

**Donlin Gold**

# **Environmental Evaluation Document**

## **New Tailings Release Scenario Evaluations**

April 2026

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## Acronyms and Abbreviations

|                   |                                                 |
|-------------------|-------------------------------------------------|
| --                | not available or not applicable                 |
| µg/L              | micrograms per liter                            |
| ADEC              | Alaska Department of Environmental Conservation |
| ADF&G             | Alaska Department of Fish & Game                |
| AWQC              | Alaska Water Quality Criteria                   |
| cfs               | cubic feet per second                           |
| CWA               | Clean Water Act                                 |
| cy                | cubic yard                                      |
| DI                | deionized                                       |
| DOC               | dissolved organic carbon                        |
| EFH               | essential fish habitat                          |
| FEIS              | Final Environmental Impact Statement            |
| ft                | foot/feet                                       |
| FEMA              | Federal Emergency Management Agency             |
| FMAE              | Failure Mode and Effects Analysis               |
| GMU               | Game Management Unit                            |
| hrs               | hours                                           |
| ICOLD             | International Commission on Large Dams          |
| LNG               | liquid natural gas                              |
| km                | kilometer                                       |
| m <sup>3</sup> /s | cubic meters per second                         |
| mg/kg             | milligrams per kilogram                         |
| mg/L              | milligrams per liter                            |
| MWMP              | meteoric water mobility procedure               |
| NA                | not applicable                                  |
| ng/L              | nanograms per liter                             |
| ONC               | Orutsararmuit Native Council                    |
| TDS               | total dissolved solids                          |
| TSF               | Tailings Storage Facility                       |
| WQS               | water quality standards                         |
| YDNWR             | Yukon Delta National Wildlife Refuge            |
| Y-K               | Yukon-Kuskokwim                                 |

## 1.0 INTRODUCTION AND PURPOSE

This Environmental Evaluation Document (EED) provides supplemental analysis of a potential failure of the Main Dam at the Tailings Storage Facility (TSF) at the Donlin Gold Project (Project) in response to two orders issued by the U.S. District Court for the District of Alaska (Court) in *Orutsaramiut Native Council v. U.S. Army Corps of Engineers*, Case No. 3:23-cv-00071-SLG (D. Alaska). Donlin Gold has prepared this analysis to inform the U.S. Army Corps of Engineers' (Corps) preparation of a supplemental environmental impact statement (SEIS) that remedies the sole issue remanded—the need for analysis of a larger potential tailings release—by the Court. This document is organized consistent with Chapter 3.24, Spill Risk, of the April 2018 Final Environmental Impact Statement (FEIS) that the Corps prepared in cooperation with the Bureau of Land Management (BLM), the U.S. Fish and Wildlife Service, the Pipeline and Hazardous Materials Safety Administration, the U.S. Environmental Protection Agency, the State of Alaska, and the federally recognized Tribal governments of Akiak/Kuskokwim River Watershed Council, Crooked Creek, Chuathbaluk, Knik, Aniak, and Napaimute (US Army Corps of Engineers 2018).

The Court ordered the Corps and the BLM (collectively, Agencies) to analyze a potential tailings release larger than the release analyzed in detail in the FEIS. The Agencies in the 2018 FEIS analyzed a release of approximately 0.5% of the maximum TSF capacity, a representative volume of the potential release from two of the failure scenarios identified by a team of experts through the state-endorsed Failure Modes and Effects Analysis (FMEA) process. The Court specifically took issue with the FEIS' rationale for selecting that release volume for analysis. The Court identified evidence in the record, including evidence of failures at other dams, that it determined justified evaluation of a larger dam release. The Court did not criticize the use of an FMEA, nor the environmental analysis of the 0.5% release. The Court also did not vacate any authorizations for the Project.

It is important to note that the comparative analysis of the larger release scenarios set forth in this document is independent of the probability of any tailings dam failure event occurring. For reasons given in the 2018 FEIS and other record evidence, a tailings dam failure event of any size is extremely unlikely to occur at the Donlin Mine, due to the unique dam design, regulatory oversight, and mitigation measures, among other factors. Consistent with the court's directive, this study assumes the occurrence of a tailings dam failure and proceeds to analyze several different release scenarios that could result from such an event.

For comparison purposes, the EED retains analysis of the 0.5% release which consisted of a partial TSF Main Dam failure—as a result of either a liner rupture causing release through the TSF underdrain or a piping failure through the Main Dam—that would occur at the end of operations when the maximum volume of tailings is contained.

This EED provides analysis of three releases larger than the 0.5% release previously analyzed in the FEIS; these tailings release scenarios were selected based on a technical analysis of the proposed Donlin TSF Main Dam, as well as other dams. For each of these scenarios, Donlin conducted a failure assessment for the Donlin TSF Main Dam, which involved three steps (BGC Engineering Alaska, Inc. [BGC] 2025).

First, Donlin identified a technically feasible failure scenario that could lead to a complete failure of a dam resulting in a release larger than the 0.5% release.<sup>1</sup> Among the with larger failure scenarios considered in the FMEA for the 2018 ROD, the expert team identified a piping failure leading to dam failure as the most plausible, although still extremely unlikely failure scenario. The Alaska Department of Natural Resources

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<sup>1</sup> Technical feasibility is an assessment of technical plausibility (e.g., dam design features)—not analysis of likelihood/possibility.

(ADNR) also recommends consideration of piping failures for embankment dams, such as the Donlin Main dam. Specifically, this failure scenario entails a piping failure, initiated by poor construction QA/QC and liner defects, that leads to seepage through the dam that causes sloughing across the dam face. This sloughing then causes dam-wide collapse and settlement of the dam materials and overtopping resulting in a breach of the dam and downstream failure.<sup>2</sup> The scenario was also assumed to occur at the end of operations (i.e., the time of greatest capacity).<sup>3</sup>

Second, Donlin evaluated the potential tailings release sizes from the larger tailings failure scenario. Research conducted by various entities of TSF main dam failures around the world shows that large dam failures do not lead to release of all materials contained in tailings facilities. Instead, there is a wide-range of release volumes. To facilitate sound planning, peer-reviewed empirical methodologies have been developed to estimate release volumes based on TSF main dam failures from throughout the world. Donlin applied five of these empirical methodologies, some of which account for specific information about the Donlin TSF and identified a technical basis for evaluating between 5.4% and 24.6% release volumes. It was further concluded that given the specific design of the Donlin TSF and recognition in the literature that any release estimates are highly context- and project-specific, no particular larger release size is more likely than another.

Next, to determine which of the five volumes to model, Donlin then conducted a literature review and comparative assessment of the Donlin TSF main dam to other dam failures throughout the world. Donlin and BGC evaluated release sizes in other recent FEISs, as well as documented dam failures from throughout the world. BGC evaluated release sizes in other FEISs, as well as documented dam failure from throughout the world.

Over the past 25 years, especially since the recent development and implementation of the Global Industry Standard for Tailings Management (GISTM), dam design and regulation in the United States has improved, with the result that the compiled data shows that there has not been a failure of a TSF Main Dam built using the downstream design method like Donlin in the United States for decades.

Donlin has designed its TSF to specifically reduce the risk of a TSF Main Dam failure. The dam will be built in phases using a resilient downstream design. Following a robust pre-design investigation, Donlin will excavate the dam foundation to bedrock and use competent (i.e., hard, structurally sound, and resistant to weathering) rock for rockfill dam construction. The TSF will have a 60-mil. (0.06inch liner and seepage recovery system), will be permitted to treat and discharge excess water, and its water will be pumped out during reclamation (i.e. dry closure).

Specifically, downstream TSF main dams like that proposed for this project are significantly 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. TSF main dam failure frequency, IEEIRP (2015) found 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 TSF main dam failures documented worldwide by Rico et al. (2008) have occurred at large dams like the TSF Main Dam greater than 300 feet high. Failure risk of TSF main dams with no ponded water after mine closure, like that proposed for the post-

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2 A downstream failure is an uncontrolled release of stored water.

3 Piping occurs when water seeps through the dam structure, creating channels (or “pipes”) that erode the dam material.

Closure TSF, is small compared to dams in active operations with ponded water (IEEIRP 2015). For all of these reasons, a tailings dam failure event at Donlin is extremely unlikely to occur

Notwithstanding that a tailings dam failure is extremely unlikely to occur, Donlin proceeded to consider which release scenarios to evaluate, assuming such an event did happen. Given the lack of failures from comparable dams, rather than select a single size release, Donlin selected a range of larger releases for inundation modeling and analysis: 5.4%, 13.3% and 24.6% in addition to the modeling of 0.5% scenario. Donlin did not model a release based on the methodology that suggested the potential for a 36% or 38% release because the literature does not provide a single incidence of a historical dam failure that showed a comparable release volume. This is despite the fact that there are numerous modern tailings facilities in the world of similar capacity to the Donlin TSF. The development of these scenarios is detailed in *Donlin Gold Project: 2025 TSF Main Dam Breach Assessment* (BGC Engineering Alaska, Inc. 2025) as shown in Attachment A to this document.

Third, Donlin modeled the geographic extent of the flow of the tailings materials (i.e., an inundation model) for an overtopping failure initiated by piping that releases the four tailings volumes—0.5%, 5.4%, 13.3%, and 24.6%.<sup>4</sup> Given that a breach event is extremely unlikely to begin with, and the uncertainty as to which release scenario would occur should there be such a failure, this report evaluates the potential environmental impacts of each of those scenarios in this EED.

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4 As further explained herein, Donlin remodeled the 0.5% release scenario with the updated software used to model the other three scenarios to enable evaluation of the any changes that would require updating the impact analysis of the 0.5% release, which serves as a baseline for the analysis herein. Each of the four TSF Main Dam releases was modeled using the US Army Corps of Engineers-developed HEC-RAS software package (Version 6.6). The 0.5% release scenario was originally modeled using FLO-2D, a Federal Emergency Management Agency (FEMA) approved two-dimensional hydraulic model. To ensure consistency across and between this original release scenario and the three release scenarios developed subsequent, the 0.5% release scenario was re-modeled using the HEC-RAS software package.

## 2.0 DESCRIPTION OF SCENARIOS

### 2.1 ALTERNATIVE 2 – DONLIN GOLD’S PROPOSED ACTION – PARTIAL (0.5%) TAILINGS DAM FAILURE (FEIS SCENARIO 9)

In the FEIS, a release of 0.5% of the maximum volume of tailings was selected to be evaluated (AECOM 2015c):

**0.5% Release.** An unplanned release of up to 1,640 acre-feet (two million cubic meters [2.6 million cubic yards - 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. This is referred to as the 0.5% release scenario.

### 2.2 ALTERNATIVE 2 – DONLIN GOLD’S PROPOSED ACTION – LARGER TAILINGS DAM FAILURE (SCENARIOS 9A, 9B, AND 9C)

As presented in Section 1.0, three additional TSF Main Dam release scenarios/volumes are evaluated in this EED:

**5.4% Release.** An unplanned release of approximately 21 million cubic meters [~27.5 million cy] of tailings and contaminated water from the TSF from a breach of the TSF Main Dam and resulting downstream failure; this is referred to herein as the 5% scenario.

**13.3% Release.** An unplanned release of approximately 55 million cubic meters [~71.5 million cy] of tailings and contaminated water from the TSF from a breach of the TSF Main Dam and resulting downstream failure; this is referred to herein as the 13% scenario.

**24.6% Release.** An unplanned release of approximately 106 million cubic meters [~138.5 million cy] of tailings and contaminated water from the TSF from a breach of the TSF Main Dam and resulting downstream failure; this is referred to herein as the 25% scenario.

### 2.3 FATE AND BEHAVIOR OF RELEASED MATERIALS

This section discusses how materials associated with a TSF Main Dam failure behave when released into the environment.

#### 2.3.1 Tailings Dam Release

At the inception of each scenario, a flood wave would originate at the TSF and move down Anaconda Creek and Crooked Creek and then to the Kuskokwim River. The flood wave that would be generated by a breach of the Donlin TSF Main Dam under each scenario is considered non-Newtonian<sup>5</sup> as it moves down Crooked Creek. For all four scenarios, the volume of tailings released is much larger than the Anaconda Creek and Crooked Creek's flows, and the influence of these creeks' flow on the properties of the

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5 Non-Newtonian fluids display variable viscosity under different forces: their resistance to flow can change depending on how fast or forcefully they are being stirred or poured. Ketchup is an example: when you squeeze a bottle or tap it, the ketchup becomes less viscous and flows more easily.

Newtonian fluids adhere to Newton's law of viscosity, which states that the viscosity (internal resistance to flow) remains constant regardless of the applied shear force. In simpler terms, when you stir or pour a Newtonian fluid, its viscosity doesn't change with the intensity of the force. Water exemplifies this behavior: no matter how hard or gently you stir it, water's viscosity remains constant, allowing for predictable and consistent flow.

tailings is negligible. However, once the flood wave discharges into the Kuskokwim River, it is expected that the tailings within the flow will be mixed and diluted, thereby exhibiting Newtonian fluid behavior.

To capture both the non-Newtonian and Newtonian flow regimes, two hydraulic models were developed. One model was configured to simulate the non-Newtonian flows along Crooked Creek, while the other model was set up for Newtonian flow conditions along the Kuskokwim River. Details regarding the model setup, inputs, assumptions, limitations, and results are presented in *Donlin Gold Project: 2025 TSF Main Dam Breach Assessment* (BGC 2025) as shown in Attachment A.

The FEIS addressed, at a high level, the differences between a partial TSF Main Dam failure occurring in the winter months and a failure occurring in the summer months; this text is presented below (see also Section 3.24.4.5 of the FEIS). The disposition of tailings under any of the larger release scenarios would not be seasonally-affected.

### **2.3.1.1 Scenario 9: Partial Tailings Dam Failure**

In the partial TSF Main Dam failure release scenario, there are seasonal differences:

- Winter: In the winter months, at least some of the released tailings could be excavated and transported back to the TSF 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.

### **2.3.1.2 Scenarios 9a, 9b, and 9c: Larger Tailings Dam Failure**

The pattern of tailings deposition in Crooked Creek resulting from any of the larger TSF Main Dam failures would be the same regardless of the season given the very large volume of tailings; the non-Newtonian modeling of Crooked Creek drainage discounts water flow in the Creek, and thus the flow and deposition in the drainage would not be seasonally affected.

In the winter months, at least some of the released tailings could be excavated and transported back to a rebuilt tailings facility thereby reducing, to some small degree, the impact of the release during the following spring thaws and open water season flows. It is likely that response activities—tailings excavation and removal—would be initially focused in the village of Crooked Creek, with further excavation work focused as part of restoration activities in Crooked Creek. Given the volume of the released tailings under any of these scenarios, and the likely multi-year removal and restoration activities, released tailings that are deposited in Crooked Creek would be mobilized during the initial spring thaw following release and for multiple following thaws and open water seasons until tailings are removed (mechanically or through natural processes) or are covered by sediments transported from unaffected upstream areas. Water released with the tailings would penetrate underlying materials, and it is likely that none of the contaminated fluids could be recovered.

## **2.3.2 Release Scenarios**

This section summarizes the potential release causes and volume estimates that might result directly or indirectly from the release of tailings from behind the dam under Scenario 9 and Scenarios 9a, 9b, and 9c.

These scenarios are conceptual views of the future and represent four potential releases. The primary purpose of the scenarios is to provide a common basis for the analysis of potential environmental impacts.

A release of tailings would reach 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). A release could occur any time during the year.

### **2.3.2.1      *Scenario 9: Partial Tailings Dam Failure***

An inundation study was conducted for the selected release scenario of up to 2.6 million cy (i.e. 0.5%) to estimate the potential downstream consequences of an outflow of tailings. (BGC 2015n). The impacts of this 0.5% release under both scenarios are set forth in FEIS Section 3.24. 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 be released. The water-only release model results presented in the FEIS are not discussed here as the larger TSF Main Dam failure scenarios necessarily will include both water and tailings. There is no water-only release possible under these scenarios and so it was not modelled. For the full 0.5% analysis, see FEIS Section 3.24.5.9.

### **2.3.2.2      *Scenarios 9a, 9b, and 9c: Larger Tailings Dam Failure***

For the larger TSF Main Dam failure scenarios, an inundation study was conducted for the 5%, 13%, and 25% release scenarios to estimate the potential downstream consequences of an outflow of tailings (BGC 2025). For these release scenarios, BGC modelled a release of a mixture of process-affected water and tailings.

Under each of the larger TSF Main Dam failures, the tailings slurry (comprising water and suspended solids) would travel the length of Crooked Creek to the Kuskokwim River. Suspended solids (tailings) entering the Kuskokwim River would be carried in suspension downstream until settling out in low-energy portions of the system (sloughs, inside of river bends, and backwaters) or in Kuskokwim Bay.

Under each of the scenarios, tailings would be deposited along the length of Anaconda Creek downstream of the TSF Main Dam, and along the length of Crooked Creek from the confluence of Anaconda Creek downstream to its mouth at the Kuskokwim River; tailings would also be deposited in Crooked Creek upstream of Anaconda Creek for a distance of between approximately 0.5 and 2 linear miles.

The modelled tailings deposition depths vary across the scenarios as shown in Figures 2.3.3, 2.3.4, and 2.3.5 and as summarized below:

- Under the 5% release scenario
  - Along Anaconda Creek, deposition depths vary from less than 1 foot to approximately 10 feet at the base of the TSF Main Dam.
  - Along Crooked Creek, deposition depths vary from less than 1 foot to approximately 15 feet.
  - Tailings deposition would be confined to an approximately 1.1-mile long section of Crooked Creek, with tailings deposited upstream and downstream from Anaconda Creek.
- Under the 13% release scenario

- Along Anaconda Creek, deposition depths vary from less than 1 foot to approximately 10 feet at the base of the TSF Main Dam.
- Along Crooked Creek, deposition depths vary from less than 1 foot to approximately 18 feet.
- Tailings deposition would be realized for a distance of approximately 1.5 linear miles upstream in Crooked Creek from the Anaconda Creek confluence, and downstream to the Kuskokwim River.
- Under the 25% release scenario
  - Along Anaconda Creek, deposition depths vary from less than 1 foot to approximately 13 feet at the base of the TSF Main Dam.
  - Along Crooked Creek, deposition depths vary from less than 1 foot to approximately 35 feet at the mouth of the creek at the Kuskokwim River.
  - Tailings deposition would be realized for a distance of approximately 2.3 miles upstream in Crooked Creek from the Anaconda Creek confluence, and downstream to the Kuskokwim River.

The total volume of tailings that may be deposited in Crooked Creek and that may be discharged to the Kuskokwim River during the initial release are presented in Table 2.3-1. Under each of the three scenarios, flow in Crooked Creek would be blocked by the deposited tailings, the depths of which would range up to approximately 35 feet.

**Table 2.3-1 Disposition and Deposition of Tailings**

| <b>Scenario</b> | <b>Total Release Volume (acre-feet)</b> | <b>Pond Volume (acre-feet)</b> | <b>Total Tailings Release Volume (acre-feet)</b> | <b>Deposition in Crooked Creek (acre-feet)</b> | <b>Discharged to Kuskokwim River (acre-feet)</b> |
|-----------------|-----------------------------------------|--------------------------------|--------------------------------------------------|------------------------------------------------|--------------------------------------------------|
| 9. 0.5% Release | 1,670                                   | 0                              | 1,670                                            | 1,630                                          | 0                                                |
| 9a. 5% Release  | 27,640                                  | 9,730                          | 17,910                                           | 11,495                                         | 9,730                                            |
| 9b. 13% Release | 54,080                                  | 9,730                          | 44,350                                           | 40,780                                         | 13,300                                           |
| 9c. 25% Release | 91,870                                  | 9,730                          | 82,140                                           | 61,464                                         | 30,406                                           |

Source: BGC 2015n, BGC 2025

Characteristics of the flows associated with each of the Scenarios are presented in Table 2.3-2. The chemical composition of the materials that would be released under a larger TSF Main Dam failure (Scenarios 9a, 9b, and 9c) is the same as those for the 0.5% TSF Main Dam failure (Scenario 9).

Table 2.3-2      Summary of Modelling Results for Tailings Dam Failure Scenarios

| Material Released         | Confluence of Crooked Creek and Anaconda Creek<br>(1.6miles from TSF) |                            |                            | Confluence of Crooked Creek and Kuskokwim River<br>(13 miles from TSF) |                            |                            | Kuskokwim River at Chuathbaluk<br>(71 miles from TSF) |                            |                            | Kuskokwim River at Aniak<br>(81 miles from TSF) |                            |                            | Kuskokwim River at Kalskag<br>(114 miles from TSF) |                            |                            |
|---------------------------|-----------------------------------------------------------------------|----------------------------|----------------------------|------------------------------------------------------------------------|----------------------------|----------------------------|-------------------------------------------------------|----------------------------|----------------------------|-------------------------------------------------|----------------------------|----------------------------|----------------------------------------------------|----------------------------|----------------------------|
|                           | Total Duration<br>(hr)                                                | Front Arrival Time<br>(hr) | Maximum Flow Depth<br>(ft) | Total Duration<br>(hr)                                                 | Front Arrival Time<br>(hr) | Maximum Flow Depth<br>(ft) | Total Duration<br>(hr)                                | Front Arrival Time<br>(hr) | Maximum Flow Depth<br>(ft) | Total Duration<br>(hr)                          | Front Arrival Time<br>(hr) | Maximum Flow Depth<br>(ft) | Total Duration<br>(hr)                             | Front Arrival Time<br>(hr) | Maximum Flow Depth<br>(ft) |
| Water and Tailings (0.5%) | 1                                                                     | 0:20                       | 15.1                       | --                                                                     | --                         | --                         | --                                                    | --                         | --                         | --                                              | --                         | --                         | --                                                 | --                         | --                         |
| Water and Tailings (5%)   | 2                                                                     | 0:20                       | 28.7                       | 10                                                                     | 2:20                       | 16.6                       | 45                                                    | 16:25                      | 10.2<br>(9.1)              | 51                                              | 19:20                      | 10.1<br>(9.3)              | 70                                                 | 44:30                      | 9.9<br>(9.2)               |
| Water and Tailings (13%)  | 2                                                                     | 0:20                       | 38.3                       | 5                                                                      | 2:10                       | 19.6                       | 45                                                    | 16:05                      | 10.2<br>(9.1)              | 51                                              | 19:00                      | 10.1<br>(9.3)              | 70                                                 | 45:00                      | 9.9<br>(9.2)               |
| Water and Tailings (25%)  | 2                                                                     | 0:20                       | 47.3                       | 5                                                                      | 1:45                       | 28.2                       | 52                                                    | 13:45                      | 11.4<br>(9.1)              | 60                                              | 16:30                      | 10.9<br>(9.3)              | 83                                                 | 37:10                      | 10.4<br>(9.2)              |

Notes:  
Maximum flow depths are depths above the USGS (2022) DEM surface. For the Kuskokwim River, that surface represents an approximate flow of 32,100 cubic feet per second (cfs; 910 cubic meters per second [m³/s]). The depth associated with that flow is not known. An additional Kuskokwim flow of 36,700 cfs (1040 m³/s) was added to the breach model to represent a total baseflow of 68,900 cfs (1950 m³/s). The maximum flow depths in parentheses for the Kuskokwim River sites represent the flow depths associated with the 36,700 cfs (1040 m³/s) of Kuskokwim River flow added to the hydraulic model.

Source: BGC 2025

### **2.3.3 Response and Remediation**

As discussed in the FEIS, this area is not currently being mined in a manner which produces mine tailings; therefore, no plan or capacity for response is presently available. New plans and response capacities would be required for the proposed project, which would be detailed in the Emergency Action Plan (EAP) required under Alaska Department of Natural Resources (ADNR) dam safety permitting (FEIS Section 3.24.1.5). These capacities would rely on 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.

Under the 0.5% release scenario, response measures would include ensuring the safety of mine employees and downstream residents, including in Crooked Creek; stabilizing the TSF breach; and implementing remedial actions to minimize impacts to and restore affected resources. Remedial actions would include removing the tailings from the primary depositional area at the Crooked Creek confluence and in areas up- and downstream to the extent practicable.

Under the 5%, 13%, and 25% release scenarios, it is likely that initial response activities—tailings excavation and removal—would be focused in the village of Crooked Creek, with further response activities focused as part of restoration activities in Crooked Creek.

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 initial summer after a release 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 be accomplished on packed snow trails, and removal of deposited material may be more effective because the ground and creek would likely be frozen. All-season access for restoration and remediation activities may be improved through the post-release construction of a road along Crooked Creek.

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).

### **2.3.4 Release Scenario Impacts**

This section examines potential effects of the 5%, 13%, and 25% release scenarios. The FEIS evaluated both “Water Release Only” and “Tailings and Water Release” scenarios for a 0.5% release. However, the 5%, 13%, and 25% release scenarios include substantially larger volumes of tailings relative to free decant pond water (see Table 2.3.2), and therefore the discussion below considers only tailings and water release scenarios.

### **2.3.4.1 *Geology***

#### **2.3.4.1.1 Alternative 2 – Donlin Gold’s Proposed Action**

##### **2.3.4.1.1.1 Scenario 9**

Please see the discussion in FEIS Section 3.24.6.1.

##### **2.3.4.1.1.2 Scenarios 9a, 9b, and 9c: Larger Tailings Dam Failure**

Effects of project-related releases on geological and paleontological resources for a 0.5% release scenario are considered very similar to impacts described for soils in Section 2.3.5.2 below. For a release of tailings and water, the tailings could conceivably be excavated and removed, reducing long-term impacts. Impacts from contaminated water would presumably seep into bedrock fractures and could impact a wide area, and remediation would be difficult.

The impacts to bedrock and paleontological resources under any of the three larger tailings release scenarios would be similar to those described for Scenario 9 in the FEIS, but over a greater spatial extent, given the much larger release volumes. Impacts due to tailings deposition would be most significant within the Crooked Creek drainage, where scour (and potential impacts to paleontological resources) would be realized and where deposition of tailings and entrained contaminated water would be greatest. Given the much larger release volumes, excavation and removal of tailings would itself likely result in additional damage to paleontological resources if present, and completing this excavation/removal may be impractical over much of the impacted area. As with Scenario 9, it is anticipated that contaminated water would seep into bedrock fractures in sections of Crooked Creek; however, the potential for seepage of contaminated water into bedrock fractures would be substantially reduced in the Kuskokwim River.

### **2.3.4.2 *Soils***

#### **2.3.4.2.1 Alternative 2 – Donlin Gold’s Proposed Action**

##### **2.3.4.2.1.1 Scenario 9**

See the discussion in FEIS Section 3.24.6.2.1, which describes the physical and chemical impacts of a 0.5% release.

##### **2.3.4.2.1.2 Scenarios 9a, 9b, and 9c: Larger Tailings Dam Failure**

Like the 0.5% release, the larger TSF release scenarios would cause significant impacts to undisturbed soils located downstream of the TSF Main Dam toe, but on a much larger scale.

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. Based on the modeling evaluation completed by BGC (2015n), whereas the tailings deposition under the 0.5% release scenario would be largely limited to Anaconda Creek and areas of Crooked Creek upstream of Eagle and Crevice Creeks, the larger release scenarios would result in substantial tailings mobilization and deposition through the entire extent of Crooked Creek between the Anaconda Creek and Kuskokwim River confluences, with estimated tailings deposition thicknesses on the order of 10 feet or more for the 5% scenario, and 30 feet or more for the 13% and 25% scenarios. Soil scouring and deposition, including relative impacts during winter versus summer months, would apply

throughout the extent of Crooked Creek. Chemical impacts to soil would be derived from the tailings and water (supernatant or porewater) released from the TSF.

As in the smaller 0.5% release, based on a screening review of analyte concentrations for TSF tailings compared to ADEC (2017b) soil cleanup level guidelines, the analytes of concern for the larger releases 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 based on general project concerns (as stated in the FEIS) 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 2.3-3 for the purpose of comparison to solids concentrations, and to identify potential contaminated water impacts to soils. However, release impacts to surface and groundwater quality are addressed separately in sections 2.3.5.7 and 2.3.5.8.

**Table 2.3-3 Media and Analytes of Concern for Soil Impacts from TSF Release Scenarios**

| Parameter | Tailings Solids:<br>Feasibility Plot (Phase 2)<br>Final Tailings Filtrate 2007 <sup>1</sup><br>(mg/kg) | Tailings Water:                       |                                                            | ADEC Soil Cleanup Levels                     |                                                          | ADEC Groundwater Cleanup Levels <sup>5</sup><br>(mg/L) |
|-----------|--------------------------------------------------------------------------------------------------------|---------------------------------------|------------------------------------------------------------|----------------------------------------------|----------------------------------------------------------|--------------------------------------------------------|
|           |                                                                                                        | TSF Pond Water <sup>2</sup><br>(mg/L) | Tailings Porewater, Buried Tailings <sup>2</sup><br>(mg/L) | Human Health Pathway <sup>3</sup><br>(mg/kg) | Migration to Groundwater Pathway <sup>4</sup><br>(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 <sup>6</sup>                           | 3.9/180 <sup>6</sup>                                     | 0.0057/0.002 <sup>6</sup>                              |
| Thallium  | 0.9 <sup>7</sup>                                                                                       | 0.00041                               | 0.00041                                                    | 1.0                                          | 0.19                                                     | 0.0002                                                 |

This table was numbered Table 3.24-11 in the FEIS.

**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 exceed ADEC groundwater cleanup level.

As shown in Table 2.3-3, 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. These concerns would qualitatively be the same under the 0.5% release and the three larger release scenarios, but to a substantially greater spatial extent under the larger scenarios. Potential impacts to groundwater and surface water are discussed further in Sections 2.3.5.7 and 2.3.5.8.

Excavation and removal of tailings under the larger release scenarios would take substantially more time and effort to complete than under the partial (0.5%) release scenario. This effort would likely take years; complete removal of tailings from all affected areas would likely be infeasible, and removal of the tailings would necessarily require removal of comingled soil as well, resulting in additional detrimental impacts to the alluvial soil system on Crooked Creek.

Simulations suggest that whereas tailings sedimentation will be substantial within Crooked Creek, flow in the Kuskokwim River will largely contain suspended solids that will be transported over large distances. Although these suspended solids will still settle out in the river to some extent, it is anticipated to result in much finer silty sediment that will not accumulate to the same thicknesses as in Crooked Creek. The result will be a much thinner blanket of tailings but spread over distances of miles, which will be infeasible to remove without causing substantially greater disturbance of native soil than leaving the tailings in place.

### **2.3.4.3     *Geohazards and Seismic Conditions***

#### **2.3.4.3.1     *Alternative 2 – Donlin Gold’s Proposed Action***

For all releases modeled, the effects of project-related releases on geohazards are considered not applicable, as releases would not impact geohazards; rather geohazards could cause or exacerbate releases or responses. The role of geohazards in potentially causing releases are incorporated into the analysis of effects in FEIS Section 3.3, Geohazards and Seismic Conditions, and the potential impact of these events on other resources are addressed in individual resource sections.

### **2.3.4.4     *Surface Water Hydrology***

#### **2.3.4.4.1     *Alternative 2 – Donlin Gold’s Proposed Action***

##### **2.3.4.4.1.1     Scenario 9**

For the discussion of impacts on surface water hydrology as the result of a 0.5% release, see FEIS Section 3.24.6.5.1.

##### **2.3.4.4.1.2     Scenarios 9a, 9b, and 9c: Larger Tailings Dam Failure**

Under both the 0.5% and the larger release scenarios, the tailings water and solids would have similar qualitative effects on the hydrology of the Crooked Creek drainage, but with substantially greater impacts and to a much larger spatial extent under a larger release. The larger release scenario simulation results

were completed by BGC (2025) and are summarized in Section 2.3.2. The BGC evaluation provides the anticipated flow rates, timing, and stage heights of the flood wave under each scenario. For the three larger scenarios (5%, 13%, and 25%, respectively), the peak discharge predicted for the community of Crooked Creek varies from approximately 130,000 cfs, to 170,000 cfs, up to 420,000 cfs, reaching the Kuskokwim River confluence within approximately 3 hours but continuing to flow with a hydrograph tail running 4 to 6 hours or more before subsiding (Figure 6-2 in BGC 2025). This can be compared to the peak average streamflow of approximately 1,600 cfs (occurring in May following breakup), calculated from 2007-2024 (BGC 2025). The Crooked Creek maximum water level rise at this location is predicted to be between 10 and 30 feet under baseflow conditions. Accordingly, the releases would be anticipated to have substantial but short-term effects on surface water flow rates, but noting that the flowing fluid would be a thick tailings slurry mixture that would deposit and remain in place as the flow rate subsides.

This flood wave would be relatively dispersed in the Kuskokwim River; for example, at the community of Chuathbaluk (the nearest downstream community from the Crooked Creek/Kuskokwim River confluence), peak discharge would occur at approximately 24 hours and would be anticipated to raise the flow rate from approximately 69,000 cfs under baseflow conditions up to values of 79,000, 78,000, and 89,000 cfs (5%, 13%, and 25% release scenarios, respectively; Figure 6-3 in BGC 2025)<sup>6</sup>. River stage under baseflow conditions would not be predicted to rise more than approximately 1 to 2.5 feet at Chuathbaluk under any of the larger releases, while peak water level rises are similar or smaller at the further downgradient communities of Aniak and Kalskag. At each of these locations, the floodwave is anticipated to remain within the established riverbank.

As discussed in Section 2.3.5.2, tailings deposition is anticipated to be limited in the Kuskokwim River relative to Crooked Creek, particularly in the main channel. Based on simulations conducted by BGC (2025), approximately 80 to 90 percent of the tailings not deposited in Crooked Creek are anticipated to represent silts and clays that will largely remain in suspension, likely reaching the Bering Sea. For these fine particulates, any leachable constituents associated with them will desorb rapidly and be diluted with Kuskokwim River water; to the extent that these released constituents affect surface water quality (described further in Section 2.3.4.6), these impacts will be short-lived and will transport downgradient with the flood wave. The other 10 to 20 percent reaching the Kuskokwim River would likely be deposited in slower side channels following substantial dilution and dispersion in the river. As such, surface water hydrology impacts are expected to be minimal within the Kuskokwim River, even under the larger release scenarios.

Longer term effects on surface water hydrology will be realized in Crooked Creek under each of the larger release scenarios. The effects would be similar to Scenario 9 described in Section 2.3.5.5.1.1, but at a much greater magnitude. As described for Scenario 9, it is anticipated that tailings accumulation at the Anaconda/Crooked Creek confluence would result in blockage of upstream flow and water accumulation. However, this temporary blockage would extend all the way down to the confluence with the Kuskokwim River. Backup of water behind the tailings would result in overflow and generation of new stream channels over top and around the sides of the tailings surface, until tailings could be excavated. As such, alteration of stream channel morphology would extend through the full length of Crooked Creek between the Anaconda Creek and Kuskokwim River confluences.

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<sup>6</sup> Although nonintuitive, the tailings release scenarios conducted by BGC indicated a greater release volume reporting to the Kuskokwim River under the 5% release scenario than under the 13% release scenario. As described by BGC (2025), this result is attributable to the different rheological properties of the tailings depending on the size of the release. For the 5% release scenario, the tailings exhibit a lower yield stress and plastic viscosity than under the 13% and 25% scenarios; as such, a greater relative proportion of the tailings migrate past Crooked Creek to reach the Kuskokwim River under the 5% scenario.

### **2.3.4.5 Groundwater Hydrology**

#### **2.3.4.5.1 Alternative 2 – Donlin Gold’s Proposed Action**

##### **2.3.4.5.1.1 Scenario 9**

For the discussion of impacts on groundwater hydrology as the result of a 0.5% release, see FEIS Section 3.24.6.6.1.

##### **2.3.4.5.1.2 Scenarios 9a, 9b, and 9c: Larger Tailings Dam Failure**

Potential effects on groundwater hydrology would be more widespread under a larger TSF Main Dam scenario than the 0.5% scenario, particularly due to tailings deposition, based on results of simulations developed by BCG (2025). Specifically:

- Whereas a 0.5% TSF Main Dam release would result in a water level rise of approximately 1 foot at the Crooked Creek/Kuskokwim River confluence (adjacent to the community of Crooked Creek), a larger release scenario would result in a water level rise of between 10 and 30 feet. However, due to the very short duration of the flood wave of a few hours, the flood wave itself is still anticipated to have a minimal or negligible effect on groundwater, lasting up to a few days.
- However, as described in Section 2.3.5.2, tailings deposition under a larger release would be extensive throughout Crooked Creek, including tailings deposition to between 10 and 30 feet or more near the Crooked Creek/Kuskokwim River confluence. Unlike the 0.5% release scenario, the larger release scenarios would potentially result in water and tailings intersecting a portion of the groundwater protection area for the Crooked Creek community well. For this reason, tailings excavation activities would likely be prioritized within the village of Crooked Creek.
- As with the 0.5% partial tailings release, tailings deposition of several feet would likely result in water table mounding. This would result in localized groundwater flow away from the Creek in the near term, but since this mounding effect would span the length of Crooked Creek, groundwater levels would eventually rise to discharge at the level of the tailings deposit surface. This effect would last for the duration of tailings removal activities, and to the extent that it results in the recharge of groundwater from tailings pore water, it would have the potential to impact groundwater quality (discussed further in Section 2.3.5.8).
- Due to the minimal water level rise and dispersed tailings deposition in the Kuskokwim River, effects of a larger TSF Main Dam release on groundwater hydrology along the Kuskokwim River would be minimal to negligible. Although the groundwater protection areas for the Aniak and Kalskag community wells overlap the Kuskokwim River (whereas the groundwater protection area for the Chuathbaluk groundwater well does not), it is highly unlikely that groundwater resources would be affected within Aniak and Kalskag given the relatively low water level rise and short duration of the flood wave (discussed in Sections 2.3.2 and 2.3.5.5.1.2).

### **2.3.4.6 Water Quality, Surface Water Quality**

#### **2.3.4.6.1 Alternative 2 – Donlin Gold’s Proposed Action**

##### **2.3.4.6.1.1 Scenario 9**

For the discussion of impacts on surface water quality as the result of a 0.5% release, see FEIS Section 3.24.6.7.1.

#### 2.3.4.6.1.2 Scenarios 9a, 9b, and 9c: Larger Tailings Dam Failure

For all releases modeled, released media would include TSF tailings (solids) and/or water. Water quality impacts would vary based on chemical attributes unique to each media, and they would also depend on seasonally dependent physical and chemical conditions at the time of release. Concentrations of analytes expected to exceed the most stringent Alaska Water Quality Criteria (AWQC) in TSF pond water and pore-water in buried tailings are summarized in Table 2.3-4. It is 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.

Meteoric water mobility procedure (MWMP) test results were also used to evaluate potential chemical impacts to surface water under the tailings mixture release scenarios. MWMP test results from the 2007 Phase 2 pilot-plant transitional final tailings are provided in Table 2.3-4 for the same analytes as those anticipated to exceed AWQC in pond water (note that no other analytes measured via MWMP exceeded AWQC, and therefore no additional analytes are included in this table). 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 TSF Main 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 over relatively long timescales (e.g., up to decades).

Analytes in either pond water, tailings pore water, or tailings leachate (as measured by MWMP) that exceed AWQC are highlighted yellow in Table 2.3-4. 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. 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). It is also anticipated that under a release scenario, dissolved iron above the AWQC in tailings pore water would oxidize and precipitate on exposure to air and Creek water.

Analytes with reported values above AWQC in MWMP leachate (the “Leachate” column in Table 2.3-4) include sulfate, arsenic, manganese, antimony, and molybdenum. In addition to the standard MWMP leachate, additional rinses with deionized (DI) water were performed to evaluate response to subsequent continued rinsing from natural precipitation (DI Rinse 1 through 4; Table 2.3-4). The MWMP results indicate that whereas sulfate, antimony, arsenic, and manganese persist in leachate through the fourth DI rinse, molybdenum concentrations decrease to below the AWQC by the third DI rinse.<sup>7</sup>

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<sup>7</sup> In addition to MWMP results, kinetic humidity cell tests were also conducted (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, consistent with the MWMP results. In contrast, sulfate concentrations in leachate dropped below the AWQC standard of 250 mg/L after week five of testing. The results indicate that sulfate concentrations in leachate from deposited tailings above AWQC could be comparatively short in duration.

**Table 2.3-4 Tailings Pond Water Quality, Tailings Pore Water Quality, and 2007 Phase 2 Pilot Plant Transitional Tailings Solids MWMP Dissolved Constituent Results for Regulated Analytes of Concern**

| Parameter                 | Units | AWQC                    | Tailings Pond Water <sup>4</sup> | Tailings Pore Water <sup>4</sup> | MWMP Leachate <sup>5</sup> | MWMP 1st DI Rinse <sup>5</sup> | MWMP 2nd DI Rinse <sup>5</sup> | MWMP 3rd DI Rinse <sup>5</sup> | MWMP 4th DI Rinse <sup>5</sup> |
|---------------------------|-------|-------------------------|----------------------------------|----------------------------------|----------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
| <b>Major Constituents</b> |       |                         |                                  |                                  |                            |                                |                                |                                |                                |
| pH                        | s.u.  | 6.5-8.5 <sup>1</sup>    | 6.5                              | 5.8                              | 6.85                       | 6.86                           | 6.73                           | 6.65                           | 7.06                           |
| Fluoride                  | mg/L  | 1 <sup>2d</sup>         | 2                                | 2                                | 0.45                       | 0.50                           | 0.47                           | 0.30                           | 0.27                           |
|                           |       |                         | 2x                               | 2x                               | --                         | --                             | --                             | --                             | --                             |
| Sulfate                   | mg/L  | 250 <sup>1</sup>        | 5,800                            | 4,400                            | 2,000                      | 1,900                          | 1,500                          | 850                            | 1,600                          |
|                           |       |                         | 23x                              | 18x                              | 8x                         | 7.6x                           | 6x                             | 3.4x                           | 6.4x                           |
| TDS                       | mg/L  | 500 <sup>1</sup>        | --                               | 7,779                            | 2,900                      | 2,820                          | 2,370                          | 1,160                          | 1,440                          |
|                           |       |                         | --                               | 16x                              | 5.8x                       | 5.6x                           | 4.7x                           | 2.3x                           | 2.9x                           |
| <b>Metals</b>             |       |                         |                                  |                                  |                            |                                |                                |                                |                                |
| Antimony                  | mg/L  | 0.006 <sup>2c</sup>     | 0.022                            | 1.1                              | 0.0393                     | 0.0448                         | 0.0431                         | 0.0239                         | 0.0222                         |
|                           |       |                         | 3.7x                             | 183.3x                           | 6.6x                       | 7.5x                           | 7.2x                           | 4x                             | 3.7x                           |
| Arsenic                   | mg/L  | 0.010 <sup>2c</sup>     | 3.3                              | 15                               | 0.463                      | 0.506                          | 0.5                            | 0.412                          | 0.402                          |
|                           |       |                         | 330x                             | 1500x                            | 46x                        | 51x                            | 50x                            | 41x                            | 40x                            |
|                           | mg/L  | 0.150 <sup>2b</sup>     | 3.3                              | 15                               | 0.463                      | 0.506                          | 0.5                            | 0.412                          | 0.402                          |
|                           |       |                         | 22x                              | 100x                             | 3x                         | 3x                             | 3x                             | 3x                             | 3x                             |
| Cadmium                   | mg/L  | 0.00064 <sup>2a,b</sup> | 0.00073                          | 0.00073                          | 0.000083                   | 0.000061                       | 0.000043                       | 0.000017                       | 0.000045                       |
|                           |       |                         | 1.1x                             | 1.1x                             | --                         | --                             | --                             | --                             | --                             |
| Iron                      | mg/L  | 1 <sup>2b</sup>         | 0.0044                           | 98                               | 0.03                       | 0.05                           | 0.02                           | <0.01                          | 0.03                           |
|                           |       |                         | --                               | 98x                              | --                         | --                             | --                             | --                             | --                             |
| Manganese                 | mg/L  | 0.200 <sup>2d</sup>     | 2                                | 2                                | 3.27                       | 3.14                           | 2.06                           | 0.870                          | 0.966                          |
|                           |       |                         | 40x                              | 40x                              | 65x                        | 63x                            | 41x                            | 17x                            | 19x                            |
| Molybdenum                | mg/L  | 0.010 <sup>2d</sup>     | 0.23                             | 0.23                             | 0.0368                     | 0.0309                         | 0.0115                         | 0.00268                        | 0.00477                        |
|                           |       |                         | 23x                              | 23x                              | 4x                         | 3x                             | 1x                             | --                             | --                             |
| Selenium                  | mg/L  | 0.0046 <sup>2b</sup>    | 0.042                            | 0.042                            | 0.004                      | 0.003                          | <0.001                         | <0.001                         | <0.001                         |
|                           |       |                         | 9x                               | 9x                               | --                         | --                             | --                             | --                             | --                             |

**Table 2.3-4 Tailings Pond Water Quality, Tailings Pore Water Quality, and 2007 Phase 2 Pilot Plant Transitional Tailings Solids MWMP Dissolved Constituent Results for Regulated Analytes of Concern**

| Parameter | Units | AWQC             | Tailings Pond Water <sup>4</sup> | Tailings Pore Water <sup>4</sup> | MWMP Leachate <sup>5</sup> | MWMP 1st DI Rinse <sup>5</sup> | MWMP 2nd DI Rinse <sup>5</sup> | MWMP 3rd DI Rinse <sup>5</sup> | MWMP 4th DI Rinse <sup>5</sup> |
|-----------|-------|------------------|----------------------------------|----------------------------------|----------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
| Mercury   | ng/L  | 12 <sup>2b</sup> | 10,000 <sup>3</sup>              | 10,000 <sup>3</sup>              | 0.000010                   | 0.000010                       | 0.000007                       | 0.000005                       | 0.000003                       |
|           |       |                  | 833x                             | 833x                             | --                         | --                             | --                             | --                             | --                             |

**Notes:**

All tailings pond water and pore-water concentrations are “dissolved” and should be used as “average” annual.

TDS = total dissolved solids

AWQC values provided are the most stringent among values provided in 18 AAC 70 and the Alaska Water Quality Criteria Manual (considering drinking water, irrigation water, and freshwater aquatic life chronic standards), as noted below. Two values are provided for arsenic, since the freshwater aquatic life chronic standard is higher than the drinking water standard, providing a more relevant comparison in Section 2.3.4.14.

1 18 AAC 70. ADEC, Alaska Water Quality Standards. Amended as of August 9, 2025, maximum drinking water levels.

2 Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances. Amended through September 8, 2022. 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. For selenium, the criterion is provided as total recoverable (0.005 mg/L), which was multiplied by 0.922 to convert to a dissolved basis per Note 64 in the Alaska Water Quality Criteria Manual.

2c Drinking water primary maximum contaminant levels.

2d Irrigation water criteria.

3 Hatch 2015a; Donlin 2015, personal communication (RE: Hg in TSF pond water email from Gene Weglinski to Nancy Darigo, Aug 26, 2015).

4 Source: SRK 2017e, Appendix C, Table C-8 (as provided in FEIS Table 3.7-33).

5 Source: SRK 2007, Tables 4-5 and 4-6, Phase 2 pilot transitional final tailings samples (as provided in FEIS Tables 3.7-28 and 3.7-29, respectively).

Yellow highlighting indicates values that exceed the AWQC. Italicized values beneath concentration values indicate factor by which concentration exceeds AWQC.

Tailings settling, water content, and flow dynamics governing the behavior of the tailings slurry following release would be similar for the 0.5% release and the larger release scenarios. It is anticipated that the tailings slurry would have a water content of approximately 54 percent by volume (corresponding to the estimated average tailings porosity within the TSF), and most of the tailings pore water would remain entrained in the tailings interstices during tailings deposition in Crooked Creek, since the tailings solids and tailings pore water would be anticipated to flow jointly, displacing creek water in its path (BGC 2025). Since long-term impacts to surface water quality will depend more on ongoing release of constituents from deposited tailings rather than from the initial-release flood wave, the severity of a given release will increase with increasing tailings volumes released. Whereas the volume of deposited tailings for a 0.5% release is estimated at approximately 1,670 acre-feet, this volume increases to approximately 11,500, 40,800, and 61,500 acre-feet under the 5%, 13%, and 25% release scenarios, respectively (BGC 2025).

The extent and duration of surface water impacts (including concentrations of analytes released from tailings resulting in surface water concentrations above the AWQC) are challenging to predict, because it depends on the rate at which tailings pore water diffuses into surface water. This diffusion rate will depend on several complex factors, including how groundwater discharging to surface water either moves through or bypasses tailings (due to the low tailings permeability), the nature of surface water scouring of tailings (exposing fresh tailings to surface water), and the mitigation procedures employed during cleanup (including installation of bypass/diversion structures). Regardless, the tailings pore water and MWMP results were used to evaluate the potential long-term release of constituents from tailings deposited in Crooked Creek. For this evaluation, the leachable constituent volumes under each release scenario were compared to the monthly discharge rates in Crooked Creek and the Kuskokwim River (Table 3.24-15 in the FEIS, reproduced below in Table 2.3-5). Based on these results, the mean annual discharge in Crooked Creek is 11.7 billion cf/year (333 billion L/year), and the mean annual discharge in the Kuskokwim River is 1,340 billion cf/year (3,800 billion L/year).

**Table 2.3-5 USGS Mean Monthly Discharge Comparison (Crooked Creek and Kuskokwim River)**

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

This table was numbered Table 3.24-15 in the FEIS

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

Based on the leachate and MWMP results, there is the potential for sulfate, total dissolved solids (TDS), antimony, arsenic, and manganese to exceed AWQC in Crooked Creek as a result of leaching from deposited tailings. MWMP results indicate that leachate concentrations still exceed after multiple leach cycles; as such, if tailings diffusion rates are high enough to result in AWQC exceedances in Crooked Creek at any point after tailings deposition, then that potential would exist for as long as tailings remain in Crooked Creek (depending on cleanup duration, this timeframe could be years to decades). This potential is greatest for arsenic and manganese, where pore water and MWMP results still exceed AWQC by over an order of magnitude by the last MWMP cycle. This potential is lower for sulfate and antimony; although the results indicate that leaching will be sustained for these constituents, the leachate concentration is less than an order of magnitude above the AWQC (Table 2.3-4) and would most likely be diluted by Crooked Creek flow. Specifically for arsenic, although the drinking water standard is predicted to be exceeded by over an order of magnitude in tailings pore water, the chronic freshwater aquatic life criterion is predicted to be exceeded to a lesser extent (Table 2.3-4).

In contrast, the leachate and MWMP results indicate that the concentrations of fluoride, cadmium, molybdenum, and selenium in tailings leachate will eventually decrease to below AWQC. These results were used to estimate a potential hypothetical timeframe over which Crooked Creek surface water concentrations would decrease below AWQC under a very conservative scenario in which solutes were diffusing out of tailings into Crooked Creek. Table 2.3-6 below provides the results of a mass balance assumption in which the total leachable constituent mass (on a mg per cf of tailings, based on summing each MWMP cycle) is released into Crooked Creek water yielding exceedance right at the AWQC, with estimation of the timeframe required to deplete the constituent mass based on the mean annual Crooked Creek flow. Note that this scenario represents a very conservative case, since faster diffusion out of tailings, although yielding higher exceedances above the AWQC in Crooked Creek, would result in faster depletion, while slower diffusion out of tailings would result in Crooked Creek concentrations below the AWQC.

**Table 2.3-6 Estimated Hypothetical Depletion Timeframe for Tailings Constituents in Crooked Creek**

| Release Scenario                       |         |                | 25%                       | 13%   | 5%    | 0.5%  |
|----------------------------------------|---------|----------------|---------------------------|-------|-------|-------|
| Tailings Volume in Crooked Creek (Mcf) |         |                | 2,677                     | 1,776 | 501   | 73    |
|                                        | AWQC    | Solute Mass    | Time to Dilute Below AWQC |       |       |       |
|                                        | mg/L    | mg/cf tailings | years                     | years | years | years |
| Fluoride                               | 1       | 132            | 1.1                       | 0.7   | 0.2   | 0.03  |
| Cadmium                                | 0.00064 | 0.024          | 0.3                       | 0.2   | 0.1   | 0.01  |
| Molybdenum                             | 0.01    | 7.91           | 6.4                       | 4.2   | 1.2   | 0.2   |
| Selenium                               | 0.0046  | 0.997          | 1.7                       | 1.2   | 0.3   | 0.05  |

The results indicate that diffusion out of tailings, to the extent that they result in AWQC exceedances in Crooked Creek for fluoride, cadmium, molybdenum, and selenium, would likely be depleted (and/or drop below AWQC following dilution) within approximately 1 year or less under most circumstances. The exception would be molybdenum under the larger (25% and 13%) scenarios, where molybdenum

exceedances might take up to 6 years or more to be depleted. Note that this hypothetical scenario assumes continuous exceedances of AWQC until source mass is depleted; it is also possible that diffusion of constituents out of tailings could persist for longer, if diffusion were periodic or seasonal. Although iron and mercury were also estimated to exceed AWQC in tailings pore water, these constituents are assumed not to be above AWQC in Crooked Creek. Specifically, oxidation and precipitation of iron would be expected on contact with oxic Crooked Creek water, while mercury precipitation as a sulfide in the TSF would be anticipated to limit mercury solubility. Although there is the possibility for mercury sulfide oxidation in tailings deposited in Crooked Creek, this process is assumed to be slow and was not estimated here.

The above discussion applies to Crooked Creek. Long-term impacts to the Kuskokwim River due to tailings leaching are substantially less likely. In the case of analytes that are anticipated to exhibit depletion (fluoride, cadmium, molybdenum, and selenium), this rinsing will likely occur quickly as tailings are discharged into the Kuskokwim River due to suspension and dispersion of tailings in Kuskokwim River water before these tailings resettle in side channels. Once settled in side channels, there is potential for continued release of sulfate, antimony, arsenic, and manganese into surface water. Concentrations of these analytes may be elevated in stagnant side channels where tailings reside, for as long as tailings are present in these areas. However, these concentrations would be highly diluted on mixing with main-stem Kuskokwim River water.

The anticipated potential effects of a tailings release on surface water quality in Crooked Creek and the Kuskokwim River are summarized below.

- In the short term, Crooked Creek would effectively be entirely displaced by tailings, forming a dam which would temporarily block Crooked Creek ambient flow (Section 2.3.5.5.1.2). The release of water associated with the tailings would result in exceedances of AWQC throughout the entire Crooked Creek drainage down to the Kuskokwim River for several constituents, including sulfate, arsenic, antimony, manganese, molybdenum, and potentially selenium and mercury. Iron would likely not exceed AWQC following oxidation and precipitation.
- As with the 0.5% release, the duration and intensity of impacts associated with dissolved constituents in entrained TSF water would likely be less severe in comparison to the prolonged adverse impacts to water quality associated with leachate from the released tailings solids. The magnitude and duration of these impacts would be increasingly severe with larger TSF Main Dam releases (from 0.5% to 5%, 13%, or 25%).
- Concentrations in surface water would be difficult to quantify, since it will depend on the extent of tailings exposure to surface water following deposition (limited to stream channels carved through tailings and precipitation on exposed tailings deposit surfaces). However, to the extent that any constituents are released into Crooked Creek with insufficient dilution to remain below AWQC, the following may be anticipated:
  - Sulfate, antimony, arsenic, and manganese impacts may persist for as long as tailings are present in Crooked Creek. This effect may be most important for arsenic and manganese, which are more likely to approach or exceed the AWQC in the long term.
  - In contrast, fluoride, cadmium, molybdenum, and selenium impacts would be expected to become depleted in Crooked Creek over the first 1 to 6 years following release, depending on the analyte and the magnitude of the release.

- Long-term impacts to the Kuskokwim River are not anticipated, except for potentially elevated sulfate, antimony, arsenic, and manganese concentrations in side channels where deposited tailings may reside.
- Risk of mercury dissolution from mercury sulfide sludge may be greater under a larger release scenario, given the larger volumes and more widespread distribution of tailings.
- In a 0.5% release, the severity of the release will depend on whether the incident occurs in the summer or the winter. Specifically, although short-term effects from released water will be more severe in winter (due to reduced dilution of TSF water), a release in winter would result in better manageability; lower ambient flow will reduce the spreading of deposited tailings, and frozen conditions would reduce the intermingling of tailings and native soils/sediments. To some extent, this would also be true for a larger release; however, the substantially greater distribution of released and redeposited tailings under a larger scenario would mean that impacts would be severe even under winter conditions. For example, as described in Section 2.3.5.5, the tailings solids released into Crooked Creek will form a dam that will block upstream ambient Crooked Creek flow. If this release were to occur in the winter, this would provide time early on to implement mitigation measures, including installation of diversions of upper Crooked Creek flow around deposited tailings. However, under a larger release (where the deposited tailings extent increases from a little over 1 mile under a 0.5% release to an approximately 13-mile length of Crooked Creek under the larger release scenarios), installing diversions and other mitigation measures during the winter prior to spring breakup would be more challenging. As noted above, initial restoration and recovery efforts would be prioritized to minimize tailings re-distribution and potential impacts to groundwater protection zones. However, these initial response efforts would take much longer under a larger release and would be likely occur across multiple seasons.
- Previously undisturbed native materials (soil and water) would be intermixed with tailings as the tailings slurry travels downstream in Crooked Creek and in the Kuskokwim River near the Crooked Creek confluence. The scenarios simulated by BGC (2025) assume release under baseflow conditions, which represent very conservative scenarios for surface water quality, as noted above. If the release were to occur in the winter (frozen soil conditions), the extent of intermixing may be lower, but intermixing of native soil, sediment, and surface water would occur regardless of season.
- As described above and based on data in Table 2.3-4, the initial water release from the dam failures would be most severe on Kuskokwim River water quality during the months of February and March, where dilution of water would be lowest under winter baseflow conditions. Following the initial flood wave, water quality in the Kuskokwim River would be controlled by release of constituents from tailings present in Crooked Creek. This has the potential to result in greater impacts to the Kuskokwim River in May, when the proportion of Crooked Creek flow as a contribution of overall Kuskokwim River flow is highest (Kuskokwim River flow is only 63 times greater than Crooked Creek in May, compared to 295 times higher in February and 309 times higher in March). However, this effect will be reduced as mitigation measures are put in place to limit leaching of tailings constituents to Crooked Creek.

### **2.3.4.7 *Water Quality, Groundwater Quality***

#### **2.3.4.7.1 *Alternative 2 – Donlin Gold’s Proposed Action***

##### **2.3.4.7.1.1 Scenario 9**

For the discussion of impacts on groundwater quality as the result of a 0.5% release, see FEIS sections 3.24.6.6.1, 3.24.6.7.1, and 3.24.6.7.2.

##### **2.3.4.7.1.2 Scenarios 9a, 9b, and 9c: Larger Tailings Dam Failure**

As described in Section 2.3.5.6 describing effects on groundwater hydrology, much of the language in the original FEIS describing the effects of a 0.5% release is qualitatively relevant to the larger release scenarios. Specifically, the greatest potential impacts to shallow groundwater hydrology and water quality would be realized within Crooked Creek as a result of the deposition of tailings. This tailings deposition would potentially alter groundwater hydrology by raising the water table adjacent to Crooked Creek, creating a mounding effect which could result in tailings interstitial pore water recharging shallow groundwater adjacent to the Creek. This effect would be most extreme immediately following tailings deposition and would decrease as groundwater levels rise due to inflow of upgradient groundwater.

Whereas this effect would be limited to an approximately one-mile stretch of Crooked Creek under a 0.5% tailings release scenario, it would be more widespread under a larger release scenario, influencing groundwater hydrology and shallow groundwater quality across a 12- to 13-mile stretch of Crooked Creek down to the confluence with the Kuskokwim River. In addition, whereas a 0.5% release was not simulated to result in encroachment of tailings and water into the groundwater protection area for the Crooked Creek community groundwater well, the footprint of deposited tailings would potentially partially overlap this groundwater protection area under each of the three larger release scenarios (Figure 2.3.6). However, actual impacts to groundwater resources could be minimized by prioritizing tailings removal in this area.

Although impacts to shallow groundwater may be widespread within Crooked Creek, effects on shallow groundwater quality would be minimal along the Kuskokwim River. As discussed in Section 2.3.5.6, the flood wave associated with a tailings release would result in minimal water level rise of a few feet within the Kuskokwim River at the downstream communities of Chuathbaluk, Aniak, and Kalskag. Although tailings solids would also travel downstream into the Kuskokwim River, these tailings would be finer-grained and would remain in suspension longer than the coarser tailings deposited in Crooked Creek, resulting in a thinner layer of deposition which would not be anticipated to significantly affect groundwater hydrology within the Kuskokwim River. Long-term exceedances of AWQS in the Kuskokwim River, as well as leaching from the thin layers of tailings deposited in Kuskokwim River sediments in stagnant water zones (e.g., sloughs, the interiors of creek bends), would be anticipated to affect shallow groundwater quality in localized zones where surface water recharges groundwater. However, across the majority of the river section where groundwater discharges to surface water, groundwater quality impacts would not be expected.

### **2.3.4.8 *Sediment Quality***

#### **2.3.4.8.1 *Alternative 2 – Donlin Gold’s Proposed Action***

##### **2.3.4.8.1.1 Scenario 9**

For the discussion of impacts on sediment quality as the result of a 0.5% release, see FEIS Section 3.24.6.7.3.

#### 2.3.4.8.1.2 Scenarios 9a, 9b, and 9c: Larger Tailings Dam Failure

The original FEIS text summarizes well the anticipated effects of a tailings release on downstream sediments. These concepts qualitatively apply to both the 0.5% release and larger release scenarios, noting that it is the magnitude and duration of impacts that would be greater with increasing tailings release volumes. Specifically:

- Sediments in Crooked Creek would be completely buried by tailings within Crooked Creek, spanning the full distance between the Anaconda Creek and Kuskokwim River confluences.
- Impacts to surface water, groundwater, and sediment quality would result from short-term tailings pore water release and long-term tailings dissolution. These effects would be substantial in Crooked Creek, and these impacts would persist over years-long time scales as tailings excavation proceeds.
- Impacts to sediment quality in the Kuskokwim River are anticipated to be substantially less severe. As noted above, the majority of the tailings will deposit in Crooked Creek; tailings that do migrate to the Kuskokwim River will contain a higher proportion of fine particulates that will remain suspended, settling over diffuse areas or discharging to the Bering Sea. Tailings accumulation may be expected in limited areas associated with side channels and low-velocity zones, but the majority of the Kuskokwim would receive limited tailings deposition and limited impacts to native sediment.

#### 2.3.4.9 *Air Quality*

There would be air emissions associated with a tailings release; for example, tailpipe emissions of criteria pollutants from response equipment. Many variables associated with unplanned events 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 release scenario.

#### 2.3.4.9.1 **Alternative 2 – Donlin Gold’s Proposed Action**

##### 2.3.4.9.1.1 Scenario 9

For the discussion of impacts on air quality as the result of a 0.5% release, see FEIS Section 3.24.6.8.1.

##### 2.3.4.9.1.2 Scenarios 9a, 9b, and 9c: Larger Tailings Dam Failure

Impacts to air quality from both gaseous and particulate emissions under a larger release scenario would exceed those described for Scenario 9 in the FEIS; this will be a function of the larger volume of tailings released and deposited in the Crooked Creek drainage. As presented in Section 2.3.5.12, a much greater areal extent of tailings would be exposed to the atmosphere under the larger release scenarios—tailings would be deposited over an area approximately 9 to 12 times the area potentially affected under the 0.5% release.

As described for the 0.5% release, with the exception of mercury, a larger release would not 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. As described in the FEIS, the tailings beach comprises more than 90 percent of gaseous mercury emissions at the Mine Site (Environ 2015); deposition of tailings and thus exposure to the atmosphere from a larger release could result in a 9- to 12-fold increase in the amount of these emissions compared to the 0.5% release. These emissions would be

realized until response activities are completed and natural processes cover or otherwise remove the tailings from atmospheric contact. Mercury emissions would be reduced to some extent as the tailings mixture would include a mercury suppressant that would help prevent the escape of mercury into the air.

Metals in fugitive dust, including mercury as well as others of concern, such as arsenic and antimony, could be mobilized during removal of the deposited tailings. The extent of mercury in air in both gaseous and particulate forms would be similar to that shown on FEIS Figure 3.8-5 (FEIS Section 3.8, Air Quality) for the Mine Site during normal operations. 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.

### **2.3.4.10 Noise and Vibration**

#### **2.3.4.10.1 Alternative 2 – Donlin Gold’s Proposed Action**

##### **2.3.4.10.1.1 Scenario 9**

For the discussion of impacts on noise and vibration as the result of a 0.5% release, see FEIS Section 3.24.6.9.1.

##### **2.3.4.10.1.2 Scenarios 9a, 9b, and 9c: Larger Tailings Dam Failure**

Under Scenarios 9a, 9b, and 9c, noise- and vibration-related impacts associated with response and remediation operations would be more intensive, and of a longer duration, than described for Scenario 9. The greater tailings deposition depths in the Crooked Creek drainage under Scenarios 9a, 9b, and 9c suggest that response, cleanup, and recovery operations in the vicinity of the village of Crooked Creek (the nearest noise sensitive receptor to the Mine Site) would require greater numbers of equipment and personnel, and would occur over a longer timeframe, than would occur under Scenario 9. These operations would result in considerable noise impacts to residents of the village during the response activities as these activities would occur within the village itself. No long-term (i.e., permanent) increases in noise or vibration would be realized by residents of the village.

Given the larger volume of tailings that would be released under Scenarios 9a, 9b, and 9c and enter the Kuskokwim River, deposition of tailings along the Kuskokwim River shoreline may occur. Should such deposition occur, response activities would be more geographically-dispersed than under Scenario 9 (i.e., would occur outside the Crooked Creek drainage). If such deposition occurs in proximity to the villages of Chuathbaluk, Upper Kalskag, or Lower Kalskag, or in proximity to residences outside of those incorporated areas, and heavy equipment is necessary for the response activity, noise impacts, and potentially vibration impacts, would be realized by residents in the vicinity of the activity. If deposition volumes are small, hand tools may be used to reduce or avoid noise or vibration impacts.

As described for Scenario 9, the duration of these impacts would last only during response and remediation activities, and would be limited to discrete geographic areas where such activities occur near a sensitive receptor.

Given the large volume of tailings that would be released under Scenarios 9a, 9b, and 9c and that would enter the Kuskokwim River, monitoring activities along the length of the river from its mouth to Crooked Creek may occur for years or decades after a release. These activities would likely utilize light aircraft and small boats, the noise from which are both typical in the region, and thus monitoring activities would not generate noise or vibration impacts.

### **2.3.4.11 Vegetation**

#### **2.3.4.11.1 Alternative 2 – Donlin Gold’s Proposed Action**

##### **2.3.4.11.1.1 Scenario 9**

##### **2.3.4.11.1.2 Scenarios 9a, 9b, and 9c: Larger Tailings Dam Failure**

An analysis of the effects of the larger release scenarios on wetlands is found in Section 2.3.5.13. The impacts on vegetation are drawn from that analysis. The disturbance processes discussed above for the 0.5% release would be realized under each of the larger tailings release scenarios. The approximate acres impacted per aggregated vegetation type are estimated in Table 2.3-7 below.

Under each of the larger tailings release scenarios, the area potentially affected by tailings deposition exceeds the extent of the wetlands/vegetation mapping performed to-date. Under the 5% scenario, an additional approximately 305 unmapped acres would be impacted; under the 13% scenario an additional 595 unmapped acres would be impacted; and under the 25% scenario an additional 702 unmapped acres would be impacted.

As described for the 0.5% release, in terms of intensity, vegetation would be impacted by the depth and type of materials released, and the rate of movement for riparian vegetation locations. The duration would be expected to be long-term, although locations would experience native vegetation regrowth in places following response and restoration activities. No rare or sensitive plants are known along Crooked Creek or those extents of the Kuskokwim River that could be affected by the deposition of tailings.

**Table 2.3-7 Acres of Vegetation Affected in the Larger Release Scenarios**

| <b>Aggregated Type</b>           | <b>5% Scenario,<br/>Approximate Area<br/>(acres)</b> | <b>13% Scenario,<br/>Approximate Area<br/>(acres)</b> | <b>25% Scenario,<br/>Approximate Area<br/>(acres)</b> |
|----------------------------------|------------------------------------------------------|-------------------------------------------------------|-------------------------------------------------------|
| Forested - Evergreen             | 615                                                  | 711                                                   | 841                                                   |
| Forested - Deciduous/Mixed       | 829                                                  | 862                                                   | 916                                                   |
| Scrub Shrub                      | 1,927                                                | 2,246                                                 | 2,562                                                 |
| Herbaceous                       | 246                                                  | 255                                                   | 264                                                   |
| Other Land Cover                 | 263                                                  | 276                                                   | 300                                                   |
| <b>Total, Mapped</b>             | <b>3,880</b>                                         | <b>4,350</b>                                          | <b>4,883</b>                                          |
| <b>Total, Including Unmapped</b> | <b>4,185</b>                                         | <b>4,945</b>                                          | <b>5,585</b>                                          |

Source: 3PPI 2014b, BGC 2025

### **2.3.4.12 Wetlands**

#### **2.3.4.12.1 Alternative 2 – Donlin Gold’s Proposed Alternative**

##### **2.3.4.12.1.1 Scenario 9**

For the discussion of impacts on wetlands as the result of a 0.5% release, see FEIS Section 3.24.6.11.1.

#### 2.3.4.12.1.2 Scenarios 9a, 9b, and 9c: Larger Tailings Dam Failure

Under any of the larger tailings release scenarios, the categories of physical disturbance that would affect vegetation and wetlands are the same as those described for the 0.5% release, as are the means by which these disturbance processes would impact wetlands.

As described for the 0.5% release, erosion is expected to be greatest where flow depths are modeled to be highest—given the larger release volumes, erosion is anticipated within Anaconda Creek and along the length of Crooked Creek downstream to its mouth (Figures 2.3.3 through 2.3.5). Given the large volumes of material that would be released under any of the three scenarios, erosion would not be expected to be reduced in winter months despite the presence of frozen soils. 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 confluences of Crooked Creek and its tributaries.

Like for the 0.5% release, erosion is taken to 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. Tables 2.3-8a, b, and c present the areas potentially impacted by the flow depth and disturbance process (erosion, deposition, or both). An approximate total of 17 miles of streams would be directly affected by tailings deposition, including 14.3 miles of perennial streams and 2.7 miles of intermittent streams (Tables 2.3-8a, b, and c).

**Table 2.3-8a Calculation of Wetland Categories by Maximum Flow Depth, 5% Scenario**

| Wetland Type                   | Flow Depth (acres) |                                            |                     | Approximate Impact Area (acres) | Area <sup>1</sup> (%) |
|--------------------------------|--------------------|--------------------------------------------|---------------------|---------------------------------|-----------------------|
|                                | Erosion (≥ 10 ft)  | Erosion and Deposition (≥ 3 ft to < 10 ft) | Deposition (< 3 ft) |                                 |                       |
| Evergreen Forested Wetlands    | 488.8              | 97.6                                       | 28.1                | 614.6                           | 15.8                  |
| Deciduous Forested Wetlands    | 93.3               | 6.9                                        | 3.1                 | 103.3                           | 2.7                   |
| Mixed Forested Wetlands        | 637.3              | 80.9                                       | 7.8                 | 726.0                           | 18.7                  |
| Evergreen Scrub Shrub Wetlands | 675.6              | 241.3                                      | 79.0                | 996.0                           | 25.7                  |
| Deciduous Scrub Shrub Wetlands | 700.1              | 170.9                                      | 60.0                | 930.9                           | 24.0                  |
| Herbaceous Wetlands            | 182.2              | 53.8                                       | 9.8                 | 245.8                           | 6.3                   |
| Ponds                          | 27.3               | 1.6                                        | 0.2                 | 29.1                            | 0.7                   |
| Rivers                         | 213.7              | 8.4                                        | 0.9                 | 223.0                           | 5.7                   |
| Intermittent Streams (miles)   | 1.7                | 0.8                                        | 0.2                 | 2.7                             | 14.0                  |
| Perennial Streams (miles)      | 11.8               | 3.8                                        | 1.1                 | 16.8                            | 86.0                  |
| Uplands                        | 1.5                | 5.1                                        | 4.2                 | 10.9                            | 0.3                   |
| Area (acre)                    | 3,019.8            | 666.5                                      | 193.1               | 3,879.5                         |                       |
| Wetland Area (% , acre)        | 77.8               | 17.2                                       | 5.0                 |                                 |                       |

Source: 3PPI et al. 2014, BGC 2025

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

**Table 2.3-8b Calculation of Wetland Categories by Maximum Flow Depth, 13% Scenario**

| Wetland Type                   | Flow Depth (acres) |                                            |                     | Approximate Impact Area (acres) | Area <sup>1</sup> (%) |
|--------------------------------|--------------------|--------------------------------------------|---------------------|---------------------------------|-----------------------|
|                                | Erosion (≥ 10 ft)  | Erosion and Deposition (≥ 3 ft to < 10 ft) | Deposition (< 3 ft) |                                 |                       |
| Evergreen Forested Wetlands    | 613.8              | 71.0                                       | 25.8                | 710.6                           | 16.3                  |
| Deciduous Forested Wetlands    | 100.0              | 5.7                                        | 1.3                 | 107.1                           | 2.5                   |
| Mixed Forested Wetlands        | 727.3              | 20.9                                       | 6.3                 | 754.4                           | 17.3                  |
| Evergreen Scrub Shrub Wetlands | 990.4              | 160.9                                      | 40.7                | 1,192.1                         | 27.4                  |
| Deciduous Scrub Shrub Wetlands | 909.6              | 117.9                                      | 26.1                | 1,053.6                         | 24.2                  |
| Herbaceous Wetlands            | 240.5              | 13.2                                       | 1.8                 | 255.4                           | 5.9                   |
| Ponds                          | 29.0               | 0.2                                        | 0                   | 29.2                            | 0.7                   |
| Rivers                         | 223.9              | 3.6                                        | 0.5                 | 228.0                           | 5.2                   |
| Intermittent Streams (miles)   | 2.7                | 0.4                                        | 0.1                 | 3.2                             | 13.8                  |
| Perennial Streams (miles)      | 16.7               | 2.3                                        | 0.7                 | 19.8                            | 86.2                  |
| Uplands                        | 6.1                | 9.6                                        | 2.9                 | 18.7                            | 0.4                   |
| Area (acre)                    | 3,840.5            | 403.1                                      | 105.6               | 4,349.1                         |                       |
| Wetland Area (% , acre)        | 88.3               | 9.3                                        | 2.4                 |                                 |                       |

Source: 3PPI et al. 2014, BGC 2025

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

**Table 2.3-8c Calculation of Wetland Categories by Maximum Flow Depth, 25% Scenario**

| Wetland Type                   | Flow Depth (acres) |                                            |                     | Approximate Impact Area (acres) | Area <sup>1</sup> (%) |
|--------------------------------|--------------------|--------------------------------------------|---------------------|---------------------------------|-----------------------|
|                                | Erosion (≥ 10 ft)  | Erosion and Deposition (≥ 3 ft to < 10 ft) | Deposition (< 3 ft) |                                 |                       |
| Evergreen Forested Wetlands    | 739.0              | 78.3                                       | 23.8                | 841.1                           | 17.2                  |
| Deciduous Forested Wetlands    | 113.2              | 0.6                                        | 0.1                 | 113.9                           | 2.3                   |
| Mixed Forested Wetlands        | 778.8              | 18.0                                       | 5.4                 | 802.1                           | 16.4                  |
| Evergreen Scrub Shrub Wetlands | 1,251.0            | 97.1                                       | 29.9                | 1,378.0                         | 28.2                  |
| Deciduous Scrub Shrub Wetlands | 1,090.7            | 74.7                                       | 18.5                | 1,183.8                         | 24.2                  |
| Herbaceous Wetlands            | 257.5              | 4.5                                        | 1.5                 | 263.6                           | 5.4                   |
| Ponds                          | 29.2               | 0.02                                       | 0                   | 29.2                            | 0.6                   |
| Rivers                         | 233.8              | 3.3                                        | 0.7                 | 237.9                           | 4.9                   |
| Intermittent Streams (miles)   | 3.3                | 0.3                                        | 0.1                 | 3.6                             | 13.5                  |
| Perennial Streams (miles)      | 20.8               | 1.9                                        | 0.6                 | 23.3                            | 86.5                  |
| Uplands                        | 20.7               | 8.8                                        | 3.4                 | 32.8                            | 0.7                   |

**Table 2.3-8c Calculation of Wetland Categories by Maximum Flow Depth, 25% Scenario**

| Wetland Type            | Flow Depth (acres) |                                            |                     | Approximate Impact Area (acres) | Area <sup>1</sup> (%) |
|-------------------------|--------------------|--------------------------------------------|---------------------|---------------------------------|-----------------------|
|                         | Erosion (≥ 10 ft)  | Erosion and Deposition (≥ 3 ft to < 10 ft) | Deposition (< 3 ft) |                                 |                       |
| Area (acre)             | 4,514.0            | 285.2                                      | 83.2                | 4,882.5                         |                       |
| Wetland Area (% , acre) | 92.5               | 5.8                                        | 1.7                 |                                 |                       |

Source: 3PPI et al. 2014, BGC 2025

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

Deposition of tailings and eroded materials would increase where flow depths are lower or where flow is impeded such as at stream meanders or at the confluences of Crooked Creek and its tributaries (Figures 2.3.3 through 2.3.5). 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). As presented for the 0.5% release, 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. The areal extent of light, moderate, and heavy burial for each of the three scenarios is presented in Tables 2.3-9a, b, and c.

Response efforts would focus on removal of tailings and return to the TSF. Impairment of wetland functions would persist beyond the response and restoration activities. Burial or fill of wetlands and waters in the Crooked Creek watershed would alter or remove their capacity to provide hydrologic, biogeochemical, and biological functions. An approximate total of 17 miles of streams would be directly affected by tailings deposition, including 14.3 miles of perennial streams and 2.7 miles of intermittent streams.

**Table 2.3-9a Calculation of Wetland Categories by Burial Depth, 5% Scenario**

| Wetland Type                   | Burial Depth (acres) |                               |                | Approximate Impact Area (acres) | Area <sup>1</sup> (%) |
|--------------------------------|----------------------|-------------------------------|----------------|---------------------------------|-----------------------|
|                                | Light (< 0.5 ft)     | Moderate (≥ 0.5 ft to < 3 ft) | Heavy (≥ 3 ft) |                                 |                       |
| Evergreen Forested Wetlands    | 49.1                 | 284.3                         | 186.1          | 519.4                           | 15.7                  |
| Deciduous Forested Wetlands    | 1.9                  | 40.5                          | 55.5           | 98.0                            | 3.0                   |
| Mixed Forested Wetlands        | 24.5                 | 290.1                         | 383.6          | 698.2                           | 21.1                  |
| Evergreen Scrub Shrub Wetlands | 138.1                | 426.8                         | 143.2          | 708.1                           | 21.4                  |
| Deciduous Scrub Shrub Wetlands | 104.1                | 415.7                         | 282.9          | 802.8                           | 24.2                  |
| Herbaceous Wetlands            | 14.8                 | 118.9                         | 102.0          | 235.6                           | 7.1                   |
| Ponds                          | 0.2                  | 3.9                           | 24.6           | 28.6                            | 0.9                   |
| Rivers                         | 1.1                  | 30.3                          | 186.9          | 218.2                           | 6.6                   |
| Intermittent Streams (miles)   | 0.3                  | 0.7                           | 1.2            | 2.2                             | 13.4                  |

**Table 2.3-9a Calculation of Wetland Categories by Burial Depth, 5% Scenario**

| Wetland Type              | Burial Depth (acres) |                               |                | Approximate Impact Area (acres) | Area <sup>1</sup> (%) |
|---------------------------|----------------------|-------------------------------|----------------|---------------------------------|-----------------------|
|                           | Light (< 0.5 ft)     | Moderate (≥ 0.5 ft to < 3 ft) | Heavy (≥ 3 ft) |                                 |                       |
| Perennial Streams (miles) | 2.0                  | 9.1                           | 3.4            | 14.5                            | 86.6                  |
| Uplands                   | 0.9                  | 2.7                           | 1.0            | 4.6                             | 0.1                   |
| Area (acre)               | 334.6                | 1,613.2                       | 1,365.8        | 3,313.6                         |                       |
| Wetland Area (% , acre)   | 10.1                 | 48.7                          | 41.2           |                                 |                       |

Source: 3PPI et al. 2014, BGC 2025

**Table 2.3-9b Calculation of Wetland Categories by Burial Depth, 13% Scenario**

| Wetland Type                   | Burial Depth (acres) |                               |                | Approximate Impact Area (acres) | Area <sup>1</sup> (%) |
|--------------------------------|----------------------|-------------------------------|----------------|---------------------------------|-----------------------|
|                                | Light (< 0.5 ft)     | Moderate (≥ 0.5 ft to < 3 ft) | Heavy (≥ 3 ft) |                                 |                       |
| Evergreen Forested Wetlands    | 19.8                 | 101.1                         | 522.2          | 643.2                           | 15.9                  |
| Deciduous Forested Wetlands    | 0.2                  | 2.4                           | 103.4          | 106.0                           | 2.6                   |
| Mixed Forested Wetlands        | 1.8                  | 9.9                           | 737.6          | 749.3                           | 18.5                  |
| Evergreen Scrub Shrub Wetlands | 49.6                 | 300.9                         | 658.4          | 1,008.8                         | 25.0                  |
| Deciduous Scrub Shrub Wetlands | 24.7                 | 206.8                         | 782.4          | 1,013.9                         | 25.1                  |
| Herbaceous Wetlands            | 0.7                  | 38.7                          | 214.8          | 254.2                           | 6.3                   |
| Ponds                          | 0.01                 | 0.1                           | 29.0           | 29.2                            | 0.7                   |
| Rivers                         | 0.2                  | 1.3                           | 226.2          | 227.6                           | 5.6                   |
| Intermittent Streams (miles)   | 0.1                  | 0.8                           | 2.1            | 3.0                             | 13.8                  |
| Perennial Streams (miles)      | 0.5                  | 5.5                           | 12.8           | 18.8                            | 86.2                  |
| Uplands                        | 0.4                  | 2.4                           | 8.2            | 10.9                            | 0.3                   |
| Area (acre)                    | 97.4                 | 663.5                         | 3,282.2        | 4,043.1                         |                       |
| Wetland Area (% , acre)        | 2.4                  | 16.4                          | 81.2           |                                 |                       |

Source: 3PPI et al. 2014, BGC 2025

**Table 2.3-9c Calculation of Wetland Categories by Burial Depth, 25% Scenario**

| Wetland Type                   | Burial Depth (acres) |                               |                | Approximate Impact Area (acres) | Area <sup>1</sup> (%) |
|--------------------------------|----------------------|-------------------------------|----------------|---------------------------------|-----------------------|
|                                | Light (< 0.5 ft)     | Moderate (≥ 0.5 ft to < 3 ft) | Heavy (≥ 3 ft) |                                 |                       |
| Evergreen Forested Wetlands    | 17.6                 | 138.4                         | 581.8          | 737.7                           | 16.4                  |
| Deciduous Forested Wetlands    | 0.1                  | 0.8                           | 112.2          | 113.2                           | 2.5                   |
| Mixed Forested Wetlands        | 1.3                  | 7.7                           | 788.7          | 797.7                           | 17.8                  |
| Evergreen Scrub Shrub Wetlands | 43.4                 | 299.1                         | 808.7          | 1,151.2                         | 25.6                  |
| Deciduous Scrub Shrub Wetlands | 20.4                 | 194.8                         | 923.8          | 1,139.1                         | 25.4                  |
| Herbaceous Wetlands            | 0.6                  | 15.5                          | 246.4          | 262.4                           | 5.8                   |
| Ponds                          | 0                    | 0.1                           | 29.1           | 29.2                            | 0.7                   |
| Rivers                         | 0.3                  | 0.9                           | 236.7          | 237.9                           | 5.3                   |
| Intermittent Streams (miles)   | 0.1                  | 0.9                           | 2.6            | 3.5                             | 13.6                  |
| Perennial Streams (miles)      | 0.5                  | 5.3                           | 16.5           | 22.3                            | 86.4                  |
| Uplands                        | 0.6                  | 2.6                           | 16.8           | 20.0                            | 0.4                   |
| Area (acre)                    | 84.2                 | 660.0                         | 3,744.1        | 4,488.4                         |                       |
| Wetland Area (% , acre)        | 1.9                  | 14.7                          | 83.4           |                                 |                       |

Source: 3PPI et al. 2014, BGC 2025

In terms of intensity, wetlands would be impacted by the depth and type of materials released, 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 release. In context, wetlands have varying functions but no specific protective designations.

### **2.3.4.13 Wildlife**

#### **2.3.4.13.1 Terrestrial Mammals**

##### **2.3.4.13.1.1 Alternative 2 – Donlin Gold's Proposed Action**

##### **2.3.4.13.1.1.1 Scenario 9**

For the discussion of impacts on terrestrial mammals as the result of a 0.5% release, see FEIS Section 3.24.6.12.1.

##### **2.3.4.13.1.1.2 Scenarios 9a, 9b, and 9c: Larger Tailings Dam Failure**

The large mammal species discussed in this section are those also discussed in FEIS Section 13.12.2.2.1. The species further discussed below are game animals managed by Alaska Department of Fish & Game (ADF&G) or are predators of game animals.

Black bear appear to be the most abundant large mammal in the Mine Site area (ARCADIS 2013). Black bear are not typically present in Game Management Unit (GMU) 18 (the area from the mouth of the Kuskokwim River upstream to the vicinity of Kalskag). The Donlin Gold Project's wildlife surveys along the

Kuskokwim River have not observed black bears (Jewett et al. 2010). Black bears have an omnivorous diet that includes salmon, berries, roots, grasses, insects, and occasionally small mammals or carrion, depending on seasonal availability.

Brown bear population levels have been estimated by ADF&G in GMU 19 (which includes the Crooked Creek drainage and Kuskokwim River basin upstream of Kalskag) based on habitat quality and known bear densities in similar habitats (Peirce 2013). In GMU 19A, habitat quality is considered moderate and capable of supporting 20 bears per 1,000 square miles, or 200 bears in GMU 19A. Brown bear have been observed infrequently during surveys near the Mine Site, most often near the Russian Mountains. Brown bear in GMU 18 are concentrated in areas away from the Kuskokwim River. The Donlin Gold Project's wildlife surveys along the Kuskokwim River did not observe brown bears (Jewett et al. 2010). Brown bears have a varied diet that includes salmon during spawning runs, as well as berries, roots, grasses, insects, and occasionally moose calves or carrion, depending on the season and food availability.

Caribou are generally not found in the Crooked Creek drainage, or north of the Kuskokwim River. The Mulchatna herd range is typically south of the River. The latest Mulchatna herd census (2008 data) indicated at least 30,000 caribou, which is at the low range of the management goal for this herd (Woolington 2013). The Mulchatna herd tends to concentrate in areas well south of the Kuskokwim River, but small numbers of animals may occasionally appear along the River. The Donlin Gold Project's wildlife surveys along the Kuskokwim River did not observe caribou (RWJ Consulting 2010). Caribou primarily feed on lichens, grasses, sedges, and shrubs, with their diet shifting seasonally to include more green vegetation and leaves during the summer months and lichens during the winter.

Moose densities in GMU 19A ranged from 0.27 to 0.44 observable moose/square mile during ADF&G aerial surveys from 2005 to 2010, and 0.25 observable moose/square mile in 2011. These densities are lower than management goals for the region (0.75-0.93 moose/square mile) (Seavoy 2012a). Much of GMU 18 consists of the Yukon Delta National Wildlife Refuge (YDNWR) to the north and the Togiak National Wildlife Refuge to the south. Moose began spreading into the Yukon-Kuskokwim (Y-K) Delta in the 1940s and the population along the Kuskokwim River is still small; hunting pressure has limited the growth rate, although riparian habitat appears to be available for expansion (Perry 2012). ADF&G aerial surveys indicate that moose densities increased in the Lower Kuskokwim area from 2004 to 2011, with the latter estimates at 0.8 moose per square mile. The population in this area appears to be growing primarily through continual immigration from surrounding areas (Perry 2012). Moose were consistently sighted during fall aerial surveys conducted by Donlin Gold contractors at the western base of the Russian Mountains, the hills west of the Owhat River, and the hills north of the Kuskokwim River (ARCADIS 2013). Moose primarily feed on willows, birch, and aspen shoots and leaves during the summer, and switch to woody twigs, bark, and aquatic plants in the winter months.

Small mammal populations fluctuate due to natural factors such as weather, wildfire impacts on habitat, and prey population cycles. Some species are managed by ADF&G as furbearers or species "that are trapped or hunted for hides, fur, or meat". Common small mammals that could exist in the Crooked Creek drainage and along the Kuskokwim River include coyotes, red fox, arctic fox, Canadian lynx, American marten, American mink, least weasel, short-tailed weasel, river otter, wolverine, beaver, muskrat, porcupine, red squirrel, lemmings, various shrews, mice, and voles, snowshoe hare, and Alaskan hare.

Direct impacts to wildlife in the path of the flood of materials would be realized from loss through drowning, burial or other direct effects. Given the much-larger volume of tailings that could be released under Scenario 9a, 9b, or 9c and the speed and height of the flood wave along Crooked Creek under

each of these scenarios, it is anticipated that most wildlife present along Crooked Creek at the time of a release would be lost. Individuals of most species found in those areas along the Crooked Creek drainage that are subject to less inundation would be expected to move from the affected area; smaller mammals and those that reside underground would be less able to move from the affected area.

The modeled larger release scenarios would result in the same types of indirect impacts (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) as described for Scenario 9. These types of impacts would be realized across a larger area of the Crooked Creek drainage due to the increased volume of released material; the areal extent over which these types of impacts would be realized are presented in Sections 2.3.5.12 and 2.3.5.13. In addition to the indirect habitat-related effects.

As described for Scenario 9, effects to wildlife species could also be realized from exposure to soil conditions (pH) or chemical contaminants that may be toxic. The number of individuals that could be so-impacted under Scenarios 9a, 9b, or 9c would be greater than that under Scenario 9 due to the larger area of tailings deposition; in addition, the timeframes over which such effects could be realized would be longer given the long duration of response and remediation activities and natural attenuation processes.

Terrestrial mammal habitat would have more long-term habitat impacts under Scenarios 9a, 9b, and 9c compared to Scenario 9. Both the riparian corridor and any submerged aquatic vegetation downstream of the tailings site would be covered in tailings material which would cause those habitats to be greatly altered. Riparian corridors would likely be smothered by tailings material and may not recover to baseline conditions. Riparian corridors serve as important bedding and holding habitats for many terrestrial mammal species and can also serve as an important food source throughout the year. As a result of Scenarios 9a, 9b, and 9c, the floodplains which are downstream of the tailings site could have streams, rivers, and tributaries filled in with tailings material which could cause those systems to no longer be viable habitats for aquatic resources such as fish, invertebrates, aquatic vegetation, or drinking water, all of which are important for terrestrial wildlife survival. The deposition of tailings material would also greatly change the downstream composition of the sediment and soils which could cause harm to smaller terrestrial mammals which utilize burrows in the soil for survival and refuge from harsh conditions.

Under Scenarios 9a, 9b, or 9c, terrestrial mammals could experience long-term exposure of heavy metals like antimony, arsenic, mercury, and thallium. Heavy metals are contaminants which can bioaccumulate in tissues resulting in chronic toxicity. In moose and caribou, heavy metals can impair kidney and liver function, disrupt reproductive success, and weaken immune responses, making populations more susceptible to disease and environmental stressors (Gibson et al. 2016; Scheuhammer et al. 2008). Similarly, in bears, chronic heavy metal exposure has been linked to neurological damage, hormonal disruption, and decreased cub survival, ultimately threatening population sustainability (Obbard et al. 2017).

Predatory species like gray wolves are particularly vulnerable due to their position at the top of the food chain, where bioaccumulation can result in higher tissue concentrations of heavy metals. In high enough levels, chronic exposure to heavy metals in predators can lead to behavioral changes, reproductive failure, and increased mortality rates (Wayland and Scheuhammer 2011). Non-lethal effects have also been observed due to chronic exposure to heavy metals in predators such as impaired sensory and

locomotor functions, reduce hunting efficiency and increase the risk of vehicle collisions and human-wildlife conflicts (García-Fernández et al. 2013).

Similarly, chronic exposure to heavy metals through bioaccumulation and soil exposure can pose health risks to small mammals. Over time, these metals can bioaccumulate in tissues, particularly in the liver, kidneys, and nervous system, leading to neurological impairment, reproductive dysfunction, and weakened immune responses (Shore and Douben 1994; Beyer et al. 2013). Behavioral changes, such as reduced predator avoidance and altered foraging strategies, have been observed in mammals exposed to sub-lethal concentrations, increasing their risk of predation and reducing survival rates (Ma 2011). Additionally, chronic toxicity can suppress population growth and disrupt ecosystem functions, especially where top predators or keystone species like beavers are affected (Beyer et al. 2013). Chronic exposure to small mammals that are low on the food chain, like mice, voles, and shrews can cause impacts beyond the individual species, as these contaminants can bioaccumulate up to higher trophic species (Shore and Douben 1994).

#### **2.3.4.13.2 Marine Mammals**

##### **2.3.4.13.2.1 Alternative 2 – Donlin Gold’s Proposed Action**

###### **2.3.4.13.2.1.1 Scenario 9**

For the discussion of impacts on marine mammals as the result of a 0.5% release, see FEIS Section 3.24.6.12.2.

###### **2.3.4.13.2.1.2 Scenario 9a, 9b, and 9c: Larger Tailings Dam Failure**

A larger release scenario may affect marine mammals, as well as prey species and habitat, in the lower Kuskokwim River and Kuskokwim Bay. In the Kuskokwim River, five marine mammal species may occur: beluga whale (*Delphinapterus leucas*), Eastern Bering Sea distinct population segment (DPS), gray whale (*Eschrichtius robustus*), Eastern North Pacific DPS, spotted seal (*Phoca larga*), ringed seal (*Pusa hispida*), and Steller sea lion (*Eumetopias jubatus*). Steller sea lions have historically been harvested in the lower river.

In 1988, beluga whales were common in Kuskokwim Bay between April and August and have been observed in the Kuskokwim River up to 25 miles (40 kilometers [km]) upstream (Frost and Lowry 1990); however, a report from May 2020 indicates that “belugas rarely occur in the Kuskokwim anymore” (NSB 2022). On May 26, 2022, a pair of belugas were observed approximately 60 miles (97 km) upstream near Bethel, likely pursuing food correlating with the king salmon runs up the River. Belugas are generally considered to be opportunistic feeders. Fish species make up a large part of their diet including herring, capelin, smelt, cod, salmon, flatfish, sculpin, lingcod, and eulachon. They will also feed on octopus, squid, shrimp, crab, clams, mussels, snails, and sandworms.

Although anticipated to be extremely uncommon, there is a possibility that gray whales may occur in the Kuskokwim River based on a previous occurrence in the area. In July 2017 a gray whale was harvested south of Bethel, near the Napaskiak. However, it was the first time that Alaskan subsistence hunters from Bethel could remember a gray whale traveling that far up the Kuskokwim River. Gray whales are the only baleen whales that are mainly bottom feeders, getting their food by scraping the side of their head along the ocean floor and scooping up sediment. Small invertebrates are captured on the baleen, while sediment and other particles are expelled through the baleen fringes.

Spotted seals are common in Kuskokwim Bay. Large land haulouts where several thousand seals may congregate occur on the sand bars around Kuskokwim Bay. During surveys performed in the 1990s in

August and September along most of Alaska's western coast, over 2,500 spotted seals were counted in Kuskokwim Bay (Rugh et al. 1997). Spotted seals are an important species for Alaskan subsistence hunters, primarily in the Bering Strait and Yukon-Kuskokwim regions (Rugh et al 1997). ADF&G seal harvest reports indicate seals have been harvested up the Kuskokwim River as far as Kwethluk, located 100 miles (161 km) upriver (Coffing et al. 1999). Adult spotted seals eat a variety of fish, crustaceans, and cephalopods and their diet varies with age, season, and location. In the northern Bering Sea, arctic cod are an important prey species but farther south, pollock and capelin are more important.

Ringed seals are distributed throughout Arctic waters in all seasonally ice-covered seas. In winter and early spring when sea ice is at its maximum coverage, they can be found in the northern Bering Sea, and throughout the Chukchi and Beaufort seas. They occur as far south as Bristol Bay in years of extensive ice coverage (Muto et al. 2022). Ringed seals are rarely seen hauled out on land. The Ice Seal Movement, Habitat Use, and Foraging Behavior Study – North Slope, Alaska reported that all four ringed seals tagged in 2016 that wintered in the Bering Sea moved south to waters near the Yukon Kuskokwim Delta (Von Duyke 2020). Therefore, it is expected that ringed seals could travel up the Kuskokwim River. Ringed seals are opportunistic and eat a variety of invertebrates, fish, and amphipods. The particular species eaten depends on availability, depth of water, and distance from shore. In Alaska waters, the important food species are arctic cod, saffron cod, shrimps, and other crustaceans.

Pacific walrus (*Odobenus rosmarus*) are known to haul out in southern Kuskokwim Bay along Cape Newenham between May through October (McDonald and Winfree 2008, Jemison 1992) and a known walrus breeding area is west of Kuskokwim Bay in the Bering Sea. Walruses eat a wide variety of soft invertebrates found on or below the seafloor by using their sensitive whiskers to search for prey. Prey items include, clams, snails, worms, sea cucumbers, and tunicates. Some walruses, mostly males, are known to occasionally prey on seals and seabirds.

During a larger release, a viscous slurry of water and tailings would be released; a majority (>80-90%) of the tailings that are discharged to the Kuskokwim River is expected to be transported in suspension due to its fine-grained nature (mostly silts and clays), ultimately reaching the mouth of the river at Kuskokwim Bay. Effects could include sedimentation of seagrasses and seabed prey species (e.g., crustaceans, shellfish), secondary impacts resulting from effects to fish prey during spawning, rearing, and migration (e.g., limited or reduced quality prey; Section 2.3.6.15.1.1.2), or changes to habitat from sedimentation and material suspension in the water column. Sedimentation could have short and long-term effects on water quality as well, potentially raising turbidity levels while dropping dissolved oxygen levels. It is expected the sedimentation and material suspension would rapidly be diluted/disseminated by the currents and tides and the overall impacts to marine mammals and water quality would be minor.

The deposition of tailing materials throughout the Kuskokwim River would lead to potential chronic exposure of heavy metals to marine mammals. In high enough levels, chronic exposure to heavy metals can lead to immunosuppression, neurological disorders, reproductive failures, and developmental abnormalities in both adults and offspring (Reijnders & Aguilar, 2002). For example, mercury has been linked to impaired cognitive function and altered behavior in dolphins, while cadmium and lead have been associated with kidney and liver damage in seals and whales (Ikemoto et al., 2004). The high trophic level of many marine mammals exacerbates their risk, as heavy metals bioaccumulate up the food chain, resulting in higher concentrations in apex predators (Das et al., 2003). Although the heavy metals would likely be largely diluted once they reached Kuskokwim Bay, chronic exposure of heavy metals by marine mammals is still a larger risk under Scenarios 9a, 9b, or 9c compared to Scenario 9.

### 2.3.4.13.3   **Birds**

#### 2.3.4.13.3.1   Alternative 2 – Donlin Gold's Proposed Action

##### 2.3.4.13.3.1.1   *Scenario 9*

Potential impacts to bird species under Scenario 9 are not addressed in the FEIS.

##### 2.3.4.13.3.1.2   *Scenario 9a, 9b, and 9c: Larger Tailings Dam Failure*

A larger tailings release under either Scenario 9a, 9b, and 9c would have a larger potential impact on bird species than Scenario 9 due to long-term habitat impacts and potential exposure to heavy metals.

The Y-K Delta is considered one of the most significant wetland ecosystems for waterfowl in North America. Covering approximately 77,000 square kilometers, the Y-K Delta provides critical breeding and nesting habitat for millions of migratory birds each year. Species such as the emperor goose, Pacific black brant, and cackling goose rely heavily on the Y-K Delta's marshes and tundra ponds for reproduction and rearing of young (Sedinger and Raveling, 1986; U.S. Fish & Wildlife Service [USFWS], 2020). Additionally, the Y-K Delta supports some of the highest densities of nesting waterfowl found anywhere in the world, making it a keystone area for continental waterfowl populations (Ely et al., 1994). Waterfowl typically have various dietary habits depending on the species, individuals often are feeding on a combination of aquatic plants, seeds, invertebrates, and small fish.

In addition to providing nesting sites, the Y-K Delta serves as a crucial stopover and molting area during migration. The abundant food resources and relative remoteness of the Y-K Delta help sustain birds during energetically demanding periods (Flint et al., 2008). The Y-K Delta also supports a variety of raptor species including bald eagles, peregrine falcons, rough-legged hawks, and northern harriers. These raptor species feed on prey species like waterfowl, various fish, and small mammals.

A larger release would deposit tailings in the riparian zones and aquatic features of the Crooked Creek and Kuskokwim River watersheds, including along the shore of the Kuskokwim River adjacent to the Y-K Delta although by the time material reaches the Delta much of it would have settled out so significant tailings deposits would not be anticipated within the YK Delta. While these are habitat areas which waterfowl use to nest, feed, and rear juveniles, the deposition of tailings material into the Y-K Delta from a larger release would be minimal in comparison to the total acreage of the area that is utilized by waterfowl so population level impacts are not expected. During a larger release, waterfowl could experience chronic exposure to heavy metals; they are susceptible to such exposure given their use of moist soil/sediment exposed habitat types. At high enough concentrations, heavy metal exposure can cause neurological impairment, reduced growth, and lower reproductive success in waterfowl species (Scheuhammer and Norris, 1996).

Raptor species would likely be less impacted compared to waterfowl; however, they do utilize the watersheds near the mine as well as the Y-K Delta as a food source. Because raptor species are a higher trophic predator, heavy metal exposure from consumption of contaminated prey species can lead to neurological damage, impaired reproduction, and reduced survival rates through bioaccumulation (Eisler, 2000; Shore et al., 2011). Chronic exposure of heavy metals can also weaken raptors' immune function and increase susceptibility to disease, further threatening raptor reproduction success (Shore et al., 2011).

While waterfowl and raptor species are heavily associated with the Y-K Delta because of the unique ecosystems it provides, upland bird species and various migratory bird species also utilize the Crooked Creek and Kuskokwim River drainages. Upland bird species which could occur include willow ptarmigan,

rock ptarmigan, sharp-tailed grouse, ruffed grouse, and spruce grouse. Many grassland and passerine migratory species could also utilize the area. Upland bird species could be more impacted than migratory bird species as a result of Scenarios 9a, 9b, and 9c due to their smaller home range. Migratory birds are highly mobile and would likely move out of the area as a result of a tailings release. Upland bird species could have more long-term habitat loss and heavy metal exposure. Through the deposition of tailings material across the floodplain of the drainages, upland bird heavy metal bioaccumulation could occur through ingestion of food sources like vegetation, seeds, berries, and invertebrates. Modeling suggests that deposition of tailing material into the floodplains would be minimal and that it is more likely the tailings material would settle out in the low energy areas of the Y-K Delta, Crooked Creek drainage, and Kuskokwim River drainage. As such, it is expected that there would be relatively low exposure of heavy metals to uplands birds through bioaccumulation during a large tailings release. Long-term chronic exposure of heavy metals to upland birds, however, can result in neurological impairment, reduced reproductive success, weakened immune function, and increased mortality (Pain and Amiard-Triquet, 2011; Burger and Gochfeld, 2000).

### **2.3.4.14 *Fish and Aquatic Resources***

#### **2.3.4.14.1 Alternative 2 – Donlin Gold’s Proposed Action**

##### **2.3.4.14.1.1 Scenario 9**

For the discussion of impacts on fish and aquatic resources as the result of a 0.5% release, see FEIS Section 3.24.6.13.

##### **2.3.4.14.1.2 Scenarios 9a, 9b, and 9c: Larger Tailings Dam Failure**

In the Donlin Gold FEIS, 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, Crooked Creek, and Kuskokwim River drainages for a 0.5% release, in which all impacts were confined to the Crooked Creek drainage. Updated modeling was conducted by BGC to evaluate the impacts of various larger dam releases (BGC 2025). A larger release would result in similar types of impacts; however, the effects would be realized on substantially more aquatic habitat. Inundation maps presented in the FEIS (FEIS Figure 3.24-2 and Figure 3.24-3 [EED Figures 2.3.1 and 2.3.2]) estimate the extent of downstream flooding and sediment deposition from a 0.5% release. For this evaluation, three new release scenarios were evaluated for the impact to aquatic habitat and fish populations.

During a larger release, a viscous slurry of water and tailings would be released downstream causing sediment deposition where the affected drainages widen and gradients flatten. The impact mechanisms and seasonality of effects would be the same as described for the partial release.

TSF Main Dam breach inundation models of 5%, 13%, and 25% release volumes (BGC 2025) predicted the expected migration of tailings and water and the extent of deposition relative to downstream receiving waters in the Anaconda Creek, Crooked Creek, and Kuskokwim River drainages; Table 2.3-10 and Table 2.3-11 present this data, and Figures 2.3.3 through 2.3.5 illustrate graphically the extent of deposition.

**Table 2.3-10 Summary of Modelled Inundation Areas**

| <b>Tailings Release Scenario</b> | <b>Crooked Creek Inundation Area (acres)</b> | <b>Kuskokwim River Inundation Area (acres)<sup>1</sup></b> |
|----------------------------------|----------------------------------------------|------------------------------------------------------------|
| 0.5%                             | 340                                          | negligible                                                 |
| 5%                               | 4,390                                        | 3,100                                                      |
| 13%                              | 4,930                                        | 2,910                                                      |
| 25%                              | 5,580                                        | 6,250                                                      |

Notes:

1 Expressed as the area flooded outside the extents of the Kuskokwim River for the baseflow conditions.

Source: BGC 2025

**Table 2.3-11 Summary of Tailings Deposition in Crooked Creek and Discharged to Kuskokwim River**

| <b>Tailings Release Scenario</b> | <b>Volume of Tailings Released (acre-ft)</b> | <b>Tailings Deposition in Crooked Creek (acre-ft)</b> | <b>Deposition in Crooked Creek (%)<sup>1</sup></b> | <b>Discharged to Kuskokwim River (acre-ft)<sup>2</sup></b> | <b>Discharged to Kuskokwim River (%)<sup>3</sup></b> |
|----------------------------------|----------------------------------------------|-------------------------------------------------------|----------------------------------------------------|------------------------------------------------------------|------------------------------------------------------|
| 0.5%                             | 1,670                                        | 1,670                                                 | 100                                                | negligible                                                 | -                                                    |
| 5%                               | 27,640                                       | 11,495                                                | 64                                                 | 9,730                                                      | 35.2                                                 |
| 13%                              | 54,080                                       | 40,780                                                | 92                                                 | 13,300                                                     | 24.6                                                 |
| 25%                              | 82,140                                       | 61,464                                                | 75                                                 | 30,406                                                     | 33.1                                                 |

Notes:

1 Expressed as a percentage of the volume of tailings released and not the total release volume.

2 Includes both tailings and pond water (except for the 0.5% release volume scenario).

3 Expressed as a percentage of the total release volume.

Source: BGC 2025

The inundation area and volume of tailings discharge to the Kuskokwim River drainage would differ by release volume. The total acreage of inundation was predicted to be 3,100 to 6,250 acres, the highest at the 25% release volume and lowest at the 5% release volume (Table 2.3-10). Even at the 5% release volume, flood flow velocity is sufficient to transport sediment into side channels and then result in some deposition of fines not deposited within the Crooked Creek drainage.

At the 5% release volume scenario, floodwaters would inundate about 4,390 acres of the Crooked Creek floodplain including all mainstem reaches and most off-channel fish habitats downstream from and within Anaconda Creek. Floodwater would also extend approximately 0.6 miles (1 km) upstream from the confluence of Anaconda and Crooked creeks. Approximately 3,100 acres of Kuskokwim River floodplain would also be inundated (Table 2.3-10). The larger-volume release scenarios would inundate more of the Crooked Creek and Kuskokwim River floodplains relative to the release volume (Table 2.3-10).

At the 5% release volume, modeling predicts that approximately 11,495 acre-feet of tailings would be deposited in the Crooked Creek drainage. Flows would be sufficient to transport 9,730 acre-feet of tailings into the Kuskokwim River and side channels, potentially depositing 10 to 20% of the volume into side

channels. The areal extent of impacted habitats would moderately increase under the higher release volumes as the volume of tailings transported to and deposited in Crooked Creek and the Kuskokwim River increases more substantially relative to flow volume. (Table 2.3-11). 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 confluences, including the confluence of Anaconda and Crooked creeks, Crooked Creek and the Kuskokwim River, and Kuskokwim River confluences with tributaries and side channels. While not directly modeled, some deposition would be anticipated to occur in backwaters and slow moving sloughs downstream from Lower Kalskag to Kuskokwim Bay, though to a lower magnitude.

All five species of Pacific salmon (Chinook [*Oncorhynchus tshawytscha*], coho [*Oncorhynchus kisutch*], sockeye [*Oncorhynchus nerka*], chum [*Oncorhynchus keta*], and pink [*Oncorhynchus gorbuscha*]) are present in the Kuskokwim River (Salmon FMP 2024) and in the reaches of Crooked Creek that would be impacted by the modeled releases. Habitat and individuals of all five Pacific salmon species have been documented within Crooked Creek in areas that would be impacted by the modeled releases as discussed below, including documented chum, coho, and Chinook salmon spawning habitats.

Anadromous whitefish (*Coregonus* sp.) and rainbow smelt (*Osmerus mordax*) are also present in the Kuskokwim River in reaches that would be impacted by a larger dam release, with documented spawning by rainbow smelt from just upstream of Bogus Creek to above Upper Kalskag. Based on the modeling, 28 anadromous streams would be impacted as shown in Table 2.3-12.

**Table 2.3-12 Anadromous Waters Catalog Listed Streams Impacted in Scenarios 9a, 9b, and 9c<sup>1</sup>**

| Stream                                  | AWC Code          | Species                     | Life Stage            | Group          |
|-----------------------------------------|-------------------|-----------------------------|-----------------------|----------------|
| Kuskokwim River                         | 335-20-16600      | coho salmon                 | rearing, present      | Pacific salmon |
|                                         |                   | Chinook salmon              | rearing, present      | Pacific salmon |
|                                         |                   | sockeye salmon              | rearing, present      | Pacific salmon |
|                                         |                   | chum salmon                 | rearing, present      | Pacific salmon |
|                                         |                   | pink salmon                 | rearing, present      | Pacific salmon |
|                                         |                   | least cisco                 | rearing, present      | Whitefish      |
|                                         |                   | inconnu                     | Present               | Whitefish      |
|                                         |                   | humpback whitefish          | Present               | Whitefish      |
|                                         |                   | broad whitefish             | Present               | Whitefish      |
|                                         |                   | rainbow smelt               | present, spawning     | Smelt          |
|                                         |                   | whitefish, undifferentiated | spawning <sup>2</sup> | Whitefish      |
| Discovery Creek                         | 335-20-16600-2300 | coho salmon                 | Present               | Pacific salmon |
| Unnamed Tributary to Kuskokwim River    | 335-20-16600-2331 | coho salmon                 | Present               | Pacific salmon |
| Unnamed Side Channel of Kuskokwim River | 335-20-16600-2332 | coho salmon                 | rearing, present      | Pacific salmon |
|                                         |                   | chum salmon                 | rearing, present      | Pacific salmon |
| Swift Creek                             | 335-20-16600-2340 | coho salmon                 | present               | Pacific salmon |
| Aniak River                             | 335-20-16600-2400 | coho salmon                 | present               | Pacific salmon |
|                                         |                   | sockeye salmon              | spawning              | Pacific salmon |

**Table 2.3-12 Anadromous Waters Catalog Listed Streams Impacted in Scenarios 9a, 9b, and 9c<sup>1</sup>**

| <b>Stream</b>          | <b>AWC Code</b>   | <b>Species</b>              | <b>Life Stage</b> | <b>Group</b>   |
|------------------------|-------------------|-----------------------------|-------------------|----------------|
|                        |                   | inconnu                     | present           | Whitefish      |
|                        |                   | Chinook salmon              | present           | Pacific salmon |
|                        |                   | pink salmon                 | spawning          | Pacific salmon |
|                        |                   | chum salmon                 | spawning          | Pacific salmon |
|                        |                   | whitefish, undifferentiated | present           | Whitefish      |
| <b>Owhat River</b>     | 335-20-16600-2411 | chum salmon                 | present           | Pacific salmon |
|                        |                   | Chinook salmon              | present           | Pacific salmon |
|                        |                   | coho salmon                 | present           | Pacific salmon |
| <b>Kolmakof River</b>  | 335-20-16600-2501 | chum salmon                 | spawning          | Pacific salmon |
|                        |                   | coho salmon                 | present           | Pacific salmon |
|                        |                   | Chinook salmon              | present           | Pacific salmon |
| <b>Victoria Creek</b>  | 335-20-16600-2530 | coho salmon                 | present           | Pacific salmon |
| <b>Holokuk River</b>   | 335-20-16600-2540 | inconnu                     | present           | Whitefish      |
|                        |                   | chum salmon                 | present           | Pacific salmon |
|                        |                   | sockeye salmon              | present           | Pacific salmon |
|                        |                   | pink salmon                 | present           | Pacific salmon |
|                        |                   | coho salmon                 | present           | Pacific salmon |
|                        |                   | whitefish, undifferentiated | present           | Whitefish      |
|                        |                   | Chinook salmon              | present           | Pacific salmon |
| <b>Sue Creek</b>       | 335-20-16600-2559 | coho salmon                 | present           | Pacific salmon |
| <b>Veahna Creek</b>    | 335-20-16600-2560 | coho salmon                 | rearing           | Pacific salmon |
| <b>Oskawalik River</b> | 335-20-16600-2630 | coho salmon                 | present           | Pacific salmon |
|                        |                   | chum salmon                 | present           | Pacific salmon |
|                        |                   | sockeye salmon              | present           | Pacific salmon |
|                        |                   | Chinook salmon              | present           | Pacific salmon |
|                        |                   | whitefish, undifferentiated | present           | Whitefish      |
|                        |                   | inconnu                     | present           | Whitefish      |
| <b>Jungjuk Creek</b>   | 335-20-16600-2641 | coho salmon                 | rearing           | Pacific salmon |
| <b>Village Creek</b>   | 335-20-16600-2669 | coho salmon                 | rearing           | Pacific salmon |
| <b>Crooked Creek</b>   | 335-20-16600-2671 | Chinook salmon              | spawning, rearing | Pacific salmon |
|                        |                   | sockeye salmon              | present           | Pacific salmon |
|                        |                   | chum salmon                 | spawning          | Pacific salmon |
|                        |                   | coho salmon                 | spawning, rearing | Pacific salmon |

**Table 2.3-12 Anadromous Waters Catalog Listed Streams Impacted in Scenarios 9a, 9b, and 9c<sup>1</sup>**

| Stream                                      | AWC Code               | Species                     | Life Stage       | Group          |
|---------------------------------------------|------------------------|-----------------------------|------------------|----------------|
|                                             |                        | pink salmon                 | present          | Pacific salmon |
| <b>Bell Creek</b>                           | 335-20-16600-2671-3020 | coho salmon                 | present          | Pacific salmon |
|                                             |                        | Chinook salmon              | rearing          | Pacific salmon |
|                                             |                        |                             |                  |                |
| <b>Getmuna Creek</b>                        | 335-20-16600-2671-3023 | Chinook salmon              | rearing          | Pacific salmon |
|                                             |                        | coho salmon                 | present, rearing | Pacific salmon |
|                                             |                        | chum salmon                 | present          | Pacific salmon |
|                                             |                        | sockeye salmon              | present          | Pacific salmon |
| <b>Unnamed Tributary to Crooked Creek</b>   | 335-20-16600-2671-3030 | coho salmon                 | rearing          | Pacific salmon |
| <b>Unnamed Tributary to Crooked Creek</b>   | 335-20-16600-2671-3031 | coho salmon                 | rearing          | Pacific salmon |
| <b>Anaconda Creek</b>                       | 335-20-16600-2671-3032 | coho salmon                 | rearing          | Pacific salmon |
| <b>Unnamed Tributary to Crooked Creek</b>   | 335-20-16600-2671-3042 | coho salmon                 | rearing          | Pacific salmon |
| <b>California Creek</b>                     | 335-20-16600-2739      | coho salmon                 | rearing          | Pacific salmon |
| <b>Downey Creek</b>                         | 335-20-16600-2740      | coho salmon                 | present, rearing | Pacific salmon |
|                                             |                        | Chinook salmon              | rearing          | Pacific salmon |
| <b>George River</b>                         | 335-20-16600-2741      | inconnu                     | present          | Whitefish      |
|                                             |                        | pink salmon                 | spawning         | Pacific salmon |
|                                             |                        | coho salmon                 | spawning         | Pacific salmon |
|                                             |                        | chum salmon                 | spawning         | Pacific salmon |
|                                             |                        | whitefish, undifferentiated | present          | Whitefish      |
|                                             |                        | Chinook salmon              | spawning         | Pacific salmon |
|                                             |                        | sockeye salmon              | present          | Pacific salmon |
| <b>Unnamed Tributary to Kuskokwim River</b> | 335-20-16600-2765      | Chinook salmon              | rearing          | Pacific salmon |
| <b>Fuller Creek</b>                         | 335-20-16600-2780      | coho salmon                 | present          | Pacific salmon |
| <b>Red Devil Creek</b>                      | 335-20-16600-2790      | coho salmon                 | rearing          | Pacific salmon |
|                                             |                        | Chinook salmon              | rearing          | Pacific salmon |

Notes:

- 1 Listed streams are impacted in all Scenarios, 5%, 13%, and 25%. Extent of impacts increases in most streams in higher release volume scenarios.
- 2 Whitefish spawning, while listed in the AWC, is not substantiated within mainstem Kuskokwim River reaches potentially impacted by a TSF release.

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). Coho and chum salmon were the most abundant.

The smallest modeled larger release, a 5% release volume, would result in substantial alterations of Crooked Creek mainstem reaches and the mouths of important fish bearing tributaries to Crooked Creek (Bell and Getmuna creeks). Models predict inundation effects extending into the Kuskokwim River upstream from Crooked Creek, and downstream to Lower Kalskag, and ultimately reaching Kuskokwim Bay. Inundation maps that illustrate the extent of flooding and sediment deposition in the Crooked Creek drainage and the Kuskokwim River downstream to Upper/Lower Kalskag are presented in drawing sets A, B, and C in BGC 2025).

For this evaluation, the mechanisms of impact are assumed to be similar to those described in the FEIS, with increased magnitude of effect and duration. As described in the FEIS, the extent and nature of the impacts of a larger release would vary depending upon the timing of release. A winter release would allow equipment access for restoration activities to a wider area than under thawed conditions. Freezing conditions could slow the spread of flood waters; however, higher release volumes and velocities could also increase ice scouring in the impacted drainages. Impacts to fish would also differ depending on the timing of release in relation to life stages and seasonal behaviors.

#### *2.3.4.14.1.2.1 Crooked Creek Drainage*

Crooked Creek would be adversely impacted upstream and downstream of the confluence with Anaconda Creek. The nature of impacts would be similar to those described for the 0.5% tailings release, but the extent of impacts would generally increase with higher release volumes.

Tailings deposition depths within the Crooked Creek drainage would differ by release volume. All releases modeled will result in deposition greater than 5 to 10 feet with the highest acreage affected at the 25% release volume and lowest at the 0.5% release volume (Figures 2.3.2 through 2.3.5). Even at the 5% release volume, the release would 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 the Crooked Creek drainage.

Burial or fill of 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. Depending on the size and timing of release, a release would adversely affect fish spawning, rearing, feeding, migration, and multiple life stages. Fish, eggs, and prey organisms present in the inundated portions during the release would be immediately impacted by higher velocities and transported and deposited materials. Material deposition would impact 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, creation of barriers to fish migration, and isolation of fish populations in upper Crooked Creek and tributaries from the lower Crooked Creek drainage.

A tailings release would adversely affect the proper functioning conditions of fish spawning, rearing, and migration habitat in lower Crooked Creek. The lower reaches of Getmuna Creek and Bell Creek, tributaries to Crooked Creek, would be inundated following a larger release, adversely impacting rearing juvenile and adult Pacific salmon present in these streams. Populations in the upper reaches could become isolated from other reaches of Crooked Creek, Bell and Getmuna creeks, and the Kuskokwim River. Deposition may result in barriers to fish migrating from the Kuskokwim River to spawning and

foraging habitat in lower Crooked Creek and its tributaries. Pacific salmon habitat, and some juveniles, in Getmuna, Bell, and Donlin creeks could be isolated from Crooked Creek and the Kuskokwim River until a passageway becomes eroded through sediment plumes in the lower reaches.

Few spawning redds would be present in the middle reaches of Crooked Creek near the confluence of Anaconda Creek in the event of a tailings release; however, incubating eggs, rearing juvenile, or adult fish in the vicinity of Anaconda Creek would be directly affected by erosion and then sediment deposition depending on the timing of a breach. 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 deposition or until response and restoration activities reestablish a connection between the upper and lower reaches.

Fish production in lower Crooked Creek, where the greatest proportion of salmon spawning and rearing occurs, would be subject to high flows at the time of the release, but would be more substantially impacted by direct burial, and possibly long-term water quality impacts resulting from the release and subsequent period of recovery. Depending on the physical and chemical nature of water quality effects, the intensity of impacts to overall fish production in Crooked Creek would vary and would result in stock-level effects to Crooked Creek drainage Pacific salmon. Resident fish species such as Arctic grayling (*Thymallus arcticus*), slimy sculpin (*Cottus cognatus*), Dolly Varden (*Salvelinus malma*), ninespine stickleback (*Pungitius pungitius*), and to a lesser extent, northern pike (*Esox lucius*) and burbot (*Lota lota*), would be affected similarly.

Water quality impacts of the 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, changes to the temperature regime, and release of chemical contaminants from the tailings. Such impacts would tend to attenuate with farther distance downstream. Water quality impacts in Crooked Creek would depend on concentrations of contaminants following release. As described in Section 2.3.5.7, the duration of water quality impacts is difficult to predict. However, if contaminant concentrations exceed AWQS after tailings settle, it is possible that concentrations of some contaminants would be sustained for as long as tailings are present. Only arsenic is anticipated to be relevant from a freshwater aquatic life perspective, since the AWQS for sulfate, TDS, antimony, and manganese are either drinking water or irrigation based (Table 2.3-4). Sustained concentrations of arsenic above AWQS could adversely impact Crooked Creek fish populations for decades through behavioral changes, decreased health, reduced reproduction, and food chain effects. Populations would likely recover slowly, even after concentrations return to pre-release conditions, though recovery would likely depend on the extent and duration of contamination. Tailing excavation could release contaminated pore water into the water column and increase concentrations, though concentrations may decrease more rapidly following tailings removal. In some cases, seasonal concentration spikes may occur. Depending on timing, seasonal spikes could adversely impact important life stages.

The Crooked Creek drainage would likely experience population-level effects that would persist for years following clean-up activities. It is anticipated that the greatest effect difference between the modeled releases would be the timeframe for recovery, with the larger events having longer restoration timeframes and longer periods for natural processes and fish use to recover. Long term impacts from altered hydrology, deposition and sedimentation, and water quality would likely persist for years following a release.

#### 2.3.4.14.1.2.2 Kuskokwim River

A larger release would adversely affect fish and their habitats in the Kuskokwim River. This would include effects on migratory habitat for adult Pacific salmon returning to spawning areas and for smolt migrating

towards Kuskokwim Bay. Sedimentation and increased velocities could prevent migration into tributaries used for spawning and rearing by other species, and depending on timing and water quality, could impede spawning migration for Pacific salmon and whitefishes. The duration and magnitude of impact would likely be limited to the period of high flow caused by the release, while the limited total amount of deposition to side channels could impact rearing habitats for a longer duration. A winter release would have the lowest overall impact on Pacific salmon in the Kuskokwim River.

Pacific salmon species have been documented in Kuskokwim River tributaries during a variety of life stages. The nature of impacts could vary depending upon the timing of release. Sedimentation could directly impact incubating eggs, rearing juvenile, or adult fish in the Kuskokwim River and side channels. There is no documented Pacific salmon spawning in main channel Kuskokwim reaches that would be affected by a dam release, but some tributaries with documented Pacific salmon spawning would be impacted at their mouths. Most spawning in these tributaries is likely further upstream and direct impacts to eggs and larval Pacific salmon would be minimal.

Rainbow smelt are documented spawning in the Kuskokwim River, between Bogus Creek and just upstream from Upper Kalskag. Rainbow smelt typically migrate up the River in mid to late May over a 4- to 5-day period and spawn in mass, and exit the river. Generally, they spawn adjacent to the thalweg. Eggs incubate for two to three weeks and larval smelt emerge and migrate to Kuskokwim Bay (Owl Ridge 2022). A tailings release occurring during this period of rainbow smelt spawning, egg incubation, and larval outmigration could reduce or potentially eliminate production of rainbow smelt during that year.

While primary effects to fish in the Kuskokwim River would be from direct interaction of the flood front, related erosion, and potential toxicity of the discharge front, there are more persistent impacts that could result from the deposition of tailings within the floodplain. Persistent water quality impacts could result in behavioral disturbance, mortality, acute and chronic levels of stress or toxicity to fish and aquatic life from release of chemical compounds from the deposited tailings. Like the Crooked Creek drainage, the duration of water quality impacts to fish populations in the Kuskokwim River would depend on concentrations after tailings have settled for some contaminants. Main channel habitats would be unlikely to experience prolonged contamination regardless of the duration of impacts to Crooked Creek based on dilution alone. However, stagnant areas, predominantly associated with slow moving sloughs and backwaters along the Kuskokwim River, primarily downstream from the Aniak River, could have concentrations of arsenic exceeding aquatic life AWQS for as long as tailings are present, and these could persist for years to decades, though likely for a shorter duration than in Crooked Creek. Prolonged impacts to these non-main channel habitats would primarily affect rearing and feeding resident fish species and migrating anadromous fish species. Pacific salmon smolt, primarily chum, pink, and sockeye salmon, may encounter slower moving waters with longer term AWQS exceedances during their outmigration from the Kuskokwim River in May through late June. Adult rainbow smelt, that typically spawn in the main channel or larger, faster moving sloughs downstream from Upper Kalskag, would be unlikely to be affected by persistent exceedances of the AWQS in stagnant waters. Some larval rainbow smelt migrating out of the river after emergence in June could be distributed to areas of persistent exceedances and be affected, but the vast majority would be downstream of Bethel within four days traveling in the faster, unaffected currents of the main River.

#### **2.3.4.14.1.2.3 Kuskokwim Bay**

Depending on the magnitude of the release, 64 to 100% of tailings would be deposited within Crooked Creek (Table 2.3-11). 80 to 90% of tailings not deposited in the Crooked Creek drainage are predicted to

reach Kuskokwim Bay. Tailings deposited in the bay could interact with a variety of anadromous, brackish, and marine fish species of all life stages that either pass through the bay for spawning and rearing or rely on habitats within the bay for all life phases. During the initial flood event, effects could include interruption of fish migrations into the river for spawning, displacement of fish from areas impacted during the flood, or even mortality. Longer term effects could include sedimentation of seagrasses and seabed prey species. Changes to habitat from sedimentation and material suspension in the water column could lead to some localized displacement of fish. Similar to the effects described above in Section 2.34.14.1.2.2, effects on fish would be most likely during and immediately following the initial flood, with the magnitude of potential effects to fish and fish habitat rapidly decreasing with distance from the mouth of the Kuskokwim River. Longer term effects, if realized, would be localized to depositional areas within the bay and could lead to avoidance by some fish species and reduction in prey quantity and quality. However, given that most tailings are captured in Crooked Creek, it is expected that sedimentation and material suspension would rapidly be diluted/disseminated by the currents and tides, and the overall impacts to fish would be short term and negligible.

### **2.3.4.15 Threatened and Endangered Species —ESA-Protected, Candidate, and Delisted Bird Species**

#### **2.3.4.15.1 Alternative 2 – Donlin Gold’s Proposed Action**

##### **2.3.4.15.1.1 Scenario 9**

For the discussion of impacts on Threatened and Endangered Species as the result of a 0.5% release, see FEIS Section 3.24.6.14.1.

##### **2.3.4.15.1.2 Scenarios 9a, 9b, and 9c: Larger Tailings Dam Failure**

Each of the larger release scenarios would release sufficient volumes of tailings such that the material may be carried in suspension beyond the City of Bethel and to the mouth of the Kuskokwim River, and into Kuskokwim Bay. Both the Steller’s eider and spectacled eider are federally listed as threatened which affords them and their habitat protection under the Endangered Species Act (ESA) of 1973. If any of the Scenarios described would have a negative impact on the eider species or their habitat, it would constitute as “take” of the species and formal Section 7 consultation would have to be initiated with USFWS. Violation of the ESA can result in large legal and financial repercussions as long as damaged relationships with the governing agencies and locals. However, while the impacts are discussed in the EED, the probability of a larger tailings spill is so low that it is not “reasonably certain to occur and therefore would not constitute an “effect of the action,” impacting threatened or listed species, or critical habitat, as a threshold matter.

Steller’s eiders (*Polysticta stelleri*) may be present in Kuskokwim Bay during the summer, and 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).

Spectacled eider (*Somateria fischeri*) nest in the Y-K Delta National Wildlife Refuge and could be present in Kuskokwim Bay during the summer. Breeding habitat is found near the mouth of the Kuskokwim River on the north shore of Kuskokwim Bay, and eiders nesting in the area may forage in the bay.

No direct impacts to either eider species are anticipated from the tailings material that is carried in suspension into either the Kuskokwim River or in Kuskokwim Bay. Indirect impacts to eider species are possible through heavy metal bioaccumulation, from consumption of prey, in particular, benthic invertebrates. If tailings in suspension were to reach Kuskokwim Bay, the material will settle out of the water column and be deposited in the sediment of the Bay. The Kuskokwim River is reported to discharge approximately four million metric tons of sediment to Kuskokwim Bay per year (Miyahara and Ingraham 1984). Under the largest release scenario, approximately 35 million metric tons of tailings would be released to the Kuskokwim River. The entirety of this mass would not be deposited in Kuskokwim Bay immediately following release, as some portion of the tailings would be deposited and would remain in the Kuskokwim River. Over the long-term, the tailings deposited in the Kuskokwim River, and tailings deposited in the Crooked Creek drainage (until such time as response activities are completed), would be a source of continued tailings loading to the Bay as tailings are remobilized during the spring thaw and flood events. In the year of release, the mass of the released tailings would exceed the mass of naturally-sourced sediment load to the Bay; in subsequent years and over time, the mass of released tailings is anticipated to be a small (and decreasing) portion of the mass of naturally-sourced sediment in the river.

Tailings that settle out of suspension in the Bay could be widely distributed as a result of currents and tidal action, and would in some locations be subject to burial due to the large sediment discharge to the Bay from the Kuskokwim River and due to sediment movement within the Bay. Over time, currents and tidal action, as well as biological activity, could re-suspend tailings material; the tailings would thus be present in the environment and bio-available in the long-term. Toxic constituents of the tailings material would bio-accumulate along the food web, particularly in those benthic species that filter feed and species that prey upon such benthic species.

Both eider species prey on benthic invertebrate species like mussels, clams, and marine worms. Benthic invertebrates live in the sediment or in some instance are filter feeders so can be expected to bioaccumulate toxic constituents, and the toxic constituents can be expected to further bio-accumulate in eider individuals as they consume contaminated benthic species and other species (such as crabs) that consume benthic species. However, given the potentially wide distribution of tailings deposition/settlement areas which would serve to reduce the concentration of tailings, and the physical process that may reduce or remove the bio-availability of the tailings, the presence of tailings in the Kuskokwim Bay environment over time are not likely to adversely affect the populations of either eider species.

#### **2.3.4.16 *Threatened and Endangered Species — ESA-Protected and Candidate Marine Mammal Species***

##### **2.3.4.16.1 Alternative 2 – Donlin Gold’s Proposed Action**

###### **2.3.4.16.1.1 Scenario 9**

For the discussion of impacts on ESA Protected and Candidate Marine Mammal Species as the result of a 0.5% release, see FEIS Section 3.24.6.14.2.

###### **2.3.4.16.1.2 Scenarios 9a, 9b, and 9c: Larger Tailings Dam Failure**

Section 2.3.5.14.2 contains a discussion of the potential impacts to marine mammals, including those listed as threatened or endangered. As presented in this section, the probability of a larger tailings spill is so low that it is not “reasonably certain to occur and therefore would not constitute an “effect of the action,” impacting threatened or listed species, or critical habitat, as a threshold matter.

### **2.3.4.17 *Land Ownership, Management, and Use***

Land ownership would not be affected by any release scenario; land management and use are discussed for each scenario.

#### **2.3.4.17.1 *Alternative 2 – Donlin Gold’s Proposed Action***

##### **2.3.4.17.1.1 Scenario 9**

For the discussion of impacts on land ownership, management and use as the result of a 0.5% release, see FEIS Section 3.24.6.15.1.

##### **2.3.4.17.1.2 Scenarios 9a, 9b, and 9c: Larger Tailings Dam Failure**

The TSF Main Dam, associated facilities, and the majority of a release trajectory resulting from a potential larger release are located on private land; a portion of the release trajectory under each of the three scenarios would overlie lands administered by the BLM, and some tailings deposition along the Kuskokwim River shoreline portions of the USFWS-managed Y-K National Wildlife Refuge could be expected. These impacts would likely require additional mitigation measures, such as the development and implementation of response-specific plans in coordination with nearby land managers.

##### **2.3.4.17.1.2.1 *Crooked Creek Drainage***

Under any of the three larger release scenarios, the impacts to land management in the Crooked Creek drainage would be acute and obvious given the volume of a release and large areal extent of tailings deposition. Impacts to land use from a larger release as described under Scenarios 9a, 9b, or 9c would be considerable, including the inundation of occupied lands and residences in the village of Crooked Creek, and the inundation of at least portions of the airport and the power plant property. Given the depth of inundation and depth of tailings deposition in the village, impacts to some structures and residences would be permanent as they would likely be destroyed.

The duration of effects would range from the duration of the release (measured in hours) to the duration of the response and restoration efforts (which may be measured in years), and would be largely geographically limited to the Crooked Creek drainage where response and restoration efforts would be focused. Impacts to the current land uses in the village would last for the duration of tailings removal and rebuilding activities in the village, which may take a period of years.

##### **2.3.4.17.1.2.2 *Kuskokwim River***

No long-term impacts to land uses along the Kuskokwim River are anticipated under Scenario 9a, 9b, or 9c. Short-term impacts to existing land uses may be realized if areas of tailings deposition are subject to a response or remediation effort; these impacts would be highly-localized and the impacts realized for a short period of time.

### **2.3.4.18 *Recreation***

#### **2.3.4.18.1 *Alternative 2 – Donlin Gold’s Proposed Action***

##### **2.3.4.18.1.1 Scenario 9**

For the discussion of impacts on recreation as the result of a 0.5% release, see FEIS Section 3.24.6.16.1.

#### 2.3.4.18.1.2 Scenarios 9a, 9b, and 9c: Larger Tailings Dam Failure

##### 2.3.4.18.1.2.1 *Crooked Creek Drainage*

In the event of a larger release under Scenario 9a, 9b, or 9c, impacts to recreation in the Crooked Creek drainage would be realized over the long-term, with some impacts lasting for generations.

Sport fishing in the region generally occurs in clear tributary streams as opposed to the turbid waters of the Kuskokwim River. Crooked Creek and Anaconda Creek—both clear tributary streams—are not popular sport fishing locations. A larger release would cause a significant loss of resident species and anadromous species fisheries in these waterways downstream of the confluence of Crooked Creek and Anaconda Creek due to tailings deposition, floodwave effects, and scour. This loss would be realized until such time as tailings removal actions or natural processes restore these waterways and resident or anadromous species re-populate the waterways; restoration of these waterways and re-population by resident or anadromous species could take decades. In the very unlikely event that sport anglers are on Crooked Creek or Anaconda Creek at the time of failure, and are in an area subject to inundation, such individuals would face a risk of death.

Sport hunting in the Crooked Creek drainage would be impacted by the loss of game species individuals as a result of a larger release as well as the expected movement of game species from the area during response and restoration activities. These direct and indirect impacts are expected to be acute or obvious in intensity, but would affect very few sport hunters. In the very unlikely event that sport hunters are in the Crooked Creek drainage at the time of release, and are in an area subject to inundation, such individuals would face a risk of death.

Recreational snowmachining or dogsled travel would be disrupted by response and restoration activities along Crooked Creek and Anaconda Creek; such areas may be closed to recreational use for the protection of the public and workers. In the unlikely event that recreational snowmachiners or dogsledders are on Crooked Creek or Anaconda Creek at the time of release, such individuals would face a risk of death.

Displacement of recreationalists would range from a period of years to perhaps generations of time, with potential permanent displacement of sport anglers and sport hunters if contamination of fish and waterfowl occurred or was perceived. Impacts to recreation would be limited to those areas affected by the release and tailings deposition. 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 recreationalists would likely make use of alternative locations for their activities. In summary, the impacts from a larger release would impact the recreation setting, but would affect few recreationalists in the area.

##### 2.3.4.18.1.2.2 *Kuskokwim River*

A larger release would result in harm to resident and anadromous fish species in the Kuskokwim River as a result of tailings deposition and impacts to spawning grounds and rearing grounds; the results of these impacts—including reduced numbers of individuals—would impact sport anglers targeting these species. While both resident and anadromous species would be impacted, the impacted areas are not heavily used by sport anglers due to their remote locations.

River recreation (primarily kayaking and rafting on the Kuskokwim River) would be impacted largely through changes in the visual environment—solids released during a larger release would visibly alter the color of the Kuskokwim River and the lower reaches of some tributaries. In the very unlikely event that kayakers or rafters are floating the Kuskokwim River in the vicinity of the mouth of Crooked Creek when

the wave front from a larger release reaches the area, the wavefront may be large enough to upset or swamp small vessels.

Recreational snowmachining or dogsled travel would be impacted if a release occurred in winter. Travel along the Kuskokwim River in the vicinity of the village of Crooked Creek and for some distance downstream would be impacted by flood waters flowing over the river ice; this impact would be short-term, dissipating in a matter of hours.

The change in the visual environment would also be visible from the air, impacting sightseeing and flightseeing, which are typically secondary recreational activities done in conjunction with travel for sport fishing and sport hunting. This impact would be short-term; if a release occurred during an open-water season, no changes would likely be evident during the following open-water season.

The direct and indirect impacts are expected to be acute or obvious in intensity, but would affect very few recreationalists.

### **2.3.4.19 Visual Resources**

#### **2.3.4.19.1 Alternative 2 – Donlin Gold’s Proposed Action**

##### **2.3.4.19.1.1 Scenario 9**

For the discussion of impacts on visual resources as the result of a 0.5% release, see FEIS Section 3.24.6.17.1

##### **2.3.4.19.1.2 Scenarios 9a, 9b, and 9c: Larger Tailings Dam Failure**

In the event of a larger release, a very large volume of water and tailings would be released into the environment, resulting in direct impacts to visual resources. Impacts would be realized across a broad geography ranging from the site of the release downstream to the mouth of the Kuskokwim River.

##### **2.3.4.19.1.2.1 Crooked Creek Drainage**

Impacts to the existing visual resources of the Crooked Creek drainage will be large and long-term. Under any of the scenarios, impacts to the appearance of the land would be realized from creek bed scour, bank erosion, and loss of vegetation along Crooked Creek and Anaconda Creek, and from the deposition of tailings within the creeks and along the banks from the point of release downstream to the mouth of Crooked Creek at the village of Crooked Creek. Tailings deposition—in addition to creek and bank scour and displaced vegetation—would strongly alter the visual character of the area from the release site downstream to the village of Crooked Creek; in this area, the creek would visually cease to exist due to tailings deposition. These impacts would be evident in the foreground and middleground. The impacts would be realized in the long-term—restoration of these areas, including removal of tailings either by natural processes or mechanical means, and vegetation and tree replanting and regrowth to the pre-release condition would take on the order of a decade or more.

Indirect impacts to visual resources may result from subsequent cleanup or restoration efforts if excavation or earthmoving equipment were used as part of these activities. Impacts would range in duration, depending upon the extent and location (setting) of the release and cleanup efforts.

##### **2.3.4.19.1.2.2 Kuskokwim River**

Impacts along the Kuskokwim River would result largely from the discoloration of waters from discharged tailings and scoured sediments and soils. The largest magnitude impacts would be realized in the hours

and days following the passage of the wavefront at any given point along the river; it is in this timeframe that tailings would be entrained in the flood flow and in solution, resulting in a visual contrast that would appear disturbed and unnatural. Impacts to the appearance of the river in the short-term would extend to the background distance zone and would extend down the Kuskokwim River to its mouth at the Bering Sea; impacts to visual resources would be evident from communities along the Kuskokwim River and from elevated or aerial locations.

No impacts to visual resources along most of the Kuskokwim River would be expected in the long-term; tailings deposited along the Kuskokwim River would be expected to re-suspend at various times during the year (breakup and Spring flood, other high water events), but the volume of these sediments would not be expected to discolor the river given the existing coloration and sediment load of the river. At the confluence of Crooked Creek and the Kuskokwim River, and downstream for a short distance, discoloration would be expected to occur over a period of years as tailings deposited in Anaconda Creek and Crooked Creek are transported downstream as a result of natural processes.

### **2.3.4.20 Cultural Resources**

#### **2.3.4.20.1 Alternative 2 – Donlin Gold’s Proposed Action**

##### **2.3.4.20.1.1 Scenario 9**

For the discussion of impacts on cultural resources as the result of a 0.5% release, see FEIS Section 3.24.6.20.1.

##### **2.3.4.20.1.2 Scenarios 9a, 9b, and 9c: Larger Tailings Dam Failure**

A larger release would impact cultural resources if released material were carried to a cultural resource site, or if remediation and restoration efforts with ground-disturbing activities occur at or near a cultural resource site. Each of the larger release scenarios could affect sites along the Crooked Creek drainage and potentially along the banks of the Kuskokwim River, and as for Scenario 9, resources may not be anticipated to return to previous levels even after actions that caused the impacts were to cease. As for Scenario 9, the probability of ground-disturbing response activities occurring at cultural resource sites is low due to the dispersed geographical distribution of known sites downstream of the TSF Main Dam, and because areas that would be subject to inundation or tailings deposition (and thus could impact cultural resources) are low lying black spruce and muskeg environments along Crooked Creek and Anaconda Creek that are considered to have a low potential for the presence of archaeological sites.

The floodwave, inundation, and tailings deposition could affect rare cultural resources along Crooked Creek and the Kuskokwim River, and some of their tributaries. Response activities in areas of tailings deposition will, as for Scenario 9, likely require a mitigation plan to limit those impacts and would occur in accordance with the Programmatic Agreement. (Note: It is not possible to identify specific cultural resources that could be affected by any of the larger release scenarios.) The probability of a larger release requiring ground disturbance cleanup within the bounds of cultural resource sites is very low given the locations where tailings would be deposited; areas subject to tailings deposition are either low-lying areas that are considered to have a low potential for the presence of sites or are shoreline areas that are and have been subject to erosion and thus sites are unlikely to be found in these areas. If tailings deposition occurred outside of cultural resource areas, there could be no impacts to cultural resources.

### **2.3.4.21 Transportation**

#### **2.3.4.21.1 Alternative 2 – Donlin Gold’s Proposed Action**

##### **2.3.4.21.1.1 Scenario 9**

For the discussion of impacts on transportation as the result of a 0.5% release, see FEIS Section 3.24.6.23.1.

##### **2.3.4.21.1.2 Scenarios 9a, 9b, and 9c: Larger Tailings Dam Failure**

A larger release would, like a 0.5% release, have a limited impact to air transportation, which would likely see an increase in air traffic related to response and monitoring efforts. Portions of the runway at Crooked Creek would be impacted by tailings deposition, and thus the ability of fixed wing aircraft to use the runway would be impacted in the short-term until tailings could be removed. There is no opportunity for water transportation near the Mine Site, and therefore direct and indirect effects to water transportation near the Mine Site as a result of a larger release would not occur.

##### **2.3.4.21.1.2.1 Crooked Creek Drainage**

There would be impacts to surface transportation along the Crooked Creek drainage; those portions of trails, easements, or other overland travel routes within the inundation area would be likely destroyed by the floodwave and scour, or would be buried by tailings deposition. If a larger tailings release occurred in winter, snowmachine travel along frozen waterways would be impacted from tailings deposition. During response and restoration activities, surface travel in all seasons in areas subject to these activities would be prevented to ensure the safety of the public and workers and to protect areas being restored.

A larger tailings release would result in short- and long-term impacts to water travel in the Crooked Creek drainage. At the time of release, any vessels in Crooked Creek downstream of the dam would likely be capsized and may be destroyed by the floodwave. In the short-term, water travel would cease to be feasible due to tailings deposition, which would fill the bed of Crooked Creek; this situation would continue until such time as natural or mechanical process restore flow in Crooked Creek. Few if any individuals would be expected to be impacted as boat travel along Crooked Creek is not common.

##### **2.3.4.21.1.2.2 Kuskokwim River**

Transportation along the Kuskokwim River would largely be expected to be unaffected. Downstream of Crooked Creek, water levels in the Kuskokwim River are modeled to rise by no more than 2 feet as the floodwave passes, with flows returning to normal levels after approximately 3 days. With notice of the release (the floodwave is modeled to reach Chuathbaluk, the nearest downstream village, more than 10 hours after release), commercial vessels such as barges would have sufficient time to prepare for the arrival of the floodwave (moving to deeper water and positioning appropriately). With this advance notice, smaller vessels could be moved from the mainstem of the River to tributaries or sloughs where the water level rise and velocity increases resulting from the floodwave would be lessened. No long-term impacts to transportation along the Kuskokwim River would be realized.

### **2.3.4.22 Sociocultural Considerations**

Under each of the larger tailings release scenarios, a number of inter-related economics, subsistence, and human health impacts would be realized that would change the sociocultural fabric of the region. Impacts to fish and wildlife species as described previously would trigger or exacerbate human health concerns regarding contaminants in the environment and change perceptions regarding the safety of

consuming subsistence food; the diminishment of mine-related economic impacts may combine with potential impacts to recreation resources to alter the cash economy of the region; the potential for early closure of the mine and associated employment losses would impact subsistence activities as the former often supports the latter. These interactions would be complex, realized in the short-term, and potentially in the long-term, and would in many cases be unmitigable.

#### **2.3.4.22.1 Cash Economy**

The Donlin Gold Project would be a large component of the regional cash economy during its operation. Under each of the larger release scenarios, gold production at the mine would cease at least temporarily while repairs are made to the TSF Main Dam and related facilities and while initial response activities are pursued in the Crooked Creek drainage. Under the largest release scenarios, the scale and cost of the response and remediation activities and the TSF Main Dam repair would fundamentally alter the economics of the Donlin Gold Project; this may result in the permanent cessation of operations and moving the mine prematurely to its closure phase, with a concomitant loss of royalty payments, employment, and sales receipts and associated impacts to the regional economy. As described in Section 3.18.2.2.1 of the FEIS, early closure triggered by a larger tailings release would have socioeconomic effects similar to those of the Closure Phase, particularly in terms of reduced employment and income. Depending when in the Operations Phase an early closure occurs would determine the magnitude of effects—if closure occurred early in the Operations Phase, other economic enterprises in the region may not have fully developed to provide viable alternatives for employment, and thus effects would be more pronounced.

The response and restoration activities following a larger tailings release would, in the short-term, increase some employment opportunities and expenditures in the Y-K region. Employment increases associated with response and restoration activities would to some extent be proportional to the size of the release—employment under Scenario 9c (a 25% release) would be larger in both numbers and duration than under Scenario 9a (a 5% release). The largest employment increases would last for a period of years during the intensive initial response activities in the Crooked Creek drainage; employment would decrease over time as response activities reach their conclusion and less-intensive restoration work becomes the predominant activity.

Indirect impacts may be realized across the region from a larger TSF Main Dam release. While the economic activity generated by Calista Corporation would be reduced as a function of cessation of royalty payments, increased indirect and induced economic effects would be realized in the short term from increased employment and spending on response and restoration activities.

Non-mining economic sectors may also be indirectly affected—employment and economic activity related to tourism and recreational fishing may be reduced if visitors avoid the region because of a tailings release; these effects are likely to be primarily realized in the near-term, with long-term effects lessened as concerns over effects diminish over time. Similarly, although of lesser importance than subsistence fishing, the limited commercial fishing may realize short-term impacts as a result of concern over the safety of consuming species from the Kuskokwim; these impacts may be realized over the long-term depending on the persistence of public perception and on biological impacts to species.

#### **2.3.4.22.2 Subsistence Economy**

Subsistence harvesting of species is a defining sociocultural component of the region and represents a substantial non-cash economic contribution to household food security and well-being. Each of the larger tailings release scenarios would result in impacts to the subsistence economy through reduction of

habitat; actualized (or assumed) biological impacts to subsistence species; reduced cash employment and royalty payments that support subsistence activities; and human health effects. At the same time, Project-related sociocultural disturbances to subsistence, including out-migration and interference from shift work, would be reduced.

Direct and indirect impacts to subsistence activities in the Crooked Creek drainage would be realized under any of the tailings release scenarios. The Crooked Creek drainage is used for the harvest of salmon, resident fish, berries/plants, ducks and geese, moose, and bear.<sup>8</sup>

Under each of the scenarios, tailings deposition in the Crooked Creek drainage would cause extensive channel and valley infilling, resulting in the loss of aquatic and terrestrial habitat and associated wildlife functions; this would eliminate the ability to harvest salmon and resident fish. As discussed in Section 2.3.5.15, the depths of tailings deposition in Crooked Creek would eliminate the presence of anadromous and native fish until such time as flow and suitable habitat is restored, and resident fish re-populate the stream and anadromous fish return to spawn. The deposition of tailings and resultant lack of flow and habitat would also render the Creek unsuitable habitat for waterfowl, eliminating the creek as a harvest location for these species. Experience with restoration activities following a tailings release in Canada indicates that these are long-term direct impacts that would likely continue for a period greater than a decade.

Berries are taken in late summer and fall in the lower reaches of the Crooked Creek drainage. Some portion of this harvest area would be inundated and would experience tailings deposition under each of the scenarios. In areas with high deposition depths, these resources may be lost until such time as restoration is complete and the areas revegetate; these impacts would be realized in the short- and long-term depending on deposition depth and time to recovery. Further, these resources may be lost to subsistence uses permanently if the plants uptake constituents from the tailings and are thus avoided by users.

Black bear and moose are both hunted along Crooked Creek. These species would be expected to move away from Crooked Creek under each of the larger tailings release scenarios due to the loss of suitable habitat and food species, and also due to the noise and human presence associated with response and remediation activities. While most habitat in the reaches of Crooked Creek above Anaconda Creek would not be impacted, access would be hindered not only by tailings deposition but also by response and restoration activities. In addition, bioaccumulation of chemical constituents found in the tailings (through consumption of plants that have taken-up such constituents, or drinking of water that is or has been in contact with tailings), may result in these species not being targeted by some subsistence users. These impacts would be realized in the short- and long-term depending on time to recovery.

Direct impacts to river-based subsistence activities along the Kuskokwim River may be realized as the floodwave passes locations where such activities are taking place; these impacts could be realized in any season. Such disruptions would be short-term, lasting only a matter of hours before water levels begin to fall and activities can resume. Tailings in suspension in the river are not anticipated to result in any direct impacts to subsistence activities.

Indirect impacts to subsistence—primarily the perception that subsistence resources would be contaminated as a result of a tailings release—would be wide-ranging. The large volumes of tailings that would be deposited in Crooked Creek and along the Kuskokwim River would represent long-term sources of contaminants into the environment, raising concerns among subsistence users about contamination of

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<sup>8</sup> Note that the harvest of salmon and resident fish in the Crooked Creek drainage is limited compared to harvests from the Kuskokwim River.

fish, including anadromous fish reared in those waters, anadromous fish returning to spawn, and resident species. The intensity of this indirect impact to subsistence harvest of resources would vary with the size of the release—the larger the volume of tailings initially released, the greater the volume of tailings that would be released over time into the system, and the greater the length of time over which subsistence user concerns regarding the safety of the resources may be realized.

#### **2.3.4.22.3 Human Health**

A larger tailings release would result in high adverse impacts to social determinants of health (HEC 1) with increases in psychosocial stress and reductions in household incomes, employment, and education attainment (in the event of early closure of the mine). High adverse impacts related to exposure to potentially hazardous materials (HEC 3) would be realized from surface water impacts, groundwater impacts, air quality impacts due to PM and VOCs during response and restoration activities, bioaccumulated chemicals in fish, and bioaccumulated chemicals in waterfowl and wildlife. Subsistence would be impacted, with potential perceptions of subsistence food contamination that extend throughout the EIS Analysis Area and downstream to Bering Sea communities (HEC 4). Impacts would vary in duration, but would be expected to be long-term under any of the three larger tailings releases due to the volumes of material involved; physical impacts would be localized generally to the Crooked Creek drainage and village of Crooked Creek. Psychosocial impacts—including perceptions of contamination—would be widespread given the wide area over which tailings material would be dispersed, but would be expected to decrease with distance from the mine. Impacts would vary in intensity depending upon the location of the receptor, and the volume of a tailings release, with more intense impacts realized by those nearer the Mine Site and by those that rely most heavily on subsistence resources.

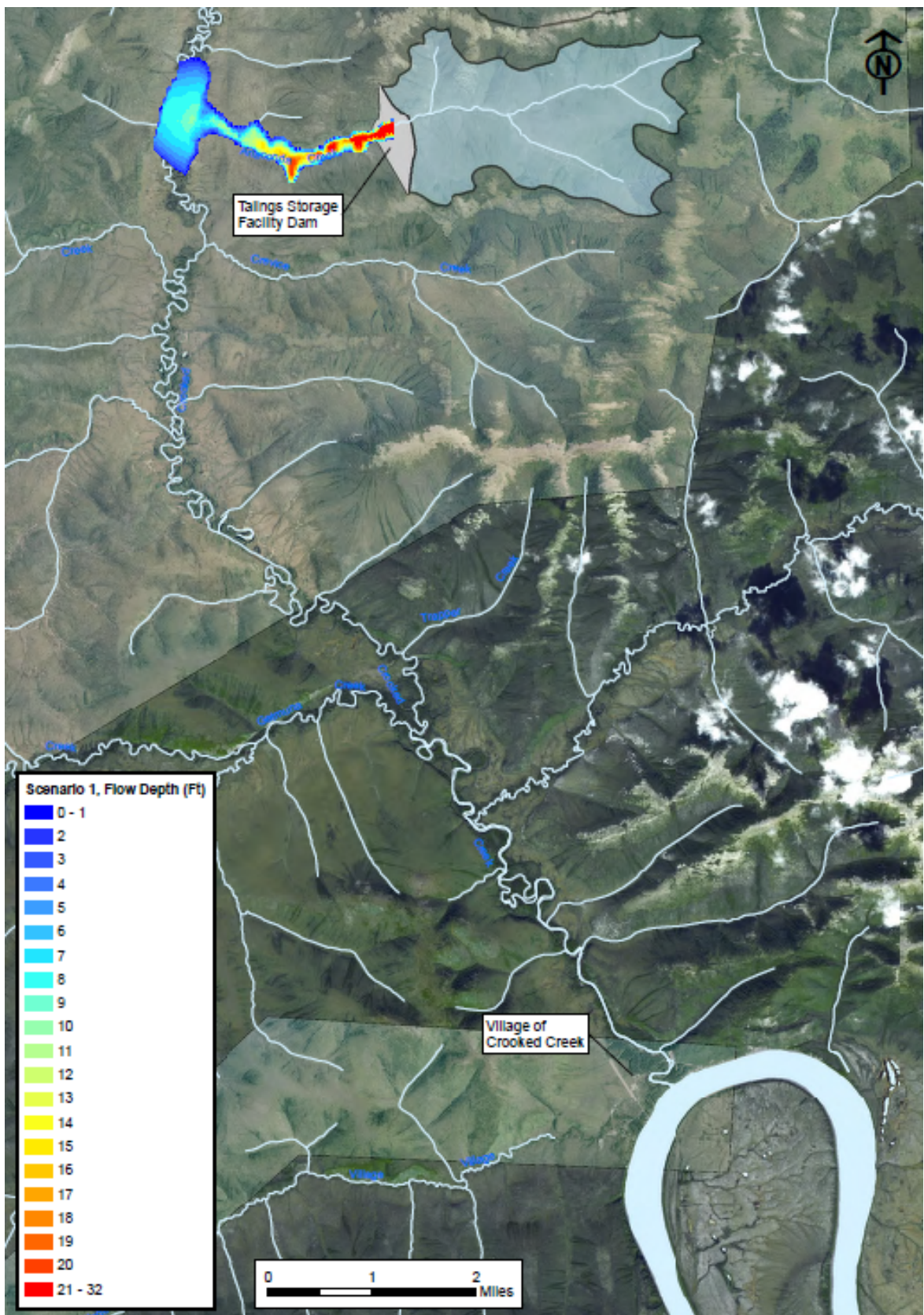
In the event that a larger tailings release triggers early closure of the mine, other human health-related effects may be realized. In addition to the adverse impacts to HEC 1 (Social determinants of health) addressed above, effects to HEC 4 (Food, nutrition, and subsistence activity) would be realized. As a result of the unexpected loss of positions due to an early closure of the mine, the decreases in food cost relative to income realized during operation would be reversed, and the increases in diet composition and food security that would be realized from operation of the mine would be negatively impacted from loss of employment and due to the realized and perceived impacts to subsistence resources. Such impacts would also occur during an orderly transition from operations to closure, but the intensity of these impacts would be exacerbated from a premature closure.

Drinking water in the village of Crooked Creek could be adversely impacted if released materials infiltrated subsurface materials—the footprint of deposited tailings is modeled to partially overlap the groundwater protection area for the village under each of the three release scenarios (Figure 2.3.6). However, actual impacts to groundwater resources would be limited by prioritizing tailings removal in this area. Drinking water from water systems in downstream communities would not be impacted as groundwater sources for these systems would not be impacted.

### **2.3.5 Impact Reducing Measures**

The effects determinations addressed above take into the account impact reducing design features presented in Table 5.2-1 in Chapter 5, Impact Avoidance, Minimization, and Mitigation of the FEIS as well as the Standard Permit Conditions and BMPs presented in Section 5.3 of the FEIS.

# Figures



## Inundation Area— 0.5% Scenario



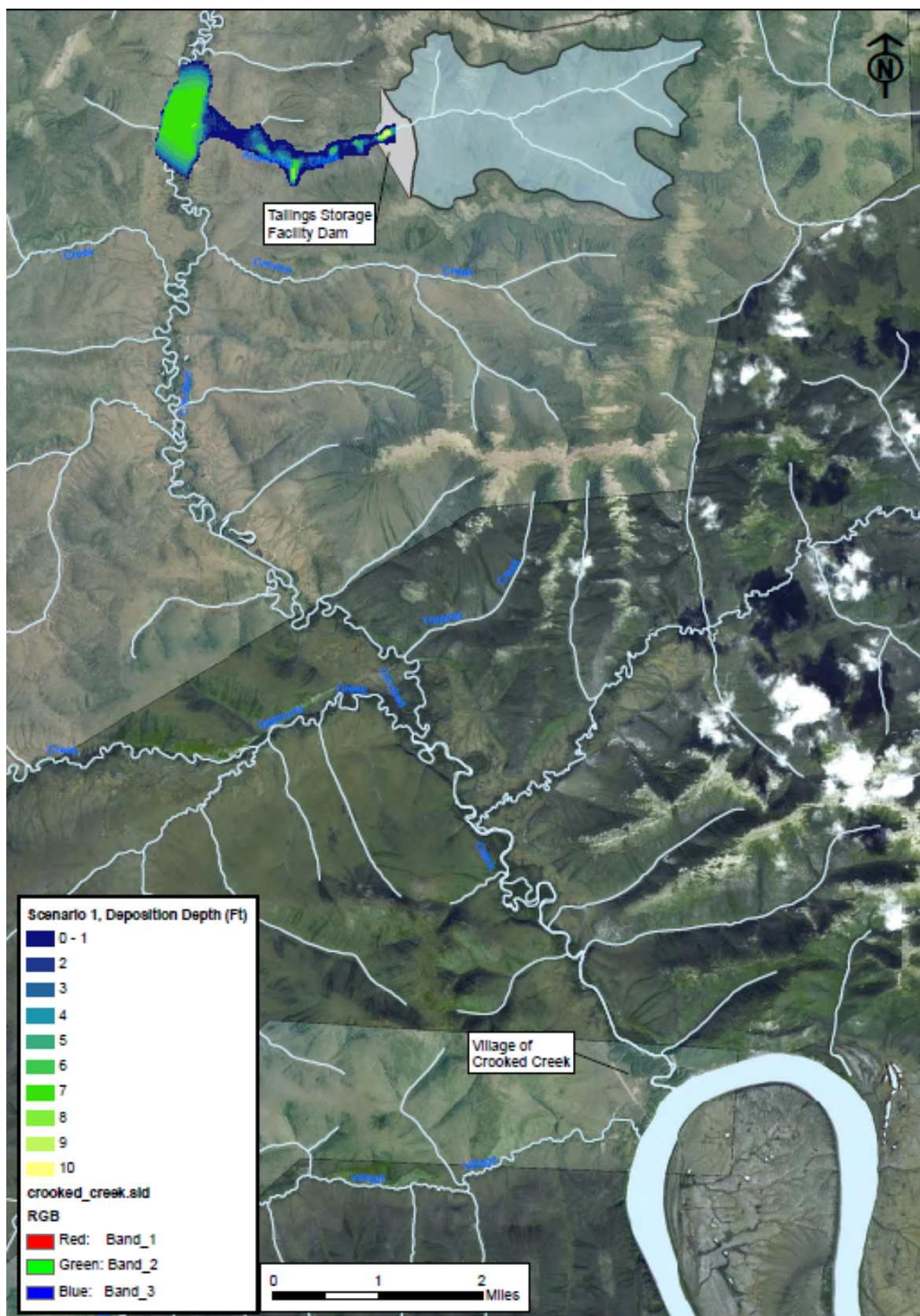
SCALE:

0 125 250 500 Feet  
0 37.5 75 150 Meters

FIGURE:

**2.3.1**

MERIDIAN: SEWARD



**Tailings Deposition Depth—  
0.5% Scenario**



FIGURE:  
**2.3.2**



**Legend**

★ Tailings release location

**Deposition depth (ft)**

|          |
|----------|
| 0 to 3   |
| 3 to 6   |
| 6 to 9   |
| 9 to 12  |
| 12 to 15 |
| 15 to 18 |
| 18 to 21 |

**Notes**

- Basemap source: ESRI World Topographic Map.

COORDINATE SYSTEM:  
NAD 1983 UTM Zone 4N



**TAILINGS DEPOSITION  
5% SCENARIO**

DONLIN GOLD PROJECT

SCALE:

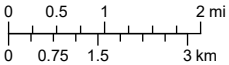
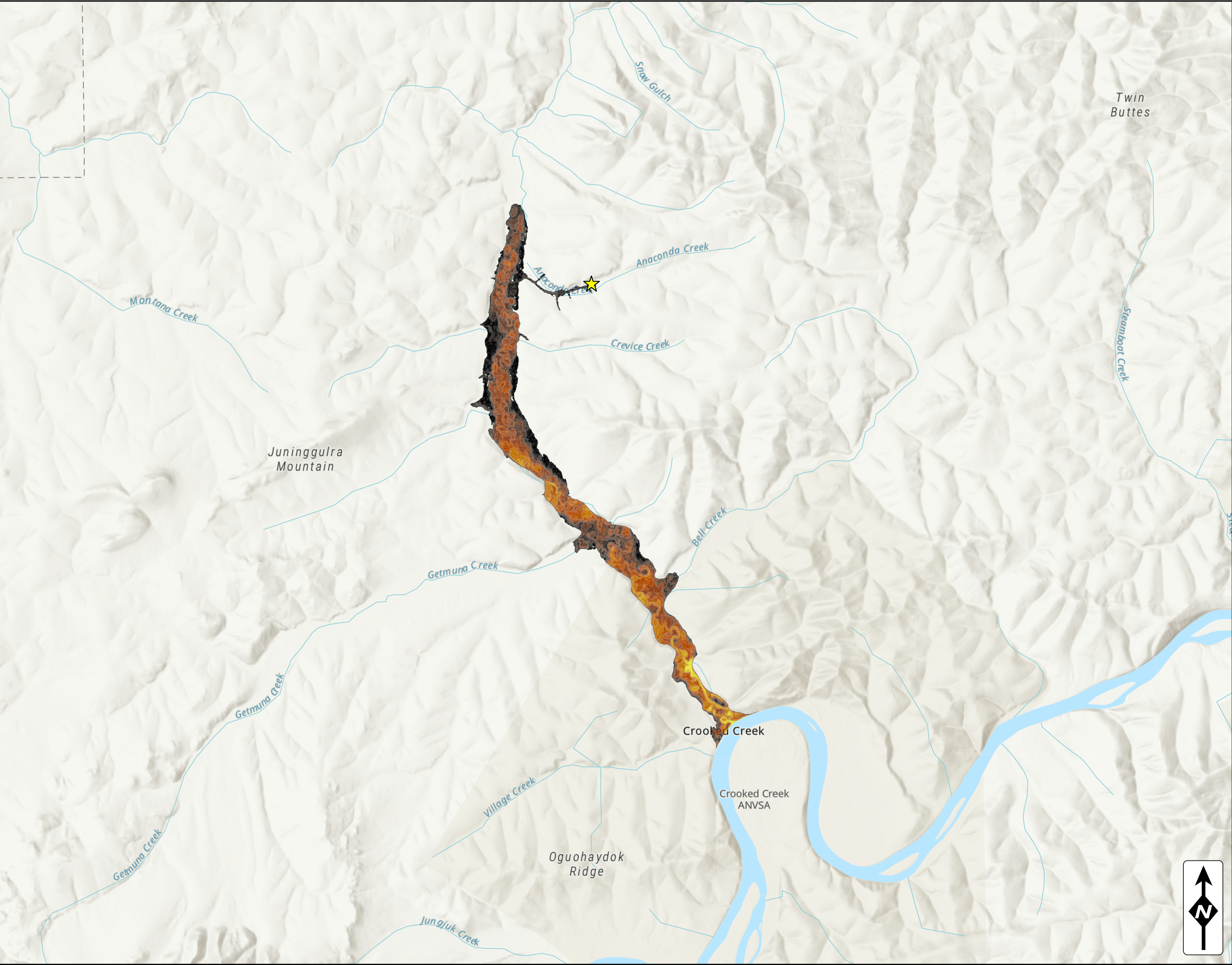


FIGURE:

**2.3.3**



**Legend**

★ Tailings release location

**Deposition depth (ft)**

|          |
|----------|
| 0 to 3   |
| 3 to 6   |
| 6 to 9   |
| 9 to 12  |
| 12 to 15 |
| 15 to 18 |
| 18 to 21 |
| 21 to 24 |
| 24 to 27 |
| 27 to 30 |

**Notes**

- Basemap source: ESRI World Topographic Map.

COORDINATE SYSTEM:  
NAD 1983 UTM Zone 4N



**TAILINGS DEPOSITION  
13% SCENARIO**

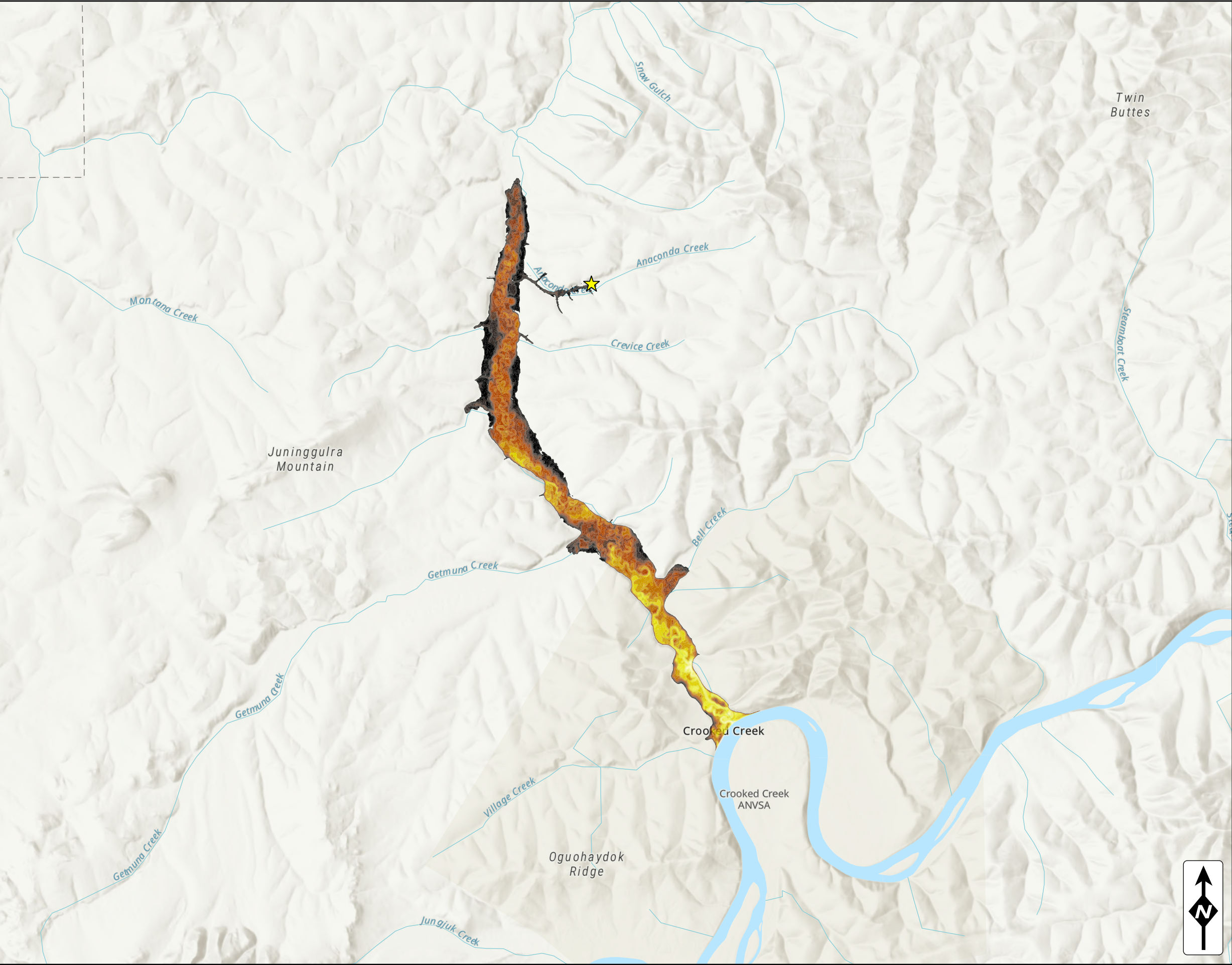
DONLIN GOLD PROJECT

SCALE:



FIGURE:

**2.3.4**



**Legend**

★ Tailings release location

**Deposition depth (ft)**

|          |
|----------|
| 0 to 3   |
| 3 to 6   |
| 6 to 9   |
| 9 to 12  |
| 12 to 15 |
| 15 to 18 |
| 18 to 21 |
| 21 to 24 |
| 24 to 27 |
| 27 to 30 |
| 30 to 33 |
| 33 to 36 |

**Notes**

• Basemap source: ESRI World Topographic Map.

COORDINATE SYSTEM:  
NAD 1983 UTM Zone 4N



**TAILINGS DEPOSITION  
24% SCENARIO**

DONLIN GOLD PROJECT

SCALE:

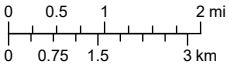
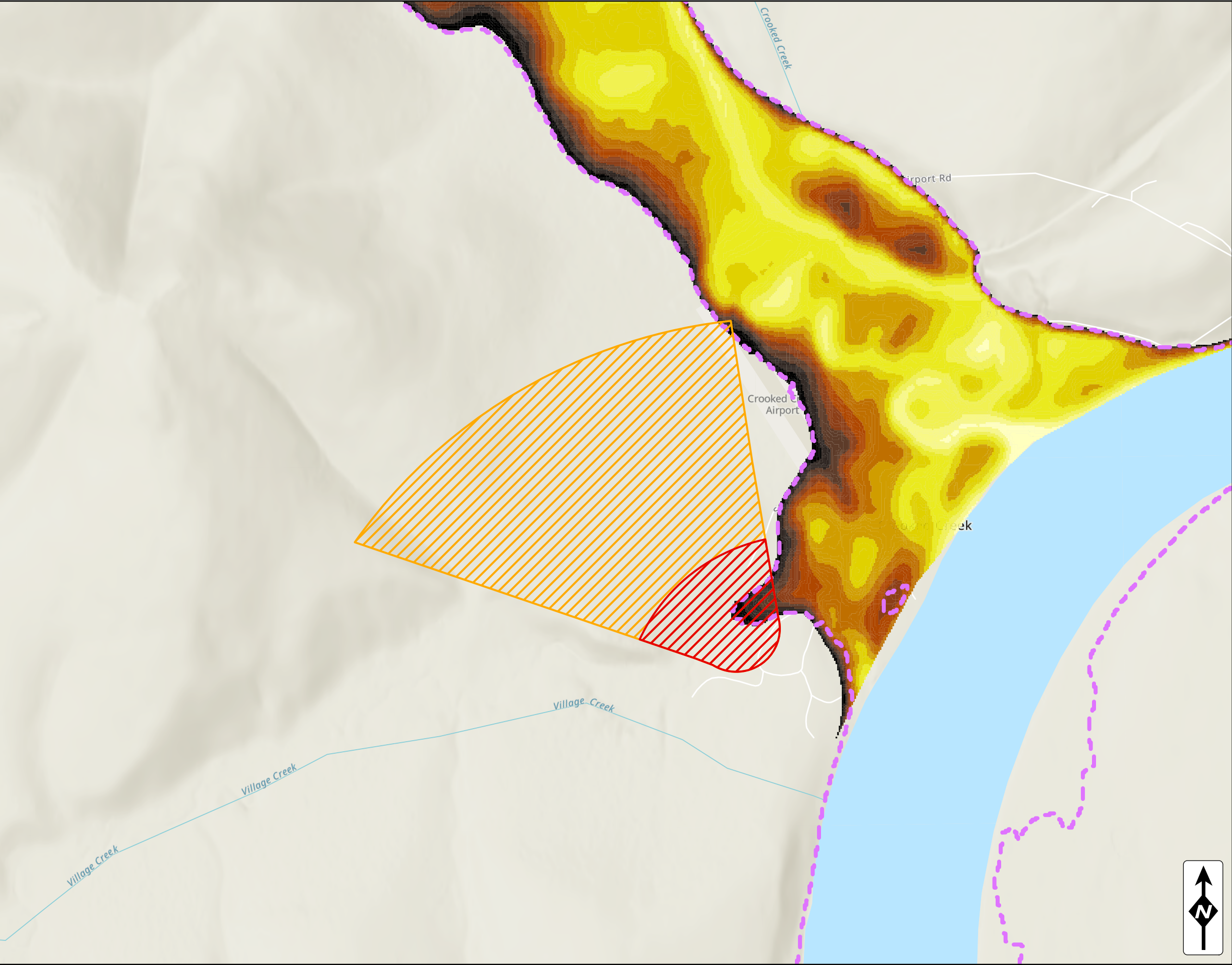


FIGURE:

**2.3.5**



**Legend**

Inundation extent (24% scenario)

**Drinking Water Protection Areas**

Zone A

Zone B

**Deposition depth (ft)**

0 to 3

3 to 6

6 to 9

9 to 12

12 to 15

15 to 18

18 to 21

21 to 24

24 to 27

27 to 30

30 to 33

33 to 36

**Notes**

- Basemap source: ESRI World Topographic Map.
- Drinking Water Protection Area Zone A:
  - Groundwater: Several months travel time
  - Surface water: 1,000-foot buffer
- Drinking Water Protection Area Zone B:
  - Groundwater: 2 years travel time
  - Surface water: 1-mile buffer

COORDINATE SYSTEM:  
NAD 1983 UTM Zone 4N



**CROOKED CREEK  
GROUNDWATER PROTECTION ZONE**  
DONLIN GOLD PROJECT

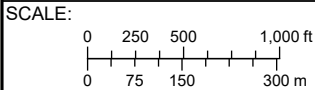


FIGURE:  
**2.3.6**