depends on the time of year that the spill occurs, but even during migration or breeding season (when more birds are present) the numbers of birds affected would be small.

<u>Alternative 3A – Reduced Diesel Barging: LNG-Powered Haul Trucks</u>

Under Alternative 3A, Scenario 5 (diesel pipeline release) is not applicable, and has not been analyzed for effects to birds. The likelihood of Scenarios 1 through 4 (ocean or river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Impacts under Scenarios 7 through 9 (cyanide, mercury, and tailings releases) for Alternative 3A would be the same as those discussed under terrestrial mammals.

Scenario 6: Liquefied Natural Gas (LNG) Release

If released, LNG will transition back to a gaseous phase if it comes into contact with warmer air or water (California Energy Commission 2014). The natural gas vapors are initially heavier than air and they form a cloud close to the ground, which is pushed downwind and eventually dissipates. If a viable ignition source is present where a vapor cloud exists at a 5 percent to 15 percent concentration in air, the vapor cloud can ignite and burn, but would not explode unless confined. Methane, the primary component of LNG, is colorless, odorless, and tasteless. It is non-corrosive and non-toxic, but is classified as a simple asphyxiant possessing a slight inhalation hazard. If breathed in high concentration, oxygen deficiency can result in serious injury or death. Unconfined mixtures of methane in air (such as an LNG release that has transitioned back to a gaseous phase) are not explosive. If released LNG comes into contact with water it will float, as it is less dense than water. If there is an ignition source, a physical explosion can occur, which can be hazardous to nearby people, buildings, or wildlife (California Energy Commission 2014).

The number and type of birds potentially affected depends on the timing and location of the spill; more birds are present in the Project Area during the summer breeding season and the fall and spring migration seasons and fewer during the winter months. However, a spill would be most likely to occur in active mine areas where few birds are likely to be.

Alternative 3B – Reduced Diesel Barging: Diesel Pipeline

Under Alternative 3B, spill Scenario 6 (LNG release) is not applicable and has not been analyzed for effects to birds. The likelihood of Scenarios 2 through 4 (river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Impacts under Scenarios 7 through 9 (cyanide, mercury, and tailings releases) for Alternative 3B would be the same as those discussed under terrestrial mammals.

Scenario 1: Ocean Barge Rupture at Sea

Under Alternative 3B there would only be ocean fuel barge trips to Bethel during Construction. Therefore, there would be no fuel barges during the Operations Phase, unlike alternatives 2 and 3A, which would dramatically reduce the risk of spills between Dutch Harbor and the Kuskokwim River. However, if an ocean barge rupture at sea did occur, the impacts to birds would be the same as those discussed under Alternative 2. During operation, the diesel (12 tankers per year) would be shipped to Tyonek, and the spill scenario would shift to Cook Inlet and waters leading to it. The types of impacts would be the same, but the birds vulnerable to effects would be different. Fewer concentrations of staging and molting birds occur than in the Kuskokwim Bay area, but the area is known to contain large numbers of both breeding and non-breeding glaucous-winged gulls and a colony of black-legged kittiwakes (see Figure 3.12-9 in Section 3.12, Wildlife) Audubon Alaska's Important Bird Areas Nearest the Project Area), as well as a variety of molting and wintering sea ducks in bays throughout lower Cook Inlet.

Scenario 5: Diesel Pipeline Release

A diesel fuel spill (large or small) from the pipeline could affect birds in much the same ways as described under Alternative 2 for truck spills or river barge spills, depending on the size of the spill and where it occurred. Many different types of birds could be affected; terrestrial species such as songbirds, raptors, and other inland-nesting or migrating species would be most likely to be affected, although a spill could also affect water birds if it reaches wetlands or waterbodies. Raptors known to nest along the proposed pipeline route and other foraging birds could be affected by contamination of food sources. If the spill reached a river at a pipeline crossing, the effects of the spill would be much like a river barge spill and the extent of effects would be potentially much larger. If the oil spilled on land rather than floating on the surface of the water, oil could sink into soil or groundwater and cause longer-term contamination that may be more difficult to detect or remove. The number and type of birds potentially affected depends on the timing, location, method(s) of dispersion and types of habitats impacted of the spill; more birds are present in the Project Area during the summer breeding season and the fall and spring migration seasons and fewer during the winter months. The geographical extent of impacts could be extensive if the spill occurred during the spring or fall when migrating species could be affected. If the spill occurred during the breeding season, a significant nesting loss could affect several Species of Concern, such as blackpoll warbler, rusty blackbird, olive-sided flycatcher, and solitary sandpiper. A large-scale spill (422,000 gallons) would be larger than a river barge spill (302,535 gallons), but smaller than an ocean barge spill (735,000), and could have long-lasting impact on both terrestrial and aquatic birds.

Alternative 4 – Birch Tree Crossing Port

Under Alternative 4, spill Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to birds. The likelihood of Scenario 2 (river barge release) occurring would be greatly reduced, and the likelihood of Scenario 4 (tanker truck release) would be increased; however, the impacts of either would be the same types as discussed under Alternative 2. Impacts under Scenarios 1 and 3, 7, 8, and 9 (ocean barge, tank farm, cyanide, mercury, and tailings) for Alternative 4 would be the same as those discussed under terrestrial mammals.

Alternative 5A – Dry Stack Tailings

Under Alternative 5A, Scenarios 5, 6, and 9 (diesel pipeline, LNG, and water and tailings releases) are not applicable and have not been analyzed for impacts to birds.

Impacts under fuel release Scenarios 1 through 4 (ocean or river barge, tank farm, and tanker truck, releases) for Alternative 5A would be the same as those discussed under Alternative 2.

Impacts under Scenarios 7 through 9 (cyanide, mercury, and tailings releases) for Alternative 5A would be the same as those discussed under terrestrial mammals.

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

Under Alternative 6A, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to birds.

Impacts under fuel release Scenarios 1 through 4 (ocean or river barge, tank farm, tanker truck) for Alternative 6A would be the same as those discussed under Alternative 2.

Impacts under Scenarios 7 through 9 (cyanide, mercury, and tailings releases) for Alternative 6A would be the same as those discussed under terrestrial mammals.

3.24.6.13 FISH AND AQUATIC RESOURCES

3.24.6.13.1 ALTERNATIVE 2 – DONLIN GOLD'S PROPOSED ACTION

Under the proposed action, two spill scenarios do not apply and are not analyzed for impacts to fish and aquatic resources. These include Scenario 5 (diesel pipeline release) and Scenario 6 (LNG release).

Scenario 1: Ocean Barge Rupture at Sea

Ocean-going cargo barges follow general but consistent routes determined by distance, protected habitat, public safety, water depth, and underwater hazards. Although spills of more than 10,000 gallons involving a barge transporting petroleum products in Alaska has not occurred since 1995, this scenario assumes that an ocean barge rupturing at sea would release of 735,000 gallons of diesel as the result of a barge grounding south of the Kuskokwim River entrance. It is further assumed that 50 percent of the release would contact the shore. While a spill of this nature and size under this scenario is not expected to occur over the life of the Donlin Gold Project (ERM 2017c), the level of impact of such a low probability ocean barge rupture would depend upon several factors. These include: 1) the nature of the incident and sea conditions (e.g., calm or stormy); 2) the specific location and extent of the spill along the shore; 3) whether a major fraction of the spill affects intertidal and nearshore ecosystems causing risks to sensitive habitats and species; and 4) the efficacy of containment and response measures implemented in a timely manner.

As described in Section 3.24.1.1, the transport, storage, and distribution of fuel would be managed according to a number of plans prepared in compliance with state and federal regulations. In particular, the Oil Discharge and Prevention Contingency Plan would describe measures to prevent and respond to a spill.

The fate and behavior of spilled diesel fuel at sea depends on weather conditions (e.g., wind, wave energy, temperature, and sun intensity); the type of ecosystem affected (e.g., estuaries, rivers, streams, lagoons, backwaters, sloughs, ponds), and physical and chemical properties of the fuel. Spilled diesel fuel in water is volatile and tends to spread quickly with an increasing surface area which causes it to reduce in concentration at the spill site. Evaporation and dispersion are primary processes responsible for the loss of spilled diesel from surface waters. When spills are subject to high-energy ocean waves, heavy winds, and sunshine, dispersal and evaporation of surface concentrations of diesel would likely take less than three to five days. Refer to Sections 3.24.4.1.1 and 3.24.5.1 for further information on the fate, transport, and general effects of spilled diesel including seasonal influences.

Impacts to fish and aquatic resources would be lower if the thin layer of diesel on the surface is blown offshore by winds than if the spill migrates to shore. If diesel spills remain offshore, the intensity of impacts would such that incidents of injury or mortality to ichthyoplankton species (eggs and larval stages of fish and invertebrates that reside in surface layers) would be detectable but populations remain within normal variation. These effects are not likely to continue through the life of the project because of the relatively rapid evaporation rates of diesel fuel. Effects would also be largely limited to the spill footprint. However, spills that reach shallow littoral or intertidal zones could have higher intensity impacts. These impacts may result in incidents of mortality or injury to individual fish or other aquatic biota and create population-level effects. The context of impacts could affect EFH with regulatory protection.

Several direct effects could occur within the spill footprint in littoral and intertidal zones including:

- Physical effects in the form of localized interference with oxygen dissolution into the water column.
- Toxicological effects, as fuel fractions are absorbed or consumed by organisms within the footprint.

- Habitat alteration as diesel fuel accumulates onto sediment habitats within the intertidal zone, causing toxicity to algae and marine macrovegetation, epibenthic and benthic communities, and avoidance by more mobile macroinvertebrates and fish.
- Local disruption of the foodweb if algae, macrovegetation, and invertebrate communities important to fish and other aquatic species are affected by the spill.

The severity of impacts would be dependent upon the size of the spill within the nearshore/intertidal zone and the character of the shoreline. While the duration of effects of diesel spills in open waters are relatively brief, areas that are physically protected from these influences have low flushing rates, or small tidal movements, and may be more vulnerable. Direct effects, therefore, may have a longer duration in these areas.

Shellfish in shallow or confined nearshore waters tend to be at higher risk from diesel spills than finfish since they are less mobile, unable to avoid exposure, and are indiscriminant filter feeders. In addition, shellfish lack enzymes that finfish and vertebrates possess so they are unable to breakdown such contaminants. In contrast, juvenile and adult finfish are generally more mobile and selective of ingested foods and have enzymes that provide a means to detoxify exposure to many oil compounds. Larval life phases of finfish are less mobile, however, and would have a relatively greater exposure to diesel spills than juveniles or adults (NOAA 2017a).

Subsistence and commercial fisheries in the Kuskokwim River also could be affected if it is determined that one of more fish stocks exposed to a spill south of the Kuskokwim River entrance have been tainted (e.g., smell or taste like a petroleum product) and, if consumed, would pose a risk to human health. Fish only could be sold for human consumption after testing confirms fish are no longer contaminated (NOAA 2017a, 2017b). Depending on the location and timing of the spill and the level of exposure adversely affecting local fisheries, the intensity of impacts would vary and may result in acute or obvious/abrupt changes in fish or other aquatic biota.

Intensity of impacts would vary based on the type and location of spills, and what species, population size, or life stages were present during that time. Spills that migrate to nearshore littoral or intertidal waters would result in incidents of mortality or injury to individual fish or other aquatic biota and create population-level effects, but limited to waters in the vicinity of the spill footprint. Nearshore impacts are not likely to last longer than the span of the Construction Phase in exposed coastal regions of the state because of the volatile nature of diesel fuel. Impacts could be of longer duration in areas that are physically sheltered or protected from wind and waves. The context of impacts could affect EFH with regulatory protection.

Scenario 2: River Barge Release

As described in Section 3.24.5.2, this scenario evaluates the very low probability accidental release of 37,817 gallons of diesel fuel caused by the grounding of a double-hull river barge, or other accident, during the summer ice-free delivery season. For the analysis, it was assumed the release would not be instantaneous but could take 48 hours, or more, for the entire volume to be released from the damaged compartments. During this time, it is expected that deployment of containment booms and other actions could recover half of the released diesel or about 18,908 gallons.

Should this scenario occur, it may have infrequent impacts to fish and aquatic biota. This could result in mortalities or injuries that have population-level effects to fish stocks possibly to a system-wide basis. If this were to occur during the spring/early summer shipping season, the severity of impacts would be influenced by the timing and location of the spill. Since unrecovered diesel fuel would move downstream with the currents, the speed of movement would vary with the level of flow in the river. ERM (2014) calculated that downstream movement could be as much as 60 miles in two days.

Immediately following the spill, response efforts would be deployed to previously identified environmentally sensitive areas downriver and in Kuskokwim Bay. Floating diesel tends to evaporate over time from mixing with river currents, wind, and waves with no, or very little, visible diesel sheen remaining within three days (NOAA 2006). ERM (2014) estimated that 39 percent of the diesel would evaporate in 4 days at a temperature of 0°C and 59 percent over this duration at 13°C. The duration and extent of impacts would be infrequent and possibly limited to waters in the vicinity of the spill, as the volume and concentration of diesel along the surface attenuates downstream. During the downstream migration of the spill, winds and currents could direct an undefined portion of the floating diesel into river margins and off-channel areas where it could remain longer. Until recovered or attenuated by natural processes, diesel concentrations would affect waters on the mainstem Kuskokwim River between the Angyaruaq (Jungjuk) Port site and Kuskokwim Bay. The context of impacts is such that waters are regulated as Essential Fish Habitat.

Depending upon the location, a spill that occurs between approximately mid-May and mid-June could have impacts to migrating anadromous fishes including rainbow smelt and multiple stocks of juvenile salmon species. This period represents the general timeframe when the largest populations of juvenile salmon are present in the mainstem Kuskokwim River, outmigrating from tributary streams to Kuskokwim Bay and the open ocean. Chinook, coho, pink, chum, and sockeye salmon have been documented during this time in the river's mainstem or tributary streams. In addition, upstream migrating rainbow smelt would be susceptible to diesel spills as they travel along the river's margins in early to mid-May and then spawn in mid to late May in the Kalskag-Aniak vicinity as documented in 2014, 2015, and 2016 field studies (Owl Ridge 2016c).

Depending on the duration of direct exposure to a diesel fuel spill, outmigrating salmon, rainbow smelt, and other fishes could experience acute toxicity, particularly those residing along the margins of the river channel or trapped within shallow water areas. During out-migration, juvenile salmon actively swimming downstream are known to occupy a variety of habitats including areas with strong currents and high flow; slower-velocity nearshore margins while feeding or seeking refuge; and off-channel habitats (Quinn 2005). Depending upon the spill location and affected river configurations, all of these habitats may be vulnerable.

Should a diesel spill occur, it likely would result from a barge grounding on shallow shoals along the margins of deeper portions of the main navigation channel (thalweg). Depending on the timing, location, and extent of the spill, actively migrating fish occupying downstream waters could be exposed to diesel fuel at concentrations that could be acutely toxic. If an accidental grounding resulting in a spill occurs, fish residing in the shallow, low velocity margins of the river downstream from the spill would be particularly vulnerable since diesel tends to concentrate along the surface in slack waters where it can adsorb onto substrates over a more extended period of time. Similarly, off-channel habitats, blind sloughs, and lagoons can have little to no current and could accumulate diesel fuel and trap fish in areas that become isolated from the main channel as water levels recede thereby extending their exposure.

River fuel spills that occur after periods of juvenile salmon out-migration or rainbow smelt spawning would result in impacts to these fish life stages. Sampling events during July, August, and September of 2014 on the Kuskokwim River between river miles 130 and 240 found very few juvenile salmon along the margins of the mainstem channel. During the same time, sampling within two large tributaries (Aniak and Holokuk rivers) found numerous juvenile salmon suggesting that the bulk of salmon rearing occurs outside of the mainstem during the ice-free period (Owl Ridge 2014b). In contrast, certain fishes such as longnose sucker, Arctic grayling, slimy sculpin, and several whitefish species were highly to moderately abundant in the mainstem during the summer months. In terms of intensity, impacts to these fish would range from detectable incidents of injury and mortality to population-level effects as a result of injury and mortality, particularly in shallow off-channel and backwater areas where young-of-the-year longnose sucker were abundantly found. These impacts would last less than one year, or up to the duration of the Construction Phase. Secondary effects to predators that consume fish subjected to diesel spills also could occur.

Depending upon the timing and location, river spills would likely result in infrequent behavioral impacts to migrating adult salmon. While such impacts would likely be sublethal in nature, fish flesh could become tainted making it unsuitable for consumption by the subsistence community or commercial markets. Intensity would be relative to the subsistence community particularly if fishing opportunities or success is adversely affected during the limited fishing seasons. Additionally, contaminated fishing nets could become unsuitable for use until cleaned or replaced (refer to the Subsistence section for further information).

Unless trapped in shallow side channels or backwaters, most juvenile and adult finfish exposed to a diesel spill are mobile and generally capable of limiting exposure until concentrations attenuate (NOAA 2017). If the spill volume is substantial, however (or if it is dispersed entirely across and downstream from narrow channel segments), acutely toxic concentrations of diesel near the surface could occur from bank to bank particularly affecting shallow river margins and backwaters. Should this occur, it could cause mortalities or injuries to certain fish stocks unable to limit exposure. Since mainstem salmon spawning in the Kuskokwim River is uncommon, imperceptible impacts to spawning adults, eggs, or very early life stages of salmon are expected.

Regarding potential impacts of a diesel spill to rainbow smelt, adult fish were found to quickly begin migrating upriver for spawning typically in early May shortly after ice-breakup. In 2014, surveys determined that major spawning occurred in late-May between 1 and 3 miles upriver of the Village of Upper Kalskag (RMs 181 to 183). These fish were found to spawn primarily on gravel/cobble substrates adjacent to a low gradient gravel bar in waters between 5 and 14 feet deep (Owl Ridge 2014a). During a similar study in 2015, rainbow smelt also were determined to spawn in late-May, but at locations downriver from lower Kalskag in a narrower river segment and at a deeper mean depth of 14.5 feet (range 8.7 to 23.4 feet) (Owl Ridge 2015a). In 2016, rainbow smelt spawning was documented in mid-May nearly at the same reaches as was observed in 2014. During these studies, eggs were found in gravel and sandy textured substrates; but since they were not found in shallow locations, their exposure to fuel oil spills would likely result in changes to behavior that may not be noticeable. In 2014, 2015, and 2016, spawning appeared to occur within a one- to two- day period rather than extending over several days. If this abrupt spawning behavior is typical, then the timing and location of a spill would be important in determining the nature and intensity of impacts. Anecdotal information obtained from Native Alaskan harvesters, suggests that this rather truncated migratory and spawning period in the Kuskokwim River is typical. Restricting the initiation of seasonal barge traffic until early June could mitigate or eliminate potential impacts of fuel spills on the spawning run of rainbow smelt.

In summary, potential overall impacts to fish and aquatic resources in the mainstem Kuskokwim River would result from a river barge release of diesel fuel subject to the timing and location of the low-probability spill event. If such an event occurs during the spring juvenile salmon out-migration or rainbow smelt spawning migration, which generally runs from May to June depending on species, it could affect an entire year class of rainbow smelt or multiple stocks of salmon species that rely on EFH throughout the river system. By mid-June, impacts to rainbow smelt and juvenile salmon would remain for resident freshwater species such as longnose sucker, grayling, and whitefish. Impacts to rainbow smelt would be expected if a potential fuel spill occurred on or upriver of discrete spawning areas during the brief spawning period of mid to late May. Impacts to adult salmon would occur in areas where spills occur if fish are unable to escape exposure. Since seaward migrations of juvenile salmon typically occur during ascending periods of seasonally higher spring flows on the river, barge groundings at such times would have a lower probability of occurring.

Scenario 3: Tank Farm Release

In the instance of a fuel release due to a tank farm rupture, a faulty valve or pipeline leak, a transfer operation line rupture, or a transfer operation human error, the spill and response would be limited to the vicinity to the spill site (either the Mine Site or a tank farm at Dutch Harbor, the proposed Angyaruaq (Jungjuk) Port site or Bethel fuel terminal). Impacts would be considered infrequent and limited to the specific release location, attenuating as the spill moves downriver or is contained by spill response activities.

Impacts to fish and aquatic resources would be highly dependent upon the timing, location of the release, and success of the emergency containment response. Fuel storage areas on the Mine Site are relatively isolated from tributary streams within the Crooked Creek basin. Potential spills would likely be controlled by full secondary containment of the storage tanks that would intercept releases before they could reach fish-bearing waters. Therefore, potential impacts from spill releases on the Mine Site may not be noticeable or measureable. Similarly, tank farm releases at Angyaruaq (Jungjuk) Port or the Bethel terminal would be largely controlled by BMPs and full secondary containment of storage tanks. Should a very low probability event occur from a transfer operation line rupture or a transfer operation human error, fuel could be released into the mainstem Kuskokwim River. Releases would be confined within containment booms previously installed prior to transfers. On-water recovery would include use of sorbents, skimmers, and pumping with 100 percent of releases (minus loss to evaporation) recovered within one day. The nature and level of impacts would be similar to those discussed in Scenario 2, River Barge Release, depending upon timing and fish presence, particularly if releases extend beyond containment booms. Any actions that would occur at Dutch Harbor or the Port of Bethel at the Bethel Yard Dock are not part of the proposed action, and are considered connected actions (see Section 1.2.1, Connected Actions, in Chapter 1, Project Introduction and Purpose and Need).

Scenario 4: Tanker Truck Release

Under this scenario, a 13,500 gallon fuel release would result from a tanker truck rollover or collision. The spill and response would be limited to the vicinity of the spill site along the road ROW, but could extend to nearby wetlands, tundra, streams, or other waterbodies. Response and recovery efforts would depend on incident timing and location but could involve sorbent booming, trenching, on-water recovery by boat or shore-based skimmers, snow and ice removal, and in-situ burning. For this scenario, it was assumed that recovery and cleanup would be complete within 7 to 10 days.

Tanker truck spills that occur on or near bridge crossings or on roads proximal to streams could cause effects to fish and aquatic resources in the stream if direct discharges were to occur. Road crossings over streams between the Angyaruaq (Jungjuk) Port site and the mine would include Crooked Creek, one of its key tributaries (Getmuna Creek), and Jungjuk Creek all of which are regulated as Essential Fish Habitat. In addition, over 45 other small creeks and drainages would be crossed several times per hour during the ice-free period. Except for Jungjuk, Getmuna and Crooked creeks, most of the small creeks and drainages are non-salmon-bearing. Since many of these small creeks eventually drain to salmon-bearing streams, potential fuel spills conveyed through them could ultimately affect fish and aquatic life downstream. Where fish populations occur in smaller creeks in the Crooked Creek drainage, they primarily consist of coho salmon and Dolly Varden char. Both species spawn in small creeks and coho juveniles rear for over 1 year before outmigrating, indicating this species is present during the entire ice-free period. As shown in Figure 3.24-4 in Section 3.13, Fish and Aquatic Resources, several species of salmon and resident fishes utilize Jungjuk, Getmuna, and Crooked creeks. Given the potential exposure of these three creeks and other drainages along the mine access road, the discharge of fuel from a potential tanker truck spill would result in mortalities to fish and aquatic invertebrate communities downstream of the spill point. In terms of intensity, these impacts would create population-level effects. Impacts would be expected to occur in the event of a catastrophic accident such as the release of fuel or chemicals from a truck having an accident near a main fish-bearing tributary, especially if it were to involve Getmuna or Crooked creek. Such impacts would be infrequent, lasting until concentrations evaporate or attenuate downstream to below toxic concentrations. The extent of impacts also would depend on the timing of the spill relative to the use of these creeks by various life stages of anadromous and resident fishes. Longer-term, indirect, but acute impacts also may occur under the low-probability scenario of fuel accidentally being released onto the ground overlying perched aquifers that ultimately discharge into streams.

Scenario 7: Cyanide Release

Under this very low probability scenario, if a water-tight tank-tainer were to fall overboard from a river or ocean barge, either in the Kuskokwim River or along the marine portion of the transportation corridor, it would be located and retrieved, resulting in no effects on fish or aquatic biota. As described in Section 3.24.5.7, rupture of a container and contact of sodium cyanide with water would be considered a worst case event and extremely unlikely to occur. All marine carriers would be certified under the International Cyanide Management Code requiring implementation of appropriate measures for security, release prevention, training, and emergency response plans and capabilities for cyanide management.

If a very low probability spill of sodium cyanide briquettes were to occur while tank-tainers are being transported within the port storage site or at the Mine Site, the resultant spill would be swept up and contained for proper disposal. If the briquettes are spilled onto wet ground or come in contact with water, the sodium cyanide would dissolve resulting in the potential release of hydrogen cyanide gas. Since tank-tainers would be stored in an area that is well-ventilated and includes secondary containment, the dissolved sodium cyanide would be collected and contained for proper disposal. Thus, there would be no effect on fish or aquatic biota.

If a very low probability roadway accident were to occur involving a truck carrying cyanide tank-tainers, a tank-tainer rupture could result. If the spilled cyanide briquettes spilled on dry ground, the briquettes could be swept up and contained for disposal resulting in no effects on fish or aquatic biota. If the sodium cyanide briquettes came into contact with water, however, this could cause them to dissolve resulting in the potential release of hydrogen cyanide that would be highly toxic to fish and aquatic wildlife. The concentrations and extent would depend on the quantity of cyanide spilled and the volume of water into which it is spilled. Even a spill in a puddle or rain could release toxic Hydrogen Cyanide gas. Initial isolation of the spill site from unprotected people or animals would be 0.1 mile for a small spill or 0.2 mile for a larger spill, and the downwind protection zone would be 0.1 to 0.2 mile for daytime or 0.2 to 0.9 mile for night. If the cyanide came into contact with water, this could result in injuries or mortalities to affected fish and aquatic communities. Although cyanide reacts readily in the environment and degrades or forms complexes and salts of varying stabilities, it is toxic to many living organisms at very low concentrations. Fish and aquatic invertebrates are particularly sensitive to cyanide exposure. Cyanide has low persistence in the environment and is not reported to be accumulated or stored in fish or aquatic organisms. There is no reported biomagnification of cyanide in the food chain.

Scenario 8: Mercury Release

A spill is highly unlikely, as the sealed flasks, pigs and drums provide a very high level of integrity and it is unlikely that these containers could rupture. Without a rupture, there would be no impact on fish or aquatic biota.

In the unlikely event that there was a mercury spill in the storage areas, either the liquid mercury or the spent carbon would be released from the containers, and the liquid elemental mercury would collect in the secondary containment. Spilled mercury would be recovered and managed appropriately. There would be no effects on fish or aquatic biota.

A low probability potential spill scenario may result from truck transportation of mercury containers from Angyaruaq (Jungjuk) Port. In the unlikely event that there is a truck accident and the containers ruptured, a mercury spill (either the liquid mercury or the spent carbon) could result. The liquid elemental mercury and the spent carbon could be released to the land or surface water. If spilled mercury escapes cleanup efforts, it would be subject to natural methylation processes thereby adding incrementally to the background mercury levels in runoff and air depositions. This, in turn, would increase the chronic exposure of methylmercury available in the food chain to aquatic biota. Since methylmercury bioaccumulates, it would increase exposure and could elevate mercury tissue concentration in certain species of fish and their predators. Only resident fish or aquatic life is likely to be impacted by spills to streams that have consequent methylation.

Scenario 9: Partial Tailings Dam Failure

An analysis of an unplanned release of up to 2.6 million cubic yards (1,607 acre-feet) of tailings and contaminated water from the TSF was conducted based on either a partial breach of the dam and resulting downstream failure or a liner rupture leading to a sinkhole and outflow of tailings through the underdrain (BGC 2015n). An inundation model predicted the expected migration of tailings and water and the extent of deposition relative to downstream receiving waters in the Anaconda Creek and Crooked Creek drainages. A TSF failure would result in significant damage to these waters, regulated as EFH. Inundation maps presented in Figure 3.24-2 and Figure 3.24-4 estimate the extent of downstream flooding and sediment deposition from a dam breach in these drainages.

During a tailings dam failure water, or a viscous slurry of water and tailings, would be released downstream causing sediment deposition where the drainage widens and the gradient flattens. The nature and extent of impacts would vary depending on the type of release and the season in which it occurs as described below:

- Tailings and Water Release
  - Winter: At least some of the released tailings could be excavated and transported back to the tailings facility thereby limiting the extent of impacts to fish and aquatic life after the spring thaw. This would reduce erosion and sediment transport in Crooked Creek. A portion of the contaminated fluids may become frozen and recoverable.
  - Summer: The extent of impacts would likely be much larger as a significant portion of the deposited tailings would be remobilized by Crooked Creek and transported downstream. Access by trucks and other large equipment would be difficult on thawed off-road areas.
- Water Only Release:
  - Winter: The volume and rate of the release likely would be too high to allow freezing to quickly impede the flow. The maximum flow rates of water would be approximately 4.0 percent of flow rates of the Kuskokwim River in the winter months (November to April), resulting in greater potential impacts. Water would not necessarily penetrate underlying materials, and there is some potential that a portion of the contaminated fluids could be recovered.
  - Summer: The maximum flow rates of water would be approximately 1.8 percent of flow in Kuskokwim River in the summer months (May to October). More water would penetrate the ground surface and infiltrate the subsurface materials, and impacts from fluids on the subsurface would be difficult to control or remediate.

Depending on the type and season of release, a tailings dam failure could affect fish populations and aquatic habitat in the Anaconda Creek and Crooked Creek drainages through several mechanisms. These include:

- Erosion that scours and transports native vegetation and substrates from intermittent and perennial streams;

- Deposition of contaminated sediments resulting in a physical migration barrier that prevents access to fish spawning, rearing, and over-wintering areas upstream and downstream of the blockage;
- Alteration of water quality constituents that could result in acute or chronic toxicity or behavioral disturbance that affects the production of fish and other aquatic biota downstream of the Anaconda Creek confluence;
- Alteration of stream hydrology and morphology in Anaconda Creek and Crooked Creek that affects the proper functioning conditions of aquatic habitat that are essential to fish spawning, rearing, and migration in these drainages;
- Elimination or reduction of pool depth and volume downstream of the Anaconda Creek confluence that are important for the survival of over-wintering fish in Crooked Creek;
- Elimination or burial of aquatic invertebrate communities and other prey species important to the diet of fish.

Erosion is expected to be greatest where the flow depths of water / tailings are modeled to be highest, near the release point and within the Anaconda Creek valley (Figure 3.24-2 and Figure 3.24-4). Erosion from the water only spill would still occur, although erosion may be reduced compared to conditions that would result from the movement of a more viscous water and tailings slurry. Erosion would also be less in winter because of frozen soils; although if the flow also transports large chunks of ice, aquatic and riparian habitat damage from ice scour would be expected. Eroded materials would be deposited where and when the water or slurry release reaches wider and flatter segments of the drainage. For both the tailings and water release and water release only scenarios, deposition of eroded materials would increase where flow depths in the receiving waters are lower such as at stream meanders or at the confluence of Anaconda and Crooked creeks.

The extent of erosion and depositional disturbance was evaluated based on Burge and Cuervo (2015) relative to potential aquatic habitat impacts in response to spill conditions modeled by BGC (2015n). The nature and extent of impacts was categorized based on three levels of flow depths:

- erosion may primarily occur at flow depths of 10 feet or higher;
- erosion and depositions may primarily occur at flow depths of less than 10 feet to 3 feet; and
- deposition may primarily occur at flow depths of less than 3 feet.

Based on this interpretation and the modeled spills, an estimated 21 acres of rivers and ponds would be disturbed under the tailings and water slurry scenario, with 90 percent of these within the spill trajectory affected by the combination of erosion and deposition (Table 3.24-22). For the water only spill scenario a substantially more extensive amount of rivers and ponds, estimated at about 177 acres, would be disturbed with about 70 percent of these affected primarily by deposition (Table 3.21-23). Aquatic habitat categories are derived from preliminary vegetation classification by 3PPI (2014b) applied in both the vegetation and wetlands Scenario 9 analysis.

Table 3.24-22: Piping Failure – Tailings and Water Slurry: Preliminary Calculation of Aquatic Habitat Categories by Maximum Flow Depth

Aquatic Habitat Category	Flow Depth (acres)			Impact Area (acres)
	Erosion (≥ 10 ft)	Erosion and Deposition (≥ 3 ft to < 10 ft)	Deposition (< 3 ft)	
Ponds	0	1.1	0.2	1.3
Rivers	0	17.8	1.9	19.7
Intermittent Streams (miles)				
Perennial Streams (miles)				
Aquatic Area (acre)	0	18.9	2.1	21.0
Aquatic Area (%)	0	90.0	10.0	

Source: 3PPI 2014b

Table 3.24-23: Piping Failure – Water Only: Preliminary Calculation of Aquatic Habitat Categories by Maximum Flow Depth

Aquatic Habitat Category	Flow Depth (acres)			Impact Area (acres)
	Erosion (≥ 10 ft)	Erosion and Deposition (≥ 3 ft to < 10 ft)	Deposition (< 3 ft)	
Ponds	0	4.2	6.3	10.5
Rivers	0	49.4	117.3	166.7
Intermittent Streams (miles)				
Perennial Streams (miles)				
Aquatic Area (acre)	0	53.6	123.6	177.2
Aquatic Area (%)	0	30.2	69.8	

Source: 3PPI 2014b

Deposition of tailings and eroded materials would be expected to increase where flow depths are lower or where flow is impeded such as at meander bends or at the confluence of Anaconda and Crooked creeks (see Figure 3.24-3). Interpreting potential aquatic habitat disturbance from the BGC (2015n) modeled spill was based on deposition depth: less than 0.5 foot was considered light burial; 0.5 foot to less than 3 feet was considered moderate burial; and 3 feet or more was considered heavy burial (Table 3.24-24). An estimated 21 acres of aquatic habitat would be covered by tailings, with 90 percent of these affected by heavy burial with 3 feet or more of tailings.

Cleanup and reclamation efforts would focus on removal and return of tailings to the TSF and restoration of aquatic habitat. Reduction of certain aquatic habitat functions would likely persist beyond cleanup. Burial or fill of waters and riparian habitats in the Anaconda Creek and Crooked Creek drainages would alter or eliminate important hydrologic, biogeochemical, and biological functions that support the aquatic ecosystem in these drainages. A total of 3.9 miles of streams would be directly affected by tailings deposition, including 3.8 miles of perennial streams and 0.1 mile of intermittent streams (Table 3.24-4; 3PPI et al. 2014).

Table 3.24-24: Piping Failure – Tailings and Water: Preliminary Calculation of Aquatic Habitat Categories by Burial Depth

Aquatic Habitat Category	Burial Depth (acres)			Area (acres)
	Light (< 0.5 ft)	Moderate (≥ 0.5 ft to < 3 ft)	Heavy (≥ 3 ft)	
Ponds	0.1	0.1	1.1	1.3
Rivers	0.1	1.8	17.8	19.7
Intermittent Streams (miles)				0.1
Perennial Streams (miles)				3.8
Aquatic Area (acre)	0.2	1.9	18.9	21.0
Aquatic Area (%)	1.0	9.0	90.0	

Source: 3PPI 2014b

Based on the water and tailings release scenario, the front of slurry would arrive at the confluence of Anaconda Creek and Crooked Creek within less than an hour, lasting about 5 hours in duration, and resulting in a maximum flow depth of nearly 8 feet. None of the slurry is predicted to reach the confluence of Crooked Creek and the Kuskokwim River 13 miles downstream (Table 3.24-25). Based on the water only release scenario, the front of water would reach Crooked Creek also in less than an hour but the wave of water, at a maximum depth of nearly 7 feet, would persist for over 48 hours. Within 24 hours the water stage at the confluence of Crooked Creek and the Kuskokwim River would be increased by 1 foot.

Table 3.24-25: Flow Inundation Extent and Travel Distance

Material Released	Total Duration (hrs.)	Confluence of Anaconda Creek and Crooked Creek (1.6 miles downstream of TSF)		Confluence of Crooked Creek and Kuskokwim River (13 miles downstream of TSF)	
		Front Arrival Time (hrs.)	Maximum Flow Depth (ft.)	Front Arrival Time (hrs.)	Maximum Flow Depth (ft.)
Water and Tailings	5.0	0.6	7.9	-	-
Water Only	>48	0.7	6.8	24.9	1.0

Source: BGC 2015n.

The water and tailings scenario would have a comparatively greater impact on fish and aquatic life from the burial and elimination of physical habitat, injury or mortality of fish and aquatic biota, displacement and stranding of fish and aquatic biota to upland areas along the affected riparian corridors, barriers to fish migration, and isolation of fish populations in the upper

Crooked Creek watershed. In addition, water quality impacts downstream of a slurry plume could result in behavioral disturbance, mortality, and acute and chronic levels of stress or toxicity to fish and aquatic life from increased turbidity and suspended solids and release of chemical contaminants from the tailings. Such impacts would tend to attenuate with farther distance downstream.

Based on the water only scenario, the burial and elimination of physical habitat from a tailings plume would not occur. While water quality impacts to fish and aquatic life would be somewhat similar to the water and tailings scenario, the increased maximum flow depth in Crooked Creek would be greater and would extend farther downstream to the Kuskokwim River for a period of over 48 hours. Depending on when this would occur, it could adversely affect the proper functioning conditions of fish spawning, rearing, and migration habitat in lower Crooked Creek, an area where the greatest proportion of salmon spawning and smolt production occurs in this drainage. An elevated flow regime can create excessive shear stress and other hydraulic forces that can cause bank erosion and degrade the morphological characteristics of a stream that support fish production. Elevated streamflows also can result in increased energy consumption by fish of various life stages as they encounter higher water velocities; rearing and migration habitat that becomes more restricted to backwaters and the margins of stream channels; and elevated turbidity and suspended sediment loads that are adverse to production of fish and their prey species.

Based on aerial surveys of salmon spawning conducted from 2004 to 2010, an annual average of 40 adult salmon (12 percent of the annual total average observed during those years) were observed in the middle and upper reaches of Crooked Creek including areas near Anaconda Creek (OtterTail 2014a). These fish consisted primarily of coho and chum salmon. Ground and aerial surveys conducted in recent years indicate that salmon distribution in the middle reaches of Crooked Creek has been relatively limited. This suggests that relatively few spawning redds likely would be present in the middle reaches of Crooked Creek near the confluence of Anaconda Creek in the event of a tailings dam failure. Incubating eggs, rearing juvenile, or adult fish in Crooked Creek in the vicinity of Anaconda Creek would be directly affected by sediment deposition, however. Fish in the upper reaches of Crooked Creek would become isolated from the lower reaches of Crooked Creek until a passageway becomes eroded through the sediment plume. Fish production in lower Crooked Creek, where the greatest proportion of salmon spawning and rearing occurs, would be subject to higher flows and water quality impacts that could result from a water only release during a tailings dam failure. Depending on the physical and chemical nature of water quality effects from such releases, the intensity of impacts to overall fish production in Crooked Creek would vary and may result in acute or obvious/abrupt changes in fish and possible population-level effects. These impacts would be limited to waters in the vicinity of the spill, and could persist over several years. In terms of context, Crooked Creek is regulated as EFH under the Magnuson-Stevens Act.

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

Under Alternative 3A, Scenario 5 (diesel pipeline release) is not applicable, and has not been analyzed for effects to fish and aquatic resources. The likelihood of Scenarios 1 through 4 (ocean or river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Impacts under

Scenarios 7 through 9 (cyanide, mercury, and tailings releases) for Alternative 3A would be the same as those discussed under Alternative 2.

Scenario 6: Liquefied Natural Gas (LNG) Release

An occurrence of pinhole leaks in LNG storage tanks, an accident involving an LNG-fueled truck, or the rupture of a storage tank at the LNG plant could occur at the Mine Site. If released, LNG dissipates readily, so long as no ignition source is present. The spill and response effort would be limited to the vicinity of the spill site. LNG storage areas on the Mine Site are relatively isolated from tributaries within the Crooked Creek basin, and therefore would likely be contained before discharges to fish-bearing waters. Impacts to fish and aquatic resources at the Mine Site may not be measurable or noticeable.

3.24.6.13.3 ALTERNATIVE 3B – REDUCED DIESEL BARGING: DIESEL PIPELINE

Under Alternative 3B, spill Scenario 6 (LNG Release) is not applicable, and has not been analyzed for effects to fish and aquatic resources. Impacts under Scenarios 1 and 2 (ocean or river barge releases) would be shifted relative to Alternative 2, and the likelihood of Scenarios 3 and 4 (tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Scenarios 7, 8, and 9 (cyanide, mercury, and tailings releases) would have the same impacts on fish and aquatic resources as Alternative 2.

Scenario 5: Diesel Pipeline Release

From the mine footprint, the proposed buried pipeline route traverses east and crosses numerous drainages of the Kuskokwim, Yentna, and Skwentna rivers and streams that discharge directly to Cook Inlet. Many of the streams are salmonid-bearing, with coho salmon and Dolly Varden Char the dominant species. Pipeline crossings are proposed on 32 streams and their tributaries along the pipeline route. The nature of effects caused by accidental fuel releases from the pipeline would be similar to those that would occur from a Scenario 4, Tanker Truck Release under Alternative 2. If a rupture of the pipeline should occur just upslope from a block valve near a river, the spill could have similar impacts to fish, aquatic biota, and related habitats as described under Scenario 2, River Barge Release. The intensity of impacts to fish and aquatic resources would depend upon the volume of the spill and proximity to local streams and groundwater sources. Large discharges of diesel fuel directly into streams could cause impacts to fish and invertebrate that result in mortality. The duration of impacts would depend on the timing and size of discharge and the fish species and life stages present during that time.

Longer-term effects may also occur if a spill contaminated soils and groundwater that, over time, discharged into streams. Fuels bound in soils or groundwater would not evaporate until released into surface waters.

3.24.6.13.4 ALTERNATIVE 4 – BIRCH TREE CROSSING PORT

Under Alternative 4, spill Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to fish and aquatic resources. The likelihood of Scenario 2 (river barge release) occurring would be greatly reduced and the likelihood of Scenario 4 (tanker truck release) would be increased; however, the impacts of either would be the same types as discussed under Alternative 2.

Impacts under Scenarios 1, 3, 7 through 9 (ocean barge, tank farm, cyanide, mercury and tailings releases) for Alternative 4 would be the same as those discussed under Alternative 2.

3.24.6.13.5 ALTERNATIVES 5A – DRY STACK TAILINGS

Impacts under Scenarios 1 through 4, and 7 and 8 (ocean or river barge, tank farm, tanker truck, cyanide, and mercury releases) for Alternatives 5A would be the same as those discussed under Alternative 2.

3.24.6.13.6 ALTERNATIVE 6A – DALZELL GORGE ROUTE

Under Alternative 6A, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to fish and aquatic resources.

Impacts under Scenarios 1 through 4, and 7 and 8 (ocean or river barge, tank farm, tanker truck, cyanide, and mercury releases) for Alternative 6A would be the same as those discussed under Alternative 2.

3.24.6.14 THREATENED AND ENDANGERED SPECIES

3.24.6.14.1 ESA PROTECTED, CANDIDATE, AND DELISTED BIRD SPECIES

Alternative 2 – Donlin Gold's Proposed Action

Under the proposed action, two spill scenarios do not apply and are not analyzed for impacts to ESA-protected, candidate, and delisted bird species. These include Scenario 5 (diesel pipeline release) and Scenario 6 (LNG release).

Scenario 1: Ocean Barge Rupture at Sea

The discussion of an ocean barge rupture at sea for birds for Alternative 2 in Section 3.24.6.12.3 is relevant to ESA protected, candidate, and delisted bird species.

Steller's eider

Steller's eiders may be present in Kuskokwim Bay during the summer shipping season. Large numbers of Steller's eiders use habitat within Kuskokwim Bay for spring staging and during a 3-week molt period following breeding. During the early spring, it is thought that the entire Alaska overwintering population of Steller's eiders spend anywhere from days to a few weeks in northern Kuskokwim Bay before leaving for northern nesting areas (Larned 2007).

Figure 3.14-1 and Figure 3.14-2 (Section 3.14, Threatened and Endangered Species) show that the closest critical habitat is approximately 10 miles west of the proposed barge route, and there is a concentration area approximately 10 miles east of the route. Steller's eiders would be especially vulnerable during their molting season (July–September) when they are temporarily unable to fly, making it more difficult for them to avoid any spilled oil.

The impacts of an ocean barge rupture on Steller's eider would vary in intensity as the effects of birds encountering spilled oil would be noticeable, and the duration would depend on what proportion of the population is affected. The extent of effects would generally be limited to the immediate area of the spill, but if a large part of the population is affected, it would be much broader. The context for effects is such that the Alaska-breeding population of the Steller's eider is listed as threatened under the ESA and the population is declining.

Spectacled eider

Spectacled eiders nest in the Yukon-Kuskokwim (Y-K) Delta National Wildlife Refuge and could be present in Kuskokwim Bay during the summer shipping season. As shown in Figure 3.14-2 (Section 3.14, Threatened and Endangered Species), the closest breeding habitat lies near the mouth of the Kuskokwim River approximately five miles from the proposed barge route. Eiders nesting in the area may forage in the bay. The types of effects an oil spill could have on spectacled eiders would be similar to those described above for Steller's eiders. Populations of both Steller's and spectacled eiders have been declining in Alaska (USFWS 2012b and 2012c).

The impacts of an ocean barge rupture on spectacled eiders would vary in intensity as the effects of birds encountering spilled oil would be noticeable, and the duration would be infrequent, assuming that a small proportion of the population is affected. The extent of effects would generally be limited to the immediate area of the spill. The context for effects is that spectacled eiders are listed as threatened under the ESA, but the portion potentially affected is not a large percentage of the population.

Scenario 2: River Barge Release

A river barge release may or may not affect either eider species, depending on the location of the barge at the time of the release. Both species are found at the mouth of the Kuskokwim River only. The size of the spill under this scenario would be 37,817 gallons, and it is likely that response efforts would succeed in recovery of at least half of the released diesel, approximately 18,908 gallons. With that volume of spill and the distance to where concentrations of either eider species might be, it is very unlikely that unrecovered oil would reach spectacled or Steller's eiders in Kuskokwim Bay. If it does, they may be adversely affected. They could also be affected if water quality or food resources are degraded by the spill, which are also very unlikely.

The intensity of impacts of a river barge release on either spectacled or Steller's eiders would vary from the oil not reaching them and their prey and habitat being unaffected, to impacts if encounter oil, which may or may not be noticeable. The duration could be infrequent, assuming that a small proportion of the population is affected. The extent of effects would generally be limited to the immediate area of the spill. The context of effects for Steller's eiders would that Steller's eiders are listed as threatened under the ESA, and the population is declining. The context of effects for spectacled eiders would be that spectacled eiders are listed as threatened under the ESA, but the population is currently stable and the portion potentially affected is not a large percentage of the population.

Scenario 3: Tank Farm Release

Neither eider species occurs in the vicinity of the tank farms located at the Angyaruaq (Jungjuk) Port, or the Mine Site. Therefore a release of diesel fuel at any of these tank farms would not have any effect on either Steller's eiders or spectacled eiders. The spill would be contained within the facility and cleaned up before it could spread to adjacent habitat. The same is true of the tank farms at Bethel and Dutch Harbor where eiders may be in the vicinity but would not be affected due to containment. Any actions that would occur at Dutch Harbor or the Port of Bethel at the Bethel Yard Dock are not part of the proposed action, and are considered connected actions (see Section 1.2.1, Connected Actions, in Chapter 1, Project Introduction and Purpose and Need).

Scenario 4: Tanker Truck Release

Neither eider species occurs in the vicinity of the project roads; therefore, a release of diesel fuel from a tanker truck would not have any effect on either Steller's eiders or spectacled eiders.

Scenario 7: Cyanide Release

None of the transport scenarios for cyanide would release cyanide into the environment where listed birds may occur. Therefore, no effects from cyanide would be expected. If a cyanide tank-tainer was lost in the water where listed eiders occur, the activity associated with recovering it may have behavioral impacts on eiders if they were present during that time.

Scenario 8: Mercury Release

None of the transport scenarios for mercury would release mercury into the environment where listed birds may occur. Therefore, no effects from mercury would be expected. If a mercury shipping container was lost in the water where listed eiders occur, the activity associated with recovering it may have behavioral impacts on eiders if they were present during that time.

Scenario 9: Partial Tailings Dam Failure

Neither eider species occurs more than 56 miles from the coast, thus not in the vicinity of the tailings dam located near the Mine Site. Therefore, a release of tailings and water or water only would not have any effect on either Steller's or spectacled eiders. The spill would be contained or diluted before it could spread to the mouth of the Kuskokwim River or other habitat.

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

Under Alternative 3A, Scenario 5 (diesel pipeline release) is not applicable, and has not been analyzed for effects to ESA protected, candidate, and delisted bird species. The likelihood of Scenarios 1 through 4 (ocean or river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Impacts under Scenarios 7 through 9 (cyanide, mercury, and tailings releases) for Alternative 3A would be the same as those discussed under Alternative 2.

Scenario 6: Liquefied Natural Gas (LNG) Release

Neither eider species is found anywhere near where the LNG would be used, so there would be no effects on eiders.

Alternative 3B – Reduced Diesel Barging: Diesel Pipeline

Under Alternative 3B, spill Scenario 6 (LNG release) is not applicable and has not been analyzed for effects to ESA protected, candidate, and delisted bird species. The likelihood of Scenarios 2 through 4 (river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2.

Scenarios 7 through 9 (cyanide, mercury, and tailings releases) would have the same impacts on ESA protected, candidate, and delisted bird species as Alternative 2.

Scenario 1: Ocean Barge Rupture at Sea

Under Alternative 3B there would only be ocean barge trips to Bethel during the Construction Phase. Therefore, there would be fewer barge trips than Alternative 2 or Alternative 3A which would reduce the risk of spills. However, if an ocean barge rupture at sea on that route did occur, the impacts to both Steller's and spectacled eiders would be the same as those discussed under Alternative 2. During operation, the diesel would be shipped to Tyonek, and the spill scenario would shift to Cook Inlet and waters leading to it. The types of impacts would be the same, but the birds vulnerable to effects would be different. Steller's eider molting and wintering habitat extends into Cook Inlet, and they would be vulnerable for the part of the molting season that overlaps with shipping, but there is no important habitat for spectacled eiders.

Scenario 5: Diesel Pipeline Release

Neither eider species occurs in the vicinity of the pipeline; therefore, a release of diesel fuel from the pipeline would not have any effect on Steller's eiders or spectacled eiders. If a pipeline release occurred in the segment of pipeline adjacent to Cook Inlet and the diesel got into the saltwater during the molting or wintering periods for Steller's eiders, they could potentially be affected.

Alternative 4 – Birch Tree Crossing Port

Under Alternative 4, spill Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to ESA protected, candidate, and delisted bird species.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 4 would be the same as those discussed under Alternative 2.

Alternative 5A – Dry Stack Tailings

Under Alternative 5A, Scenarios 5, 6, and 9 (diesel pipeline, LNG, and water and tailings releases) are not applicable and have not been analyzed for impacts to ESA protected, candidate, and delisted bird species.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and water only tailings releases) for Alternative 5A would be the same as those discussed under Alternative 2.

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

Under Alternative 6A, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to ESA protected, candidate, and delisted bird species.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 6A would be the same as those discussed under Alternative 2.

3.24.6.14.2 ESA-PROTECTED AND CANDIDATE MARINE MAMMAL SPECIES

Alternative 2 – Donlin Gold's Proposed Action

Under the proposed action, two spill scenarios do not apply and are not analyzed for impacts to ESA-protected and candidate marine mammals. These include Scenario 5 (diesel pipeline release) and Scenario 6 (LNG release).

Scenario 1: Ocean Barge Rupture at Sea

The discussion of an ocean barge rupture at sea for marine mammals for Alternative 2 in Section 3.24.6.12.2 is relevant to ESA protected and candidate marine mammals.

The threatened and endangered marine mammals along the Bering Sea ocean barge corridor include fin whales, humpback whales, and North Pacific right whales. The Southwest stock of northern sea otters occurs near Unalaska Island, so may be present in the nearshore waters adjacent to Dutch Harbor. Small and very small spills are unlikely to impact most of these species. They are highly mobile with large ranges relative to the small area that would be affected by a small spill and short time period over which dispersion or evaporation would occur. In terms of intensity, such a case would result in changes in behavior that may not be noticeable, with no noticeable incidents of injury or mortality. The duration of impacts would be infrequent and not longer than the span of the Construction Phase. The extent or scope of impacts would be limited to the vicinity of the Project Area. In terms of context, legislative protection exists for all threatened and endangered marine mammals under the MMPA and ESA. Additionally, North Pacific right whales have an exceedingly small population size (approximately 30 whales) and the barge corridor traverses one of only two areas designated as critical habitat for this species. In the event of a large or very large spill in the vicinity of cetaceans, injury is more likely to occur. Although injury is likely to be sublethal, as described in Section 3.24.6.12.2, and would not have population level effects for most species, injurious effects to even one individual North Pacific right whale would potentially have deleterious population level effects. In the event of a large or very large spill, the intensity would range from detectible injuries to population-level effects on right whales, although the duration of the event causing injury would be infrequent, based on how quickly a spill disperses, evaporates, or is otherwise contained. The extent or scope would depend on the breadth of the spill and area over which it dispersed, so could range from the vicinity of the Project Area to throughout the EIS Analysis Area. Sea otters could contact fuel if a spill occurred in or spread to nearshore waters. The 2004 grounding of the freighter Selendang Ayu on Unalaska Island released more than 300,000 gallons of non-crude (bunker) oil and caused at least two sea otter mortalities, whereas there is no indication that smaller-scale spills (mean size of about 921 gallons) have an impact on the Southwest stock of northern sea otters (USFWS 2014b). The viscosity and volatility of crude or bunker oil and diesel fuel differ, so it may be inappropriate to extrapolate effects of diesel on otters from known oil impacts. Few pinnipeds would be affected by an ocean barge rupture at sea, since major haulouts in or near Bristol Bay are well beyond the barge corridor. If a rupture were to occur nearer to Kuskokwim Bay and currents and winds dispersed the fuel shoreward prior to evaporation, some seals could encounter fuel and experience short-term, but noticeable physical effects in discrete areas of the spill or fuel dispersal range. Potential impacts of an ocean barge rupture on threatened and endangered marine mammals would vary depending on the size and location of a spill, proximity to marine mammals, species impacted, and wind and weather conditions.

Scenario 2: River Barge Release

A diesel fuel spill due either to grounding or collision on the Kuskokwim River could result in the same type of effects on marine mammals that occur in the river or Kuskokwim Bay as described above for an ocean barge rupture. Small or very small spills are most likely to occur and would likely be contained and/or disperse and evaporate quickly. Marine mammals would have to be at the spill site at the time of occurrence to incur physical effects derived from breathing or ingesting the fuel. Although of low probability of occurrence, a large or very large spill would have a correspondingly greater footprint, potentially moving downstream from the spill site toward Kuskokwim Bay. In such an instance, the potential for contact with diesel fuel increases.

The frequency of occurrence of threatened or endangered marine mammals in the Kuskokwim River, from the mouth of the river to Angyaruaq (Jungjuk) Port, is very low. The nearest walrus and sea lion haulouts are in northern Bristol Bay and outside of the Donlin Gold Project Area, bearded seals are rare in the lower Kuskokwim River (1 to 2 per year) and the other species may infrequently occur in Kuskokwim Bay, but are unlikely in the river. There have been no reports of ESA-protected cetaceans in the Kuskokwim River. The potential for direct contact between ESA-protected marine mammals with diesel fuel, were a spill to occur in the Kuskokwim River, is therefore, quite low. If such were to occur, the intensity would range from imperceptible to detectible without population effects. The duration of both the event and the effects would be infrequent and not longer than the span of the Construction Phase. The extent or scope of impacts would be limited to the vicinity of the spill (but, ranging from the spill location to some distance down river with a larger spill). In terms of context, species are protected under the ESA, in accordance with criteria in Section 3.14, Threatened and Endangered Species.

Scenario 3: Tank Farm Release

Spills at storage tanks at the Mine Site would have no effect on marine mammals. All storage tanks would have secondary containment equal to a minimum of 110 percent of the total maximum volume of the largest tank in the secondary containment area.

Since it is assumed that a diesel spill would be contained and recovered, it would not spread to adjacent waters, resulting in little chance for marine mammals to contact the diesel fuel. In terms of intensity, the impacts of a tank farm release on marine mammals would not be likely to be noticeable, last only as long as the recovery and cleanup operations, limited to the immediate area of the spill, and involve MMPA- and ESA-protected marine mammals, in accordance with criteria in Section 3.14, Threatened and Endangered Species.

Scenario 4: Tanker Truck Release

Fuel spills resulting from a tanker truck incident are unlikely to affect marine mammals. The on-land release, small to very small volume for most spills, and the on-board spill response kits further minimize potential for impact to waterways. Furthermore, marine mammal sightings are rare as far up the Kuskokwim River as Angyaruaq (Jungjuk) Port. Since a spill emanating from a tanker truck is not likely to affect areas used by marine mammals in the Project Area, there would be no anticipated effects of such a spill on threatened and endangered marine mammals.

Scenario 7: Cyanide Release

None of the transport scenarios for cyanide would release cyanide into the environment where listed marine mammals may occur. Therefore, no effects from cyanide would be expected. If a cyanide container was lost in the water where listed marine mammals occur, the activity associated with recovering it may have behavioral impacts on them if they were present.

Scenario 8: Mercury Release

None of the transport scenarios for mercury would release mercury into the environment where listed marine mammals may occur. Therefore, no effects from mercury would be expected. If a mercury tank-tainer was lost in the water where listed marine mammals occur, the activity associated with recovering it may have behavioral on them if they were present during that time.

Scenario 9: Partial Tailings Dam Failure

Spills resulting from a partial tailings dam failure are unlikely to affect marine mammals. A water only spill could potentially reach the Kuskokwim River; however, it would rapidly be diluted, and marine mammal sightings are rare as far up the river as Angyaruaq (Jungjuk) Port. Since a spill emanating from a tailings dam is not likely to affect areas used by marine mammals in the Project Area, there would be no anticipated effects of such a spill on threatened and endangered marine mammals.

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

Under Alternative 3A, Scenario 5 (diesel pipeline release) is not applicable, and has not been analyzed for effects to ESA protected and candidate marine mammals. The likelihood of Scenarios 1 through 4 (ocean or river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Impacts under Scenarios 7 through 9 (tanker truck, cyanide, mercury, and tailings releases) for Alternative 3A would be the same as those discussed under Alternative 2.

Scenario 6: Liquefied Natural Gas (LNG) Release

A release of LNG would occur only at the Mine Site and would have no potential to affect marine mammals.

Alternative 3B – Reduced Diesel Barging: Diesel Pipeline

Under Alternative 3B, spill Scenario 6 (LNG release) is not applicable and has not been analyzed for effects to ESA protected and candidate marine mammals. The likelihood of Scenarios 2 through 4 (river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Impacts under Scenarios 7 through 9 (cyanide, mercury, and tailings releases) for Alternative 3B would have the same impacts on marine mammals as Alternative 2.

Scenario 1: Ocean Barge Rupture at Sea

The discussion of an ocean barge rupture at sea for marine mammals for Alternative 3B in Section 3.24.6.12.2 is relevant to ESA protected and candidate marine mammals. The ESA-protected species of primary concern is the Cook Inlet beluga whale, found only in Cook Inlet and primarily in the upper inlet. The Cook Inlet delivery route traverses designated critical habitat for this species. Potential impacts of an ocean barge rupture on threatened or endangered marine mammals would vary depending on the size and location of a spill, proximity to marine mammals, species involved, and wind and weather conditions.

Scenario 5: Diesel Pipeline Release

The proposed diesel pipeline would begin in Tyonek and connect to Beluga, after which it would cross the Beluga River. Spills occurring along this segment of the pipeline route, particularly where it crosses the river, could impact marine mammals. The proximity of this segment of the pipeline to Beluga and Tyonek should facilitate intense response efforts once a leak is detected. The intensity and extent of impact depend on the time of year, size of the spill, and how quickly it disperses. Beluga whales commonly forage at the mouth of and in the Beluga River during summer through fall and could either be directly impacted by skin or nasal contact with the spilled diesel or indirectly impacted if prey species are contaminated. The intensity of impacts would range from imperceptible to detectible without population-level effects, depending on the season, presence of and numbers of belugas. The duration of effects would likely be infrequent and occur during a discrete event. The extent or scope would be generally limited to the area near the spill, although the impact zone depends on the size of the release, time to detection, season, and weather conditions. The context for belugas and their potentially impacted designated critical habitat is protected by ESA legislation.

<u>Alternative 4: Birch Tree Crossing (BTC) Port</u>

Under Alternative 4, spill Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to ESA protected and candidate marine mammals.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 4 would be the same as those discussed under Alternative 2.

<u>Alternative 5A: Dry Stack Tailings</u>

Under Alternative 5A, Scenarios 5, 6, and 9 (diesel pipeline, LNG, and water and tailings releases) are not applicable and have not been analyzed for impacts to ESA protected and candidate marine mammals.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and water only tailings releases) for Alternative 5A would be the same as those discussed under Alternative 2.

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

Under Alternative 6A, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to ESA protected and candidate marine mammals.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 6A would be the same as those discussed under Alternative 2.

3.24.6.15 LAND OWNERSHIP, MANAGEMENT, AND USE

Land ownership would not be affected by any spill scenario; land management and use are discussed for each scenario.

3.24.6.15.1 ALTERNATIVE 2 – DONLIN GOLD'S PROPOSED ACTION

Under the proposed action, two spill scenarios do not apply and are not analyzed for land use and management impacts. These include Scenario 5 (diesel pipeline release) and Scenario 6 (LNG release).

Scenario 1: Ocean Barge Rupture at Sea

If the spill location is away from the coastline and prevailing weather conditions prevent the spill from reaching land, there would be no effect to land use. If the spill were to occur near the coastline, minimal impacts to shorelines may occur. In such an event, there would be no impact to land management. In terms of intensity, impacts to land uses of impacted coastlines would result in minimal impacts to coastlines due to rapid dispersal and evaporation of diesel. The impacts would be brief in duration (diesel lasts three to five days in the marine environment), and limited to impacted waters and those coastlines affected.

Scenario 2: River Barge Release

Impacts could occur to land management if the spill requires management action. In terms of intensity, land management effects would range from no impact to unmeasurable or unapparent changes. The duration of impacts would be brief, lasting only the duration of the spill. The extent of impacts would be limited to the vicinity of the spill site that would require actions by the land manager. These impacts would likely require additional mitigation measures, such as the development of a spill contingency plan in coordination with potential land managers.

Impacts to land uses of impacted shorelines would result in minimal impacts to shorelines due to rapid dispersal and evaporation of diesel. These impacts would be brief (within a month there would be no or very little visible diesel sheen remaining), and limited to the vicinity of impacted shorelines.

Scenario 3: Tank Farm Release

Storage of diesel would occur in tank farms located in Dutch Harbor, Bethel, Angyaruaq (Jungjuk) Port, and the Mine Site. Impacts could occur to land management if the spill requires management action. Table 3.24-1 shows the progression for very small and small spills with high and medium probabilities, and large and very large spills both having very low probabilities.

A very low probability, large volume (possibly 1 million gallons or more), potential spill scenario is a catastrophic tank failure at a tank farm, such as the Bethel Port, Angyaruaq (Jungjuk) Port, or the mine-site tank farm. The entire volume of the tank's contents would be released to secondary containment; recovery would be 100 percent, minus any loss to evaporation. However, impacts could include evacuation of nearby homes and businesses due to fumes and potential fire danger, as in the case of the Bethel Port tank farm. Any actions that would occur at Dutch Harbor or the Port of Bethel at the Bethel Yard Dock are not part of the proposed action, and are considered connected actions (see Section 1.2.1, Connected Actions, in Chapter 1, Project Introduction and Purpose and Need).

In terms of intensity, impacts to land management would range from no impact to impacts that may not be measurable or apparent. The duration of impacts would be brief and last the duration of the spill. The extent would be limited to the vicinity of the spill site that would require actions by the land manager. These impacts would likely require additional mitigation measures, such as the development of a spill contingency plan in coordination with potential land managers. Impacts to land use from diesel spills at a tank farm would thus range from no impact for small spills to impacts that may require evacuation of lands due to fire danger. Cleanup operations should be complete within seven days, and limited to nearby landowners for large spills.

Scenario 4: Tanker Truck Release

In the event of a release from a tanker truck, impacts to land uses would vary widely in intensity depending on the size of the spill, current land use, and possible impacts to fisheries. The duration of impacts would range from brief to changes that may reasonably be expected to convert (or revert) to another use frequently, over the life of the project (duration of impacts may increase if subsistence or fisheries are impacted). The extent or scope of impacts would be limited to road or nearby landowners. Impacts could occur to land management if the spill requires management action. Therefore, land management would range from no impact to impacts that may not be measurable or apparent, last the duration of the spill, and limited to the vicinity of the spill site that would require actions by the land manager. These impacts would likely require additional mitigation measures, such as the development of a spill contingency plan in coordination with potential land managers.

Scenario 7: Cyanide Release

In the unlikely event of a sodium cyanide release, direct and indirect effects to land, management and use are expected to be minimal and limited to a short disruption of land uses in the immediate vicinity of the spill during cleanup activities. Limited impacts could occur to land management if the spill requires management action. Therefore, land management would range from no impact to impacts that may not be measurable or apparent, last the duration of the spill, and would be limited to the vicinity of the spill site that would require actions by the land manager. The intensity of negative impacts on land use would likely not be measurable or apparent, limited to existing limited land uses and confined to the immediate area of the spill. The environmental effects would be confined to a small area.

Scenario 8: Mercury Release

The effects of a mercury release are very similar to that of a cyanide release. In the unlikely event of a mercury release, direct and indirect effects to land management and use are expected to be minimal and limited to a short disruption of land uses in the immediate vicinity of the spill during cleanup activities. Limited impacts could occur to land management if the spill requires management action.

A release of mercury into the environment at transfer facilities or along the road and adjacent water bodies is considered a low probability event, as mercury would have multiple containment levels. Cleanup would occur quickly due to the multiple containment systems. Therefore, land management would range from no impact to impacts that may not be measurable or apparent, last the duration of the spill, and would be limited to the vicinity of the spill site that would require actions by the land manager. The intensity of negative impacts on land resources caused by a disruption of land uses in the immediate area of the spill would likely not be measurable or apparent. The environmental effects would be confined to a small area.

Scenario 9: Partial Tailings Dam Failure

The tailings dam, associated facilities, and the spill trajectory resulting from a potential partial tailings dam failure are located on private land (Native Patent or Interim Conveyed—see Figure 3.15-1C, Section 3.15, Land Ownership, Management, and Use). If there were to be a partial tailings dam failure, of either water and tailings or just water, the impacts to land management would range from no impact to acute or obvious impacts, depending upon the volume of spill and location of spill trajectory. The duration of effects would range from the duration of the spill to the duration of the cleanup effort, and limited to the vicinity of the spill site that would require actions by the land manager owners. These impacts would likely require additional mitigation measures, such as the development of a spill contingency plan in coordination with nearby land managers. Impacts to land use from a partial tailings dam failure would thus range from no impact for small spills to impacts that may require evacuation of lands, be intermittent in duration, and limited to nearby landowners for large spills.

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

Under Alternative 3A, Scenario 5 (diesel pipeline release) is not applicable, and has not been analyzed for effects to land use and management. The likelihood of Scenarios 1 through 4 (ocean or river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Impacts under Scenarios 7 through 9 (cyanide, mercury, and tailings releases) for Alternative 3A would be the same as those discussed under Alternative 2.

Scenario 6: Liquefied Natural Gas (LNG) Release

Impacts to land use from an LNG spill at the Mine Site would range in intensity depending on the size of the spill, LNG would quickly dissipate, and most likely limited to the Mine Site or nearby landowners. No residential or commercial areas are located in the vicinity of the Mine Site; therefore, an LNG spill would not impact these land uses. An explosion could potentially alter the landform, but not the proposed industrial use within the area. There would be no impact to land management.

3.24.6.15.3 ALTERNATIVE 3B – REDUCED DIESEL BARGING: DIESEL PIPELINE

Under Alternative 3B, Scenario 6 (LNG release) is not applicable and has not been analyzed for effects to land use and management. Impacts under Scenarios 1 and 2 (ocean or river barge releases) would be shifted relative to Alternative 2, and the likelihood of Scenarios 3 and 4 (tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Scenarios 7 through 9 (cyanide, mercury, and tailings releases) would have the same impacts on land use and management as Alternative 2.

<u>Scenario 5: Diesel Pipeline Release</u>

Under Alternative 3B, landowners identified along the natural gas pipeline under Alternative 2, as well as the landowners along the additional 19-mile segment from the start of the pipeline to the Tyonek dock could potentially be impacted by a diesel pipeline release. Depending on the size of the spill, there would likely be discrete direct impacts to ecological resources both on land as well as river and streams that would continue until cleanup is complete (days to months depending on spill size). Therefore, land management would range from no impact to impacts that may not be measurable or apparent, last the duration of the spill, and would be limited to the vicinity of the spill site that would require actions by the land manager. These impacts would likely briefly restrict existing land uses along the ROW such as recreation and subsistence resources (see Section 3.16, Recreation, and Section 3.21, Subsistence, respectively). Cleanup activities would also likely briefly halt the proposed industrial land use of the land along the pipeline. Overall, impacts to land use would likely be acute or obvious, but effects would be brief, (extending through cleanup) and affect extensively available resources found in the region.

3.24.6.15.4 ALTERNATIVE 4 – BIRCH TREE CROSSING (BTC) PORT

Under Alternative 4, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to land use and management. The likelihood of Scenario 2 (river barge release) occurring would be greatly reduced and the likelihood of Scenario 4 (tanker truck release) would be increased; however, the impacts of either would be the same as those discussed under Alternative 2.

Impacts under Scenarios 1, 3, 7 through 9 (ocean barge, tank farm, cyanide, mercury, and tailings releases) for Alternative 4 would be the same as those discussed under Alternative 2.

3.24.6.15.5 ALTERNATIVE 5A – DRY STACK TAILINGS

Under Alternative 5A, Scenarios 5, 6, and 9 (diesel pipeline, LNG, and water and tailings releases) are not applicable and have not been analyzed for impacts to land use and management.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and water only tailings releases) for Alternative 5A would be the same as those discussed under Alternative 2.

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

Under Alternative 6A, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to land use and management.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 6A would be the same as those discussed under Alternative 2.

3.24.6.16 RECREATION

3.24.6.16.1 ALTERNATIVE 2 – DONLIN GOLD'S PROPOSED ACTION

Under the proposed action, two spill scenarios do not apply and are not analyzed for recreation impacts. These include Scenario 5 (diesel pipeline release) and Scenario 6 (LNG release).

<u>Scenario 1: Ocean Barge Rupture at Sea</u>

A potential rupture of an ocean barge at sea under Alternative 2 would release 735,000 gallons of diesel fuel, and 50 percent of this would reach shore in the Kuskokwim Bay area. This release would likely have a limited effect on existing recreation activities and use patterns, because of limited recreation use in this project spill area. The recreation activities affected could include offshore sport fishing, sea kayaking, and sailing; activities that occur primarily or entirely during ice-free portions of the year. Within the Project Area, these recreation activities largely take place close to shore in areas where there would be minimal interaction with ocean barges and a potential fuel spill. The level of recreation use differs along the length of the ocean barge route, but existing recreation levels are predominantly low. The ocean barges proposed under Alternative 2 generally travel in areas far from shore where little to no recreation activities occur. Those recreation activities that could be affected would likely be clustered around Dutch Harbor and Bethel. In the event of an ocean barge rupture at sea, it is likely that a spill would occur in an area a large distance away from areas of existing recreation use and have no direct or indirect impacts to recreation. If the spill happened near to the shore or during a period of high recreation use (summer) it could displace recreationists in the area, both from the spill directly and from the response effort indirectly. The impact from this spill would vary depending on the area affected and existing recreation levels.

In the event of a spill near to shore in areas where recreation takes place, the displacement of recreationists would occur immediately after the spill, during the response effort, and possibly afterword if there was a perception of contamination. The response effort, depending on the magnitude of the spill and the amount of shoreline at risk, would likely extend for one week or less, with most intensive cleanup efforts occurring in the days following the spill. The likelihood of an ocean barge rupture close to shore in areas of seafaring recreation would be very low. Displacement due to the spill and the response effort would likely not affect a large number of recreationists. Therefore, the intensity of impacts to recreation as a result of an ocean barge rupture would range from changes in use levels that may not be measurable or apparent to noticeable changes, depending on the amount of recreation that was taking place in the area at the time of a spill.

Given the volume of fuel that could be spilled in the event of an ocean barge rupture and potential for dispersion, a spill could quickly affect a large area. If the spill occurred near the shore, it could have the potential to affect hundreds of miles of shoreline and displace shoreline recreation. For that reason, the extent of a large ocean barge rupture would affect recreationists throughout a large area and throughout the EIS Analysis Area. In terms of context, the recreation opportunities that would potentially be affected, including near shore recreation, occur frequently within the region.

Overall, the impacts to recreation as a result of an ocean barge rupture are dependent upon the spill location. If a spill occurred in areas where recreation does not take place, there would be no direct or indirect effects, but there would be impacts if a rupture occurred near shore where there are existing low levels of recreation. Depending on the number of recreationists, this would result from the brief displacement due to spill and response efforts affecting recreation resources that vary in context by designation and management direction (discussed in Section 3.15, Land Ownership, Management, and Use.

Scenario 2: River Barge Release

In the event of a river barge diesel release, impacts to recreation activities would likely be minimal due to the existing low levels of recreation along the Kuskokwim River (see Section 3.16.2.3.1). Under Alternative 2, the transport of fuel by barge up the Kuskokwim River would be limited to the summer delivery season. For this reason, potential impacts would be restricted to recreation activities such as summer sport fishing, kayaking, rafting, and sport hunting along the river. There would be no impact to winter recreation activities such as snowmachining or winter sport hunting in the Project Area. While low in probability, the release of a large volume of diesel from a barge grounding would have the potential to directly impact recreation activities downriver of the spill.

As discussed in Section 3.16.2.3.1, the level of recreation in the Kuskokwim River is low, and the recreation that takes place is primarily related to sport hunting and fishing activities. The contamination of fish and animals from ingestion could disrupt sport fishing and sport hunting along the river and in Kuskokwim Bay. The presence of fuel in the water and subsequent response activities would likely displace other recreation activities. Due to existing low recreation use levels along the river, however, these direct and indirect impacts are expected to result in changes in recreation that may not be measurable or apparent. The displacement of recreationists would occur immediately after a spill, continue throughout the response effort, and possibly afterward if there is a perception of contamination. Depending on the magnitude of the spill and the length of river that would be impacted, the intensity of impacts to recreation would likely be greatest in the days and weeks following the spill and diminish as fuel is dispersed. Efforts would likely continue for one or two weeks following the spill. Depending on river current, weather, and amount of diesel spilled, the diesel could travel far downriver and possibly to Kuskokwim Bay. Displacement of recreation activities would be greater in areas with focused response efforts. Response efforts could take place at any point from the spill to Kuskokwim Bay, but would remain limited to the Kuskokwim River and Bay. Consequently, the extent of impacts to recreation as a result of a river barge release would vary and may extend throughout the EIS Analysis Area. There are ample alternative locations for river-based recreation activities throughout the region; many of which exert a larger draw for guided and unguided sport fishing and sport hunting. As a result, a fuel release from the grounding of a river barge would affect recreation resources that are widely available in the area. Those recreationists displaced by a potential spill would likely seek alternative locations.

In the event of a spill, the intensity of impacts to recreation activities may not be measurable or apparent due to the existing low levels of recreation along the Kuskokwim River, and the extent of impacts would be limited to the vicinity of the Kuskokwim River and to a lesser degree Kuskokwim Bay. The number of recreationists displaced as a result of the spill and subsequent response effort would be minimal and affect recreation resources that are widely available within the Project Area. Those recreationists displaced by a river barge release would likely seek other alternatives within the region to engage in their preferred recreation activities.

Scenario 3: Tank Farm Release

In the instance of a diesel fuel release at a tank farm, there would be no direct or indirect impacts to recreation. The spill and subsequent response effort would be limited to the vicinity of the spill site, either the Mine Site or a tank farm at Angyaruaq (Jungjuk) Port or Bethel. In all tank farm release scenarios, potential spills would occur in locations that would be closed to the public and therefore not open to recreation activities. Since the spill and response efforts would remain on-site in an area without public access, and recovery would be 100 percent, there would be no direct or indirect impacts to recreation as a result of a diesel fuel release at a tank farm. Any actions that would occur at Dutch Harbor or the Port of Bethel at the Bethel Yard Dock are not part of the proposed action, and are considered connected actions (see Section 1.2.1, Connected Actions, in Chapter 1, Project Introduction and Purpose and Need).

Scenario 4: Tanker Truck Release

In the event of a diesel fuel release from a tanker truck rollover or a tanker truck collision, the spill and response effort would have no effect on recreation resources. Under Alternative 2, a tanker truck release would be limited to the vicinity of the spill site on the road, and potentially the land and waters adjacent to the road. In all instances, potential tanker truck spills would occur in locations that would be closed to the public and not be open to recreation activities. Direct and indirect impacts of the release would not extend to areas with the potential for recreation. As a result, there would be no direct or indirect impacts to recreation from a tanker truck diesel fuel release.

Scenario 7: Cyanide Release

In the event of a container of sodium cyanide being lost overboard from a barge, impacts to recreation activities would likely be minimal due to the existing low levels of recreation along the Kuskokwim River (see Section 3.16.2.2.2) and recreation would be disturbed by recovery efforts. The transport of sodium cyanide by barge up the Kuskokwim River would occur during the summer delivery season. For this reason, potential impacts would be restricted to recreation activities such as summer sport fishing, kayaking, rafting, and sport hunting along the river. There would be no impact to winter recreation activities such as snowmachining or winter sport hunting in the Project Area.

A tank-tainer rupture, including due to vehicle collision during overland transport, is considered a very low probability event. Impacts to recreation from cleanup activities would include a brief displacement of sport hunting and fishing. Due to existing low recreation use levels along the river, however, these direct and indirect impacts are expected to result in changes in recreation that may not be measurable or apparent. The duration of displacement of recreationists would occur immediately after the containers were lost, and continue throughout the response effort. Displacement of recreation activities would be greater in areas with focused response efforts. Consequently, the extent of impacts to recreation as a result of a lost sodium cyanide container would be limited within a subregion. There are ample alternative locations for recreation activities throughout the region; many of which exert a larger draw for guided and unguided sport fishing and sport hunting. As a result, a lost container would affect recreation resources that are widely available in the area. Those recreationists displaced by a potential spill would likely seek alternative locations.

In the event of a sodium cyanide tank-tainer rupture while being transported within the port storage or Mine Site areas, or from a vehicle collision during transport from Angyaruaq (Jungjuk) Port to the Mine Site, there would be no direct or indirect effects to recreation. These areas are closed to the public for safety reasons, and no recreation would be taking place there.

In the event of a lost container, the impact intensity of changes to recreation activities may not be measurable or apparent due to the existing low levels of recreation, and the extent of impacts would be limited to the vicinity of the spill site. The number of recreationists displaced as a result of the loss and subsequent response effort would be minimal and affect recreation resources that are widely available within the Project Area. Those recreationists displaced by recovery of a container would likely seek other alternatives within the region to engage in their preferred recreation activities.

Scenario 8: Mercury Release

The effects of a mercury release are very similar to that of a cyanide release. In the unlikely event of a mercury release, direct and indirect effects to recreation resources are expected to be minimal and limited to the immediate vicinity of the spill during cleanup activities.

A release of mercury into the environment at transfer facilities or along the road and adjacent water bodies is considered a low probability event, as mercury would have multiple containment levels. Cleanup would occur quickly due to the multiple containment systems. In the event of a lost container, the impact intensity of changes to recreation activities may not be measurable or apparent due to the existing low levels of recreation, and the extent of impacts would be limited to the vicinity of the spill site. The number of recreationists displaced as a result of the loss and subsequent response effort would be minimal and affect recreation resources that are widely available within the Project Area. Those recreationists displaced by recovery of a container would likely seek other alternatives within the region to engage in their preferred recreation activities.

Scenario 9: Partial Tailings Dam Failure

In the event of a partial tailings dam failure, impacts to the recreation setting would be acute or obvious, but the levels of recreation activities downstream from the Mine Site are estimated to remain very low. The recreation activities that may be affected by a partial tailings dam failure could include sport fishing, river recreation (such as kayaking and rafting), recreational snowmachining, and sport hunting. Sport anglers generally use clear tributary streams as opposed to the turbid waters of the Kuskokwim River, and Crooked Creek and Anaconda Creek are not popular sport fishing or sport hunting locations. While low in probability, a partial tailings dam failure may cause probable loss or damage to anadromous fisheries, which could impact sport anglers. There would be impacts to recreational sightseeing as visual resources would be impacted. Sightseeing and flightseeing are typically secondary recreational activities done in conjunction with travel for sport fishing and sport hunting.

If a release occurred in winter, it could impact recreational snowmachine or dogsled travel on a small portion of the Kuskokwim River and on Crooked and Anaconda creeks. These direct and indirect impacts are expected to be acute or obvious in intensity, but would affect very low recreation use levels. Displacement of recreationists would be brief in duration, with potential displacement of sport anglers and sport hunters through the life of the project if contamination of fish and waterfowl occurred or was perceived. Impacts to recreation would be limited to the vicinity of the spill site. Resources would be widely available in context as there are ample alternative locations for recreation, many of which are more popular locations for guided and unguided sport fishing and sport hunting. Displaced recreationists would likely make use of alternative locations for their activities. In summary, the impacts from a partial tailings dam failure would impact the recreation setting, but would affect few recreationists in the area.

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

Under Alternative 3A, Scenario 5 (diesel pipeline release) is not applicable and has not been analyzed for impacts to recreation. The likelihood of Scenarios 1 through 4 (ocean or river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Impacts under Scenarios 7, 8, and 9 (cyanide, mercury, and tailings releases) for Alternative 3A would be the same as those discussed under Alternative 2.

Scenario 6: Liquefied Natural Gas (LNG) Release

An LNG release, either from pinhole leaks in LNG storage tanks, an accident involving an LNG-fueled truck, or the rupture of a storage tank at the LNG plant, would have no effect on recreation resources. Storage tanks and trucks would be located within the Mine Site. Thus, potential LNG releases, could occur in the Mine Site area, which would be closed to the public. Little cleanup response would likely be required because potential LNG releases would vaporize rapidly. Therefore, no direct or indirect impacts to recreation would result.

3.24.6.16.3 ALTERNATIVE 3B – REDUCED DIESEL BARGING: DIESEL PIPELINE

Under Alternative 3B, Scenario 6 (LNG release) is not applicable and has not been analyzed for impacts to recreation. Impacts under Scenarios 1 and 2 (ocean or river barge releases) would be shifted relative to Alternative 2, and the likelihood of Scenarios 3 and 4 (tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Scenarios 7 through 9 (cyanide, mercury, and tailings releases) would have the same impacts on recreation as Alternative 2.

Scenario 5: Diesel Pipeline Release

Under Alternative 3B, the diesel pipeline ROW would follow the same alignment as the proposed natural gas pipeline under alternative 2. (Only one pipeline would be constructed; the diesel pipeline would replace the natural gas pipeline.) The buried diesel pipeline ROW would be within 1,000 feet of or collocated with the Iditarod National Historic Trail (INHT) for approximately 22.9 miles. If a diesel pipeline release were to occur as a result of a pinhole leak or a pipeline rupture in the vicinity of the INHT, it could affect the setting and experience of recreation and result in some displacement of recreation activities. If a diesel pipeline release were to occur away from INHT, which is approximately 292 miles of the pipeline, there would likely be no direct or indirect impacts to recreation resources.

If a diesel pipeline release were to occur in the vicinity of the INHT, it would emit an odor noticeable by recreationists. The spill recovery efforts may require closure of trail sections around the spill site, which could result in displacement of recreation activities. In addition, response efforts would likely use the trail system for access to the spill site, which could either cause more displacement or affect the experience of recreationists. Impacts to recreation would be more likely in the event of a winter pipeline release, as the existing levels of summer recreation on the trail system are very low.

In the event of a diesel pipeline rupture near the INHT in the winter, displacement of recreationists would occur immediately after the spill and during the response effort. In terms of duration, the response effort, depending upon the magnitude of the spill, would likely continue until cleanup is complete (days to months depending on spill size). The likelihood of a diesel pipeline rupture close to the INHT in the winter would be very unlikely. If this spill scenario were to occur, however, the displacement of recreation due to the spill and the response effort could potentially affect snowmachiners, skiers, and possibly organized race participants and vicarious users. Recreation levels for winter activities along the INHT would vary depending upon the timing of various organized INHT events. The intensity of impacts to recreation as a result of a diesel pipeline rupture would depend on the level of response effort required. If a spill response effort interrupted the Iditarod race, recreation impacts would change to acute or obvious due to the increases in users, spectator attention, and historic context surrounding the INHT for the Iditarod race. Pinhole leaks would require less response effort. The amount that could potentially be spilled in the event of a diesel pipeline release could be dispersed to a large area, but would not extend beyond the area surrounding the spill site. Effects to recreationists would include displacement in and around the spill response effort. In context, the INHT is a congressionally designated trail system that is used primarily in the winter, with several annual organized races along the pipeline ROW in that area.

If a pipeline rupture were to occur, the intensity would depend on the number of recreationists that may be displaced by the event. The extent would remain limited to the vicinity of the spill site. Although response efforts may use existing trails for access, the extent would not extend beyond the area of the spill. The response effort would be infrequent and displace recreationists during the cleanup period, likely extending for one to two months following the spill.

3.24.6.16.4 ALTERNATIVE 4 – BIRCH TREE CROSSING (BTC) PORT

Under Alternative 4, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to recreation. The likelihood of Scenario 2 (river barge release) occurring would be greatly reduced, and the likelihood of Scenario 4 (tanker truck release) would be increased; however, the impacts of either would be the same types as discussed under Alternative 2. Impacts under Scenarios 1, 3, 7 through 9 (ocean barge, tank farm, cyanide, mercury, and tailings releases) for Alternative 4 would be the same as those discussed under Alternative 2.

3.24.6.16.5 ALTERNATIVE 5A – DRY STACK TAILINGS

Under Alternative 5A, Scenarios 5, 6, and 9 (diesel pipeline, LNG, and water and tailings releases) are not applicable and have not been analyzed for impacts to recreation.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and water only tailings releases) for Alternative 5A would be the same as those discussed under Alternative 2.

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

Under Alternative 6A, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to recreation.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 6A would be the same as those discussed under Alternative 2.

3.24.6.17 VISUAL RESOURCES

3.24.6.17.1 ALTERNATIVE 2 – DONLIN GOLD'S PROPOSED ACTION

Under the proposed action, two spill scenarios do not apply and are not analyzed for visual impacts. These include Scenario 5 (diesel pipeline release) and Scenario 6 (LNG release).

Impacts to visual resources expected to result from very small (less than 10 gallons) and small (10 to 99.9 gallons) diesel spills would be imperceptible. No change in scenic quality or landscape character attributes would occur. Consequently, potential impacts to visual resources expected to result from very small and small diesel spills are not discussed.

Scenario 1: Ocean Barge Rupture at Sea

In the event of an ocean barge rupture at sea (total release of a very large volume to the water), direct impacts to visual resources could result. Though considered a very low probability event, such an occurrence would result in strong visual contrast created by the sheen of diesel effluent on the surface of the water compared to unaffected areas. Direct impacts to visual resources would occur briefly and limited to the vicinity of the spill site, as dispersal and evaporation would occur within 3-5 days, thereby limiting the geographic extent to which the spill could spread while still intact. The remote routes followed by ocean barges make it unlikely that diesel fuel would be detected on adjoining shorelines. No indirect impacts to visual resources are expected to result from an ocean barge rupture at sea.

Scenario 2: River Barge Release

In the event of a grounding of a river barge and subsequent release of a single fuel laden barge into the riverine environment, direct impacts to visual resources could result. Though considered a very low probability event, such an occurrence would result in strong visual contrast of diesel effluent on the surface of the water compared to unaffected areas. The confined river channel would likely make diesel evident on adjoining shorelines. Though diesel fuel on the surface of the water would be detectable at close proximity, visual contrast between the affected areas and unaffected upriver (or potential down river) areas would be most evident from elevated or aerial locations. Affected area would appear disturbed and unnatural. The scope of the affected area would extend to the background distance zone if the spill was not contained and the discharge was transported by river current to Kuskokwim Bay. The context of direct impacts would affect villages along the Kuskokwim River, and affect scenic quality attributes of the Yukon Delta NWR. Direct impacts would occur briefly, as diesel would not be detectable on the surface after 3 days, due to dispersal and evaporation. No indirect impacts to visual resources are expected to result from grounding of a river barge and total release of a single fuel laden barge into the riverine environment.

Scenario 3: Tank Farm Release

In the event of a large volume (possibly 1 million gallons or more) spill scenario from a failure of a diesel storage tank, the spill and subsequent response effort would be limited to the vicinity of the spill site – either the Mine Site or a tank farm at Angyaruaq (Jungjuk) Port or Bethel. Under this scenario, direct impacts to visual resources would occur. Direct impacts to visual resources would result from the visual contrast of the diesel effluent in the secondary containment facility against the surrounding environment. Any actions that would occur at Dutch Harbor or the Port of Bethel at the Bethel Yard Dock are not part of the proposed action, and are considered connected actions (see Section 1.2.1, Connected Actions, in Chapter 1, Project Introduction and Purpose and Need).

Scenario 4: Tanker Truck Release

Impacts to visual resources would be expected to result from a potential medium to large volume (up to 13,500 gallons) spill resulting from a tanker truck rollover and release of the entire contents of the tanker truck to the surrounding environment. Released fuel would be visible on the surface of surrounding land and water; however, visual contrast of the spill would be weak and limited to a discrete geographic extent to existing topography and vegetation. In the event that in-situ burning is required, visual contrast of affected areas could increase; however, direct impacts would remain limited to the vicinity of the spill site due to topography and intact surrounding vegetation. Because of the extent of burned areas in the Kuskokwim Mountains, such activity would be consistent with larger scale landscape attributes. The context of direct impacts would be that sensitive resources or special management areas are located in the vicinity of mine access or operations-related roadways.

Scenario 7: Cyanide Release

In the unlikely event of a sodium cyanide release, direct and indirect effects to visual resources are expected to be minimal and likely would be limited to brief, low visual contrast of cleanup activities.

The intensity of negative impacts on visual resources caused by spill cleanup in the immediate area of the spill would likely result in low to no visual contrast against the existing landscape. The direct effects would be confined to a small area would briefly affect visual resources.

Scenario 8: Mercury Release

In the unlikely event of a mercury release at a cultural resource site, direct and indirect effects to visual resources are expected to be minimal and likely would be limited to brief, low visual contrast of cleanup activities.

The intensity of negative impacts on visual resources caused by spill cleanup in the immediate area of the spill would likely result in low to no visual contrast against the existing landscape. The direct effects would be confined to a small area would briefly affect visual resources.

Scenario 9: Partial Tailings Dam Failure

In the event of a liner rupture or tailings dam breach in which a large volume of water or water and tailings is released into the environment, direct impacts to visual resources could result. While unlikely in probability, impacts would extend to the background distance zone and potentially affect visual resources in the vicinity of villages along the Kuskokwim River. A release of tailings and water would result in strong visual contrast against the existing landscape from materials transported downstream and excavated soils as part of cleanup efforts. A water only release would likely have some reduction of impacts over a release of water and tailings, but would still cause a high visual contrast that would appear disturbed and unnatural. Impacts to visual resources would be evident from communities along the Kuskokwim River and from elevated or aerial locations. Indirect impacts to visual resources may result from subsequent cleanup efforts if excavation or earthmoving equipment were used as part of the recovery effort. Impacts would range in duration, depending upon the extent and location (setting) of the release and cleanup efforts.

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

Under Alternative 3A, Scenario 5 (diesel pipeline release) is not applicable and has not been analyzed for effects to visual resources. The likelihood of Scenarios 1 through 4 (ocean or river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Scenarios 7 through 9 (cyanide, mercury, and tailings releases) for Alternative 3A would have the same impacts on visual resource as Alternative 2.

Scenario 6: Liquefied Natural Gas (LNG) Release

In the event of an LNG release, direct and indirect impacts to visual resources could result from a large or very large release, if there is a subsequent vapor ignition of LNG at the Mine Site LNG plant or form a leak on the LNG-powered haul trucks. Direct effects would be result from visual contrast of burned vegetation against the surrounding landscape. The extent or scope of direct impacts would be such that viewer extent is limited by topography over the majority of the Project Area. There is no particular context to visual resources.

3.24.6.17.3 ALTERNATIVE 3B – REDUCED DIESEL BARGING: DIESEL PIPELINE

Under Alternative 3B, Scenario 6 (LNG release) is not applicable and has not been analyzed for impacts to visual resources. The likelihood of Scenarios 1 through and 4 (ocean or river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Scenarios 7 through 9 (cyanide, mercury, and tailings releases) for Alternative 3B would have the same impacts on visual resources as Alternative 2.

Scenario 5: Diesel Pipeline Release

In the event of a large or very large spills occurring due to rupture of the diesel pipeline, direct and indirect impacts to visual resources of the Kuskokwim River as well as other rivers crossed by the pipeline, would be similar to that described under Scenario 2 (River Barge Grounding). In the event of a large or very large spills occurring due to rupture of the diesel pipeline in one of the inland segments, direct impacts to upland areas would result in moderate to strong visual contrast against the existing landscape and would not extend beyond the foreground-middleground distance zone, as shut-off valves would limit the release volume.

3.24.6.17.4 ALTERNATIVE 4 – BIRCH TREE CROSSING PORT

Under Alternative 4, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to visual resources. Impacts under Scenario 2 (river barge release) would be eliminated upriver, but the same as Alternative 2 for downriver. The likelihood of Scenario 4 (tanker truck release) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2.

Impacts under Scenarios 1, 3, and 7 through 9 (ocean barge, tank farm cyanide, mercury, and tailings releases) for Alternative 4 would be the same as those discussed under Alternative 2.

3.24.6.17.5 ALTERNATIVE 5A – DRY STACK TAILINGS

Under Alternative 5A, Scenarios 5, 6, and 9 (diesel pipeline, LNG, and water and tailings releases) are not applicable and have not been analyzed for impacts to visual resources.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and water only tailings releases) for Alternative 5A would be the same as those discussed under Alternative 2.

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

Under Alternative 6A, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to visual resources.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 6A would be the same as those discussed under Alternative 2.

3.24.6.18 SOCIOECONOMICS

3.24.6.18.1 ALTERNATIVE 2 - DONLIN GOLD'S PROPOSED ACTION

Under the proposed action, two spill scenarios do not apply and are not analyzed for socioeconomic impacts. These include Scenario 5 (diesel pipeline release) and Scenario 6 (LNG release).

Scenario 1: Ocean Barge Rupture at Sea

It is unlikely that an ocean barge rupture at sea would result in increased employment or income opportunities in the Y-K region. Manpower requirements would be low, as response efforts would be limited to overflights to observe the dispersal of the diesel.

The impacts on employment, income, and sales would be negative if commercial and recreational fishing and/or tourism were to suffer due to the real or perceived impacts of a spill. While these negative employment, income, and sales effects would be brief, their intensity would vary and may result in changes in socioeconomic indicators well outside normal variation and trends if a major spill occurs with shoreline contact and/or contamination of fish.

The State of Alaska has a "Zero Tolerance Policy" with respect to contamination of seafood by an oil spill. If the ADEC finds that a spill threatens to contaminate a body of water or fishery management area, fishing vessels, tenders, and seafood processors must be inspected before, during, and after conducting fishing activities or receiving seafood products (18 AAC 34.600-625).

Moreover, under authority of AS 16.05.060, the ADF&G would close fisheries in areas where there is a likely threat of contamination from a spill. Areas would remain closed to all commercial and recreational fishing, pending monitoring and assessment indicating that the threat of contamination is eliminated. A closed area may be enlarged if the threat of contamination expands to adjacent bays and fishing grounds. The intensity of the adverse impacts of a fishery closure on employment, income, and sales would be especially elevated if the closure coincides with the salmon fishing season in the Y-K region, which occurs during summer months.

The negative employment, income, and sales effects associated with a disruption of commercial or recreational fishing would affect communities within the Y-K region, with imperceptible effects outside the region, and effects would involve primarily minority and low-income communities.

Due to the remoteness of a spill resulting from an ocean barge rupture at sea, the effects on public infrastructure and services and fiscal conditions would likely be imperceptible.

Impacts to socioeconomic resources from an ocean barge rupture at sea would vary if a spill affected local coastal fisheries and communities. The intensity of impacts under this scenario would vary depending on if the spill occurred close to the shoreline, resulting in commercial fishing closures and a reduction in tourism. Duration of impacts would likely be brief, affecting socioeconomic resources during the spill and subsequent cleanup efforts. Disruptions of commercial or recreation fishing would likely affect communities within the Y-K region, given that a large spill could disperse across a large area. In context a spill would affect primarily minority and low-income communities.

Scenario 2: River Barge Release

The cleanup and remediation activities following a river barge grounding in which a large volume of diesel is released into the environment would briefly increase employment opportunities and expenditures in the Y-K region. Manpower requirements would be especially high if labor-intensive response efforts such as mechanical recovery and physical removal are used. Employment associated with cleanup and recovery operations would be brief due to the rapid recovery or dispersion of the spilled diesel. No employment opportunities would be created by smaller spills, as cleanup crews would be small and likely consist of Donlin Gold personnel.

Over the longer term, the impacts on employment, income, and sales would be negative if commercial and recreational fishing and/or tourism were to suffer due to the real or perceived impacts of the spill. These negative employment, income, and sales impacts would be similar to those discussed under Scenario 1 (ocean barge rupture at sea), but more focused towards the Kuskokwim River communities. In terms of context, these effects would affect primarily minority and low-income communities.

To the extent that cleanup and remediation activities disrupt local marine and air traffic patterns, by precluding barge traffic in appropriate cleanup areas or by spill cleanup workers taking most of the available seats on local flights, brief shortages of commodities or services could occur in those communities in the Y-K region in close proximity to the spill. These shortages could have a negative effect on local businesses as well as consumers.

The intensity of impacts under this scenario would vary and may result in changes in socioeconomic indicators well outside normal variation and trends if a major spill occurred, resulting in commercial fishing closures and a reduction in tourism. Duration of impacts would likely be brief, affecting socioeconomic resources during the spill and subsequent cleanup efforts. The extent or scope of disruptions of commercial or recreation fishing would likely be limited to the vicinity of the Kuskokwim River. In terms of context, impacts would affect primarily minority and low-income communities.

Scenario 3: Tank Farm Release

Impacts to socioeconomic resources in the event of a catastrophic tank failure at a tank farm into the secondary containment would be similar to those discussed under Scenario 2. 100 percent of the spill would be captured by secondary containment.

Scenario 4: Tanker Truck Release

It is unlikely that cleanup and remediation activities following a tanker truck release would result in increased employment opportunities in the Y-K region. Cleanup crews would be small and likely consist of Donlin Gold personnel.

A tanker truck accident could result in the release of diesel into the environment along the road, including a water body. However, the intensity of the negative impacts on employment, income, and sales caused by a disruption of commercial and recreational fishing and/or tourism would likely be difficult to perceive or measure. The environmental effects would be confined to a small area, and recovery and cleanup should be completed within 7 to 10 days (less in easily accessed locations).

Scenario 7: Cyanide Release

It is unlikely that cleanup and remediation activities following a sodium cyanide release would result in increased employment opportunities in the Y-K region. Cleanup crews would be small and likely consist of Donlin Gold personnel, trained in safe handling and spill response procedures.

A tank-tainer accident could result in the release of sodium cyanide into the environment at transfer facilities or along the road and adjacent water bodies. The intensity of negative impacts on employment, income, and sales caused by a disruption of commercial and recreational fishing and/or tourism would likely be difficult to perceive or measure. The environmental effects would be confined to a small area.

Scenario 8: Mercury Release

The effects of a mercury release are very similar to that of a cyanide release. It is unlikely that cleanup and remediation activities following a mercury release would result in increased employment opportunities in the Y-K region. Cleanup crews would be small and likely consist of Donlin Gold personnel, trained in safe handling and spill response procedures.

A release of mercury into the environment at transfer facilities or along the road and adjacent water bodies is considered a low probability event, as mercury would have multiple containment levels. The intensity of negative impacts on employment, income, and sales caused by a disruption of commercial and recreational fishing and/or tourism would likely be difficult to perceive or measure. Environmental effects would likely be confined to a small area.

Scenario 9: Partial Tailings Dam Failure

The cleanup and remediation activities following a partial tailings dam failure in which a large volume of water, or water and tailings, is released into the environment would briefly increase employment opportunities and expenditures in the Y-K region. Manpower requirements would be especially high if labor-intensive response efforts such as mechanical recovery and physical removal are used, such as in the case of a tailings and water release in winter. Employment increases for cleanup activities would be brief (up to four years). No employment opportunities would be created by smaller releases of tailings from the mill or from piping to the TSF, as cleanup crews would be small and likely consist of Donlin Gold personnel.

Over the longer term, the impacts on employment, income, and sales would be negative if commercial and recreational fishing and/or tourism were to suffer due to the real or perceived impacts of the spill. Water contamination could also create drinking water bans, which would also negatively impact local business and consumers. These negative employment, income, and sales impacts would be similar to those discussed under Scenario 1 (ocean barge rupture at sea), but more focused towards Crooked Creek and the Kuskokwim River communities. In terms of context, the impacts would affect primarily minority and low-income communities.

The intensity of impacts under this scenario would vary if a large spill occurred, potentially resulting in commercial fishing closures, a reduction in tourism, or local drinking water restrictions. The intensity of impacts would depend upon the season, and whether a release was only water, or both water and tailings. Greater intensity impacts would be expected to occur during summer as tailings could be mobilized to a larger area by waterways, and it would be more difficult to move cleanup-up equipment into the area. Duration of impacts would likely be brief (less than four years), affecting socioeconomic resources during the spill and subsequent cleanup efforts. Disruptions of commercial or recreation fishing would likely be limited in extent to areas around Crooked Creek, Anaconda Creek, and the Kuskokwim River. In context, effects would affect primarily minority and low-income communities.

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

Under Alternative 3A, Scenario 5 (diesel pipeline release) is not applicable and has not been analyzed for effects to socioeconomics. The likelihood of Scenarios 1 through 4 (ocean or river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Scenarios 7 through 9 (cyanide, mercury, and tailings releases) for Alternative 3A would have the same impacts on socioeconomics as Alternative 2.

Scenario 6: Liquefied Natural Gas (LNG) Release

It is unlikely that cleanup and remediation activities following an LNG release would result in increased employment opportunities in the Y-K region. In the event of a fire or explosion, responders would be trained fire fighters and other industry professionals. Because released LNG would quickly evaporate leaving no residue when it came into contact with soil or water, there would be no need for workers for environmental cleanup.

In addition, the quick evaporation of released LNG and absence of a residue means that negative impacts to employment, income and sales due to a disruption of commercial or recreational fisheries would be imperceptible.

An LNG release would be limited in extent, changes in socioeconomic indicators would be difficult to perceive or measure, and occur briefly.

3.24.6.18.3 ALTERNATIVE 3B – REDUCED DIESEL BARGING: DIESEL PIPELINE

Under Alternative 3B, Scenario 6 (LNG release) is not applicable and has not been analyzed for effects to socioeconomics. Impacts under Scenario 1 (ocean barge releases) would be shifted relative to Alternative 2, and the likelihood of Scenarios 2 through 4 (river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Impacts under Scenarios 7 through 9 (cyanide, mercury, and tailings releases) for Alternative 3B would have the same impacts on socioeconomics as Alternative 2.

Scenario 5: Diesel Pipeline Release

The cleanup and remediation activities following a diesel pipeline break in which a large volume of diesel is released into the environment would briefly increase employment opportunities and expenditures in communities in close proximity to the section of the pipeline where the break occurred. These positive employment, income, and sales impacts would be similar to those discussed under a river barge grounding under Alternative 2. No employment opportunities would be created by smaller spills, as cleanup crews would be small and would likely consist of Donlin Gold personnel.

If the diesel spilling from a break in the pipeline reached wetlands, freshwater ponds and lakes, streams, or larger rivers, the impacts on employment, income, and sales would be negative to the extent that commercial and recreational fishing and/or tourism suffered due to the real or perceived impacts of the spill. These negative employment, income, and sales impacts would be similar to those discussed under a river barge grounding under Alternative 2, but more limited in area towards the communities in close proximity to the section of the pipeline where the break occurred.

3.24.6.18.4 ALTERNATIVE 4 – BIRCH TREE CROSSING (BTC) PORT

Under Alternative 4, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to socioeconomics.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 4 would be the same as those discussed under Alternative 2.

3.24.6.18.5 ALTERNATIVE 5A – DRY STACK TAILINGS

Under Alternative 5A, Scenarios 5, 6, and 9 (diesel pipeline, LNG, and water and tailings releases) are not applicable and have not been analyzed for impacts to socioeconomics.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and water only tailings releases) for Alternative 5A would be the same as those discussed under Alternative 2.

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

Under Alternative 6A, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to socioeconomics.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 6A would be the same as those discussed under Alternative 2.

3.24.6.19 ENVIRONMENTAL JUSTICE

3.24.6.19.1 ALTERNATIVE 2 – DONLIN GOLD'S PROPOSED ACTION

Under Alternative 2, two spill scenarios do not apply and are not analyzed for effects to minority or low-income communities. These include Scenario 5 (diesel pipeline release) and Scenario 6 (LNG release).

Scenario 1: Ocean Barge Rupture at Sea

Under Alternative 2, ocean barges would transport diesel fuel from West Coasts ports to Dutch Harbor, and then on to Bethel. Most of the travel area would be far from shore, and would have minimal effects of local commercial or subsistence fisheries. However, there could be adverse impacts from a spill that made contact with the shoreline or created real or perceived contamination of fish, marine mammals, and other subsistence resources. It is unlikely for an ocean barge rupture at sea to result in employment opportunities for low-income or minority communities. There could be brief adverse impacts to employment, income, and sales if commercial fishing or tourism-related sport fishing declined from real or perceived spill contamination. There may be adverse health impacts from reduced income, community anxiety about an ocean barge rupture at sea, effects to near shore subsistence, and potential exposure to diesel or diesel fumes. Monitoring overflights could increase the risk of injury or accident related to air transportation.

The extent of impacts of an ocean barge spill that reached shorelines would depend upon the size of the spill and cleanup response times. Impact levels would also depend upon the time of the spill.

Overall, the direct and indirect impacts to the minority and low-income communities of the Y-K region from an ocean barge rupture at sea would be difficult to perceive or measure, but changes in socioeconomic indicators may be slightly outside normal variation and trends if the spill affected local coastal commercial fisheries and subsistence marine resources. Impact intensity would be imperceptible or difficult to perceive or measure for an ocean barge rupture away from the coast, but higher if the ocean barge spill reached the shoreline. The duration of impacts would be such that changes would be expected to return to pre-activity levels after the spill event. Depending upon the size of the spill, the extent or scope of impacts to minority and low-income communities would vary and may affect unique communities throughout the EIS Analysis Area.

Minority and low-income communities would likely not incur disproportionate adverse impacts, and Scenario 1 would not raise an environmental justice concern.

Scenario 2: River Barge Release

Potential spills would likely be small or very small, which would not add employment opportunities. However, a large spill would temporarily create additional employment in the Y-K region. Cleanup activities could cause brief shortages of goods in the Y-K region if cleanup activities disrupt marine and air traffic patterns. Negative employment, income, and sale impacts resulting from commercial and recreation fishing impacts would be similar to those described under Scenario 1 (ocean barge rupture at sea), but would be limited in extent to the Kuskokwim River communities. A large diesel spill could also affect subsistence resources directly and necessitate small adjustments in harvest patterns, but with the potential to have higher intensity impacts of perceived contamination of Kuskokwim River salmon and resident species. There may be adverse health impacts from reduced income, community anxiety about a river barge release, effects to near shore subsistence, and potential exposure to diesel or diesel fumes. Risk of injury or accident related to air and water transportation would also increase.

Intensity of impacts would vary within the context of minority and low-income communities between quickly contained or a low volume spills or high volume river barge release in the Kuskokwim River, If a large volume of diesel was released from a river barge grounding, cleanup activities would temporarily increase employment and expenditures in the Y-K region. Quickly contained or low volume spills would not disproportionately affect minority or low-income communities and Scenario 2 would not raise an environmental justice concern. While a large spill has a low probability of occurrence, adverse impacts from a large diesel release from a barge on the Kuskokwim River would disproportionately impact minority and low-income communities. Subsistence, recreation, and commercial fisheries would be adversely affected, with interrelated subsistence, health, and socioeconomic impacts to the minority and low-income communities along the Kuskokwim River near the release.

Scenario 3: Tank Farm Release

Storage and transfer of diesel fuel would occur in tank farms located in Dutch Harbor, Bethel, Angyaruaq (Jungjuk) Port, and at the Mine Site. Spills would be released into secondary containment structures, and it is unlikely that diesel would be released to the environment. If it did, cleanup response time would determine impacts. A spill quickly contained would have minimal effects to subsistence, health, or socioeconomic resources, but there may be health impacts to communities closest to the tank farms from anxiety over a tank farm release. A tank farm spill would not create additional employment in the Y-K region. In terms of intensity, impacts to low-income and minority communities would be difficult to perceive or measure, and limited to areas within a subregion. Minority and low-income communities would not incur disproportionate adverse impacts, and Spill Scenario 3 would not raise an environmental justice concern. Any actions that would occur at Dutch Harbor or the Port of Bethel at the Bethel Yard Dock are not part of the proposed action, and are considered connected actions (see Section 1.2.1, Connected Actions, in Chapter 1, Project Introduction and Purpose and Need).

Scenario 4: Tanker Truck Release

A tanker truck release would be limited to the vicinity of the spill site and cleanup would be of short duration. A tanker truck release would not create additional employment opportunities in the Y-K region. There may be imperceptible health impacts to communities closest to the tanker trunk from anxiety over a tanker truck release, although a tanker truck release is unlikely to affect subsistence resources. Minority and low-income communities would not incur disproportionate adverse impacts, and Scenario 4 would not raise an environmental justice concern.

Scenario 7: Cyanide Release

It is likely that natural dispersion would be completed by the time cleanup could be initiated, and small, discrete areas would be impacted. If a tank-tainer ruptured and came into contact with water, there would be brief access restriction for areas of 0.1 to 0.9 radii of the spill. The spill could be toxic to aquatic and terrestrial animals, but sodium cyanide has a low persistence in the environment and does not enter a cycle of food chain bioaccumulation. There could be perceptions of contamination of subsistence foods throughout the EIS Analysis Area. Cyanide gas is highly toxic to humans, and could build up in the enclosed spaces of the port storage and mine processing areas; but steps would be taken to ensure there was ventilation in enclosed spaces. Cleanup and remediation activities following a sodium cyanide release would not result in increased employment opportunities in the Y-K region. In terms of intensity, impacts to socioeconomic resources would be difficult to perceive or measure. Impacts to subsistence resources would vary and may necessitate large-scale changes affecting high productivity resources or harvest practices through multiple seasons of the year, in the immediate vicinity of the spill. A similar level of intensity would occur to human health in the immediate vicinity of the spill. Although there would be impacts to minority and low-income communities, minority and low-income communities would not incur disproportionate adverse impacts, and Scenario 7 would not raise an environmental justice concern.

Scenario 8: Mercury Release

In the event of a mercury release, some mercury would be emitted as highly toxic gaseous mercury. This could affect terrestrial mammals harvested by subsistence hunters, but there are likely to be few animals in the area with mining activities and human presence. If spilled mercury escapes cleanup efforts, it would be subject to natural methylation processes and would add incrementally to the mercury levels in background and air depositions, and bioaccumulate in fish and fish-eating animals. There could also be perceptions of subsistence foods contamination throughout the EIS Analysis Area. Bioaccumulation could have human health effects from consumption of fish and animals containing elevated mercury levels and community anxiety over the safety of subsistence foods. Mercury could briefly impact groundwater and air quality in the immediate vicinity of the spill. It is unlikely that cleanup and remediation activities following a mercury release would result in increased employment opportunities in the Y-K region, and declines in employment, income, and sales caused by a disruption of commercial and recreational fishing and/or tourism would likely be low.

In terms of intensity, impacts to socioeconomic resources would be difficult to perceive or measure. Impacts to health resources would vary in intensity and could result in illness or injury patterns that may require intervention. Impacts to subsistence resources would also vary and changes may necessitate large-scale changes affecting high productivity resources or harvest practices through multiple seasons of the year.

Quickly contained or low volume mercury spills would not disproportionately affect minority or low-income communities, and Scenario 8 would not raise an environmental justice concern. While a large spill has a low probability of occurrence, adverse impacts from a large mercury release would disproportionately impact minority and low-income communities. Subsistence, recreation, and commercial fisheries would be adversely affected, with interrelated subsistence, health, and socioeconomic impacts to the minority and low-income communities along the Kuskokwim River near the release.

Scenario 9: Partial Tailings Dam Failure

The TSF dam is considered a Hazard Class I by ADNR, implicating a probable loss of one or more lives if a dam breach occurred. There could be local bans on drinking water if contaminated by a tailings dam failure. A tailings release in winter could impede snowmachine travel by subsistence hunters from Crooked Creek. The cleanup and remediation activities following a tailings dam failure in which a large volume of water, or water and tailings, is released into the environment would temporarily increase employment opportunities and expenditures in the Y-K region. Labor requirements would be especially high if mechanical recovery and physical removal were part of the remediation effort, such as in the case of a tailings and water release in winter. There could be declines in employment, income, and sales from commercial and recreational fishing and/or tourism if impacted by real or perceived impacts of the spill.

The intensity of impacts would depend upon the season, and whether a release was only water, or both water and tailings. Greater intensity impacts would occur during summer as tailings could be mobilized to a larger area by waterways, and it would be more difficult to move remediation equipment into the area. Duration of impacts would likely be such that changes would be expected to return to pre-activity levels after actions causing impacts were to cease.

Impacts would be limited to the area of the release, with perceived contamination of subsistence foods throughout the EIS Analysis Area.

Quickly contained or very small partial tailings dam failures would not disproportionately affect minority or low-income communities and Scenario 9 would not raise an environmental justice concern. While a large volume tailings dam failure has a low probability of occurrence, adverse impacts from the spill event would disproportionately impact minority and low-income communities. There would be interrelated subsistence, health, and socioeconomic impacts to the minority and low-income communities along the Kuskokwim River near the tailings dam.

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

Under Alternative 3A, Scenario 5 (diesel pipeline release) is not applicable and has not been analyzed for effects to minority or low-income communities. The likelihood of Scenarios 1 through 4 (ocean or river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Impacts under Scenarios 7 through 9 (cyanide, mercury, and tailings releases) for Alternative 3A would be the same as those discussed under Alternative 2.

Scenario 6: Liquefied Natural Gas (LNG) Release

If released, LNG would transition back to a gaseous phase when contacting warmer air, soil, or water (California Energy Commission 2014). Air emissions would primarily consist of methane, which is not known to have serious health impacts except in confined spaces as it can act as an asphyxiant. There may be community anxiety from an LNG release that may have health impacts because of the known risks in confined spaces. A release of LNG and the transition to gaseous phases are not expected to occur in a confined space. Methane is a potent GHG, but is unlikely to directly affect health-related impacts. It is unlikely that cleanup and remediation activities following an LNG release would result in increased employment opportunities in the Y-K region.

Intensity of impacts would be community anxiety from an LNG release on human health impacts. Impacts would be limited to the vicinity of the spill site and such that changes to human health would be expected to return to pre-activity levels after the spill. In context, minority and low-income communities would not incur disproportionate adverse impacts, and Spill Scenario 6 would not raise an environmental justice concern.

3.24.6.19.3 ALTERNATIVE 3B – REDUCED DIESEL BARGING: DIESEL PIPELINE

Under Alternative 3B, Scenario 6 (LNG release) is not applicable and has not been analyzed for effects to minority or low-income communities. Impacts under Scenarios 1 and 2 (ocean or river barge releases) would be shifted relative to Alternative 2, and the likelihood of Scenarios 3 and 4 (tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Scenarios 7, 8, and 9 (cyanide, mercury, and tailings releases) would have the same impacts on minority or low-income communities as Alternative 2.

Scenario 5: Diesel Pipeline Release

Potential spills would create additional employment if a large volume of diesel were released. Subsistence resources would be unlikely to be impacted. Human health impacts may be possible if drinking water supplies were impacted.

In context, impacts to minority or low-income communities would be unlikely to occur, and impacts would be limited to the vicinity of the spill site and such that changes to communities would be expected to return to previous levels after the spill. Minority and low-income communities would not incur disproportionate adverse impacts, and Spill Scenario 5 would not raise an environmental justice concern.

3.24.6.19.4 ALTERNATIVE 4 – BIRCH TREE CROSSING (BTC) PORT

Under Alternative 4, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to minority or low-income communities.

Under Alternative 4, the probability for a river barge release would be reduced, and the probability of a tanker truck release would be increased. Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 4 would be the same as those discussed under Alternative 2.

3.24.6.19.5 ALTERNATIVE 5A – DRY STACK TAILINGS

Under Alternative 5A, Scenarios 5, 6, and 9 (diesel pipeline, LNG, and water and tailings releases) are not applicable and have not been analyzed for impacts to minority or low-income communities.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and water only tailings releases) for Alternative 5A would be the same as those discussed under Alternative 2.

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

Under Alternative 6A, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to minority or low-income communities.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 6A would be the same as those discussed under Alternative 2.

3.24.6.20 CULTURAL RESOURCES

A programmatic agreement is currently under development with consultation among Donlin Gold, the Corps, BLM, the Advisory Council on Historic Preservation, Alaska State Historical Preservation Officer, and tribal representatives and will likely include protection of historic properties during emergency response under the National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR Section Part 300) (Advisory Council on Historic Preservation 2014).

3.24.6.20.1 ALTERNATIVE 2 – DONLIN GOLD'S PROPOSED ACTION

Under Alternative 2, two spill scenarios do not apply and are not analyzed for impacts to cultural resources. These include Scenario 5 (diesel pipeline release) and Scenario 6 (LNG release).

Scenario 1: Ocean Barge Rupture at Sea

Depending on the location of the spill and prevailing weather conditions at the time of the spill, the intensity impacts to cultural resources potentially located along shorelines would vary. Impacts would range in intensity from undetectable changes in integrity, to measurable changes in integrity but not sufficient enough to affect NRHP eligibility. Impacts to cultural resources from spilled diesel fuel could include contamination of organic cultural materials and site sediments. If ground-disturbing cleanup activities were to occur within the bounds of cultural resource areas, direct impacts would be of higher intensity and resources would not be anticipated to return to previous levels even after actions that caused the impacts were to cease. The extent or scope of impacts would be limited to discrete portions of the EIS Analysis Area that are considered rare in context. Any clean-up that could impact cultural resources would likely require a mitigation plan to limit those impacts. The probability of an ocean barge rupture requiring ground disturbance cleanup within the bounds of cultural resource sites is very low. If the spill occurred outside of cultural resource areas, there would be expected to be no impacts to cultural resources.

Scenario 2: River Barge Release

Although considered a very low probability event, a river barge grounding spill scenario would impact cultural resources if a response effort occurred near culture resources areas. Depending upon the location, release of diesel fuel from up to two barge compartments could potentially result in direct impacts to cultural resources through loss of integrity for eligibility to the NRHP. Impacts to cultural resources from spilled diesel fuel could include contamination of organic cultural materials and site sediments. While diesel fuel evaporates and disperses much more quickly than crude oil, there would be impacts from cleanup activities along the shoreline of the Kuskokwim River in close proximity to traditional use areas with potential to contain cultural resources. Because of the confined river channel, diesel would likely be evident on shorelines adjoining known cultural sites. In terms of context, the direct impacts of a diesel spill from the grounding of a river barge would affect sites and villages along the Kuskokwim River. The duration of impacts would vary and resources may not be anticipated to return to previous levels even after actions that caused the impacts were to cease, if intensive ground-disturbing activities occur within the boundaries of cultural resource sites. The probability of ground-disturbing cleanup activities occurring at cultural resource sites is low due to dispersed geographical distribution of sites along the river, if it were to occur. If the spill occurred outside of cultural resource areas, there would be expected to be no impacts to cultural resources.

Scenario 3: Tank Farm Release

In the event of a large volume spill scenario (possibly one million gallons or more) from a catastrophic tank failure, the entire volume of the tank contents would be released to a secondary containment, with 100 percent recovery, minus any loss to evaporation. No direct or indirect effects to cultural resources would result from this scenario.

Scenario 4: Tanker Truck Release

Direct impacts to cultural resources from a potential medium to large volume spill (up to 13,500 gallons) resulting from a tanker truck rollover or major collision and release of entire contents of the tanker truck to the surrounding environment would impact cultural resources if such a release would occur within the bounds of a cultural resource site. Impacts to cultural resources from spilled diesel fuel could include contamination of organic cultural materials and site sediments. The probability of this occurrence would be very low; however, such an event would likely result in direct impacts through loss of integrity for eligibility to the NRHP from cleanup activities. These impacts would likely severely damage the site and resources would not be anticipated to return to previous levels even after actions that caused the impacts were to cease. The extent or scope of impacts would be limited to discrete portions of the EIS Analysis Area. There would be a very low probability of a tanker truck release within the bounds of a cultural resource site. No impacts would occur to cultural resources in the event of a tanker truck spill outside the area of a cultural resource site.

Scenario 7: Cyanide Release

In the unlikely event of a sodium cyanide release at a cultural resource site, direct and indirect effects to cultural resources are expected to be minimal and likely would entail limited site disturbance during cleanup activities.

The intensity of negative impacts on cultural resources caused by spill cleanup in the immediate area of the spill would likely not result in detectable changes in integrity. The direct effects would likely be confined to a small area and would likely not involve cultural resources. The effects on cultural resources would be considered unlikely to occur due to the limited extent of potential releases and short duration cleanup operations.

Scenario 8: Mercury Release

In the unlikely event of a mercury release at a cultural resource site, direct and indirect effects to cultural resources are expected to be minimal and likely would entail limited site disturbance during cleanup activities.

The intensity of negative impacts on cultural resources caused by spill cleanup in the immediate area of the spill would likely not result in detectable changes in integrity. The direct effects would likely be confined to a small area and would likely not involve cultural resources. The effects on cultural resources would be considered to be unlikely to occur due to the limited extent of potential releases and short duration cleanup operations.

Scenario 9: Partial Tailings Dam Failure

A partial tailings dam failure spill scenario would impact cultural resources if water or tailings were carried to a cultural resource site, or response efforts with ground-disturbing activities occurred near cultural resources. The spill scenario could affect sites near the Mine Site and potentially along the Kuskokwim River, and resources may not be anticipated to return to previous levels even after actions that caused the impacts were to cease. The probability of ground-disturbing cleanup activities occurring at cultural resource sites is low due to the dispersed geographical distribution of sites downstream of the tailings dam. Impacts would occur in a discrete geographic area, but could affect rare cultural resources within the region. Clean-up activities would likely require a mitigation plan to limit those impacts and would occur in accord with the Programmatic Agreement. (Note: It is not possible to identify specific cultural resources that could be affected by a potential partial tailings dam failure.) The probability of partial tailings dam failure requiring ground disturbance cleanup within the bounds of cultural resource sites is very low. If the failure occurred outside of cultural resource areas, there could be no impacts to cultural resources.

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

Under Alternative 3A, Scenario 5 (diesel pipeline release) is not applicable and has not been analyzed for impacts to cultural resources. The likelihood of Scenarios 1 through 4 (ocean or river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Impacts under Scenarios 7 through 9 (cyanide, mercury, and tailings releases) for Alternative 3A would be the same as those discussed under Alternative 2.

Scenario 6: Liquefied Natural Gas (LNG) Release

The likelihood that an LNG release would occur within the bounds of a cultural resource site would be extremely low. LNG dissipates rapidly into the atmosphere, so there is no liquid spill to clean up. If there were a source to ignite the released LNG before it disperses, then there could be an explosion and fire. This would most likely be confined to the vicinity of the LNG storage tank and truck fueling station. Since these are intensive industrial sites, there is little risk of damage to cultural resources adjacent to or in the vicinity of the Mine Site. An LNG spill is unlikely, and the risk of impacts to cultural resources is very low.

3.24.6.20.3 ALTERNATIVE 3B – REDUCED DIESEL BARGING: DIESEL PIPELINE

Under Alternative 3B, Scenario 6 (LNG Release) is not applicable and has not been analyzed for effects to cultural resources. Impacts under Scenarios 1 and 2 (ocean or river barge releases) would be shifted relative to Alternative 2, and the likelihood of Scenarios 3 and 4 (tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Scenarios 7 through 9 (cyanide, mercury, and tailings releases) would have the same impacts to cultural resources as Alternative 2.

Scenario 5 Diesel Pipeline Release

Under Alternative 3B, impacts from a diesel pipeline release to cultural resources would be dependent upon the location of the release, the proximity of cultural resources, and the extent of cleanup activities. While diesel fuel generally evaporates rapidly, it also quickly penetrates porous soils. In the event that such a release occurred within or adjacent to a cultural resource site, direct and indirect impacts to the site would likely result in loss of integrity to the NRHP (resulting from the potential for fire, as well as ground disturbance during extensive cleanup activities). The duration of impacts would be such that resources would not be anticipated to return to previous levels even after actions that caused the impacts were to cease. The extent and context of impacts would be related to the number and significance of affected resources; a release that impacted multiple sites could affect resources throughout the EIS Analysis Area In terms of context, impacts could affect eligibility for the National Register of Historic Places. In addition, the proposed pipeline corridor is collocated or adjacent (within 1,000 feet) to the INHT for approximately 22.9 miles, between MP 50 and MP 106. For these portions of the pipeline, a diesel fuel release and the subsequent cleanup activities would likely result in direct impacts to the resource. The potential for indirect effects is also present, as subsequent fire and spill response activities would result in visual impacts to the trail's setting through the life of the project (see Visual Resources in Section 3.24.6.17). The likelihood of a diesel release from the pipeline would be low in probability.

3.24.6.20.4 ALTERNATIVE 4 – BIRCH TREE CROSSING PORT

Under Alternative 4, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to cultural resources. The likelihood of Scenarios 2 and 3 (river barge and tank farm release) occurring would be greatly reduced and the likelihood of Scenario 4 (tanker truck release) would be increased; however, the impacts of either would be the same types as discussed under Alternative 2. Impacts under Scenarios 1, 7, and 8 (ocean barge, cyanide, and mercury releases) for Alternative 4 would be the same as those discussed under Alternative 2.

3.24.6.20.5 ALTERNATIVE 5A– DRY STACK TAILINGS

Impacts under Scenarios 1 through 4, and 7 and 8 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and water only tailings releases) for Alternative 5A would be the same as those discussed under Alternative 2.

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

Under Alternative 6A, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG Release) are not applicable and have not been analyzed for impacts to cultural resources.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 6A would be the same as those discussed under Alternative 2.

3.24.6.21 SUBSISTENCE

A potential spill of fuel or other toxic substances would directly affect subsistence resources and may displace access to those resources. Spills would indirectly affect competition for those resources, since reduced abundance and availability of affected resource might have to serve the needs or a constant-sized user group. Socio-cultural impacts to subsistence would be the same as described for Alternative 2. For this reason, the analysis of spill scenarios will focus on the effects to subsistence resources.

An important indirect effect on subsistence uses due to a spill is highlighted in research conducted after the Exxon Valdez oil spill which showed that people's perception of risk regarding the contamination of subsistence resources had an effect on whether they trusted that those resources were safe to eat. The perception that resources were unsafe to eat had an effect on overall harvests.

Local people have expertise assessing the safety of subsistence foods if there are observable irregularities in the animal, fish, or plant. Invisible contamination cannot be easily assessed, which creates uncertainty and anxiety. Even a perception of contamination can have an effect on subsistence harvests. During the Exxon Valdez oil spill, local people could see the oil but they had no way of assessing whether the animals, fish, and plants they depended on for subsistence were safe to eat. Initially, locals assumed they were not safe to eat and the year after the oil spill, subsistence harvests dropped by 77 percent in some communities.

> The primary reason that interviewed households gave for reductions in subsistence harvests was concern that resources had been contaminated by the oil. The concern undermined people's confidence in their own abilities to discern if foods were safe to eat using traditional knowledge… Subsistence harvests and uses rebounded the second and third post spill year… [But]…concerns about the long-term health risks associated with subsistence foods, as well as concerns about spill effects on the resource populations upon which subsistence uses depend, persisted (Fall et al. 2001).

To alleviate people's concerns about contamination, two things are important: first is quick response and containment of any spill, especially a spill in water; and second, is a system for testing wild foods for contaminants that would provide local people with complete and understandable information in a timely manner.

> From the perspective of risk communication, two key themes stand out. The first is the importance of a collaborative, multidisciplinary approach from the earliest stages of response. The second is the necessity of an effective, interactive communication process that develops a credible message and delivers it well and is flexible and reflexive enough to adapt as its audience responds. Crosscutting both of these themes is the importance of sound science, local knowledge, and observations, a public process above suspicion, and sensitivity to the cultural context in which issues are defined and the message is received. These lessons must be applied to each stage of the process, from contingency planning, to spill response, to long-term restoration (Fall et al. 2001).

Overall, the specific behavior and fate of toxic substances potentially released (i.e., diesel fuel and LNG) from the Donlin Gold Project are different from crude oil in the Exxon Valdez example. The impacts to subsistence resources as a result of an ocean barge rupture, river barge release, or tank farm release, would depend upon the extent and duration of the spill, weather conditions, and the speed of the response. In the case of a large scale spill, assessing risks and providing timely information regarding food safety would be of critical importance.

3.24.6.21.1 ALTERNATIVE 2 – DONLIN GOLD'S PROPOSED ACTION

Under the proposed action, two spill scenarios do not apply and are not analyzed for subsistence impact. These include Scenario 5 (diesel pipeline release) and Scenario 6 (LNG release).

Scenario 1: Ocean Barge Rupture at Sea

The ocean barges proposed under Alternative 2 generally travel in areas far from shore where little to no subsistence activities occur. Within the Project Area, subsistence activities largely take place close to shore and in areas where there would be minimal interaction with ocean barges or a potential fuel spill, based on normal transit routes.

In the event of a diesel spill at sea, there would be little to no opportunity to recover the product before dispersal. In this scenario, approximately 367,500 gallons would reach the shore. While dispersal and evaporation would take three to five days, it could have the potential to affect hundreds of miles of shoreline and could affect near shore subsistence activities. If the cleanup response is rapid and oil does not reach or affect animals or plants, the impact on subsistence uses would persist only briefly (less than four years) and necessitate only small adjustments in harvest patterns. The extent of the effects would be limited to the immediate area of the spill. In terms of context, impacts would affect harvest of locally abundant subsistence resources. However, as the size of the spill increases and response time lags, the intensity of impacts would increase. The indirect effect of perceived contamination might be seen as contaminating salmon runs in the event of a spill in the mouth of the Kuskokwim River.

Scenario 2: River Barge Release

Potential spills would most likely be small or very small and would likely be contained and/or disperse and evaporate fairly quickly. Such an event would also undermine people's confidence in the safety of the resource. Research shows that concerns persist long after the spill event; for this reason response times are critical.

If a spill were quickly contained, there would be minimal effects on subsistence resources or people's confidence in the resource. Access to subsistence resources would not be affected in the scenario of a rapid containment. In terms of intensity, the direct impacts on subsistence resources from a river barge release in the Kuskokwim River would disturb or displace access to less than 10 percent (if measurable) of the subsistence use area for generally abundant resources. The extent or scope of effects would be limited to the immediate area of the spill, and changes would be expected to return to pre-activity levels after the spill. In terms of context, the impact would affect abundant subsistence resources, except for migratory waterfowl and Chinook salmon which are protected under the Migratory Bird Treaty Act or urgent conservation measures in recent years. The indirect effect of perceived contamination would be seen as contaminating salmon and resident species in the event of a fuel barge spill in the Kuskokwim River.

Scenario 3: Tank Farm Release

Storage of diesel fuel would occur in tank farms located in Dutch Harbor, Bethel, Angyaruaq (Jungjuk) Port, and at the Mine Site. Only in the extremely unlikely event of simultaneous failure of the secondary containment structure and a tank or multiple tanks, would diesel be released to the surrounding environment. Under such circumstances, the same conditions as in previous scenarios apply: if the spill is quickly contained, there would be minimal effect on subsistence resources or people's confidence in the resource. The extent of effects would be limited to the immediate area of the spill. In terms of context, impacts would affect abundant subsistence resources. Access to subsistence resources would not be affected. Any actions that would occur at Dutch Harbor or the Port of Bethel at the Bethel Yard Dock are not part of the proposed action, and are considered connected actions (see Section 1.2.1, Connected Actions, in Chapter 1, Project Introduction and Purpose and Need).

Scenario 4: Tanker Truck Release

Fuel spills resulting from a tanker truck incident are unlikely to affect subsistence resources. Tanker truck spills would most likely occur on land, would be of small volume, and the on-board spill response kits would be utilized to minimize potential impacts. The intensity of effects from a tanker truck fuel spill would be the same as described for Scenarios 1 and 2. The duration, extent, and context would be the same as described above for Scenario 1.

Scenario 7: Cyanide Release

If tank-tainers lost overboard were retrieved and were not ruptured, there would be no effect on subsistence resources.

In the event of a tank-tainer spill at a storage site or at the Mine Site, the resultant spill would be contained, as the tank-tainer would be located in an area that includes secondary containment. There would be no effect on subsistence resources.

If a truck carrying cyanide tank-tainers had an accident on the road, a tank-tainer rupture could result. If the spilled cyanide briquettes spilled on dry ground, there would be no effect on subsistence resources. If the sodium cyanide came into contact with water, it would dissolve and the resulting hydrogen cyanide would be highly toxic to aquatic wildlife or animals drinking it. Even a spill in a puddle or rain could release toxic cyanide gas. Initial isolation of the spill site from unprotected people or animals would be 0.1 mile for a small spill or 0.2 mile for a larger spill, and the downwind protection zone would be 0.1 to 0.2 mile for daytime or 0.2 to 0.9 mile for night. If the cyanide came into contact with water, then both aquatic and terrestrial mammals could be adversely affected. Although cyanide reacts readily in the environment and degrades or forms complexes and salts of varying stabilities, it is toxic to many living organisms used for subsistence at very low concentrations. Cyanide has low persistence in the environment and is not reported to be accumulated or stored in any mammals and therefore there is no reported biomagnification of cyanide in the food chain. The intensity of impacts from a truck-based cyanide release that came into contact with water would vary and may be acute and/or obvious. Changes to subsistence resources would be expected to return to pre-activity levels after the spill event. The extent or scope of impacts would be realized by communities within a subregion, and affect abundant subsistence resources. However, there may be indirect effects of perceived contamination of subsistence food resources that would be realized by communities across subregions or throughout the EIS Analysis Area.

Scenario 8: Mercury Release

This scenario summarizes the potential spill or release causes and potential impacts that might result directly or indirectly from the transportation and storage of mercury. In the unlikely event that the cargo is lost overboard a mercury spill could only result if the containers ruptured. Without a rupture, there would be no impact on subsistence resources.

In the unlikely event that there was a mercury spill in the storage areas either the liquid mercury or the spent carbon would be released from the containers. The liquid elemental mercury would collect in the secondary containment. Spilled mercury would be recovered and managed appropriately. There would be no effects on subsistence resources.

A low probability potential spill scenario may result from truck transportation of mercury containers to Angyaruaq (Jungjuk) Port. In the unlikely event that there is a truck accident and the containers ruptured, a mercury spill (either the liquid mercury or the spent carbon) could result. The liquid elemental mercury and the spent carbon could be released to the land or surface water.

If elemental mercury is spilled, some of it would be emitted as gaseous mercury, which could be highly toxic to animals. However, with all the expected activity at the site of an accident and cleanup, few, if any, terrestrial mammals would be expected to be exposed. If spilled mercury escapes cleanup efforts, it would be subject to natural methylation processes and would add incrementally to the mercury levels in background and air depositions, thus increasing the chronic exposure of aquatic biota and fish and, since it bioaccumulated, it would also increase exposure to fish-eating animals. The intensity of direct effects of a truck-based mercury release would vary and may be acute and/or obvious. Changes to subsistence resources would be expected to return to pre-activity levels after the spill event. The extent or scope of impacts would be realized by communities within a subregion, and affect abundant subsistence resources. The indirect effect of perceived contamination would be acute and/or obvious, particularly in light of widespread concern in the Kuskokwim River villages about mercury contamination from the historic Red Devil Mine.

Scenario 9: Partial Tailings Dam Failure

The estimate of impacts to subsistence from a partial tailings dam failure scenario is based on the overlap of subsistence uses areas by EIS Analysis Area villages, by season, and the area affected by the spill scenarios. Specific impacts to subsistence activities would depend upon the spill volume and content (water and tailings versus water only), the season, the time for dispersal before spill response, and the effectiveness of the response and cleanup. In addition to potential direct impacts, in which subsistence activities would be displaced by a spilled materials and spill response activities, the potential perception that subsistence resources are contaminated is also important, as noted in Section 3.24.6.21 above.

In a summer spill event of tailings and contaminated water, the material would transit Anaconda Creek, and deposit an estimated 1,300 acre-feet of tailings in Crooked Creek. In summer, subsistence uses of the Crooked Creek drainage are very limited because the creek is shallow and sinuous, and not conducive to boat access. Most summertime subsistence fishing occurs in the Kuskokwim River rather than in this tributary. Berries are taken in late summer and fall in the lower reaches of the Crooked Creek Drainage, and bear hunting, likely in spring, occurs in the drainage up to about Crevice Creek.

The intensity of direct displacement in the summer tailings and contaminated water event would disturb or displace access to portions less than 10 percent (if measurable) of the subsistence use area for generally abundant species. However, any spill of hazardous materials into Crooked Creek would raise concerns among subsistence users about contamination of fish in Crooked Creek and beyond, including salmon returning to spawn in the drainage, and resident species. In this case, the intensity of this indirect impact to subsistence activities would be higher, based on the spill scenario volume.

In a summer spill event of water only, the released material would reach the Kuskokwim River; but the transit of Crooked Creek would be slowed by the wide floodplain, and the release is modeled to be 1 foot or less at the confluence of Crooked Creek and the Kuskokwim River. The spill material would represent approximately 1.8 percent of the flow in the Kuskokwim River during May through October. The greatest effect would be perceived contamination of subsistence fish resources, and this would likely extend to subsistence fishing communities all the way up and down the Kuskokwim River.

The winter spill event scenarios, for both tailings and contaminated water, and for contaminated water only, would directly affect winter subsistence uses in Crooked Creek and in the Kuskokwim River near the confluence with Crooked Creek. Subsistence users from Crooked Creek access the drainage in winter, traveling by snow machine for trapping and for bear in spring. A spill event would impede this access, and hunters would probably go to other areas. The greatest effect would be the indirect impact of perceived contamination of subsistence resources, near the spill event, but also affecting confidence in any subsistence resources that pass through the spill zone. This may include resident fish species used by many communities. As a result, the impacts would be acute or obvious/abrupt and extend across subregions or throughout the EIS Analysis Area.

Taken together, the various partial tailings dam failure scenarios have discrete direct effects, but the indirect effects of perceived contamination of subsistence foods would be acute or obvious/abrupt and extend across subregions or throughout the EIS Analysis Area. The duration of perceived contamination would likely extend through one to three years for most subsistence fishers, and the context includes resources that are highly valued or of high cultural importance. Valued resources affected include Essential Fish Habitat and the Kuskokwim River Chinook salmon stock, while the subsistence harvest practices of the affected villages are of high cultural importance.

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

Under Alternative 3A, Scenario 5 (diesel pipeline release) is not applicable, and has not been analyzed for effects to subsistence. The likelihood of Scenarios 1 through 4 (ocean or river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be of the same types as discussed under Alternative 2. Impacts under Scenarios 7 through 9 (cyanide, mercury, and tailings releases) for Alternative 3A would be the same as those discussed under Alternative 2.

Scenario 6: Liquefied Natural Gas (LNG) Release

LNG spills could be small (pinhole leaks from the storage tanks or spills while fueling the LNG-fueled trucks), or larger (LNG-fueled truck accident or unlikely rupture of LNG plant storage tank). If released, LNG would transition back to a gaseous phase (California Energy Commission 2014). If a large amount of LNG is spilled on water within a short period of time, the relatively warmer temperature of the water would cause the LNG to rapidly transition to its gaseous phase.

It is unlikely that subsistence resources would be affected by an accidental release of LNG. The extent of effects would be limited to the immediate area of the spill. There is no particular context for impacts. Access to subsistence resources would not be affected.

3.24.6.21.3 ALTERNATIVE 3B – REDUCED DIESEL BARGING: DIESEL PIPELINE

Under Alternative 3B, Scenario 6 (LNG release) is not applicable and has not been analyzed for effects to subsistence. The likelihood of Scenarios 2 through 4 (river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be of the same types as discussed under Alternative 2. Scenarios 7 through 9 (cyanide, mercury, and tailings releases) would have the same impacts on subsistence as Alternative 2.

Once the diesel pipeline is installed, the spill risks associated with ocean barging (Scenario 1) and River Barging (Scenario 2) would be eliminated. Spill risks associated with diesel fuel tank farm storage and tanker trucks would be drastically reduced. However, this alternative introduces additional spill risks associated with the transportation of fuel along the pipeline corridor. Diesel fuel shipments would be routed to Tyonek, and a pipeline segment would run from Tyonek to Beluga. This section discusses the spill risks associated with diesel pipeline transportation.

Scenario 1: Ocean Barge Rupture at Sea

Under this alternative, a diesel pipeline from Tyonek to the Mine Site would eliminate diesel fuel barging up the Kuskokwim River during the Operations and Closure Phases. An initial supply of diesel fuel for the Construction Phase would need to be barged to the Mine Site; however, during Construction, the risk of an ocean barge rupture along the Western Alaska delivery route from Dutch Harbor to Bethel and to Angyaruaq (Jungjuk) would be very low due to drastically reduced volume. If a spill were to occur, the resulting effects or changes in subsistence resources, uses, and needs would be similar to those discussed under Alternative 2.

During the Operations and Closure phases, diesel fuel would be delivered by ocean-going vessel to a fuel dock at Tyonek, resulting in an increased spill risk from ocean barge rupture in Cook Inlet. Diesel fuel spills could occur if a tanker ran aground or was otherwise compromised; however, only one or two barge compartments would be expected to fail. This scenario is considered unlikely. In the event of such an occurrence, the direct impacts would be as described above under Alternative 2 and would depend on the size of the spill, wind and weather, the extent of dispersion, cleanup response time, and time of year. If a spill occurred during the summer salmon runs, the intensity would vary and may be acute or obvious/abrupt. The duration and extent would depend on the breadth of the spill and the area over which it dispersed. In the event of small spills, the intensity would be lower, changes to subsistence would be expected to return to pre-activity levels after the spill, and impacts would be limited to communities within a subregion. The context is such that legislative protection exists for all marine mammals under the MMPA. As with other spill scenarios, the indirect effect of perceived contamination from a diesel fuel barge spill would be of higher in intensity and extend across subregions or throughout the EIS Analysis Area.

Scenario 5: Diesel Pipeline Release

Spills from the proposed pipeline, associated pump stations, valves, or pigging facilities could occur during project operation. A spill on land would have less of an impact than a spill in water since spills in water could potentially have a wider footprint and affect various fish species that are important subsistence resources for many communities. If the spill reached a river at a pipeline crossing, the effects of the spill would be much like a river barge spill. The pipeline crosses several streams that are habitat for spawning salmon and some non-salmon species. To minimize disturbance during Construction and risks during Operations, Horizontal Directional Drilling would be used at some of the main anadromous stream crossings, including the Kuskokwim River and the branches of the George River.

A spill of this scale could result in major to catastrophic impacts to waterbodies, wetlands and vegetation, birds, fisheries, and subsistence uses. Indirect impacts of perceived contamination would occur, and extend to communities across subregions or throughout the EIS Analysis Area.

3.24.6.21.4 ALTERNATIVE 4 – BIRCH TREE CROSSING (BTC) PORT

Under Alternative 4, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to subsistence. The likelihood of Scenario 2 (river barge release) occurring would be greatly reduced due to shorter barge distances; however, the impacts would be of the same types as discussed under Alternative 2. Impacts under Scenarios 1, 3, 4, 7 through 9 (ocean barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 4 would be the same as those discussed under Alternative 2.

3.24.6.21.5 ALTERNATIVE 5A – DRY STACK TAILINGS

Under Alternative 5A, Scenarios 5, 6, and 9 (diesel pipeline, LNG, and water and tailings releases) are not applicable and have not been analyzed for impacts to subsistence.

Direct and indirect impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and water only tailings releases) for Alternative 5A would be the same as those discussed under Alternative 2.

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

Under Alternative 6A, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to subsistence.

Direct and indirect impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 6A would be the same as those discussed under Alternative 2.

3.24.6.22 HUMAN HEALTH

A spill of fuel or other toxic substance could cause stress to community members in close proximity from real or perceived risks of contamination, and potentially impact human health. Invisible contamination cannot be easily determined, which creates anxiety about the safety of subsistence foods and water quality. Quick response and containment of spills (particularly for spills in water) and a system of testing wild foods and drinking water for contaminants to give local people complete and understandable information in a timely manner could help alleviate some anxiety and reduce potential impacts to human health.

3.24.6.22.1 ALTERNATIVE 2 – DONLIN GOLD’S PROPOSED ACTION

Scenario 1: Ocean Barge Rupture at Sea

The ocean barges proposed under Alternative 2 generally travel in areas far from shore where little to no subsistence activities occur. However, if a large diesel spill occurred near the shore it could affect hundreds of miles of coastline and impact near shore subsistence activities. If diesel fuel came ashore, an ocean barge rupture at sea has potential to affect shallow groundwater resources in shoreline zones directly contacted by seawater. Although difficult to predict with certainty, air quality impacts would not be likely to occur. The impact intensity would depend on the spill volume and spill response times.

It is unlikely that an ocean barge rupture at sea would result in increased employment or income opportunities in the Y-K region as response efforts would be limited to overflights to observe the dispersal of the diesel. There would be short-term (1-12 months) adverse impacts on employment, income, and sales if commercial fishing or sport fishing and related tourism were to decline due to the real or perceived impacts of a spill.

There are potential adverse impacts to social determinants of health (Health Effects Criteria [HEC] 1) with psychosocial stress resulting from community anxiety over an ocean barge rupture at sea. An ocean barge rupture release may involve a vessel accident or injury, and monitoring overflights could increase the risk of injury or accident related to air transportation (HEC 2). There could be potential diesel or diesel fume exposure (HEC 3), and impacts to near shore subsistence (HEC 4). Human health impacts would be short-term (1-12 months) and limited to the vicinity of the spill area. Impacts would result in risks of illness or injury patterns if little to no diesel reached shoreline, but would increase in intensity as volume of diesel spilled and amount reaching the shoreline increased.

Scenario 2: River Barge Release

A river barge release would likely be small or very small, and if contained quickly, would limit impact to subsistence resources. Although difficult to predict with certainty, air quality impacts would not be likely to occur. The cleanup and remediation activities following a river barge grounding in which a large volume of diesel is released into the environment would temporarily increase employment opportunities and expenditures in the Y-K region. Labor requirements would be especially high in the event of mechanical recovery and physical removal efforts. Employment associated with cleanup and recovery operations would be of short duration due to the rapid recovery or dispersion of the spilled diesel. No employment opportunities would be created by smaller spills. There would be brief adverse impacts on employment, income, and sales if commercial fishing or sport fishing and related tourism were to decline due to the real or perceived impacts of a spill.

There are potential adverse impacts to social determinants of health (HEC 1) with psychosocial stress resulting from community anxiety over a river barge release. A river barge release may involve a vessel accident or injury, and the remediation effort could increase the risk of injury or accident related to air and vessel transportation (HEC 2). There could be potential diesel or diesel fume exposure (HEC 3), and impacts to subsistence (HEC 4). Human health impacts would be short-term (1-12 months) with limited impact to households. Impacts would vary for small spills and spills that that reach a limited length of river bank, but would increase as volume of released diesel increases and larger stretches of riverbank are impacted. Health impacts would be similar to those discussed under Scenario 1 (ocean barge rupture at sea), but would be focused towards the Kuskokwim River communities.

Scenario 3: Tank Farm Release

A tank farm release from a failure of a diesel storage tank in Dutch Harbor, Bethel, Angyaruaq (Jungjuk) Port, or at the Mine Site into secondary containment would have very little evaporation release due to the limited surface area. If a tank farm release occurred in cold weather, the lower temperatures would further reduce the evaporation rate and VOC emissions. A tank farm spill would not create additional employment in the Y-K region related to cleanup activities, and there would not be additional transportation to aid the response effort. Any actions that would occur at Dutch Harbor or the Port of Bethel at the Bethel Yard Dock are not part of the proposed action, and are considered connected actions (see Section 1.2.1, Connected Actions, in Chapter 1, Project Introduction and Purpose and Need).

There are potential adverse impacts to social determinants of health (HEC 1) with psychosocial stress resulting from community anxiety over a tank farm release. There could be potential diesel or diesel fume exposure (HEC 3), and impacts to subsistence resources (HEC 4). In terms of impact duration, spills would likely be quickly contained or released to secondary containment.

Scenario 4: Tanker Truck Release

A tanker truck incident may cause diesel to be released to the mine access road, and possibly to surrounding land or water bodies. Spills may completely evaporate, or may be transported downstream. It is unlikely that cleanup and remediation activities following a tanker truck release would result in increased employment opportunities in the Y-K region, and there would be no increase in transportation levels. The mine access road would not be open to commercial or recreational transportation, and a tanker trunk release is unlikely to impact travel patterns or be detrimental to local businesses.

There are potential adverse impacts to social determinants of health (HEC 1) with psychosocial stress resulting from community anxiety over a tanker truck release. A tanker truck release may involve a surface transportation accident or injury, but is not likely to create increased risks for transportation-related injury or accident (HEC 2). The duration of impacts would be short-term (1-12 months). There could be potential diesel or diesel fume exposure (HEC 3), and impacts to subsistence resources (HEC 4).

Scenario 7: Cyanide Release

There would be no impacts to human health if a tank-tainer spill occurred at a storage site or at the Mine Site as sodium cyanide would be released into secondary containment. There would be no impact to human health if the dry briquettes did not contact water.

If the spilled cyanide contacted water, there would be brief access restrictions for areas within a radius of 0.1 to 0.9 miles from the spill depending upon the spill volume. Some of the cyanide would volatize into hydrogen cyanide gas, which could build up in enclosed areas. Cyanide gas is highly toxic and could be quickly fatal to a human. Port storage and mine processing areas would be well-ventilated. Cyanide gas released outside of an enclosed space would dissipate quickly. Spill response plans prepared by Donlin would contain a phone number for individuals to call to get information on the spill and consult about health effects.

A cyanide spill that contacted water could be toxic to fish and wildlife, including those used for subsistence. Sodium cyanide would not bioaccumulate as it has as a low persistence time in the environment. There would be an indirect effect of perceived contamination of subsistence food resources. There could be potential impacts to groundwater if cyanide dissolved in water infiltrated the ground. A cyanide release would not create additional employment in the Y-K region related to remediation activities.

There are potential adverse impacts to social determinants of health (HEC 1) with psychosocial stress resulting from community anxiety over a cyanide release. A cyanide release may involve a surface or water transportation accident or injury, but is not likely to create increased risks for transportation-related injury or accident (HEC 2). Sodium cyanide dissolves into toxic hydrogen cyanide when in contact with water, and there could be exposures to potentially hazardous materials (HEC 3). There would be elevated impacts to subsistence resources in the vicinity of the spill, with potential perceptions of subsistence food contamination throughout the EIS Analysis Area (HEC 4). Impacts would be short-term and small limited impacts to households. A release of dry cyanide briquettes would have no impacts to human health, and a cyanide release that came into contact with water could have risks to illness or injury patterns and intervention may be necessary.

Scenario 8: Mercury Release

If elemental mercury is spilled, some of it would be emitted as gaseous mercury, which could be toxic to terrestrial mammals harvested by subsistence hunters, but at extremely low levels. In addition, there are likely to be few animals in the area of a mercury spill given mining activities and human presence. If spilled mercury escapes cleanup efforts, it would be subject to natural methylation processes and would add incrementally to the mercury levels in background and air depositions, and bioaccumulate in fish and fish-eating animals.

If there is a mercury release, mercury could enter the water table and potentially impact groundwater in a local area, and could also result in impacts to local air quality. It is unlikely that cleanup and remediation activities following a mercury release would result in increased employment opportunities in the Y-K region. Cleanup crews would be small and likely consist of Donlin Gold personnel, trained in safe handling and spill response procedures. The intensity of adverse impacts on employment, income, and sales caused by a disruption of commercial and recreational fishing and/or tourism may not be measurable or apparent.

A mercury container rupture would be responded to by trained personnel and spilled mercury would be recovered and managed appropriately. Spill response plans prepared by Donlin would contain a phone number for individuals to call to get information on the spill and consult about health effects.

There are potential adverse impacts to social determinants of health (HEC 1) with psychosocial stress resulting from community anxiety over a mercury release. A mercury release may involve an accident or injury, but is not likely to create increased risks for future injury or accident (HEC 2). There could be exposures to potentially hazardous materials (HEC 3). Mercury bioaccumulates, and there would be noticeable impacts to subsistence resources in the vicinity of the spill (HEC 4). Most health impacts would be infrequent and limited to the area of the spill, but there could be perceptions of subsistence food contamination that extend beyond affected communities.

Scenario 9: Tailings Dam Failure

If a release occurred in summer, drinking water in Crooked Creek and other communities closest to the Mine Site could be adversely impacted if a release infiltrated subsurface materials. Perceived contamination of subsistence foods would be acute or obvious/abrupt and extend throughout the EIS Analysis Area. A tailings release in winter could impede snowmachine travel by subsistence hunters from Crooked Creek.

The cleanup and remediation activities following a tailings dam failure in which a large volume of water, or water and tailings, is released into the environment would temporarily increase employment opportunities and expenditures in the Y-K region. Labor requirements would be especially high if mechanical recovery and physical removal were part of the remediation effort, such as in the case of a tailings and water release in winter. Employment increases for cleanup activities would be short-term (1-12 months). No employment opportunities would be created by smaller releases of tailings from the mill or from piping to the TSF or other small spills. There would be adverse impacts on employment, income, and sales if commercial fishing or sport fishing and related tourism were to decline due to the real or perceived impacts of a spill. Water contamination could also create drinking water bans, which would also negatively impact local business and consumers.

There are potential adverse impacts to social determinants of health (HEC 1) with psychosocial stress resulting from community anxiety over a tailings dam release. There could be exposures to potentially hazardous materials (HEC 3). Subsistence may be impacted, with potential perceptions of subsistence food contamination that extend throughout the EIS Analysis Area (HEC 4). Impacts would vary in duration, be limited to the area of the spill, and would vary in intensity depending upon the season, volume, and content of a spills release.

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

Under Alternative 3A, Scenario 5 (diesel pipeline release) is not applicable and has not been analyzed for effects to human health. The likelihood of Scenarios 1 through 4 (ocean or river barge, tank farm and tanker truck releases) occurring would be greatly reduced, but the impacts would be the same as those discussed under Alternative 2. Impacts under Scenarios 7 through 9 (cyanide, mercury, and tailings releases) for Alternative 3A would be the same as those discussed under Alternative 2.

Scenario 6: Liquefied Natural Gas Release

In the event of an LNG release to soil or water, the LNG would transition back to a gaseous phase (California Energy Commission 2014). Air emissions would primarily consist of methane, which is not known to have serious health impacts except in confined spaces as it can act as an asphyxiant. There may be community anxiety from an LNG release that may have health impacts because of the known risks in confined spaces. A release of LNG and the transition to gaseous phases are not expected to occur in a confined space. Methane is a potent GHG, but is unlikely to directly affect health-related impacts from climate change. It is unlikely that cleanup and remediation activities following an LNG release would result in increased employment opportunities in the Y-K region. In the event of a fire or explosion, responders would be trained fire fighters and other industry professionals. Negative impacts to employment, income and sales due to a disruption of commercial or recreational fisheries are unlikely to occur.

There are potential adverse impacts to social determinants of health (HEC 1) with psychosocial stress resulting from community anxiety over an LNG release. An LNG release may increase risks of accident or injury, particularly if there was a fire or explosion (HEC 2). There could be exposures to potentially hazardous materials (HEC 3). Impacts would be brief and limited to the area of the spill. In context, minority and low-income communities would not incur disproportionate adverse impacts.

3.24.6.22.3 ALTERNATIVE 3B – REDUCED DIESEL BARGING: DIESEL PIPELINE

Under Alternative 3B, Scenario 6 (LNG release) is not applicable and has not been analyzed for effects to human health. Impacts under Scenario 1 (ocean barge releases) would be shifted relative to Alternative 2, and the likelihood of Scenarios 2 through 4 (river barge, tank farm and tanker truck releases) occurring would be greatly reduced; but the impacts would be the same as those discussed under Alternative 2. Impacts under Scenarios 7 through 9 (cyanide, mercury, and tailings releases) for Alternative 3B would have the same impacts on human health as Alternative 2.

Scenario 5: Diesel Pipeline Release

A diesel pipeline release poses risks to local groundwater quality, which could impact local drinking water quality. Impacts would be confined to a discrete portion of the pipeline corridor and would persist for more than six years and possibly the life of the project. A spill on water would be unlikely to impact subsistence fisheries in most of the EIS Analysis Area, but would have impacts to subsistence similar to those described for a river barge spill, but more concentrated towards the communities in close proximity to the section of the pipeline where the break occurred.

The cleanup and remediation activities following a diesel pipeline break in which a large volume of diesel is released into the environment would temporarily increase employment opportunities and expenditures in communities in close proximity to the section of the pipeline where the break occurred. There may be adverse impacts on employment, income, and sales if the spill reached waterways and impacted commercial or sport fisheries.

There are potential adverse impacts to social determinants of health (HEC 1) with psychosocial stress resulting from community anxiety over a diesel pipeline release. The response effort could include burns and temporary increases in surface and air transportation, which may increase risks of accident or injury (HEC 2). There could be exposures to potentially hazardous materials (HEC 3), with particular potential risk for drinking and groundwater contamination. There could be possible impacts to subsistence fisheries, but these are unlikely for most of the EIS Analysis Area (HEC 4). Impacts would vary in duration and may last longer than 6 years and possibly the life of the project. Impacts may increase if drinking water supplies were affected.

3.24.6.22.4 ALTERNATIVE 4 – BIRCH TREE CROSSING PORT

Under Alternative 4, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to human health. The likelihood of Scenario

2 (river barge release) occurring would be greatly reduced, but the impacts would be the same as those discussed under Alternative 2. Impacts under Scenarios 1, 3, 4, 7 through 9 (ocean barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 4 would be the same as those discussed under Alternative 2.

3.24.6.22.5 ALTERNATIVE 5A – DRY STACK TAILINGS

Under Alternative 5A, spill Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to human health.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 5A would be the same as those discussed under Alternative 2.

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

Under Alternative 6A, Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to human health.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and tailings releases) for Alternative 6A would be the same as those discussed under Alternative 2.

3.24.6.23 TRANSPORTATION

3.24.6.23.1 ALTERNATIVE 2 – DONLIN GOLD'S PROPOSED ACTION

Under the proposed action, two spill scenarios do not apply and are not analyzed for impacts to transportation. These include Scenario 5 (diesel pipeline release) and Scenario 6 (LNG release).

<u>Scenario 1: Ocean Barge Rupture at Sea</u>

Ocean-going cargo barges follow general but consistent routes determined by distance, protected habitat, public safety, water depth, and underwater hazards. Although barges normally follow these routes of travel, circumstances occasionally require deviation from the typical routes. Diesel fuel evaporates, particularly when subject to high-energy ocean waves and wind. However, if there were to be an ocean barge diesel spill at sea, water transportation systems could be affected because the spill could disrupt the pattern of shipping routes through that area. Immediately following the spill and during response efforts, barges may be forced to find alternate routes for shipping or travel outside of normal routes depending on the dispersion of the spill. In addition, the response effort would increase the number of vessels using those routes as response teams travel to the spill site. However, the barge travel options to the Port of Bethel are vast, and there are many opportunities for avoiding certain areas or other vessels. Similarly, the cleanup effort would likely increase the number of flights to the region as response staff are mobilized to the nearest transportation hub.

In terms of impact duration, the displacement of barges to alternate routes and increased air transportation would occur immediately after the spill and during response efforts, which would last less than one season and likely only a matter of days or weeks. Depending on where the spill occurred, there could be a generally low proportion of vessels that would experience route displacement and additional vessel traffic for one or two days. Depending on ocean currents, where the spill was located, the release's proximity to shore, and the rate of evaporation, the diesel could disperse quickly to a large area. Spill response would cover the extent of the spill, and although would likely be limited to overflights, it is possible that a small increase of vessel traffic could result for response mobilization. Therefore, the extent of the impacts to water transportation as a result of an ocean barge rupture would be realized by communities throughout the EIS Analysis Area. The majority of goods in Alaska are delivered by barge. Depending on where the spill occurred, the transportation of goods to some ports could be impacted. For that reason, the context of the shipping transportation system in the state has limited comparable alternate routes, facilities, or modes.

In summary, depending on where the spill occurred, the impact of an ocean barge rupture at sea would have impacts on the water and air transportation system in the state of Alaska. Barges and flights delivering goods have limited comparable alternate routes, facilities, or modes in Alaska, and the impacts of a response effort could potentially affect a small proportion of total vessel and aircraft traffic. Depending on the location of the rupture, disturbance or displacement of transportation access, mode, or traffic levels may not be measurable or apparent. Shipping and air traffic volume would be increased during the response effort, and vessels not involved in spill response may be required to temporarily use alternate routes. However, the impacts would be brief (four years or less), shipping routes are wide, and alternate routes are plentiful.

Scenario 2: River Barge Release

A fuel release due to a river barge grounding would have no direct or indirect impacts to surface and a limited impact to air transportation systems, which would likely see a slight increase in air traffic. A river barge grounding would occur during the summer shipping season. Winter transportation such as snowmachines would not be affected. Impacts to water transportation systems would occur immediately after a spill and during spill response efforts, which would last a number of days. Depending on the location of the spill, vessels using the Kuskokwim River for transportation would be forced to either halt operations for the duration of the response effort or use an alternate route to avoid the spill site. If there were a river barge release on the Kuskokwim River, a number of vessels would be either displaced to alternate routes or halted until response was complete. Therefore, the intensity of impacts to water transportation as a result of a river barge release would be noticeable. Currently, vessel traffic on the Kuskokwim River services villages upriver of Bethel, a roadless area, making the water transportation system in the region an important resource. The vessels would be displaced or halted immediately after the spill and during response, but last a number of days. The spill and response would primarily impact the spill site, but could extend as far as Bethel or the Kuskokwim Bay if the spill occurred in the lower river and diesel floated downriver and threatened important shorelines. The extent or scope of impacts would likely remain in the river and bay.

The duration of impacts to water transportation would last for the time of the response effort. The extent or scope of impacts could encompass areas from the spill site to the Kuskokwim Bay. There are a number of vessels that would be affected, with limited comparable alternate routes, facilities, or modes. In terms of intensity, noticeable disturbance or displacement of transportation access, mode, or traffic levels would occur

Scenario 3: Tank Farm Release

In the instance of a fuel release due to a tank farm rupture, a faulty valve or pipeline leak, a transfer operation line rupture, or a transfer operation human error, the spill and response would be limited to the vicinity of the spill site (either the Mine Site or a tank farm at Angyaruaq [Jungjuk] Port or Bethel). There would be no need for extra resources to aid the response effort, and the vessel traffic on the Kuskokwim River would not increase as a result of the spill. Potential spills would occur in locations that are closed to commercial or recreational transportation systems (at the Mine Site or port tank farms). Moreover, each scenario of a tank farm release includes recovery estimates that would capture 100 percent of the loss, minus any loss to evaporation. Since the spill and response efforts would remain on-site in an area without public access and recovery would be 100 percent without additional vessel response, there would be no direct or indirect impacts to water, surface, or air transportation as a result of a tank farm release. Any actions that would occur at Dutch Harbor or the Port of Bethel at the Bethel Yard Dock are not part of the proposed action, and are considered connected actions (see Section 1.2.1, Connected Actions, in Chapter 1, Project Introduction and Purpose and Need).

Scenario 4: Tanker Truck Release

In the instance of a fuel release due to a tanker truck rollover, or a tanker truck collision, the spill and response would be limited to the vicinity of the spill site on the road, and potentially in a nearby waterbody or stream. Neither air traffic nor the vessel traffic on the Kuskokwim River would likely increase as a result of the spill. Potential spills would occur in locations that would be closed to commercial or recreational transportation systems. The spill and response efforts would remain on-site in an area without public access, and there would be recovery of a majority of the substance without additional vessel or air traffic response. There would be no direct or indirect impacts to water, surface, or air transportation as a result of a tanker truck fuel release.

Scenario 7: Cyanide Release

In the unlikely event of a sodium cyanide release, direct and indirect effects to transportation resources are expected to be minimal and limited to a short disruption of the immediate transportation network during cleanup activities.

A tank-tainer accident could result in the release of sodium cyanide into the environment along the ocean or river corridors, at transfer facilities, or along the road and adjacent water bodies. The intensity of negative impacts on transportation resources caused by a disruption of surface transportation or vessel traffic in the immediate area of the spill may not be measurable or apparent. The environmental effects would be confined to a small area. The effects on transportation resources would be realized by communities within a subregion as a result of potential releases and short duration cleanup operations.

Scenario 8: Mercury Release

The effects of a mercury release are very similar to that of a cyanide release. In the unlikely event of a mercury release, direct and indirect effects to transportation resources are expected to be minimal and limited to a short disruption of the immediate transportation network during cleanup activities.

A release of mercury into the environment along the ocean or river corridors, at transfer facilities, or along the road and adjacent water bodies is considered a low probability event, as mercury would have multiple containment levels. The intensity of negative impacts on transportation resources caused by a disruption of surface transportation or vessel traffic in the immediate area of the spill may not be measurable or apparent. The environmental effects would be confined to a small area. The effects on transportation resources would be realized by communities within a subregion as a result of potential releases and short duration cleanup operations.

Scenario 9: Partial Tailings Dam Failure

A partial tailings dam failure would have a limited impact to air transportation, which would likely see a slight increase in air traffic related to spill response and monitoring efforts. There would be impacts to surface transportation in the vicinity of the tailings dam, and impacts would depend upon sediment deposition and possible flooding of surrounding land. If excavation and earthmoving equipment from the Mine Site were part of recovery efforts, these vehicles could dominate surface travel in the vicinity. The Mine Site would have restricted access and employees would typically be flown into work; there is a limited level of surface transportation that could potentially be disrupted in communities downstream of the tailings dam.

A partial tailings dam failure would impact water travel on Crooked Creek and Anaconda Creek, and may impact water travel on the Kuskokwim River. Depending upon the volume and trajectory of materials released in the event of a partial tailings dam failure, vessels could be displaced or could have to find alternate routes until the spill response was complete on affected waterways. If a partial tailings dam failure occurred in winter, snowmachine travel along frozen waterways would be impacted. Impacts to water transportation would be medium intensity, with the potential to be high intensity for Crooked Creek. The area in the vicinity of the tailings dam is roadless, and water transportation is thus considered an important resource. In terms of intensity, impacts would result in noticeable disturbance or displacement of transportation access, mode, or traffic levels. The extent or scope of impacts would be realized by communities within a subregion and persist briefly during the spill event. Impacts would primarily affect travel along small waterways close to the tailings dam and a segment of the Kuskokwim River.

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

Under Alternative 3A, Scenario 5 (diesel pipeline release) is not applicable and has not been analyzed for effects to transportation. The likelihood of Scenarios 1 through 4 (ocean or river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Impacts under Scenarios 7 through 9 (cyanide, mercury, and tailings releases) for Alternative 3A would be the same as those discussed under Alternative 2.

Scenario 6: Liquefied Natural Gas (LNG) Release

An occurrence of pinhole leaks in LNG storage tanks, an accident involving an LNG-fueled truck, or the rupture of a storage tank at the LNG plant could occur at the Mine Site. If released, LNG dissipates readily, and there is low risk of fire or explosion in open areas. The spill and response effort would be limited to the vicinity of the spill site, which would be closed for safety. Spill response would not require the use of outside airstrips, trails, or waterways. Since the spill would remain on-site in an area without public access, there would be no direct or indirect impacts to surface, air, or water transportation resources as a result.

3.24.6.23.3 ALTERNATIVE 3B – REDUCED DIESEL BARGING: DIESEL PIPELINE

Under Alternative 3B, Scenario 6 (LNG release) is not applicable and has not been analyzed for effects to transportation. Impacts under Scenario 1 (ocean barge release) would be shifted relative to Alternative 2, and the likelihood of Scenarios 2 through and 4 (river barge, tank farm and tanker truck releases) occurring would be greatly reduced; however, the impacts would be the same types as discussed under Alternative 2. Scenarios 7 through 9 (cyanide, mercury, and tailings releases) would have the same impacts on transportation as Alternative 2.

<u>Scenario 5: Diesel Pipeline Release</u>

Public access to the diesel pipeline ROW by way of surface transportation would be limited over the majority of the pipeline by remoteness of the route, though there is use of existing trail systems such as the INHT. For spill scenario impacts on recreational users of trails systems see Section 3.24.6.16, Recreation. If a diesel pipeline release were to occur as a result of a pinhole leak or a pipeline rupture, there would be no direct or indirect impacts to water transportation. If such releases were to occur, response efforts would use surface (if in the winter) and air transportation to reach the spill site. Spill response would likely increase flight activity at one or more of the four existing airstrips (Beluga, Rainy Pass, Farewell, and the Mine Site) that would have been upgraded for the construction of the pipeline. The six airstrips that were built solely for pipeline construction would have been reclaimed and no longer available for use. The increase of air transportation would occur immediately following the release and during the response effort, which could take less than two weeks for a pinhole leak or several weeks for a rupture. If the spill occurred in the winter and it was possible to travel to the site using surface transportation along the ROW, there would be some impact to trail system users, as discussed in Section 3.24.6.16, Recreation.

The volume of air traffic or surface transportation that would be affected by a diesel pipeline release would be small. With only a small number of airstrips and operations being affected, the intensity of disturbances may not be measurable or apparent. In terms of impact duration, the response effort, depending on the magnitude of the spill, would likely be one or two seasons long. The spill and response would remain at a particular spot along the pipeline ROW, and effects would not extend beyond the immediate area. However, response would be staged from the Mine Site or Anchorage using airstrips and helicopter landing pads closest to the spill, which could be quite far away. Therefore, the extent of impacts to transportation systems as a result of a diesel pipeline release would be realized by communities throughout the EIS Analysis Area. A release would affect local airstrips where general aviation has alternate routes, facilities, or modes of transport (there are a large number of float/ski plane accessible lakes in the region).

Transportation resources have alternative routes, facilities, or modes of transport in the area, and would be impacted immediately following the spill and during response efforts. The extent or scope of impacts could reach as far as Anchorage. A low number of airstrips would be involved in response efforts and see an increase in operations. As a result, the intensity of impacts to air transportation may not be measurable or apparent.

3.24.6.23.4 ALTERNATIVE 4 – BIRCH TREE CROSSING (BTC) PORT

Under Alternative 4, spill Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to transportation. The likelihood of Scenario 2 (river barge release) occurring would be greatly reduced, but the impacts would be the same as those discussed under Alternative 2. Impacts under Scenario 3 (tank farm release) would be shifted relative to Alternative 2, and the likelihood of Scenario 4 (tanker truck release) occurring would be increased; however, the impacts would be the same types as discussed under Alternative 2. Impacts under Scenarios 1, 7 through 9 (ocean barge, cyanide, mercury, and tailings releases) for Alternative 4 would be the same as those discussed under Alternative 2.

3.24.6.23.5 ALTERNATIVE 5A – DRY STACK TAILINGS

Under Alternative 5A, spill Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to transportation.

Impacts under Scenarios 1 through 4, and 7 through 9 (ocean or river barge, tank farm, tanker truck, cyanide, mercury, and water only tailings releases) for Alternative 5A would be the same as those discussed under Alternative 2.

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

Under Alternative 6A, spill Scenario 5 (diesel pipeline release), and Scenario 6 (LNG release) are not applicable and have not been analyzed for impacts to transportation.

Impacts under Scenarios 1 through 4, and 7 and 8 (ocean or river barge, tank farm, tanker truck, cyanide, and mercury releases) for Alternative 6A would be the same as those discussed under Alternative 2.

3.24.7 IMPACT REDUCING MEASURES

Effects determinations take into account impact reducing design features (Table 5.2-1 in Chapter 5, Impact Avoidance, Minimization, and Mitigation) proposed by Donlin Gold and also the Standard Permit Conditions and BMPs (Section 5.3) that would be implemented.

Design features important for preventing or reducing impacts from potential spills include:

- Cyanide and mercury spill response planning would be components of Donlin Gold's hazardous materials management and spill plans. The applicable training, inspection, reporting, preparedness, spill prevention, contingency planning, and emergency procedures required by RCRA and ADEC Division of Spill Prevention and Response would be implemented. Emergency response information would be provided and maintained according to Title 49 CFR 172;

- Donlin Gold will coordinate with and help educate people who want to travel in the area during the pipeline construction period through its Public Outreach Plan to either allow controlled access through or within construction zones or identify alternate access;
- Design features for cyanide include cyanide detoxification of the leach tailings and cyanide handling, storage, and transport in compliance with the International Cyanide Management Code (ICMC);
- Secondary containment would be provided for all fuel and chemical storage tanks to prevent release of stored contents to the environment;
- Ocean and river fuel barges would be double hulled and have multiple isolated compartments for transporting fuel to reduce the risk of a spill;
- Donlin Gold would implement barge guidelines for operating at certain river flow rates, and conduct ongoing surveys of the Kuskokwim River navigation channel to identify locations that should be avoided to minimize effects on bed scour and the potential for barge groundings. As part of the proposed operation, equipment will be available to free or unload / lighter barges in the event of groundings. The equipment will be available as part of ongoing operations, it will not all be dedicated standby equipment;
- Special ISO-approved watertight tank-tainers would be used for the transport of cyanide and the containers would be tracked during shipment. Design features for cyanide also include cyanide handling, storage, and transport in compliance with the ICMC;
- The project design includes special flasks and metric ton containers for mercury transport;
- To reduce impacts on existing river traffic and potential for groundings and accidents, Donlin Gold would establish navigational aids and develop procedures for queuing in narrow channels. Donlin Gold vessels would use state-of-the-art navigation and communication equipment;
- The above-ground fault crossing of the pipeline was designed to resist surface fault rupture hazards, and would be designed to withstand the stress that could occur during a seismic event;
- A special permit granted by PHMSA would allow the use of strain based design in areas where geotechnical hazards may be present to maintain equivalent levels of safety. The strain based design may use heavier wall pipe in these areas, rather than just using the wall thickness required for pressure containment, so that equivalent levels of safety are maintained;
- Donlin Gold would conduct a public outreach program that would include information regarding participation in the “One-Call” program, hazards associated with the unintended release of natural gas, unintended release indicators, and reporting procedures;
- The TSF and water dams will be designed using rockfill, bedrock foundations, multiple filter zones, liners, and downstream construction methods to address seismic hazards, static stability, and seepage concerns. This aligns with specific Mount Polley Independent Review Panel recommendations for Best Applicable Practices (BAP) for

tailings retention dam design. Final design would be reviewed by ADNR Dam Safety and subject to change as needed to protect life and property;

- Monitoring activities of the Waste Rock Facility [WRF] and tailings dam would be conducted to include water quality, biological resources, and vegetation. In addition, all dams on site would be monitored for mass stability to detect potential movement;
- Main line valves (block valves) would be placed at intervals of no more than 20 miles along the length of the pipeline to minimize loss of contents during a leak event;
- A horizontal directional drilling (HDD) plan would be developed for each HDD river crossing to reduce potential effects from "frac-out," which can occur if drilling fluids are lost into fractures or voids and released into the river above; and
- The project design will include features to limit permafrost impacts at the Mine Site such as excavation to bedrock beneath large structures where needed, such as the TSF abutment and foundation of the WRF. Final design would be reviewed by ADNR Dam Safety and subject to change as needed to protect life and property.

Standard Permit Conditions and BMPs important for preventing or reducing impacts from potential spills include:

- Development and maintenance of ODPCPs, SPCC Plans, and FRPs;
- Compliance with ADNR Dam Safety requirements through certificates of approval to construct and operate dams to include preparation of Emergency Action Plans and completion of a FMEA;
- Verification that project vessels are equipped with proper emergency towing equipment in accordance with 18 AAC 75.027(f);
- Verifying pipeline integrity with visual and other non-destructive inspections of welds, hydrostatic testing, use of in-line inspection tools, and aerial inspections; and
- Use of cathodic protection (specific method to be determined in final design) for corrosion protection of the steel pipeline.

Additional measures are being considered by the Corps and Cooperating agencies to further minimize project impacts, as reasonable and practicable, and are further assessed in Chapter 5, Impact Avoidance, Minimization, and Mitigation (Section 5.5 and Section 5.7). Examples of additional measures being considered that are applicable to this resource include:

- For marine barging in the Bearing Sea - implement measures to minimize the risk of spills, including: avoiding operation of watercraft in fall and winter and in the presence of sea ice to the extent practicable; using double-hull tanks for fuel transport to reduce tank rupture risk; and using fully-operated vessel navigation systems composed of radar, chartplotter, sonar, marine communications systems, and satellite navigation receivers, as well as automatic identification system (AIS) for vessel tracking;
- Make the Emergency Action Plan for the tailings dam available to the public to review. Require a communication and alert system to be in place that is sufficient to warn people in Crooked Creek and boaters on the Kuskokwim near Crooked Creek of the potential need to move out of the area; and

- Monitor tailings dam with remote sensing devices as part of the monitoring program, for early detection of any movement or disturbance to the dam.

3.24.8 COMPARISON OF IMPACTS BY SCENARIO

Table 3.24-26 below summarizes the impacts from all spill scenarios for each resource. The tables show the impacts from Alternative 2; all other alternatives are presumed to be the same as Alternative 2 unless specified.

Table 3.24-26: Summary of Spill Scenario Impacts

Resource	Scenario 1- Ocean Barge Rupture	Scenario 2- River Barge Release	Scenario 3- Tank Farm Release	Scenario 4- Tanker Truck Release	Scenario 5- Diesel Pipeline Release	Scenario 6- LNG Release	Scenario 7- Cyanide Release	Scenario 8- Mercury Release	Scenario 9- Partial Tailings Dam Failure
Likelihood	Very low probability, very large volume During Operations under Alternative 3B, ocean fuel barges would not transit to Dutch and on to Bethel.	Very low probability, large volume During Operations under Alternative 3B, river fuel barges would not transit the Kuskokwim River.	Rupture: Very low probability, large volume Faulty valve: High probability, very small volume Transfer operation line rupture: Low probability, medium to large volume Transfer operation human error: Low probability, very small volume	Rollover: Low probability, medium to large volume Collision: Low probability, very small volume During Operations under Alternative 3B, tanker trucks would not operate on the mine access road.	Pinhole leaks: High to very high probability, low volume Rupture: Very low probability, high to very high volume This scenario only applies to Alternative 3B – Diesel Pipeline.	Low probability, low to medium volume This scenario only applies to Alternative 3A – LNG-Powered Haul Trucks.	Lost cargo overboard: Very low probability, small volume Vehicle collision: Very low probability, small volume	Lost cargo overboard: Very low probability, small volume Container rupture: very low probability, small volume Truck accident: Low probability, very small volume	Tailings and water: Very low probability, very high volume Water only: Very low probability, very high volume Under Alternative 5A – Dry Stack Tailings, the dams would retain the operating pond and very few tailings. The risk of tailings mobilization from dam failure would be very low.
Geology and Paleontology	Impacts to surficial deposits along shorelines are discussed in Sediment Quality, Section 3.24.6.7.3	Impacts to surficial deposits along shorelines are discussed in Sediment Quality, Section 3.24.6.7.3	Same impacts described for Soils, Section 3.24.6.2 in all alternatives.	Same impacts described for Soils, Section 3.24.6.2 in all alternatives.	Same impacts described for Soils, Section 3.24.6.2 in all alternatives.	No Impacts in all alternatives	Cyanide not captured in secondary containment cannot be excavated and would be left to disperse naturally.	Same impacts described for Soils, Section 3.24.6.2 in all alternatives.	Same impacts described for Soils, Section 3.24.6.2 in all alternatives.
Soils	This scenario is not applicable to soils.	This scenario is not applicable to soils.	Small volumes and immediate response would create impacts.	Limited soil excavation might be required.	*Alt 3B:* Soils could be impacted depending on size of spill.	This scenario is not applicable to soils.	Cyanide not captured in secondary containment cannot be excavated and would be left to disperse naturally.	Impacted soils would be remediated. Limited soil excavation might be required.	Some soils could be indefinitely impaired above baseline conditions.
Geohazards and Seismic Conditions	This scenario is not applicable to geohazards.	This scenario is not applicable to geohazards.	This scenario is not applicable to geohazards.	This scenario is not applicable to geohazards.	This scenario is not applicable to geohazards.	This scenario is not applicable to geohazards.	This scenario is not applicable to geohazards.	This scenario is not applicable to geohazards.	This scenario is not applicable to geohazards.
Meteorology	No effects to meteorology.	No effects to meteorology.	No effects to meteorology.	No effects to meteorology.	No effects to meteorology.	No effects to meteorology.	No effects to meteorology.	No effects to meteorology.	No effects to meteorology.
Surface Water Hydrology	Ocean currents would influence dispersal of diesel.	River flow would impact dispersal of diesel.	Moving water such as a creek or stream would impact dispersal of diesel.	Moving water such as a creek or stream would impact dispersal of diesel.	*Alt 3B:* Moving water such as a creek or stream would impact dispersal of diesel.	*Alt 3A:* A release of LNG would not be impacted by surface water hydrology.	Moving water such as a creek or stream would impact dissolution of cyanide.	Moving water such as a creek or stream would impact attenuation processes of mercury.	Flows in Anaconda Creek would be highly impacted.
Groundwater Hydrology	Shallow groundwater resources at shoreline areas could be impacted.	Shallow groundwater resources at shoreline areas could be impacted.	No effects to groundwater hydrology.	Potential impacts if spills reached the water table.	*Alt 3B:* All sizes of spills could infiltrate water table and require remediation.	*Alt 3A:* No effects to groundwater hydrology.	No effects to groundwater hydrology.	No effects to groundwater hydrology.	Shallow groundwater in the Crooked Creek floodplain could be minimally impacted.
Water Quality: Surface Water Quality	Most contamination would be on upper levels of water column, likely exceeding water quality standards for hydrocarbons for a while.	The river water column would be contaminated, likely exceeding water quality standards for hydrocarbons for a while.	Releases into water could result in contamination, likely exceeding water quality standards for hydrocarbons, if not recovered and contained, for a while.	Releases into water could result in contamination, likely exceeding water quality standards for hydrocarbons, if not recovered and contained, for a while.	*Alt 3B:* All sizes of spills could result in contamination, likely exceeding water quality standards for hydrocarbons and require remediation.	*Alt 3A:* No effects to surface water quality.	If cyanide released into the Kuskokwim River, concentrations would locally exceed threshold for fresh water for a brief period of time. Cyanide released on land into water would exceed the water quality criterion for cyanide.	A release of mercury directly to surface water would result in concentrations of mercury in excess of applicable water quality standards.	Surface water quality would have impacts exceeding water quality standards from the Anaconda Creek and Crooked Creek drainages to the Kuskokwim confluence.

Table 3.24-26: Summary of Spill Scenario Impacts

Resource	Scenario 1- Ocean Barge Rupture	Scenario 2- River Barge Release	Scenario 3- Tank Farm Release	Scenario 4- Tanker Truck Release	Scenario 5- Diesel Pipeline Release	Scenario 6- LNG Release	Scenario 7- Cyanide Release	Scenario 8- Mercury Release	Scenario 9- Partial Tailings Dam Failure
Water Quality: Groundwater Quality	Diesel would remain on the surface for a short time and would not impact groundwater resources.	Most diesel would not impact groundwater; however, a very small fraction would contact the river banks and a subfraction could affect unconfined surficial groundwater resources.	Released diesel that reaches groundwater would not be in concentrations that exceed water quality standards.	Released diesel that reaches groundwater may be in concentrations that exceed water quality standards.	*Alt 3B:* All sizes of spills could result in contamination, likely exceeding water quality standards for hydrocarbons and require remediation.	*Alt 3A:* No effects to groundwater hydrology.	Small amounts of cyanide could result in exceeding water quality standards, but would have no substantial effect.	Mercury could enter the water table and concentrations could exceed water quality criterion.	Groundwater quality would have impacts exceeding water quality standards from the Anaconda Creek and Crooked Creek drainages to the Kuskokwim confluence.
Water Quality: Sediment Quality	A small fraction of diesel could be adsorbed at river mouths	Impacts could result from adsorption of diesel in the water column, and could exceed sediment quality guidelines.	Impacts to affected area could exceed sediment quality standards until contained, recovered or attenuated naturally.	Impacts to affected area could exceed sediment quality standards until contained, recovered or attenuated naturally.	*Alt 3B:* All sizes of spills could result in contamination, likely exceeding water quality standards for hydrocarbons and require remediation.	*Alt 3A:* No effects to surface water.	Concentrations of cyanide in sediments would be low.	Mercury would collect in sediments where it could increase the bioavailability and accelerate the rates of transport away from the area of the spill. Concentrations in the sediments could exceed guideline thresholds.	Sediment quality would have impacts exceeding water quality standards from the Anaconda Creek and Crooked Creek drainages to the Kuskokwim confluence.
Air Quality	Evaporation of diesel fuel would generate minimal VOCs and HAPs. Air quality would return to pre-activity levels quickly.	Evaporation of diesel fuel would generate minimal VOCs and HAPs. Air quality would return to pre-activity levels quickly.	Evaporation of diesel fuel would generate minimal VOCs and HAPs. Air quality would return to pre-activity levels quickly.	Evaporation of diesel fuel would generate minimal VOCs and HAPs. In-situ burning may be used for remediation. Ambient air quality would return to pre-burn conditions relatively quickly	*Alt 3B:* Leaks could evaporate before response. In-situ burning may be used for remediation.	*Alt 3A:* LNG air emissions would consist primarily of methane, which is a potent GHG. Air quality would rapidly return to pre-activity levels.	If some volatizes, it could be toxic to life. However, outdoor the gas would dissipate rapidly.	Portions of the mercury could volatilize into the atmosphere. Elemental mercury vapor may remain in the atmosphere for more than a year, although it would disperse from the spill area.	Gaseous mercury emissions from a release would be minimal from rapid transport and dilution of the tailings.
Noise and Vibration	Some noise impacts associated with response efforts.	Some noise impacts associated with response efforts.	Some noise impacts associated with response efforts.	Some noise impacts associated with response efforts.	*Alt 3B:* Some noise impacts associated with response efforts.	*Alt 3A:* Some noise impacts associated with response efforts.	No effects to noise.	No effects to noise.	Some noise impacts associated with response efforts.
Vegetation	Diesel may leave a residue on intertidal resources, causing the inability to photosynthesize or transpire	Vegetation could be damaged or killed from the coating effect or through degradation of water quality.	Minimal effect on vegetation.	Damage to adjacent terrestrial vegetation and possible contamination of adjacent aquatic or riparian vegetation.	*Alt 3B:* Impacts may include damage to vegetation, potentially including rare or sensitive plants.	*Alt 3A:* LNG is non-toxic to vegetation, but the temperature of LNG could freeze and kill vegetation on contact.	If the cyanide came into contact with water, it can inhibit respiration and affect a plant's ability to absorb nutrients from soil.	Exposure of plants to mercury can reduce photosynthesis, transpiration rate, water uptake, chlorophyll synthesis, and seed viability.	Impacts in isolated areas from removal, chemical contamination, burial, or reduction in soil nutrients.
Wetlands	Diesel reaching shoreline marshes and intertidal wetlands could kill vegetation and associated micro and macro fauna, and overwhelm or eliminate most wetland functions.	Wind and wave action could transport some of the unrecovered diesel into riverine wetlands where it may damage wetland vegetation.	Spilled diesel that is captured with secondary containment or recovered with sorbents and booms would not discharge to wetlands.	Large concentrations of diesel fuel on wetland vegetation would kill the vegetation on contact, but lower concentrations may have little effect.	*Alt 3B:* Diesel in the soil slow to degrade with extensive contact with plant roots may kill plants. Excavation may be required for recovery.	*Alt 3A:* LNG is non-toxic to vegetation, but the temperature of LNG could freeze and kill wetland vegetation on contact.	Adverse effects on aquatic plants are unlikely at concentrations that cause acute effects on most fish and invertebrates.	Toxic effects may include reduced seed germination, reduced seedling vigor, chromosomal abnormalities, reduced growth, foliar injury, reduced chlorophyll and phytomass. Wetlands may act as sources or sinks of metals.	Impacts in isolated areas from removal, chemical contamination, burial, or reduction in soil nutrients.

Table 3.24-26: Summary of Spill Scenario Impacts

Resource	Scenario 1- Ocean Barge Rupture	Scenario 2- River Barge Release	Scenario 3- Tank Farm Release	Scenario 4- Tanker Truck Release	Scenario 5- Diesel Pipeline Release	Scenario 6- LNG Release	Scenario 7- Cyanide Release	Scenario 8- Mercury Release	Scenario 9- Partial Tailings Dam Failure
Wildlife: Terrestrial Mammals	A large spill could affect exposed mammals, but the numbers of each species involved would be too few for population-level effects	A large spill could have physiological effects to exposed mammals, but the numbers of each species involved would be too few for population-level effects.	Large spills could impact small numbers of small mammals.	Large spills could impact small numbers of small mammals.	*Alt 3B:* Mammals in the vicinity at time of release could be affected, but with human activity at the response site, terrestrial mammals would not come close enough to be affected.	*Alt 3A:* With the level of human activity at the site, terrestrial mammals would not be expected to come close enough to be affected by an LNG release.	Cyanide would be highly toxic to terrestrial animals drinking it.	Gaseous mercury could be highly toxic to animals. However, with activity at the site, few, if any, terrestrial mammals would be expected to be exposed to it.	Impacts to small numbers from burial, contaminate exposure, or impacts to habitat.
Wildlife: Marine Mammals	Direct impacts of fuel spills on marine mammals may include sublethal effects from ingestion.	Direct impacts of fuel spills on marine mammals may include sublethal effects from ingestion.	There is little chance for marine mammals to contact the diesel fuel.	Unlikely to affect marine mammals.	*Alt 3B:* Harbor seals at the mouth of the Beluga River could be directly impacted by skin or nasal contact with the spilled diesel or indirectly impacted if prey species are contaminated.	*Alt 3A:* No effects to marine mammals.	Unlikely to affect marine mammals.	Unlikely to affect marine mammals.	Unlikely to affect marine mammals.
Wildlife: Birds	Several species of birds could be highly impacted.	Several species of birds could be highly impacted.	The numbers of birds affected would be small.	The numbers of birds affected would be small.	*Alt 3B:* Several species of birds could be highly impacted.	*Alt 3A:* Birds could be affected by gaseous LNG.	Cyanide would be highly toxic to birds drinking it.	Gaseous mercury could be highly toxic to birds. However, with activity at the site, few, if any, birds would be expected to be exposed to it.	Impacts to small numbers from burial, contaminate exposure, or impacts to habitat.
Fish and Aquatic Resources	Spills that reach littoral or intertidal zones could highly impact fish and aquatic resources that reside in the nearshore spill footprint.	Fish and aquatic resources in the Kuskokwim River could be highly impacted.	Fish and aquatic resources could be highly impacted if diesel reached water bodies.	Fish and aquatic resources could be highly impacted if diesel reached water bodies.	*Alt 3B:* Fish and aquatic resources could be highly impacted if diesel reached water bodies.	*Alt 3A:* Little to no effects to fish and aquatic resources.	If the sodium cyanide came into contact with water, it could be highly toxic to fish and aquatic wildlife.	Unrecovered mercury would add incrementally to the levels of background and air mercury, increasing the chronic exposure of aquatic biota and fish and fish-eating animals.	Fish and aquatic resources could be highly impacted in the event of a release.
Threatened and Endangered Species: Birds	The two species of ESA-listed birds could be highly impacted.	The two species of ESA-listed birds could be highly impacted if spill were at the mouth of the Kuskokwim River.	No effects to ESA-listed birds.	No effects to ESA-listed birds.	*Alt 3B:* No effects to ESA-listed birds.	*Alt 3A:* No effects to ESA-listed birds.	None of the scenarios for cyanide would release cyanide into the environment where the two species of ESA-listed birds may occur.	None of the scenarios for mercury would release mercury into the environment where the two species of ESA-listed birds may occur.	A tailings release would not reach into the environment where listed birds may occur.
Threatened and Endangered Species: Marine Mammals	Direct impacts of fuel spills on ESA-listed marine mammals may include sublethal effects from ingestion.	Direct impacts of fuel spills on ESA-listed marine mammals may include sublethal effects from ingestion.	There is little chance for ESA-listed marine mammals to contact the diesel fuel.	Unlikely to affect ESA-listed marine mammals.	*Alt 3B:* Cook Inlet Beluga whales at the mouth of and in the Beluga River could either be directly impacted by skin or nasal contact with the spilled diesel or indirectly impacted if prey species are contaminated.	*Alt 3A:* No effects to ESA-listed marine mammals.	None of the scenarios for cyanide would release cyanide into the environment where ESA-listed marine mammals may occur.	None of the scenarios for mercury would release mercury into the environment where ESA-listed marine mammals may occur.	Unlikely to affect ESA-listed marine mammals.

Table 3.24-26: Summary of Spill Scenario Impacts

Resource	Scenario 1- Ocean Barge Rupture	Scenario 2- River Barge Release	Scenario 3- Tank Farm Release	Scenario 4- Tanker Truck Release	Scenario 5- Diesel Pipeline Release	Scenario 6- LNG Release	Scenario 7- Cyanide Release	Scenario 8- Mercury Release	Scenario 9- Partial Tailings Dam Failure
Land Ownership, Management, and Use	Minimal impacts to land use at shoreline, and no impact to land management.	Minimal impacts to land management if response requires management action.	Impacts could include evacuation of nearby homes and businesses due to fumes and potential fire danger.	Minimal impacts to land use and minimal impacts to land management if response requires management action.	*Alt 3B:* Landowners along pipeline affected by response. Land use would be affected according to the biological effects.	*Alt 3A:* No effects to land use or management.	Minimal effects to land use and management and limited to a short disruption of land uses during cleanup activities.	Minimal effects to land use and management and limited to a short disruption of land uses during cleanup activities.	Minimal impacts to land management if response requires management action.
Recreation	Some recreational activities near shore could be affected.	Some recreational activities on or near the Kuskokwim River could be affected.	No effects to recreation	No effects to recreation.	*Alt 3B:* If spill occurred in the vicinity of the INHT in the winter, recreation could be highly impacted.	*Alt 3A:* No effects to recreation.	Some recreational activities on or near spill site could be affected.	Some recreational activities on or near spill site could be affected.	Some recreational activities on or near the Kuskokwim River could be affected.
Visual Resources	Strong visual contrast from the sheen of diesel on the surface compared to unaffected areas.	Strong visual contrast from the sheen of diesel on the surface compared to unaffected areas.	Some visual contrast from the diesel in the secondary containment facility against the surrounding environment.	Weak visual contrast from the diesel against the surrounding topography.	*Alt 3B:* Strong visual contrast from the sheen of diesel on the surface compared to unaffected areas.	*Alt 3A:* Some visual impacts, if vegetation in the immediate area were burned.	Some visual impacts from response efforts.	Some visual impacts from response efforts.	Some visual impacts from release and recovery efforts in impacted areas.
Socioeconomics	Little to no employment opportunities from response activities. Some commercial fisheries could be impacted.	Some employment opportunities from response activities. Some commercial fisheries could be impacted.	Some employment opportunities from response activities.	Little to no employment opportunities from response activities.	*Alt 3B:* Some employment opportunities from response effort. Some impacts to commercial and recreational fishing and/or tourism.	*Alt 3A:* No employment opportunities from response effort.	Little or no employment opportunities from response effort.	Little or no employment opportunities from response effort.	Some employment opportunities from response activities. Some commercial fisheries could be impacted.
Environmental Justice	Minority and low-income communities would likely not incur disproportionate adverse impacts.	A large spill could disproportionately impact minority and low-income communities.	Minority and low-income communities would not incur disproportionate adverse impacts.	Minority and low-income communities would not incur disproportionate adverse impacts.	*Alt 3B:* Minority and low-income communities would incur some disproportionate adverse impacts.	*Alt 3A:* Minority and low-income communities would not incur disproportionate adverse impacts.	Minority and low-income communities would not incur disproportionate adverse impacts.	Minority and low-income communities would not incur disproportionate adverse impacts.	Minority and low-income communities would incur some disproportionate adverse impacts.
Cultural Resources	Depending on location of the spill, there could be no impacts or high impacts.	Depending on location of the spill, there could be potentially high impacts.	No impacts to cultural resources.	Depending on location of the spill, there could be no impacts or high impacts.	*Alt 3B:* Depending on location of the spill, there could be no impacts or high impacts, particularly to the INHT.	*Alt 3A:* Little or no impacts to cultural resources.	Little or no impacts to cultural resources.	Little or no impacts to cultural resources.	Depending on location of the spill, there could be potentially high impacts.
Subsistence	Possible impacts to shoreline subsistence resources and access if spill were near shore.	Potentially high impacts to subsistence resources and access.	Little or no effect to subsistence resources and access.	Little or no effect to subsistence resources and access.	*Alt 3B:* Potentially high impacts to subsistence resources and access depending on location of spill.	*Alt 3A:* No impact to subsistence resources.	Potentially some effects to subsistence resources.	Potentially some effects to subsistence resources, as effects to birds and terrestrial mammals.	Potentially high impacts to subsistence resources and access.
Human Health	HECs that may indicate adverse effects are HEC 1, HEC 2, HEC 3, and HEC 4.	HECs that may indicate adverse effects are HEC 1, HEC 2, HEC 3, and HEC 4.	HECs that may indicate adverse effects are HEC 1, HEC 3, and HEC 4.	HECs that may indicate adverse effects are HEC 1, HEC 2, HEC 3, and HEC 4.	*Alt 3B:* HECs that may indicate adverse effects are HEC 1, HEC 2, HEC 3, and HEC 4.	*Alt 3A:* HECs that may indicate adverse effects are HEC 1, HEC 2, and HEC 3.	HECs that may indicate adverse effects are HEC 1, HEC 2, HEC 3, and HEC 4.	HECs that may indicate adverse effects are HEC 1, HEC 2, HEC 3, and HEC 4.	HECs that may indicate adverse effects are HEC 1, HEC 2, HEC 3, and HEC 4.
Transportation	Potential disruption of water transportation systems in the ocean.	Likely disruption of water transportation systems on the Kuskokwim River.	No effects to water, surface or air transportation.	No effects to water, surface or air transportation.	*Alt 3B:* Potential disruptions of air and surface transportation, particularly on airstrips and the INHT	*Alt 3A:* No effects to water, surface or air transportation.	Minimal effects to water, surface or air transportation.	Minimal effects to water, surface or air transportation.	Likely disruption of water transportation systems on Crooked Creek.