Fairbanks Gold Mining Inc.

Fort Knox Pit Lake Evaluation 2023 Update

Fort Knox Mine

Fairbanks, Alaska

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Fort Knox Pit Lake Evaluation – 2023 Update

Fort Knox Mine, Fairbanks, Alaska

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Acronyms and Abbreviations

2019 Update	Fort Knox Pit Lake Evaluation 2019 Update
2021 Update	Fort Knox Pit Lake Evaluation 2021 Update
2023 Update	Fort Knox Pit Lake Evaluation 2023Update
°C	degree Celsius
ADEC	Alaska Department of Environmental Conservation
amsl	above mean sea level
BCHL	Barnes Creek heap leach
FGMI	Fairbanks Gold Mining, Inc
gpm	gallon per minute
gpm/ft^2	gallon per minute per square foot
Knight Piésold	Knight Piésold Consulting
memorandum	Fort Knox Pit Lake Evaluation – 2023 Update
mg/L	milligram per liter
MWMP	Meteoric Water Mobility Procedure
NADP	National Atmospheric Deposition Program
RO	reverse osmosis
Site	Fort Knox Mine, located near Fairbanks, Alaska
s.u.	standard unit
SWS	Schlumberger Water Services
TDS	total dissolved solids
TSF	tailings storage facility
USACE	U.S. Army Corps of Engineers
WAD	weak-acid dissociable

Executive Summary

This Fort Knox Pit Lake Evaluation – 2023 Update (memorandum) presents an update to the closure pit lake evaluation, which was completed in support of reclamation and closure planning for the Fort Knox Mine, located near Fairbanks, Alaska (Site). The objectives of this pit lake evaluation were to update flow, volume, and chemistry data for evaluating post-closure pit filling rates, pit water quality, and the potential for stratification. The pit lake evaluation was completed using GoldSim, which was linked to PHREEQC for geochemical speciation modeling. This memorandum builds on the 2021 evaluation (Arcadis 2022) with an updated mine plan and flow, volume, and chemistry data. The pit lake evaluation results suggest that the current reclamation approach will be effective in maintaining acceptable pit lake water quality.

This 2023 update to the pit lake evaluation is based on relevant mining and reclamation milestones presented in the Fort Knox Mine Reclamation and Closure Plan (FGMI 2020) and Fort Knox Reclamation and Closure Plan Amendment 1 (FGMI 2021), which includes the following assumptions:

- Continued mining in the western portion of the pit (Gilmore expansion area) through 2028 and filling of the eastern pit with groundwater, precipitation, and runoff.
- Milling of Fort Knox and satellite ores with tailings deposition in the pit through 2028, at which point the mill is scheduled to be shut down.
- Discrete transfers and long-term flows from the tailings storage facility (TSF) decant ponds, heap leach facility, and the groundwater interception system directed to the pit starting in 2024.

Model predictions included in this memorandum are as follows:

- The pit lake will fill to the contact with alluvium (1,430 feet above mean sea level) in 2080, at which point pit lake water will begin to discharge to Fish Creek alluvium.
- Pit lake chemistry will be alkaline with significant buffering capacity throughout pit filling. Most constituents will remain at concentrations less than the water quality standards for the model simulation period.
- Concentrations of nitrate, ammonia, weak acid-dissociable cyanide, arsenic, cadmium, copper, selenium, total dissolved solids, and silver will be greater than water quality standards during early pit filling; however, these constituent concentrations will decrease to less than the standards before the pit lake reaches the contact with alluvium.
- Antimony concentrations will be slightly greater than the water quality standard (3 percent above) when the pit lake reaches the contact with alluvium (2080) and will decrease to less than the standard in 2085.
- Model results are not particularly sensitive to changes in the precipitation inputs (+/- 20 percent) or highly conservative assumptions for groundwater inflow chemistry.
- The potential exists that the pit lake will become permanently stratified; the driving factor is the pit lake geometry.

The pit lake evaluation will continue to be updated as reclamation concepts are modified and as additional site data become available. Given the prediction that antimony concentrations will be close to the water quality standard when the pit lake level reaches the alluvium, it is recommended that antimony model predictions be refined in future updates. Although consideration of active water management/treatment strategies may become necessary if continued data collection and model refinement suggest antimony will be above the water quality standard in 2080, this evaluation is not recommended at this time.

1 Introduction

This Fort Knox Pit Lake Evaluation – 2023 Update (memorandum) presents an update to the closure pit lake evaluation, which was completed in support of reclamation and closure planning for the Fort Knox Mine, located near Fairbanks, Alaska (Site). This memorandum was updated from the previous pit lake evaluation (Arcadis 2022). The Site is owned and operated by Fairbanks Gold Mining, Inc. (FGMI), a subsidiary of Kinross Gold Corporation. This pit lake evaluation update reflects the reclamation and closure concepts presented in the Fort Knox Mine Reclamation and Closure Plan (FGMI 2020), Fort Knox Reclamation and Closure Plan Amendment 1 (FGMI 2021), or more recent data. As part of this evaluation, the existing closure water balance and chemistry model was refined, and the inputs were updated with operational data estimates through closure, post-closure flow/volume forecasts, and updated site water chemistry data. The most significant update to the pit lake evaluation is inclusion of planned tailings deposition in the pit lake from 2024 through 2028. This memorandum includes updated pit lake model results as well as an evaluation of the potential for stratification of the pit lake during the post-closure period, which may affect discharge water quality in the future.

The objectives of this update are to:

- Present updated water flow/volume data for input to the pit lake water balance
- Present updated input water chemistry data
- Develop estimates of post-closure pit lake water quality compared to Alaska reference standards
- Evaluate the potential for stratification in the post-closure pit lake
- Determine the effectiveness of the current reclamation approach from a water quality perspective.

2 Project Background

The Site is located approximately 15 miles northeast of Fairbanks, Alaska in T2N, R2E and T2N, R3E, Fairbanks Meridian near the headwaters of the Fish Creek drainage. The land is owned by the State of Alaska, the Alaska Mental Health Trust, and private parties. Water Management Consultants, Inc. (WMC [2006]) describes the site climate, topography, hydrology, hydrogeology, and geology; therefore, this information is not replicated in this memorandum.

The Fort Knox Mine Reclamation and Closure Plan (FGMI 2020) was submitted to the Alaska Department of Natural Resources in January 2020 and the Fort Knox Reclamation and Closure Plan Amendment 1 (FGMI 2021) was submitted in February 2021. This section describes the elements of site operations and the Fort Knox Mine Reclamation and Closure Plan that are relevant to the pit lake evaluation.

2.1 Pit Expansion (through 2028)

Mining will continue in the Gilmore expansion area (western portion of the pit) through 2028. There will be a ridge of unmined material between the completed eastern pit bottom and the development of a western pit bottom in the Gilmore expansion area. Ore from the Gilmore expansion area will be processed at the mill or placed in the BCHL facility for leaching. Mining will be completed at the end of 2028. The final pit configuration is shown on Figure 1.

Pit dewatering will continue through 2028, as needed, to provide slope stability and to facilitate continued mining in the Gilmore expansion area. However, some natural groundwater inflow, direct precipitation, pit wall runoff water, and tailings slurry water will accumulate in the east pit lake.

As it receives groundwater inflow, precipitation, runoff, tailings slurry inflows, and transfers from the TSF decant ponds, the east pit lake will continue to fill up to the elevation of the ridge separating the west pit bottom of the Gilmore expansion area, at which point the pit lake will overflow into the west pit area, eventually combining to create one pit lake. As described in Section 6, the pit lake is expected to overflow into the west pit area starting in 2028 and combine into one pit lake in 2029.

2.2 Milling With Tailings Deposition in the Pit (2024 through 2028)

Milling at the Site will continue through 2028 using ores from three sources: Fort Knox Mine, Gil Mine, and Manh Choh Mine. Beginning in the second quarter of 2024, mill tailings (slurried for transport) will be deposited in the east pit. During this time, mill process water will be drawn from the TSF North Decant Pond/Barge Pond. Beginning in third quarter 2025, mill process water will be pumped from the pit lake into the TSF ponds for storage and reuse in the milling circuit.

At the end of milling operations, the remaining water in the TSF decant ponds will be transferred to the pit; FGMI estimates that approximately 3,000 acre-feet of water will be transferred at this time. Following mill shut down at the end of 2029, planned reclamation of the north TSF decant pond will be completed and surface water diversion will be initiated. After the pond transfers, runoff to all areas of the TSF will be diverted, allowing for dry closure of the TSF.

Consistent with the Fort Knox Mine Reclamation and Closure Plan (FGMI 2020), a 35-year timeframe (through 2061) is assumed for collection and pumpback of TSF toe seepage. Based on recent groundwater modeling, flows from the groundwater interception system are expected to decrease from 400 gallons per minute (gpm) in 2027 to 0 gpm by 2048 (discussed further in Section 4.6). Beginning in 2029, downgradient groundwater pumpback flows will be conveyed into the east pit instead of the TSF decant ponds.

2.3 Active Heap Leaching (through 2031)

Heap leaching at the WCHL and BCHL facilities will continue through approximately 2031. After the end of economic leaching, an initial draindown from the heap leach pads will be pumped to the pit lake for 2 to 3 months. After the initial transfer, residual draindown from the heap leach facilities will gravity-flow to the pit throughout the post-closure period.

2.4 Closure (2032 and Beyond)

After the end of mining and active transfers to the pit lake, the pit lake will continue to fill with water from natural discharges including pit-area groundwater inflow, direct precipitation to the pit lake, pit wall runoff, and runoff from disturbed/undisturbed areas above the pit rim that have not been diverted. The pit lake is expected to fill throughout several decades up to the contact between bedrock and Fish Creek alluvium (1,430 feet above mean sea level [amsl]), at which point the pit lake water could begin to flow into the downgradient alluvial groundwater.

3 Closure Water Balance Modeling – Updated Input Data

The existing site-wide closure water balance model was initially developed in 2011 using GoldSim modeling software (www.goldsim.com) to incorporate operational flows from facilities outside the pit area (Schlumberger Water Services [SWS] 2011). The pit lake portion of the site-wide model was based on the original pit lake modeling from 2006 (WMC 2006). The model was updated using GoldSim Version 14.0 R3 based on the current mine plan and closure strategy, described above. Updated site information, including current and forecasted water flows and water volume data are described below. Water chemistry data were also updated and are described in Section 4. Table 1 provides a summary of updates made between the 2021 model update and this current 2023 update.

3.1 Closure Pit Geometry

The final pit configuration, shown on Figure 1, is based on the Phase 10 mine plan expansion. Stage-volume and stage-surface area curves for the ultimate pit configuration are shown on Figure 2. As noted in Section 2.4, the contact between bedrock and overlying alluvium occurs at 1,430 feet amsl. Based on additional groundwater modeling (Section 3.3.4), once the pit lake stage reaches 1,430 feet amsl, pit lake water will begin to flow into alluvial groundwater toward the TSF. At this point, the pit volume and surface area will be 184,100 acre-feet and 401 acres, respectively (Figure 2). This spill point elevation was selected to represent a conservative estimate at which discharge may occur to the environment via the Fish Creek alluvium.

3.2 In-Pit Backfill

Previous model updates (e.g., HydroGeologica 2019) accounted for approximately 18 million tons of waste rock that would have been placed within the lower elevations of the east pit bottom. However, in-pit waste rock disposal is no longer part of the mine plan and was not included in this pit lake evaluation.

3.3 Pit Water Balance Inflows and Outflows

The closure water balance model tracks the magnitude and timing of flows into and out of the pit during the recovery period. The flows are outlined below, presented in Table 2, and shown on Figure 3:

- Inflows:
  - Direct precipitation
  - Undisturbed catchment area runoff
  - Disturbed catchment area runoff
  - Waste pile runoff
  - Pit wall runoff

  - Groundwater inflow
  - TSF decant pond transfers
  - Interception system pumping (TSF seepage and downgradient groundwater)
  - Draindown and runoff/infiltration from heap leach facilities
  - Tailings slurry inflows
- Outflows:
  - Evaporation
  - Overflow to alluvium.

These individual flow components are described further in the following subsections.

3.3.1 Precipitation and Evaporation

No updates were made to the precipitation and evaporation inputs from the 2021 pit lake evaluation. A summary of how precipitation and evaporation are accounted for in the model is provided below.

The model uses average monthly precipitation based on the Fort Knox Mine operational water balance model (Knight Piésold Consulting [Knight Piésold] 2019). The model adjusts the monthly precipitation to account for snow; precipitation from November through April is assumed to occur as snow, while half of the precipitation in May and October is assumed to occur as snow. While variable, snowpack melting is assumed to occur from mid-May through mid-July and accounts for an estimated sublimation of 45 percent of the snowpack (HydroGeologica 2019).

The model uses site-specific monthly pan evaporation rates based on the Fort Knox Water Balance Standard Operating Procedure (HydroGeologica 2019). Pan evaporation scaling factors, generally consistent with the fourth quarter 2014 calibrated operational water balance (HydroGeologica 2019), were used for open water (0.75), the leach pads (0.25), undisturbed areas (0.3), and disturbed areas (0.3). Evaporation losses from the pit lake were calculated as the product of the monthly pan evaporation rate (Table 3), the open water scaling factor (0.75), and the pit lake surface area, which changes as a function of pit lake volume/stage (Figure 2). Average monthly precipitation and pan evaporation at the Site are presented in Table 3, below.

Table 3. Average Precipitation and Evaporation

Month	Average Precipitation (Inches)	Average Pan Evaporation (inches)
January	0.92	0.0
February	0.61	0.0
March	0.63	0.0
April	0.27	0.0
May	1.1	1.5
June	1.9	4.5
July	3.2	4.3

Month	Average Precipitation (Inches)	Average Pan Evaporation (inches)
August	3.4	2.8
September	2.2	0.8
October	1.3	0.25
November	1.0	0.0
December	0.87	0.0
Total	17.4	14.2

3.3.2 Runoff

No updates were made to the runoff inputs from the 2021 pit lake evaluation. A summary of how runoff is accounted for in the model is provided below.

Undisturbed areas, disturbed areas, and waste rock dumps within the pit catchment will provide runoff to the pit. Figure 4 shows the areas that may provide runoff within the pit catchment and Table 4 presents runoff areas and parameters. Runoff was calculated as the product of precipitation (Section 3.3.1), the catchment area, and a runoff coefficient. Runoff coefficients were calculated as a function of precipitation, evaporation, and groundwater infiltration as follows:

$$runoff\ coefficient = \left(\frac{precipitation - evaporation}{precipitation}\right) * (1 - infiltration)$$

Average monthly precipitation and evaporation at the Site are presented in Table 2. Infiltration was set as 34 percent of precipitation (6 inches per year), consistent with the groundwater flow model used to model groundwater inflow into the pit (Section 3.3.4).

The undisturbed catchment area is 23 acres. The disturbed catchment area, consisting of haul roads, buildings, yards, and other reworked areas, total 313 acres. The waste piles comprise 337 acres; however, it was assumed that waste pile areas contribute less runoff than undisturbed areas. Specifically, it was assumed that flat and sloped waste pile areas (223 acres each) yield 10 and 55 percent of the runoff per unit area relative to undisturbed areas, respectively; this was accounted for in the model by scaling the waste pile areas down by these percentages when calculating runoff. As a result of site operations, some runoff from this area is captured and rerouted before entering the pit. Between 2023 and 2028, the fraction of runoff that enters the pit will range from 60 to 85 percent; before 2023 and after 2028 the fraction is 100 percent.

Note, the Fort Knox Reclamation and Closure Plan Amendment 1 (FGMI 2021) includes plans for an additional waste rock dump (Victoria Creek waste rock dump), which was constructed south of the open pit. This waste rock dump was constructed in a separate surface water catchment area from the pit and therefore it is not anticipated to impact the pit lake water balance. As such, construction of the Victoria Creek waste rock dump does not affect this 2023 model update.

While the BCHL facility is within the pit catchment and the WCHL facility will ultimately drain to the pit, runoff from these features is discussed in Section 3.3.7.

3.3.3 Pit Wall Runoff

No updates were made to the pit wall runoff inputs from the 2021 pit lake evaluation. A summary of how pit wall runoff is accounted for in the model is provided below.

Pit wall runoff was calculated based on the precipitation rate onto the pit footprint area, minus the pit lake area. A pit wall runoff coefficient of 35 percent (i.e., 35 percent of precipitation reaches the lake) was applied to account for infiltration and evaporation.

3.3.4 Groundwater Inflow

For the previous (2021) model update (Arcadis 2022), groundwater inflow into the pit was modeled using a calibrated numerical three-dimensional groundwater flow model developed using MODFLOW-USG code, a publicly available groundwater flow simulation program developed by the U.S. Geological Survey (Panday et al 2015). For this 2023 model update, the groundwater inflow terms were modified to allow the GoldSim model to be run independently of the groundwater flow model. Specifically, groundwater inflow rate was modeled as a function of pit lake stage. The inflow versus stage relationship was constructed by combining the inflow versus time results with the pit lake stage versus time results from the groundwater flow model (Arcadis 2022). Two separate stage-groundwater inflow relationships were used: one for the period of active mining and dewatering (current through 2028), and one for the closure period when dewatering is ceased (2029 and beyond). These stage-groundwater inflow relationships replace the previous (2021) groundwater inflow versus time relationship. A summary of the original groundwater model development is provided below and in the previous model update (Arcadis 2022).

3.3.5 Tailings Storage Facility Decant Pond Transfers

Between now and 2030, inflows to the TSF include mill process water, direct precipitation, surface runoff, consolidation water, seepage/groundwater from the interception system, and RO system brines. Outflows include evaporation, seepage, entrainment, makeup to the heap leach facilities, and discharge via the RO system. While previous model updates (e.g., HydroGeologica 2019) have modeled these flows explicitly, the previous 2021 model update (Arcadis 2022) and this 2023 model update include estimated decant pond volumes at closure based on site operational decision making. TSF decant pond water has been actively managed by FGMI through RO treatment and offsite discharge, with the goal of reducing water inventory prior to closure. Consistent with the current mine plan, the TSF decant ponds will be used to store process water for milling operations. Process water will be pumped from the pit into the TSF decant ponds beginning in third-quarter 2025. FGMI estimates that at the end of milling operations (end of 2029), there will be approximately 3,000 acre-feet of water in the North TSF pond/Barge Pond that will be transferred to the pit in 2030. There will not be a separate south TSF pond transfer because the south TSF pond is anticipated to be filled with tailings prior to closure, with decant water gravity draining to the North Pond/Barge Pond. Therefore, the south TSF pond will not contain additional volume to transfer.

3.3.6 Interception System Pumping

The interception system collects a mixture of seepage from the TSF and downgradient groundwater. Currently, this water is treated via RO and discharged offsite or recirculated back to the decant ponds; however, starting in 2029, this water will be pumped to the pit (updated from 2027 in the previous model update). The volume and rate of pumping to the pit during the closure and post-closure periods were calculated as the sum of TSF seepage and groundwater collection.

The groundwater interception system currently collects groundwater at a rate of approximately 400 gpm. Additional groundwater modeling has demonstrated that through time, the groundwater pumping rate can be decreased while remaining in compliance with downgradient groundwater quality standards. Consistent with that modeling, the groundwater interception system pumping rate is assumed to be 400 gpm from 2029 through 2038, 200 gpm from 2039 through 2048, and 0 gpm starting in 2049.

Previous pit lake model updates calculated the TSF seepage rate as a function of decant pond volume (HydroGeologica 2019). Following the transfer of the decant ponds, the seepage rate was assumed to remain constant at 100 gpm, which was the low end of the TSF seepage-decant pond stage curve. The 2021 update (Arcadis 2022) refined this approach to account for temporal draindown of the tailings. It is assumed that once the decant ponds are transferred to the pit, the porewater within the tailings will drain out and the TSF seepage rate will decrease through time from the current rate of approximately 2,000 gpm. The temporal draindown rates were approximated using Darcy's law, applied to vertical porewater flow. The TSF was divided into coarse and fine tailings components, and drainable volumes and seepage rates were calculated according to the parameters presented in Table 5, below.

Table 5. TSF Seepage Estimate Summary

Parameter	Coarse Tailings	Fine Tailings
Average TSF thickness	247 feet	247 feet
Area	20 percent (150 acres)	80 percent (601 acres)
Drainable porosity	15 percent	5 percent
Drainable volume	4,172 acre-feet	7,881 acre-feet
Hydraulic conductivity	$2x10^{-5}$ cm/sec	$5x10^{-7}$ cm/sec
Vertical hydraulic gradient	1	1
Seepage rate	1,445 gpm	205 gpm

Note:
cm/sec = centimeter per second

Based on the parameters above, the TSF seepage rate was approximated as 1,649 gpm from 2029 through May 2031 and 205 gpm thereafter. Ultimately, TSF draindown will likely be a smooth curve instead of a step-function; however, this estimate is sufficient for the purposes of the pit lake model. Consistent with the Fort Knox Mine Reclamation and Closure Plan (FGMI 2020), it is assumed that TSF seepage will be intercepted for a 35-year timeframe (through 2063); after 2063, it assumed any residual draindown will not result in water quality exceedances in downgradient groundwater.

3.3.7 Barnes Creek and Walter Creek Heap Leach Facilities

Once processing of the leach solution is no longer economical, solution stored in the in-heap ponds and draindown from the leach pads will be pumped to the pit. It is assumed that active heap leaching will continue through 2031 and active transfer of leach solution and draindown will occur in 2032. Based on typical operating volumes, the WCHL pond and the BCHL pond are assumed to have 135 and 169 acre-feet, respectively, that will need to be transferred to the pit.

Process solution draindown rates were not modified from the 2021 model update (Arcadis 2022). However, a summary of the development of these rates is provided below.

The process solution draindown rates are based on the WCHL draindown analyses developed in 2013 (Knight Piésold 2013), which were developed for the WCHL facility assuming an average pad thickness of 280 feet and a solution application rate of 16,000 gpm. These modeling results were extrapolated to the current configuration (accounting for both WCHL and BCHL) by scaling the draindown rates based on the current combined solution application rate, as follows:

- The application rate assumed for the WCHL draindown modeling was 16,000 gpm (Knight Piésold 2013).
- The current application rates were calculated from recent leach solution flow rates and active heap leaching areas
  - BCHL facility: 0.0053 gallon per minute per square foot (gpm/ft^2) over 36.9 acres = 8,500 gpm
  - WCHL facility: 0.0025 gpm/ft^2 over 145 acres = 15,800 gpm
  - Combined current leach solution application rate of 24,300 gpm.

The scaling factor was calculated as the ratio of the current leach solution application rate (24,300 gpm) to the rate corresponding to the draindown modeling (16,000 gpm); the resulting scaling factor is 1.52. The majority of the process water will drain in the first few months, and residual process water will gravity-drain and be routed to the pit through the post-closure period; this flow rate is estimated to decrease through time to approximately 4 gpm. Initial draindown, occurring in the first year (2032), will total approximately 1,230 acre-feet. Residual draindown from 2033 through pit filling will total approximately 330 acre-feet.

In addition to pond and draindown water, runoff and infiltration of direct precipitation and snowmelt through the pads will also be collected in the heap leach ponds and will be transferred to the pit throughout the closure and post-closure periods, at an average annual rate of approximately 524 gpm. This flow rate is estimated based on the direct precipitation/snowmelt rate onto the pad footprints (435 and 297 acres, respectively for WCHL and BCHL facilities) minus evaporation (with a 25 percent pan evaporation scaling factor). From 2032 through pit filling, runoff and infiltration will total approximately 44,300 acre-feet. Long-term flow rates from net precipitation are presented in Table 6, below.

Table 6. Precipitation Flow Through the Heap Leach Pads

Month	Precipitation Through the Pads (gpm)
January	409
February	299
March	280
April	122
May	336
June	364

Month	Precipitation Through the Pads (gpm)
July	944
August	1,189
September	940
October	552
November	463
December	388
Average	524

3.3.8 Mill Tailings

From second-quarter 2024 through the end of 2028, mill tailings will be deposited into the pit instead of the TSF. Mill tailings will be pumped as a slurry from the mill into the pit. Starting in the third quarter of 2025, water will be pumped from the pit lake to the TSF for storage and reuse in the mill process circuit. These additional inflows (water and solids) and outflows were accounted for in the model as follows:

- Water volume added to the pit as part of the tailings slurry was calculated from the planned ore processing rates (Table 7, below), assuming the slurry mixture would be 45 percent solids by mass. Based on testing data provided by FGMI, it was assumed that 70 percent of the Fort Knox ore mass and 73 percent of the combined Gil/Fort Knox ore mass would remain after processing and would be transferred to the pit as tailings. Testing data were not available for the Manh Choh ore; it was therefore conservatively assumed that 100 percent of ore mass processed would be transferred to the pit as tailings. Based on these assumptions, average yearly flows associated with the tailings slurry addition range from 1272 gpm (2028) to 3,556 gpm (2026).
- Process water for milling and slurry transport to the pit will be pumped from the pit starting in third quarter 2025. It was assumed that 100 percent of the water that flows into the pit with the tailings slurry would be pumped out of the pit for storage in the TSF and reuse in the processing.
- It was assumed that at the end of milling (end of 2028), there would be leftover process water associated with the mill (e.g., process ponds) that will need to be transferred to the pit. It was assumed 1,000 acre-feet will be transferred at the beginning of 2029.
- The model accounts for the volume occupied within the open pit by tailings solids and tailings pore space. The model currently assumes a settled tailings porosity of 40 percent. Upon discharge to the pit, the tailings slurry water fully mixes with the lake water, but then as the tailings settle, some of the mixed lake water is entrained within tailings pore space at the current lake water chemistry at each time step. This tailings pore water is effectively taken out of communication with pit lake water, such that the chemistry of the pore water does not evolve as pit lake chemistry evolves over time. This approach assumes limited diffusion of solutes between tailings pore water and open lake water.

Table 7. Crusher Feed to Mill (kilotons)

Year	Fort Knox	Gil	Manh Choh	Total
2024	4957	2259	382	6544
2025	3495	1656	1393	8539
2026	6190	1254	1095	7019
2027	5364	560	1095	3108
2028	2736	0	372	6544

4 Closure Water Quality Modeling – Updated Input Data

The closure water balance model includes water chemistry data, which are linked to the individual flow components to calculate chemical mass loading and concentrations through time in the pit lake. The water chemistry input data were updated in the model with recent site data and information described in this section and presented in Tables 8a and 8b. When calculating averages for water quality data, if all analytical results for a constituent were less than the analytical reporting limit, the concentration for that constituent was set to zero in the water chemistry model. If only some analytical results were less than analytical reporting limit, the average concentration for that location was calculated by substituting all nondetect values with half the reporting limit for the analysis. Derivation of representative water quality data is described below.

Water quality input data (Tables 8a and 8b) and model-calculated solute concentrations (described further below) are compared to Alaska reference standards. The Alaska reference standards were developed based on water quality standards cited in Alaska Department of Environmental Conservation (ADEC) 18 Alaska Administrative Code 70 (amended as of April 13, 2022) and by selecting the lowest of drinking water, aquatic, irrigation, and human health standards for inorganic constituents listed in the Alaska Water Quality Criteria Manual for Toxic and other Deleterious Organic and Inorganic Substances (ADEC 2022). Aquatic standards for cadmium, copper, lead, nickel, silver, and zinc are hardness-based; the estimated calcium and magnesium concentrations in the pit lake at the spill point elevation were used to calculate a hardness value of 124 milligrams per liter (mg/L) as calcium carbonate for the baseline scenario. The ammonia standard was calculated based on the estimated pH of the pit lake (8.19 standard units [s.u.] for the baseline scenario) and an estimated temperature of 10 degrees Celsius (°C), which is the long-term average pit dewatering well temperature and corresponds to the middle of the temperature range from the Fresh Water Reservoir (0 to 22 °C).

4.1 Direct Precipitation

No updates were made to direct precipitation input chemistry from the 2021 pit lake evaluation.

Consistent with the 2019 Update (HydroGeologica 2019), precipitation chemistry was calculated based on the average concentration in samples collected between 2015 and 2017 at station AK01 Poker Creek, Fairbanks North Star Borough, AK as part of the National Atmospheric Deposition Program (NADP [2019]).

4.2 Undisturbed Catchment Area Runoff

No updates were made to undisturbed catchment area runoff input chemistry from the 2021 pit lake evaluation.

Background surface water quality data for upper Barnes Creek were used to represent the undisturbed catchment runoff. These data were used in previous pit lake model updates and were based on average data from Upper Barnes Creek (MWH 2004).

4.3 Waste Pile, Pit Wall, and Disturbed Catchment Runoff

No updates were made to waste pile, pit wall, and disturbed catchment runoff input chemistry from the 2021 pit lake evaluation.

The water quality of waste pile, pit wall, and disturbed catchment runoff was estimated from waste rock testing using the Meteoric Water Mobility Procedure (MWMP). Specifically, MWMP data from annual waste rock samples collected from the Site between 2007 and 2017 were used to estimate the water quality. MWMP results suggest that manganese concentrations may exceed Alaska reference standards (Table 6).

4.4 Groundwater Inflow

No updates were made to groundwater inflow chemistry from the 2021 pit lake evaluation.

Consistent with the 2019 Update (HydroGeologica 2019), water quality data were used from dewatering well samples collected between 2016 and 2018. Specifically, geometric means were calculated for each well location and each pit dewatering sector. Then, calculated water chemistry data for each sector were weighted based on the sector dewatering pumping rates measured in 2018 (Piteau 2018). The flow-weighted average data are presented in Table 8a. The flow-weighted average arsenic concentration (0.016 mg/L) used in the model to represent groundwater inflow to the pit was slightly greater than the reference standard (0.010 mg/L), and the estimated groundwater antimony level (0.006 mg/L) is at the reference standard. These input pit groundwater chemistry data (Table 8a) were consistent with water quality data from samples of mixed pit groundwater directed to the RO system (RO feed). For comparison, these data along with the averaged groundwater chemistry data by pit sector are provided in in Appendix A.

Because groundwater flow is anticipated to be the largest single input to the pit lake during filling (Figure 3) and there is variability in constituent concentrations within pit dewatering wells (Appendix A), a conservative scenario was evaluated (described further in Section 7) using the maximum concentrations of constituents of concern from each of the pit dewatering sectors.

4.5 Tailings Storage Facility Decant Pond Transfers

Water chemistry of the TSF decant pond transfers was assumed to be equivalent to current TSF chemistry, as presented in Table 8b. Recent sample results for the TSF decant ponds contained elevated concentrations of antimony, arsenic, copper, weak acid-dissociable (WAD) cyanide, nitrate, nitrite, sulfate, and total dissolved solids (TDS) compared to the Alaska reference standards (Table 8b).

4.6 Interception System Pumping

The interception system collects a mixture of seepage from the TSF and downgradient groundwater. Water quality of the seepage component was assumed to be equivalent to current north decant pond chemistry.

An estimate of downgradient groundwater chemistry was calculated based on samples collected from wells MW-5, MW-6, and MW-7 from 2019 through October 2023. Water chemistry data were averaged by well and then averaged for the area to develop a representative water chemistry for input to the model (Table 8a). Concentrations of iron and manganese were estimated to be greater than the Alaska reference standards.

4.7 Barnes Creek and Walter Creek Heap Leach Facilities

The water chemistry of the process water portion of heap leach transferred to the pit lake was estimated for the modeling based on water quality analyses of pregnant leach solution from 2017 through October 2023. This water chemistry shows that concentrations of pH, aluminum, ammonia, antimony, cadmium, copper, WAD-cyanide, iron, mercury, nickel, nitrate, nitrite selenium, silver, zinc, and TDS are elevated compared with Alaska reference standards (Table 8b). The actual heap process water will likely have lower metals and nitrogen compound concentrations as it enters the pit because the water will first run through the carbon in column plant prior to discharge. As a conservative assumption, this water chemistry estimate is applied to the process water throughout the post-closure period. Chemistry of the natural infiltration through the pads was represented in the model based on final, rinsed leachate data from column leach-rinse tests performed on spent heap leach material (McClelland 2010; Table 8b). Concentrations of aluminum, arsenic, and WAD-cyanide, as well as pH, were elevated in the leachate compared to Alaska reference standards.

4.8 Mill Tailings

As noted in Section 3.3.8, mill tailings will be conveyed to the pit as a slurry from 2024 through 2028. Three ore sources will be processed (Fort Knox, Gil, and Manh Choh) at the annual rates presented in Table 7. Due to the ore characteristics and subsequent processing needs, the ore will be processed in batches:

- Manh Choh ore will be processed by itself.
- Gil ore will be processed in a 1:1 ratio with Fort Knox ore.
- FGMI plans to mill more Fort Knox ore than Gil ore; thus, there will be periods when only Fort Knox ore is processed.

Tailings slurry addition to the pit lake adds chemical mass to the pit lake via the water contained in the slurry mixture as the solids are deposited in the bottom of the pit. The model also includes the option of additional, subsequent leaching from tailings after the tailings are placed into the pit lake by assigning additional “leach cycles” on the model dashboard. Additional leaching from the tailings may occur, for example, if the tailings are placed into a large dilute volume when added to the pit and/or are allowed to mix substantially. However, for the purposes of this model, since the tailings are being placed into the pit early on in the pit filling period with low initial water volumes, mixing with pit water is anticipated to be minimal. Accordingly, it is assumed that subsequent leaching of the ore following placement in the pit will also be minimal, and therefore the subsequent leach cycles were set to zero. As noted above, there are in effect three different processing conditions based on the feed ore with different annual processing rates (Table 7). Therefore, the model accounts for tailings addition to the pit lake as three separate streams with different rates: Fort Knox, Fort Knox/Gil, and Manh Choh. While feed source changes may occur on the order of weeks months, the model uses the planned annual processing rates, which is sufficient for understanding long-term pit filling and water quality changes.

For each mill tailings stream, chemistry was defined for the slurry water filtrate based on direct sampling of filtrate water or scaling from tailings leachate results (Meteoric Water Mobility Procedure [MWMP] data) as follows (Table 8b):

- Tailings slurry filtrate – represents the water quality of the water contained in the slurry mixture that is conveyed into the pit lake.
  - Fort Knox: Tailings filtrate median (2015 – 2021) reported in the Gil Mine Geochemistry Report (Kinross 2021)
  - Manh Choh: Detoxified tailings solution (2022 Updated Bulk Leach), reported in Manh Choh Geochemical Characterization Report (SRK 2022)
  - Fort Knox/Gil: Direct Fort Knox/Gil tailings slurry filtrate samples were not available, thus, the chemistry was developed from the other sources using professional judgment. For aluminum, antimony, arsenic, manganese, and molybdenum, concentrations were scaled from the Fort Knox/Gil tailings MWMP results (referenced below) based on the ratios observed between MWMP results and tailings slurry filtrate for the Fort Knox and Manh Choh ores. For all other analytes (including major ions and analytes with non-detect values by MWMP), concentrations were assumed equal to Fort Knox Tailings slurry filtrate.
- Tailings solids leachate – represents additional chemical mass that is released from the tailings solids due to leaching in the pit lake. The potential for leaching was determined through MWMP tests. As noted above, although this feature is included in the model, the current model simulations assume no additional leaching following tailings deposition in the pit lake. However, these data were evaluated and used in derivation of tailings slurry filtrate water quality as described above.
  - Fort Knox: Tailings MWMP median (2015 – 2021) reported in the Gil Mine Geochemistry Report (Kinross 2021)
  - Manh Choh: Detoxified tailings MWMP (2022 Updated Bulk Leach), reported in Manh Choh Geochemical Characterization Report (SRK 2022)
  - Fort Knox/Gil: Gil Year 2 + Fort Knox MWMP results, reported in Gil Mine Geochemistry Report (SRK 2022).

As noted in Section 3.3.8, the model accounts for the volume occupied within the open pit by tailings solids and tailings pore space. The model currently assumes a settled tailings porosity of 40 percent. Upon discharge to the pit, the tailings slurry water fully mixes with the lake water, but then as the tailings settle, some of the mixed lake water is entrained within tailings pore space at the current lake water chemistry at each time step. This tailings pore water is effectively taken out of communication with pit lake water, such that the chemistry of the pore water does not evolve as pit lake chemistry evolves over time. This approach assumes limited diffusion of solutes between tailings pore water and open lake water.

It was assumed that at the end of milling (end of 2028), there would be leftover process water associated with the mill (e.g., process ponds) that will need to be transferred to the pit. It was assumed 1,000 acre-feet will be transferred at the beginning of 2029. The chemistry of this water was set to a weighted ratio of the Fort Knox tailings slurry filtrate and the Manh Choh tailings slurry filtrate, which are the two ores that will be processed in 2028 (Table 7).

5 Pit Lake Water Quality Geochemical Modeling Methods

No updates were made to the pit lake geochemical modeling methods from the 2021 pit lake evaluation. A summary of geochemical modeling methods is provided below.

The closure pit lake model, developed in GoldSim, was linked with the geochemical equilibrium model, PHREEQC (Parkhurst and Appelo 2013) to simulate thermodynamic, geochemical reactions and provide a more realistic estimate of pit lake water chemistry throughout the modeling period. The modeling approach conceptualizes the pit lake as a completely mixed solution that results from instantaneous mixing of inflowing waters with specific chemical loadings. Solute mass rinsed from reactive site materials was represented based on the geochemical source term data described above.

PHREEQC was used for geochemical speciation, mixing, and reaction modeling conducted for this assessment. This code is publicly available through the U.S. Geological Survey, has been rigorously tested, and has been used in numerous geochemical predictions. PHREEQC is an industry standard tool used to conduct geochemical calculations to predict the chemistry of natural or impacted waters in the environment. This software uses thermodynamic equilibrium and speciation calculations to determine the concentration of mixed solutions as they evolve after allowing for mineral precipitation and trace element sorption under imposed gas and redox conditions. The resulting model output contains the aqueous concentrations of simulated elements, the speciation of the aqueous solutes, the solubility of relevant minerals, and the effects of sorption based on number of available sites and competition for weak and strong sorption sites. The PHREEQC model used the MINTEQv4 thermodynamic database supplied with the v2.15.02 version of PHREEQC (released March 31, 2013). This database is widely used for geochemical modeling and was selected for this study because it includes the full range of elements present at the site, as well as key sorption reactions for iron oxyhydroxides (e.g., ferrihydrite). Sorption reactions can be an important process for removing a range of dissolved solutes from solution. Details of the geochemical modelling approach are presented below:

- The mixed pit lake chemistry was equilibrated with a carbon dioxide slightly oversaturated compared to atmospheric conditions (log pCO_2, -3.2), based on observations at mine sites (Eary 1999), and with atmospheric oxygen content (log pO_2, -0.67).
- This solution was equilibrated with specific mineral phases that, if oversaturated, were allowed to precipitate from the solution. The specific minerals (calcite, gypsum, ferrihydrite, and gibbsite) were selected based on literature review of mine waters by Eary (1999).
- Adsorption of species (antimony, arsenic, cadmium, copper, lead, nickel, calcium, phosphate, zinc, and sulfate) onto ferrihydrite was simulated according to Dzombak and Morel (1990). The mass of available ferrihydrite was limited to that precipitated by the solution under modeled conditions. For antimony, the MINTEQv4 thermodynamic database was modified slightly by removing the SbO_3^- species in favor of the fully hydrated $Sb(OH)_6^-$ species to be more consistent with the Dzombak and Morel sorption model.
- Non-equilibrium manganese oxidation and precipitation was modeled in GoldSim as a first-order process. The most significant source of manganese to the pit lake is from the groundwater interception system (Table 6). Due to reducing conditions in the groundwater, the interception system water contains reduced manganese (Mn(II)) at approximately 1 mg/L. Over time, Mn(II) is expected to oxidize in the pit to form Mn (III/IV)

oxyhydroxides. The kinetics of abiotic manganese oxidation and loss from the system was estimated using a first-order rate constant, per Morgan (2005), resulting in a half-life of 1.9 years.

- Non-equilibrium WAD-cyanide degradation was modeled in GoldSim as a first-order process. In previous submittals, degradation of WAD-cyanide in the pit lake and in heap leach porewater was approximated by applying of a half-life of 80 days for the first 2.5 years and 1,241 days after 2.5 years (Schafer and Associates 1990). In this 2023 update, the slower (more conservative) half-life of 1,241 days (3.4 years) was used. The cyanide half-life is applied once cyanide is no longer being added to the leach circuit (beginning of 2031).

6 Pit Lake Water Balance Results

The pit lake water balance was modeled in GoldSim based on the flow terms described in Section 3.3 at daily time steps from January 2024 through January 2124. The modeled pit lake stage and volume are shown on Figure 5. The modeled inflows and outflows are presented in Table 2 and shown on Figure 3.

The eastern pit will begin filling in 2024 after dewatering there is ceased. The pit lake will continue to fill, even as mining and dewatering continues in the western portion of the pit, and it is expected to overflow into the west pit area starting in 2026 and combine into one pit lake in 2029. The pit lake will fill to the estimated alluvium spill over point (1,430 feet amsl) in November 2080, approximately 57 years after the start of pit lake filling in 2024 (Figure 3); at this stage, the pit lake water volume will be approximately 173,600 acre-feet and the surface area will be 401 acres. The three most significant pit lake inflows (up to the alluvium contact point) will be groundwater inflow (62,600 acre-feet), leach pad flows (43,400 acre-feet), and interception system pumping (25,500 acre-feet). Once the pit lake stage reaches 1,430 feet amsl, pit lake water will begin to flow into Fish Creek alluvium downgradient of the pit toward the current TSF area. Prior to this date, the pit lake will act as a hydraulic sink with continued inward hydraulic gradients that maintain groundwater flow toward the pit lake.

7 Pit Lake Water Quality Results

Model results for pit lake water quality are presented in this section for the baseline scenario. Additional pit lake water quality results associated with the groundwater maximum concentrations scenario and precipitation sensitivity analysis are presented in Section 8.

Pit lake water chemistry was modeled using a daily time step from January 2024 through January 2124. Predicted pit lake water quality is presented in Table 9 for select timepoints corresponding with distinct intervals of water management operations or pit lake development events. Pit lake water quality is summarized below. Overall, when the pit lake begins to flow into alluvium (2080), with the exception of antimony, constituent concentrations are less than Alaska water quality standards; the antimony concentration is slightly greater than the standard in 2080 (Table 9) and decreases to below the standard in 2085.

- General chemistry
  - The pH of the pit lake water is predicted to be circumneutral to slightly alkaline throughout filling (8.19 s.u. in 2080), typical of an alkaline water in equilibrium with atmospheric carbon dioxide.
  - Alkalinity is variable during early pit filling and then begins to consistently decrease after 2048 toward levels consistent with inflowing groundwater (80 mg/L calcium carbonate). In 2080, pit lake alkalinity is

predicted to be 110 mg/L as calcium carbonate. This level of alkalinity throughout filling indicates consistent buffering capacity in the pit lake.

- Sulfate and TDS concentrations in the pit lake generally decrease through time from approximately 390 and 734 mg/L, respectively, following transfer of the North Decant Pond in 2029, to approximately 103 and 278 mg/L in 2080, respectively. The decrease in sulfate and TDS concentrations is reflective of dilution of high-sulfate and high-TDS pit lake inputs (e.g., TSF decant ponds and leach pad draindown [Tables 8a and 8b]), by groundwater, surface runoff, and precipitation.

- Nitrogen compounds:
  - Ammonia and nitrate concentrations may exceed the water quality standard during early pit lake filling during mill tailings addition. The maximum nitrate concentration in the pit lake is predicted to be approximately 38 mg/L in 2027. Nitrate concentrations then decrease to less than the standard in 2065 and will be approximately 8.9 mg/L in 2080 (Table 9). The maximum ammonia concentration in the pit lake is predicted to be approximately 1.3 mg/L in 2032. Ammonia concentrations then decrease to less than the standard in 2033 and will be approximately 0.4 mg/L in 2080 (Table 9).
  - WAD-cyanide concentrations are predicted to increase to approximately 6.7 mg/L in the pit lake following tailings slurry addition (up to 11 mg/L) and draindown of the heap leach facilities (55 mg/L), which contain elevated levels of WAD-cyanide. WAD-cyanide concentrations then decrease through time, as the result of degradation and dilution, to less than the water quality standard in 2059 and less than the typical reporting limit (0.001 mg/L) in 2080 (Table 9).
- Metals and metalloids:
  - With the exception of arsenic, antimony, cadmium, copper, selenium, and silver, all metals and metalloids are predicted to be less than water quality standards throughout pit filling.
  - Arsenic concentrations in the pit lake (Figure 6) will increase during early pit filling following tailings slurry addition, transfer from the TSF decant pond, and pumpback of TSF seepage, which contain arsenic at concentrations greater than the standard (Tables 8a and 8b). Arsenic concentrations decrease over time due to dilution from precipitation, runoff, and groundwater inflows, which have relatively low arsenic concentrations. Arsenic concentrations are reduced further through sorption to ferrihydrite, which is formed in the pit lake via iron oxidation. Arsenic concentrations peak at approximately 0.34 mg/L in 2025 and decrease below the standard in 2041. At the time of pit spillover into alluvium, the predicted arsenic concentration is 0.007 mg/L (Table 9).
  - Antimony concentrations in the pit lake (Figure 7) will increase during early pit filling following tailings slurry inflows and transfers from the TSF decant ponds and pumpback of TSF seepage, which contain antimony at concentrations greater than the standard (Tables 8a and 8b). Antimony adsorption to ferrihydrite was modeled; however, the sorption affinity is relatively low above pH 8. Therefore, antimony concentrations are predicted to decrease slowly over time as decant pond water and tailings slurry inflows and TSF seepage inflows are diluted with other pit inputs. At the time of pit spillover into alluvium, the predicted antimony concentration (0.00615 mg/L) is slightly greater than the water quality standard (0.006 mg/L), decreasing to less than the standard in 2085.
  - Cadmium concentrations in the pit lake will increase during early pit filling during tailings slurry addition and following heap leach pad draindown, which contains cadmium at concentrations greater than the standard (Tables 8a and 8b). Cadmium concentrations decrease over time due to dilution and adsorption to ferrihydrite. Cadmium concentrations peak at approximately 0.00055 mg/L in 2027 and decrease below

the standard in 2036. At the time of pit spillover into alluvium, the predicted cadmium concentration is 0.000103 mg/L (Table 9).

- Copper concentrations in the pit lake will increase during early pit filling during tailings slurry inflows and heap leach pad draindown, which contain copper at concentrations greater than the standard (Tables 8a and 8b). Copper concentrations decrease over time due to dilution and adsorption to ferrihydrite. Copper concentrations peak at approximately 0.2 mg/L in 2027 and decrease below the standard in 2035. At the time of pit spillover into alluvium, the predicted copper concentration is 0.00235 mg/L (Table 9).
- Selenium concentrations in the pit lake will increase during early pit filling during tailings slurry inflows, which contain selenium at concentrations greater than the standard (Tables 8a and 8b). Selenium concentrations decrease over time due to dilution. Selenium concentrations peak at approximately 0.006 mg/L in 2027 and decrease below the standard in 2029. At the time of pit spillover into alluvium, the predicted selenium concentration is 0.00108 mg/L (Table 9).
- Silver concentrations in the pit lake will increase during early pit filling during tailings slurry inflows, which contain silver at concentrations greater than the standard (Tables 8a and 8b). Silver concentrations decrease over time due to dilution. Silver concentrations peak at approximately 0.035 mg/L in 2025 and decrease below the standard in 2029. At the time of pit spillover into alluvium, the predicted silver concentration is 0.00093 mg/L (Table 9).

Overall, the baseline model scenario indicates that pit lake water quality will be acceptable at the time of spillover to alluvium (2080). With the exception of antimony, constituent concentrations are less than Alaska water quality standards; the antimony concentration is slightly greater than the standard in 2080 and decreases to below the standard in 2085 (Table 9). Arcadis understands that based on FGMI's waste management permit, a water treatment plan may be required if model predictions suggest that any analytes will be above water quality standards at the time of contact with alluvium. Although antimony is currently predicted to be above the water quality standard in 2080, the simulation result of 0.00615 mg/L is approximately 3 percent above the water quality standard, which is considered to be within uncertainty limits for both analytical measurement and model prediction over the 60-year simulation timeframe. Accordingly, further data collection and model refinement are recommended to understand whether antimony concentrations are truly expected to be above the water quality standard prior to consideration of water management alternatives. The concentration of antimony in the pit lake is sensitive to tailings slurry chemistry and flow, TSF seepage pumpback chemistry and flow, and the published sorption parameters for antimony on ferrihydrite. Future model updates may refine these model inputs to better understand the potential for antimony water quality exceedances.

8 Model Sensitivity Analyses

8.1 Groundwater Maximum Concentrations

Groundwater flow is anticipated to be the largest single input to the pit lake during filling (Figure 3 and Table 2) and, through time, pit lake chemistry is predicted to approach that of groundwater. However, there is considerable variability in constituent concentrations observed in pit dewatering wells, which were used to derive representative groundwater inflow chemistry (Table 8a). This variability was controlled by flow-weighting the chemistry from each of the dewatering sectors, as described in Section 4.4. However, a conservative model scenario was also evaluated in which groundwater was assumed to have the maximum metal/metalloid concentrations from each pit dewatering sector (Appendix A). pH and alkalinity were held constant (consistent with the flow-weighted average [Table 8a]) and no other changes were made to the model. The selected groundwater chemistry for this dataset (maximum concentrations from each sector in Appendix A) exceeds water quality standards for antimony, arsenic, and lead. Although the groundwater quality dataset was not updated as part of this evaluation, this sensitivity simulation was rerun to understand the combined effects of groundwater concentration sensitivity and model modifications described above.

Water quality results for this model scenario are presented in Table 10. Similar to the baseline model scenario, when the pit lake reaches the contact with alluvium (2080), antimony is the only constituent with concentration greater or equal to the water quality standard. The results are summarized as follows:

- Like the baseline scenario, arsenic, cadmium, copper, WAD-cyanide, nitrate, selenium, silver, sulfate, and TDS exceed water quality standards for discrete periods of time during early pit filling. However, each constituent decreases to less than their respective water quality standards by 2080 (Table 10).
- Like the baseline scenario, antimony concentrations in the pit lake increase during early pit filling following tailings slurry inflows, transfers from the TSF decant ponds, and pumpback of TSF seepage, which contain antimony at concentrations greater than the standard (Table 8b). Antimony concentrations then slowly decrease over time. However, because the groundwater inflow term in this scenario contains antimony concentrations greater than the water quality standard (Appendix A), antimony exceeds the water quality standard when the pit lake reaches the contact with alluvium (2080) with a concentration of 0.00973 mg/L.
- Similarly, the groundwater inflow term in this scenario contains arsenic greater than the water quality standard. Arsenic concentrations are predicted to be below the water quality standard as the pit lake reaches the contact with alluvium (2080), but it is predicted to increase up to the water quality standard by 2100 (to a level considered to be within model uncertainty) because the groundwater input exhibits elevated arsenic, and the groundwater inflow term is the dominant contribution in the long term.

Overall, this model scenario demonstrates that even with conservative assumptions regarding groundwater inflow chemistry (the single largest pit inflow), pit chemical concentrations relative to water quality standards are similar to the baseline scenario. Specifically, only antimony and arsenic concentrations are greater or equal to water quality standards either when the pit lake reaches the contact with alluvium (2080) or in the long-term following pit lake contact with alluvium. Although arsenic exceeds the water quality standard in the averaged groundwater flow (Appendix A), it is important to note that this evaluation cannot adequately account for likely groundwater quality improvements as the pit becomes saturated, limiting continued wall rock oxidation in the vicinity of the pit lake pumping wells. Further, considering that antimony exceeds the water quality standards in only 29 percent of the groundwater inflow (Appendix A), it is unlikely that overall average groundwater inflow concentrations will exceed the antimony standard. As noted in Section 7, antimony concentrations within the pit lake are sensitive to tailings slurry chemistry and flow, TSF seepage pumpback chemistry and flow, and the sorption parameters for antimony on ferrihydrite. Future model updates may refine this model input to better understand the potential for antimony water quality exceedances.

8.2 Precipitation Sensitivity Analysis

Additional model runs were conducted to evaluate the sensitivity of the pit lake filling and chemistry to variation in annual precipitation at the Site during the post-closure period. The average annual precipitation record was increased and decreased by 20 percent to evaluate the effect on the resulting pit lake filling curve, time to overflow, and pit lake water quality. The year in which the pit lake stage reaches the contact with the alluvium ranges from 2073 to 2091 for the high and low precipitation scenarios, respectively.

Water chemistry results for the high and low precipitation scenarios are presented in Tables 11 and 12, respectively. In the low precipitation scenario, results were similar to the baseline scenario: antimony was the only constituent that was equal to or greater than water quality standards at the time of pit filling (2091 in this scenario). In the low precipitation scenario, antimony continues to decrease in the pit after reaching the contact with alluvium, and decreases below the standard in 2122. In the high precipitation scenario, antimony decreases to below the standard in 2070, 3 years before the pit lake water level reaches the contact with alluvium (2073).

9 Pit Lake Stratification Analysis

Consistent with the previous pit lake model updates, the potential for permanent pit lake stratification was evaluated using several lines of evidence, including pit lake geometry, density gradients, and wind shear stress. This memorandum uses the same methods, updated with the current model results.

As in natural lakes, mine pit lakes may permanently or seasonally stratify vertically. Stratification in pit lakes is caused by density differences in the water column, which are based on temperature and salinity/TDS differences. Factors that affect circulation include geometry of the lake (i.e., surface area to depth ratio) and surface wind shear stress. Mixing or seasonal turnover of lake waters generally results when the shallower portion of the lake exhibits water movement from wind shear and other currents or increasing surface water density due to lower seasonal atmospheric temperatures sufficient to displace the deeper, denser water in the lake.

Permanent stratification of the Fort Knox pit lake would affect pit lake water quality in the developing zones. A permanently stratified (meromictic) lake would result in a bottom layer that does not mix with the upper water column. Based on the Fort Knox closure concepts, the lower layer would likely be dominated by the higher TDS waters from the tailings slurry inflows, decant pond transfers, and heap leach facility draindown water mixed with groundwater. The upper mixed water zones (mixolimnion) would undergo seasonal turnover based on seasonal temperature changes and would generally reflect a mixture of groundwater, surface/pit wall runoff, and direct precipitation. This zone would be in contact with the upper alluvium through which the significant portion of groundwater discharge is predicted to occur.

Simple analytical equations were applied to provide a screening-level assessment for evaluating stratification potential in the pit lake. These equations were developed by Tchobanoglous and Schroeder (1985), U.S. Army Corps of Engineers (USACE 1986 and 1987), Jewell (2009), and Boehrer and Schultze (2009). Key factors considered in this screening level evaluation are presented in Table 13. During active water transfers to the pit lake (e.g., decant pond pumping, heap leach facility draindown, interception system pumping) and tailings deposition with pit water pumping/reuse for mill process water, it is expected that the pit lake water will be thoroughly mixed. Therefore, stratification potential was evaluated beginning in year 2033 (after active pumping into and out of the pit lake), 9 years after the start of pit lake filling. The results of the analytical calculations (Table 13) suggest there is a potential for permanent stratification in the pit lake during the post-closure period due to the relatively small pit lake surface area to depth ratio, shallow wind mix depth, and long residence times. However, the densities of the runoff and mixed operational waters are not significantly different, suggesting that colder surface water in the pit lake during the fall may be sufficiently dense to cause turnover to some depth, and wind mixing would overcome the buoyancy forces caused by the minor density differences. The likelihood and depth of this seasonal turnover are uncertain. However, any permanent stratification that occurs would serve to isolate a portion of the higher TDS water at depth and improve water quality in the upper portions of the pit lake, such that the assumption of a well-mixed pit lake in the GoldSim model is conservative for the purposes of water quality evaluation.

10 Conclusions and Recommendations

Overall, the pit lake evaluation results suggest that the current reclamation approach will be effective from a water quality perspective. Specifically, the updated pit lake modeling indicates the following:

- During the several decades following mine closure, the pit lake will act as a hydraulic sink with continued inward hydraulic gradients that maintain groundwater flow toward the pit lake. During this period, pit lake water will not discharge to the environment, and the water surface will be separated from the ground surface by steep high walls.
- Based on the current mine reclamation and closure concepts, the updated pit lake water balance model indicates that the pit lake will fill to the spill point elevation of 1,430 feet amsl in 2080, approximately 57 years after beginning to fill. At that time, pit lake water will begin to discharge to Fish Creek alluvium and to mix with downgradient groundwater.
- The updated model predictions indicate that the pit lake chemistry will be alkaline (pH approximately 8.19 s.u.), with alkalinity of approximately 124 mg/L as calcium carbonate, and that the water will have moderately high TDS (up to 734 mg/L before decreasing) throughout pit filling.
- Most water quality constituents are predicted to remain at concentrations less than the Alaska water quality standards for the entire model simulation period.
- Concentrations of nitrate, ammonia, TDS, and WAD-cyanide are predicted to be greater than water quality standards during early pit filling; however, these constituent concentrations are predicted to decrease to less than the standards before the pit lake reaches the contact with alluvium.
- Several metals and metalloids, including arsenic, cadmium, copper, selenium, and silver are predicted to be greater than water quality standards during early pit filling; however, these constituent concentrations are predicted to decrease to less than the standards before the pit lake reaches the contact with alluvium.
- Antimony concentrations in the pit lake will be slightly greater than the water quality standard when the pit lake reaches the contact with alluvium (2080) and will decrease to less than the standard in 2085.
- Even with conservative assumptions regarding groundwater inflow chemistry (assuming maximum concentrations from each of the pit dewatering sectors), pit chemical concentrations relative to water quality standards are similar to the baseline scenario. Only antimony concentrations are greater or equal to water quality standards at the time of pit filling (2080) in the model scenario using groundwater maximum concentrations.
- Variability in precipitation rates (+/- 20 percent) were evaluated using sensitivity modeling; the rate of filling to the spill point elevation varied by -7 to +11 years. The variability did not have a significant effect on the predicted water chemistry results.
- A screening-level evaluation of stratification indicates that there is potential for the pit lake to become permanently stratified, with pit lake geometry representing the driving factor. However, the densities of the runoff and operational waters indicate that seasonal turnover could occur to some depth. Permanent stratification would likely improve the water quality of pit lake water discharging to the environment once the

lake level reaches the spill point elevation. The near-surface water quality, in direct contact with the alluvium, would likely reflect a mixture of precipitation, surface/pit wall runoff, and groundwater. More detailed modeling may be required to verify stratification and provide additional detail in the water quality predictions.

Based on the updated modeling results, the following recommendations should be considered:

- The pit lake model should be updated, as needed, to reflect any changes in the Fort Knox Mine reclamation and closure plan and water management system and as additional site data become available.
- Given the prediction that antimony concentrations will be close to the water quality standard when the pit lake level reaches the alluvium, it is recommended that antimony model predictions be refined in future model updates based on additional data collected. It is also recommended that the potential for antimony sorption to ferrihydrite be evaluated further to confirm the geochemical model sorption parameters used in this evaluation, either through literature investigation or through field-relevant bench testing. Although it may become necessary in the future, consideration of specific water management/treatment alternatives for addressing antimony are not considered necessary at this time.

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Tables

Table 1
Model Updates Summary
Fairbanks Gold Mining, Inc.
Fort Knox Mine
Fairbanks, Alaska

Model Component/Sub-Unit	Changes Incorporated in the 2023 Pit Lake Evaluation
General	• Model timeframe updated to run from 1/1/2024 through 1/1/2124
Chemistry Inputs	Input chemistry updated for the following components: • Leach pad pregnant solution (averages updated with more recent data) • Downgradient pumpback wells (averages updated with more recent data) • Barge Pond (updated to more recent sample with complete dataset [August 2023]) • Included chemistry for tailings streams (solid and liquid) that will be deposited in the pit (see Tailings Deposition section below)
Pit Lake	• Groundwater inflow vs. pit lake stage relationship incorporated into GoldSim model. This relationship replaces the previous (2021) groundwater inflow versus time relationship. Inflow versus stage relationship was constructed by combining inflow versus time MODFLOW input with the pit lake stage versus time GoldSim output from the previous model. • Pumping/dewatering set to end on 12/31/2028.
Leach Pads	• The model updated to include leach pad draindown/transfer to pit in 2032 instead of 2031. • Leach pad pregnant solution (averages updated with more recent data)
TSF Seepage	• TSF seepage draindown function start was shifted from 1/1/2027 to 1/1/2029, consistent with maintenance of a TSF decant pond through 2029. • Similarly, downgradient groundwater pumpback (assumed to occur for 20 years from closure) was shifted by two years, consistent with closure in 2030.
TSF Decant Ponds	• Changed North Pond transfer to 3000 acre-feet in 2029 (assumed transfer occurs over all of 2029). South Pond transfer was removed as the South Pond will be filled with tailings prior to closure.
Mill Tailings Deposition	• The model was revised to account for deposition of mill tailings slurry in the pit, which will occur from 2024 through 2028. • The model accounts for variable processing rates in each year and three different tailings streams (Fort Knox, combined Fort Knox and Gil, and Manh Choh) with different chemistries.

Table 2
Fort Knox Closure Pit Lake Water Balance Summary
Fairbanks Gold Mining, Inc.
Fort Knox Mine
Fairbanks, Alaska

ARCADIS

Closure Pit Lake Modeling Period	Results Date	Pit Filling Elapsed Time (years)	Pit Lake Elevation (feet amsl)	Pit Lake Volume (acre-feet)	Closure Pit Lake Water Balance Modeling Component											
					Cumulative Inflow (acre-feet)										Cumulative Outflow (acre-feet)	
					Direct Precipitation	Undisturbed Catchment Runoff	Disturbed Catchment Runoff	Pit Wall Runoff	Waste Pile Runoff	Groundwater Inflow	TSF Decant Pond Transfers	Interception System Pumping	Net Tailings Water Deposition	Heap Leach Facility Flows	Lake Evaporation	Overflow to alluvium
Pit filling starts (beginning of 2024)	1/1/2024	0	--	--	--	--	--	--	--	--	--	--		--	--	0
End of Milling and Tailings Addition to Pit (end of 2028)	1/1/2029	5	822	11,585	325	51	696	1,855	322	6,569	0	0	6,199	0	228	0
End of North Decant Pond transfer to pit (end of 2029)	1/1/2030	6	874	19,995	462	65	881	2,200	407	7,995	3,008	3,305	6,199	0	323	0
Pit lake prior to leach pad draindown	12/31/2031	8	921	27,969	829	92	1,251	2,858	578	10,747	3,008	7,194	6,199	0	581	0
Heap leach pads initial draindown period (1 year of draindown)	1/1/2033	9	950	33,344	1,033	106	1,436	3,179	663	12,096	3,008	8,175	6,199	2,379	726	0
20 years of filling	1/1/2044	20	1,123	72,882	3,927	255	3,471	6,488	1,604	25,821	3,008	17,301	6,199	11,788	2,775	0
40 years of filling	1/1/2064	40	1,320	132,797	11,231	527	7,171	11,790	3,313	47,284	3,008	25,534	6,199	28,896	7,951	0
Pit lake up to alluvium spill point	11/20/2080	57	1,430	173,619	18,853	758	10,316	15,803	4,766	62,579	3,008	25,534	6,199	43,362	13,354	0
Pit lake approximately 20 years after spill to alluvium	11/20/2100	77	1,533	217,810	29,240	1,030	14,015	20,025	6,476	76,736	3,008	25,534	6,199	60,469	20,718	0

Acronyms and Abbreviations:
-- = not applicable
amsl = above mean sea level
TSF = tailings storage facility

Table 4
Runoff Terms Summary
Fairbanks Gold Mining, Inc.
Fort Knox Mine
Fairbanks, Alaska

Feature	Area Within Pit Catchment (acres)	Chemistry	Runoff Coefficient	Infiltration	Evaporation	Runoff (inches/year)
Pit wall	898 (maximum, decreases as pit fills)	Waste rock MWMP	0.35	Not defined/modeled	Not defined/modeled	5.2
Undisturbed catchment area	23	Background surface water	Ranges from 0 to 0.59. Calculated monthly as: ((precip - evap)/precip)x(1-infil)	0.34	Pan evap with 0.3 scaling factor	7.1
Disturbed catchment area	313	Waste rock MWMP	Ranges from 0 to 0.59. Calculated monthly as: ((precip - evap)/precip)x(1-infil)	0.34	Pan evap with 0.3 scaling factor	7.1
Waste piles	445 (scaled area used = 144.6)	Waste rock MWMP	Ranges from 0 to 0.59. Calculated monthly as: ((precip - evap)/precip)x(1-infil)	0.34	Pan evap with 0.3 scaling factor	2.3
Heap leach pads	732	Rinsed ore MWMP	Runoff and infiltration are combined because there is a liner with leachate collection. Calculated as net precip minus net evap.		Pan evap with 0.25 scaling factor	14

Acronyms and Abbreviations:
evap = evaporation
infil = infiltration
MWMP = Meteoric Water Mobility Procedure
precip = precipitation

Table 8a
Input Chemistry Data for the 2023 Pit Lake Model Update - Precipitation, Runoff, and Groundwater
Fairbanks Gold Mining, Inc.
Fort Knox Mine
Fairbanks, Alaska

ARCADIS

Water Quality Modeling Input Data			Precipitation	Undisturbed Catchment Runoff	Waste Pile, Disturbed Catchment, and Pit Wall Runoff	Groundwater Inflow to Pit	Groundwater Downgradient of the TSF
Parameter	Alaska Water Quality Standards		NADP Site AK01, Fairbanks Site Precipitation Chemistry	Upper Barnes Creek, Background Data	Waste Rock MWMP Data 2007-2017	Flow-Weighted 2016-2018 Dewatering Well Samples	Average of Samples from MW-5, MW-6, and MW-7, January 2019 through October 2023
	Standard	Basis					
pH (s.u.)	6.5 - 8.5	WQS	5.2	7.0	NA	7.6	8.00
Alkalinity as $CaCO_3$	> 20	AQ(c)	0	15	116	80	244
Aluminum	0.087	AQ(c)	0	0	0.14	0.016	0.014
Ammonia	1.81	AQ(c)	0.066	0.010	0	0.027	0.243
Antimony	0.006	DW	0	0.0025	0.004	0.006	0.000262
Arsenic	0.01	DW	0	0.003	0.0049	0.016	0.00100
Barium	2	DW	0	0.005	0.0083	0.0034	0.0214
Cadmium	0.00029	AQ(c)	0	0.0001	0.000055	0.00005	0.000033
Calcium	NA	NA	0	4.4	28	33	74.1
Chloride	230	AQ(c)	0.055	0.7	2	1.4	9.7
Chromium	0.1	DW	0	0.0020	0.00041	0.00072	0.0026
Copper	0.0108	AQ(c)	0	0	0.0043	0.00035	0
WAD-cyanide	0.0052	AQ(c)	0	0	0	0	0.0020
Fluoride	1	IRR	0	0.06	0.34	0.34	0.198
Iron	1	AQ(c)	0	0.22	0.049	0.058	9.73
Lead	0.0032	AQ(c)	0	0.0040	0.00020	0.0015	0.000121
Magnesium	NA	NA	0.0053	1.6	4.6	5	10.7
Manganese	0.2	IRR	0	0	0.053	0.023	0.97
Mercury	0.00005	HH	0	0.00030	0	0	0
Nickel	0.062	AQ(c)	0	1.0	0.001	0.0011	0.0056
Nitrate, as N	10	DW	0.14	0.25	2.4	0.93	1.01
Nitrite, as N	1	DW	0	0.01	0	0.11	0.00470
Phosphorus	NA	NA	0	0.08	0.04	0.011	0.031
Potassium	NA	NA	0.012	0.5	8.4	1	1.62
Selenium	0.005	AQ(c)	0	0.002	0.00041	0.00049	0.000615
Silver	0.0047	AQ(a)	0	0.001	0	0	0
Sodium	NA	NA	0.025	2	16	13	24.2
Sulfate	250	WQS	0.13	6.7	0	99	32.2
Zinc	0.14	AQ(c)	0	0.003	0.0091	0.0023	0.029
TDS	500	WQS	0	80	152	247	345

Notes:
1. Shaded cells indicate value exceeds Alaska water quality standards.
2. All data are in milligrams per liter (mg/L), unless otherwise noted.
3. For calculating averages, if all results for a location were nondetect, a value of zero was used for modeling. Otherwise, averages were calculating using one-half of the reporting limit for nondetect results.
4. Alaska water quality standards based on ADEC 18 Alaska Administrative Code 70 (amended as of April 13, 2022) and Alaska Water Quality Criteria Manual for Toxic and other Deleterious Organic and Inorganic Substances (ADEC 2022). Value shown is the lowest standard of drinking water, irrigation, stock water, aquatic, or human health standards.
5. Aquatic standards for cadmium, copper, lead, nickel, silver, and zinc are hardness-based. The estimated calcium and magnesium concentrations in the pit lake at the spill point elevation (Table 9) were used to calculate the hardness value of 124 mg/L as $CaCO_3$.
6. The ammonia standard is based on the estimated pH and temperature of the pit lake. The pH was set equal to 8.19, which is the modeled pH of the pit lake at the spill point elevation (Table 9). The temperature was assumed to be 10 degrees Celsius, which is the long-term average of pit dewatering well groundwater.

Acronyms and Abbreviations:
AC(a) = aquatic standard (acute)
ADEC = Alaska Department of Environmental Conservation
AQ(c) = aquatic standard (chronic)
$CaCO_3$ = calcium carbonate
DW = drinking water standard
HH = human health criteria for noncarcinogens
IRR = irrigation standard
MWMP = Meteoric Water Mobility Procedure
NA = not available or not applicable
NADP = National Atmospheric Deposition Program
s.u. = standard unit
TDS = total dissolved solids
TSF = tailings storage facility
WAD = weak-acid dissociable

Reference:
ADEC. 2022. Alaska Water Quality Criteria Manual for Toxic and other Deleterious Organic and Inorganic Substances. September 8.

Table 8b
Input Chemistry Data for the 2023 Pit Lake Model Update - TSF, Leach Pad, and Tailings Deposition
Fairbanks Gold Mining, Inc.
Fort Knox Mine
Fairbanks, Alaska

ARCADIS

Water Quality Modeling Input Data			Current North TSF Decant Pond Chemistry	Heap Leach Draindown Chemistry		Fort Knox Tailings Slurry Filtrate	Fort Knox Tailings Leachate	Fort Knox/Gil Tailings Slurry Filtrate	Fort Knox/Gil Tailings Leachate	Manh Choh Tailings Slurry Filtrate	Manh Choh Tailings Leachate	Final Process Water Transfer
Parameter	Alaska Water Quality Standards		Sample Results from August 15, 2023 (or most recent available data)	Average of Pregnant Leach Solution Samples, January 2019 through October 2023	Post-Final Rinse MWMP Extract (column testing, 2010)	Fort Knox Tailings Filtrate Median (2015-2021), reported in Gil Mine Geochemistry Report (Table 4)	Fort Knox Tailings MWMP Median (2015 - 2021), reported in Gil Mine Geochemistry Report (Table 5)	Scaled from Fort Knox/Gil Tailings Leachate Results as Described in Report	Gil Year 2 + Fort Knox MWMP results, reported in Gil Mine Geochemistry Report (Table 5)	Detoxified Tailings - Manh Choh Master Composite (Air) (2022 Updated Bulk Leach), reported in Manh Choh Geochemical Characterization Report	Detoxified Tailings - Manh Choh Master Composite (Air) (2022 Updated Bulk Leach), reported in Manh Choh Geochemical Characterization Report	Scaled from Fort Knox and Manh Choh Tailings Slurry Filtrate as Described in Report
	Standard	Basis										
pH (s.u.)	6.5 - 8.5	WQS	7.8	10	9.2	9.5	9.2	7.9	7.9	7.7	7.9	9.0
Alkalinity as $CaCO_3$	> 20	AQ(c)	82.5	147	48	55	102	54	54	62	73	56
Aluminum	0.087	AQ(c)	0.070	0.203	0.32	1.89	0.669	0.195	0.069	1.89	0.669	1.9
Ammonia	1.81	AQ(c)	1.47	16.9	NA	0	0	0	0.71	0	0	0
Antimony	0.006	DW	0.0169	0.00645	0	0.021	0.0153	0.00892	0.0065	0.010	0.010	0.019
Arsenic	0.01	DW	0.0372	0.0325	0.021	0.060	0.070	0.434	0.19	1.6	0.70	0.310
Barium	2	DW	0.0373	0.0139	0	0.040	0.0050	0.040	0	0.040	0.0050	0.040
Cadmium	0.00029	AQ(c)	0.000067	0.0043	0	0.00020	0	0.00020	0	0.0030	0	0.00066
Calcium	NA	NA	110	152	5	42.0	4.5	42.0	6.1	42	4.5	42
Chloride	230	AQ(c)	52.6	92.3	0	63.0	45.2	63.0	2.8	63	45.2	63
Chromium	0.1	DW	0	0.0085	0	0	0.0009	0	0	0	0	0
Copper	0.0108	AQ(c)	0.023	0.609	0	0.300	0.0010	0.30	0	0.20	0.17	0.28
WAD-cyanide	0.0052	AQ(c)	0.0137	54.5	0.027	11	0.0060	11	0.053	0.70	0.20	9.3
Fluoride	1	IRR	0.50	0.578	0	0.80	2.0	0.8	0	0	0	0.67
Iron	1	AQ(c)	0.166	1.54	0	1.67	0.612	1.67	0.14	3.1	0.50	1.9
Lead	0.0032	AQ(c)	0.00013	0.000138	0	0.0019	0.0003	0.0019	0	0.027	0.17	0.0060
Magnesium	NA	NA	14.6	0.905	0	0.90	0.30	0.90	0	0.90	0.30	0.90
Manganese	0.2	IRR	0.055	0.012	0	0.0060	0	0.024	0.012	0.020	0.010	0.0083
Mercury	0.00005	HH	0	0.00141	0	0	0	0	0	0	0	0
Nickel	0.062	AQ(c)	0.0342	0.13	0	0.060	0	0.060	0	0.050	0	0.058
Nitrate, as N	10	DW	36.5	100	0	28	1.18	28	0	140	11	46.2
Nitrite, as N	1	DW	1.5	6.93	0.065	1.26	0.060	1.26	0.15	0	0	1.1
Phosphorus	NA	NA	0.015	0.0155	0	0.030	0.030	0.030	0	0.030	0.030	0.030
Potassium	NA	NA	8.71	5.55	1.9	15.8	20	15.8	2.2	15.8	20	15.8
Selenium	0.005	AQ(c)	0.00248	0.00905	0	0.0034	0.00080	0.0034	0	0.030	0.030	0.0077
Silver	0.0047	AQ(a)	0	0.020	0	0	0	0.098	0	0	0	0
Sodium	NA	NA	98.4	143	18	120	84.5	120	24	770	200	226
Sulfate	250	WQS	256	99	8	153	17.7	153	8.4	2300	760	502
Zinc	0.14	AQ(c)	0	0.817	0	0.100	0	0.10	0	0	0	0.084
TDS	500	WQS	780	1091	100	584	280	226	79	4300	1500	1188

Notes:
1. Shaded cells indicate value exceeds Alaska water quality standards.
2. All data are in milligrams per liter (mg/L), unless otherwise noted.
3. For calculating averages, if all results for a location were nondetect, a value of zero was used for modeling. Otherwise, averages were calculating using one-half of the reporting limit for nondetect results.
4. Alaska water quality standards based on ADEC 18 Alaska Administrative Code 70 (amended as of April 13, 2022) and Alaska Water Quality Criteria Manual for Toxic and other Deleterious Organic and Inorganic Substances (ADEC 2022). Value shown is the lowest standard of drinking water, irrigation, stock water, aquatic, or human health standards.
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IRR = irrigation standard
MWMP = Meteoric Water Mobility Procedure
MWMP = Meteoric Water Mobility Procedure
NA = not available or not applicable
NADP = National Atmospheric Deposition Program
s.u. = standard unit
TDS = total dissolved solids
TSF = tailings storage facility
WAD = weak-acid dissociable

Reference:

ADEC. 2022. Alaska Water Quality Criteria Manual for Toxic and other Deleterious Organic and Inorganic Substances. September 8.

Table 9
2023 Closure Pit Lake Water Chemistry Predictions (Base Case Model)
Fairbanks Gold Mining, Inc.
Fort Knox Mine
Fairbanks, Alaska

ARCADIS

		Date	1/1/2025	1/1/2029	1/1/2030	1/1/2033	1/1/2044	1/1/2064	11/20/2080	11/20/2100
		Years of Pit Lake Filling	1	5	6	9	20	40	57	77
		Pit Lake Elevation (feet)	669	821	838	920	1103	1296	1430	1533
Parameter	Alaska Water Quality Standards		1 year of filling	End of Milling and Tailings Addition to Pit (end of 2028)	End of North Decant Pond transfer to pit (end of 2029)	Heap leach pads initial draindown period (1 year of draindown)	20 years of filling	40 Years of Filling	Pit Lake up to Alluvium Spill Point	Pit Lake Approximately 20 Years after Spill to Alluvium
	Standard	Basis								
pH (s.u.)	6.5 - 8.5	WQS	7.94	7.97	8.07	8.14	8.21	8.20	8.19	8.18
Alkalinity as $CaCO_3$	> 20	AQ(c)	63	70.4	88	103	118	114	110	107
Aluminum	0.087	AQ(c)	0.0062	0.0069	0.0086	0.0100	0.0115	0.0111	0.0108	0.0105
Ammonia	1.82	AQ(c)	< 0.05	< 0.05	0.4	1.2	0.7	0.5	0.4	0.3
Antimony	0.006	DW	0.0091	0.0131	0.01305	0.01085	0.00778	0.00683	0.00615	0.00563
Arsenic	0.01	DW	0.2052	0.23634	0.133090	0.070224	0.007128	0.005743	0.007271	0.00852
Barium	2	DW	0.0256	0.0285	0.0283	0.0232	0.01572	0.01222	0.01018	0.00880
Cadmium	0.00029	AQ(c)	0.000249	0.000496	0.000313	0.000401	0.000178	0.000119	0.000103	0.000092
Calcium	NA	NA	32.3	37.6	59.3	63.7	52.1	45.6	40.7	37.1
Chloride	230	AQ(c)	38.6	43.0	40.3	33.9	19.5	14.03	11.06	9.09
Chromium	0.1	DW	< 0.0002	< 0.0002	0.00027	0.00084	0.00081	0.00068	0.00063	0.00059
Copper	0.0108	AQ(c)	0.08946	0.09209	0.03854	0.03056	0.00332	0.00262	0.00235	0.00216
WAD-cyanide	0.0052	AQ(c)	6.22590	6.11190	3.53910	3.05570	0.15086	0.00246	< 0.001	< 0.001
Fluoride	1	IRR	0.53	0.54	0.50	0.46	0.39	0.37	0.35	0.34
Iron	1	AQ(c)	0.076656	0.099338	0.009372	0.005795	< 0.002	< 0.002	< 0.002	< 0.002
Lead	0.0032	AQ(c)	0.000064	0.000109	0.000072	0.000051	< 0.00002	0.000021	0.000023	0.000025
Magnesium	NA	NA	1.65	2.10	6.33	6.87	6.46	6.00	5.46	5.03
Manganese	0.2	IRR	0.02	0.01	0.05	0.05	0.02	0.0017	0.0009	0.00059
Mercury	0.00005	HH	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	0.062	AQ(c)	0.0383	0.0414	0.0347	0.0316	0.0191	0.0114	0.0103	0.0096
Nitrate, as N	10	DW	22.8	34.0	31.1	28.2	15.6	11.1	8.9	7.3
Nitrite, as N	1	DW	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Phosphorus	NA	NA	0.024	0.026	0.023	0.021	< 0.02	< 0.02	< 0.02	< 0.02
Potassium	NA	NA	10.67	11.69	9.65	7.57	5.26	4.50	4.14	3.91
Selenium	0.005	AQ(c)	0.00328	0.00574	0.00411	0.00324	0.00183	0.00129	0.00108	< 0.001
Silver	0.0047	AQ(a)	0.03525	0.01070	0.00620	0.00464	0.00214	0.00120	0.00093	0.00075
Sodium	NA	NA	103	166.0	126.6	96.0	57.9	43.7	37.4	33.2
Sulfate	250	WQS	193	390	309	231	148.2	118.3	103.2	91.8
Zinc	0.14	AQ(c)	0.0424	0.0392	0.0222	0.0353	0.0142	0.0105	0.0093	0.0085
TDS	500	WQS	448	734	640	534	378	313	278	253

Notes:

1. Shaded cells indicate value exceeds Alaska water quality standards.
2. All data are in milligrams per liter (mg/L), unless otherwise noted.
3. The basis for Alaska water quality standards are summarized in Tables 8a and 8b.
4. Aquatic standards for cadmium, copper, lead, nickel, silver, and zinc are hardness-based. The estimated calcium and magnesium concentrations in the pit lake at the spill point elevation were used to calculate the hardness value of 124 mg/L as $CaCO_3$.
5. The ammonia standard is based on the estimated pH and temperature of the pit lake. The pH was set equal to 8.19, which is the modeled pH of the pit lake at the spill point elevation. The temperature was assumed to be 10 degrees Celsius, which is the long-term average of pit dewatering well groundwater and the middle of the range observed at the Fresh Water Reservoir.

Acronyms and Abbreviations:

< = calculated value was less than typical laboratory reporting limit; value shown is the typical reporting limit
> = greater than
AC(a) = aquatic standard (acute)
AQ(c) = aquatic standard (chronic)
$CaCO_3$ = calcium carbonate
DW = drinking water standard
HH = human health criteria for noncarcinogens
IRR = irrigation standard
NA = not available or not applicable
s.u. = standard unit
TDS = total dissolved solids
WQS = Water Quality Standard

Table 10
2023 Closure Pit Lake Water Chemistry Predictions (Maximum Groundwater Concentrations)
Fairbanks Gold Mining, Inc.
Fort Knox Mine
Fairbanks, Alaska

		Date	1/1/2025	1/1/2029	1/1/2030	1/1/2033	1/1/2044	1/1/2064	11/20/2080	11/20/2100
		Years of Pit Lake Filling	1	5	6	9	20	40	57	77
		Pit Lake Elevation (feet)	669	821	838	920	1103	1296	1430	1533
Parameter	Alaska Water Quality Standards		1 year of filling	End of Milling and Tailings Addition to Pit (end of 2028)	End of North Decant Pond transfer to pit (end of 2029)	Heap leach pads initial draindown period (1 year of draindown)	20 years of filling	40 Years of Filling	Pit Lake up to Alluvium Spill Point	Pit Lake Approximately 20 Years after Spill to Alluvium
	Standard	Basis								
pH (s.u.)	6.5 - 8.5	WQS	7.94	7.97	8.07	8.14	8.21	8.20	8.19	8.18
Alkalinity as $CaCO_3$	> 20	AQ(c)	63	70.3	88	103	118	113	110	107
Aluminum	0.087	AQ(c)	0.0062	0.0069	0.0086	0.0100	0.0115	0.0111	0.0108	0.0105
Ammonia	1.83	AQ(c)	< 0.05	< 0.05	0.4	1.2	0.7	0.5	0.4	0.3
Antimony	0.006	DW	0.0099	0.0146	0.01465	0.01309	0.01085	0.01028	0.00973	0.00917
Arsenic	0.01	DW	0.2060	0.23765	0.134320	0.071586	0.007457	0.006720	0.008688	0.01024
Barium	2	DW	0.0258	0.0288	0.0287	0.0236	0.01635	0.01294	0.01093	0.00954
Cadmium	0.00031	AQ(c)	0.000249	0.000496	0.000313	0.000401	0.000182	0.000124	0.000107	0.000095
Calcium	NA	NA	32.7	38.3	60.1	64.8	53.7	47.4	42.6	39.0
Chloride	230	AQ(c)	38.9	43.5	40.9	34.7	20.6	15.24	12.31	10.33
Chromium	0.1	DW	0.00265	0.00472	0.00510	0.00762	0.01006	0.01109	0.01141	0.01128
Copper	0.0120	AQ(c)	0.08960	0.09255	0.03901	0.03138	0.00367	0.00294	0.00264	0.00242
WAD-cyanide	0.0052	AQ(c)	6.22580	6.11180	3.53910	3.05590	0.15141	0.00247	< 0.001	< 0.001
Fluoride	1	IRR	0.58	0.63	0.60	0.60	0.57	0.57	0.57	0.55
Iron	1	AQ(c)	0.076958	0.099659	0.009371	0.005788	< 0.002	< 0.002	< 0.002	< 0.002
Lead	0.0037	AQ(c)	0.000121	0.000206	0.000180	0.000201	0.000149	0.000255	0.000337	0.000411
Magnesium	NA	NA	2.37	3.38	7.70	8.79	9.09	8.95	8.51	8.06
Manganese	0.2	IRR	0.02	0.02	0.06	0.06	0.02	0.0039	0.0023	0.00145
Mercury	0.00005	HH	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	0.070	AQ(c)	0.0400	0.0445	0.0380	0.0362	0.0255	0.0175	0.0168	0.0162
Nitrate, as N	10	DW	22.9	34.2	31.3	28.5	16.0	11.6	9.3	7.8
Nitrite, as N	1	DW	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Phosphorus	NA	NA	0.024	0.027	0.024	0.023	< 0.02	< 0.02	< 0.02	< 0.02
Potassium	NA	NA	10.72	11.77	9.73	7.68	5.42	4.68	4.32	4.10
Selenium	0.005	AQ(c)	0.00330	0.00578	0.00415	0.00330	0.00191	0.00139	0.00118	0.00103
Silver	0.0058	AQ(a)	0.03525	0.01070	0.00620	0.00464	0.00214	0.00120	0.00093	0.00075
Sodium	NA	NA	104	167.9	128.6	98.9	61.9	48.2	42.0	37.8
Sulfate	250	WQS	198	399	318	245	166.9	139.4	125.0	113.4
Zinc	0.16	AQ(c)	0.0428	0.0400	0.0229	0.0367	0.0159	0.0121	0.0109	0.0100
TDS	500	WQS	456	748	655	555	407	345	311	286

Notes:

1. Shaded cells indicate value exceeds Alaska water quality standards.
2. All data are in milligrams per liter (mg/L), unless otherwise noted.
3. The basis for Alaska water quality standards are summarized in Tables 8a and 8b.
4. Aquatic standards for cadmium, copper, lead, nickel, silver, and zinc are hardness-based. The estimated calcium and magnesium concentrations in the pit lake at the spill point elevation were used to calculate the hardness value of 141 mg/L as $CaCO_3$.
5. The ammonia standard is based on the estimated pH and temperature of the pit lake. The pH was set equal to 8.19, which is the modeled pH of the pit lake at the spill point elevation. The temperature was assumed to be 10 degrees Celsius, which is the long-term average of pit dewatering well groundwater and the middle of the range observed at the Fresh Water Reservoir.

Acronyms and Abbreviations:

< = calculated value was less than typical laboratory reporting limit; value shown is the typical reporting limit
> = greater than
AC(a) = aquatic standard (acute)
AQ(c) = aquatic standard (chronic)
$CaCO_3$ = calcium carbonate
DW = drinking water standard
HH = human health criteria for noncarcinogens
IRR = irrigation standard
NA = not available or not applicable
s.u. = standard unit
TDS = total dissolved solids
WQS = Water Quality Standard

Table 11
High Precipitation Sensitivity Analysis Results
Fairbanks Gold Mining, Inc.
Fort Knox Mine
Fairbanks, Alaska

ARCADIS

		Date	1/1/2025	1/1/2029	1/1/2030	1/1/2033	1/1/2044	1/1/2064	8/23/2073	8/23/2093
		Years of Pit Lake Filling	1	5	6	9	20	40	50	70
		Pit Lake Elevation (feet)	672	821	844	929	1125	1336	1430	1550
Parameter	Alaska Water Quality Standards		1 year of filling	End of Milling and Tailings Addition to Pit (end of 2028)	End of North Decant Pond transfer to pit (end of 2029)	Heap leach pads initial draindown period (1 year of draindown)	20 years of filling	40 Years of Filling	Pit Lake up to Alluvium Spill Point	Pit Lake Approximately 20 Years after Spill to Alluvium
	Standard	Basis								
pH (s.u.)	6.5 - 8.5	WQS	7.95	7.98	8.08	8.14	8.20	8.18	8.18	8.16
Alkalinity as $CaCO_3$	> 20	AQ(c)	65	71.5	88	103	115	109	107	103
Aluminum	0.087	AQ(c)	0.0064	0.0070	0.0086	0.0100	0.0112	0.0107	0.0105	0.0102
Ammonia	1.86	AQ(c)	< 0.05	< 0.05	0.4	1.1	0.6	0.4	0.4	0.3
Antimony	0.006	DW	0.0089	0.0128	0.01281	0.01057	0.00736	0.00630	0.00586	0.00523
Arsenic	0.01	DW	0.2001	0.23205	0.132950	0.069931	0.008028	0.006677	0.007591	0.00893
Barium	2	DW	0.0252	0.0280	0.0279	0.0226	0.01492	0.01140	0.01014	0.00854
Cadmium	0.00028	AQ(c)	0.000244	0.000486	0.000311	0.000390	0.000168	0.000111	0.000101	0.000088
Calcium	NA	NA	32.2	37.2	58.0	61.8	49.3	42.3	39.2	34.9
Chloride	230	AQ(c)	37.7	42.0	39.5	32.9	18.3	12.90	11.08	8.80
Chromium	0.1	DW	< 0.0002	< 0.0002	0.00027	0.00081	0.00076	0.00063	0.00059	0.00054
Copper	0.0104	AQ(c)	0.08766	0.08969	0.03839	0.02895	0.00316	0.00244	0.00227	0.00205
WAD-cyanide	0.0052	AQ(c)	6.06910	5.96770	3.51310	2.96320	0.14257	0.00245	< 0.001	< 0.001
Fluoride	1	IRR	0.52	0.53	0.50	0.46	0.38	0.35	0.34	0.32
Iron	1	AQ(c)	0.071227	0.090875	0.008981	0.004758	< 0.002	< 0.002	< 0.002	< 0.002
Lead	0.0030	AQ(c)	0.000064	0.000109	0.000073	0.000051	< 0.00002	0.000020	0.000021	0.000022
Magnesium	NA	NA	1.72	2.13	6.19	6.67	6.11	5.54	5.19	4.68
Manganese	0.2	IRR	0.02	0.01	0.05	0.05	0.02	0.0016	0.0010	0.00063
Mercury	0.00005	HH	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	0.060	AQ(c)	0.0378	0.0410	0.0345	0.0312	0.0187	0.0113	0.0106	0.0099
Nitrate, as N	10	DW	22.3	33.2	30.5	27.3	14.7	10.3	8.9	7.1
Nitrite, as N	1	DW	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Phosphorus	NA	NA	0.024	0.026	0.023	0.022	< 0.02	< 0.02	< 0.02	< 0.02
Potassium	NA	NA	10.60	11.59	9.64	7.56	5.23	4.46	4.24	3.97
Selenium	0.005	AQ(c)	0.00321	0.00562	0.00406	0.00317	0.00174	0.00120	0.00107	< 0.001
Silver	0.0044	AQ(a)	0.03436	0.01077	0.00635	0.00467	0.00209	0.00115	0.00097	0.00076
Sodium	NA	NA	101	162.5	124.9	94.1	55.5	41.4	37.4	32.5
Sulfate	250	WQS	188	381	304	225	139.2	107.9	98.1	84.6
Zinc	0.14	AQ(c)	0.0412	0.0383	0.0222	0.0345	0.0136	0.0099	0.0092	0.0082
TDS	500	WQS	440	720	631	522	359	292	269	239

Notes:

1. Shaded cells indicate value exceeds Alaska water quality standards.
2. All data are in milligrams per liter (mg/L), unless otherwise noted.
3. The basis for Alaska water quality standards are summarized in Tables 8a and 8b.
4. Aquatic standards for cadmium, copper, lead, nickel, silver, and zinc are hardness-based. The estimated calcium and magnesium concentrations in the pit lake at the spill point elevation were used to calculate the hardness value of 115 mg/L as $CaCO_3$.
5. The ammonia standard is based on the estimated pH and temperature of the pit lake. The pH was set equal to 8.19, which is the modeled pH of the pit lake at the spill point elevation. The temperature was assumed to be 10 degrees Celsius, which is the long-term average of pit dewatering well groundwater and the middle of the range observed at the Fresh Water Reservoir.

Acronyms and Abbreviations:

< = calculated value was less than typical laboratory reporting limit; value shown is the typical reporting limit
> = greater than
AC(a) = aquatic standard (acute)
AQ(c) = aquatic standard (chronic)
$CaCO_3$ = calcium carbonate
DW = drinking water standard
HH = human health criteria for noncarcinogens
IRR = irrigation standard
NA = not available or not applicable
s.u. = standard unit
TDS = total dissolved solids
WQS = Water Quality Standard

Table 12
Low Precipitation Sensitivity Analysis Results
Fairbanks Gold Mining, Inc.
Fort Knox Mine
Fairbanks, Alaska

ARCADIS

Date			1/1/2025	1/1/2029	1/1/2030	1/1/2033	1/1/2044	1/1/2064	2/24/2091	2/24/2111
Years of Pit Lake Filling			1	5	6	9	20	40	67	87
Pit Lake Elevation (feet)			666	821	832	911	1079	1254	1430	1515
Parameter	Alaska Water Quality Standards		1 year of filling	End of Milling and Tailings Addition to Pit (end of 2028)	End of North Decant Pond transfer to pit (end of 2029)	Heap leach pads initial draindown period (1 year of draindown)	20 years of filling	40 Years of Filling	Pit Lake up to Alluvium Spill Point	Pit Lake Approximately 20 Years after Spill to Alluvium
	Standard	Basis								
pH (s.u.)	6.5 - 8.5	WQS	7.92	7.97	8.07	8.15	8.22	8.21	8.21	8.20
Alkalinity as $CaCO_3$	> 20	AQ(c)	61	69.3	88	104	121	118	115	113
Aluminum	0.087	AQ(c)	0.0060	0.0068	0.0086	0.0101	0.0118	0.0115	0.0112	0.0110
Ammonia	1.78	AQ(c)	< 0.05	< 0.05	0.5	1.2	0.7	0.5	0.4	0.3
Antimony	0.006	DW	0.0092	0.0134	0.01331	0.01114	0.00826	0.00746	0.00658	0.00616
Arsenic	0.01	DW	0.2105	0.24070	0.132980	0.070424	0.006206	0.004742	0.006967	0.00810
Barium	2	DW	0.0261	0.0290	0.0288	0.0238	0.01663	0.01320	0.01027	0.00913
Cadmium	0.00030	AQ(c)	0.000254	0.000507	0.000314	0.000413	0.000188	0.000129	0.000107	0.000098
Calcium	NA	NA	32.5	38.0	60.7	65.7	55.4	49.6	43.0	40.1
Chloride	230	AQ(c)	39.6	44.0	41.1	35.0	20.9	15.40	11.07	9.43
Chromium	0.1	DW	< 0.0002	< 0.0002	0.00027	0.00087	0.00087	0.00075	0.00069	0.00066
Copper	0.0113	AQ(c)	0.09125	0.09458	0.03860	0.03235	0.00351	0.00285	0.00248	0.00233
WAD-cyanide	0.0052	AQ(c)	6.39050	6.26330	3.56100	3.15470	0.16033	0.00248	< 0.001	< 0.001
Fluoride	1	IRR	0.53	0.55	0.51	0.47	0.41	0.39	0.37	0.36
Iron	1	AQ(c)	0.082314	0.108580	0.009717	0.007107	< 0.002	< 0.002	< 0.002	< 0.002
Lead	0.0034	AQ(c)	0.000064	0.000110	0.000071	0.000050	0.000020	0.000023	0.000028	0.000030
Magnesium	NA	NA	1.58	2.06	6.49	7.08	6.88	6.54	5.83	5.50
Manganese	0.2	IRR	0.02	0.01	0.05	0.05	0.02	0.0017	0.0007	0.00052
Mercury	0.00005	HH	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	0.065	AQ(c)	0.0387	0.0419	0.0348	0.0319	0.0196	0.0115	0.0099	0.0093
Nitrate, as N	10	DW	23.3	34.7	31.7	29.1	16.7	12.2	8.9	7.6
Nitrite, as N	1	DW	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Phosphorus	NA	NA	0.023	0.026	0.022	0.021	< 0.02	< 0.02	< 0.02	< 0.02
Potassium	NA	NA	10.75	11.79	9.65	7.56	5.29	4.53	4.01	3.83
Selenium	0.005	AQ(c)	0.00335	0.00587	0.00416	0.00331	0.00194	0.00141	0.00110	< 0.001
Silver	0.0051	AQ(a)	0.03618	0.01060	0.00603	0.00460	0.00220	0.00126	0.00089	0.00075
Sodium	NA	NA	106	169.6	128.2	98.0	60.7	46.5	37.5	34.0
Sulfate	250	WQS	198	399	314	237	158.6	130.9	110.6	101.5
Zinc	0.15	AQ(c)	0.0436	0.0402	0.0222	0.0361	0.0149	0.0112	0.0096	0.0089
TDS	500	WQS	456	749	650	547	399	338	291	271

Notes:

1. Shaded cells indicate value exceeds Alaska water quality standards.
2. All data are in milligrams per liter (mg/L), unless otherwise noted.
3. The basis for Alaska water quality standards are summarized in Tables 8a and 8b.
4. Aquatic standards for cadmium, copper, lead, nickel, silver, and zinc are hardness-based. The estimated calcium and magnesium concentrations in the pit lake at the spill point elevation were used to calculate the hardness value of 131 mg/L as $CaCO_3$.
5. The ammonia standard is based on the estimated pH and temperature of the pit lake. The pH was set equal to 8.19, which is the modeled pH of the pit lake at the spill point elevation. The temperature was assumed to be 10 degrees Celsius, which is the long-term average of pit dewatering well groundwater and the middle of the range observed at the Fresh Water Reservoir.

Acronyms and Abbreviations:

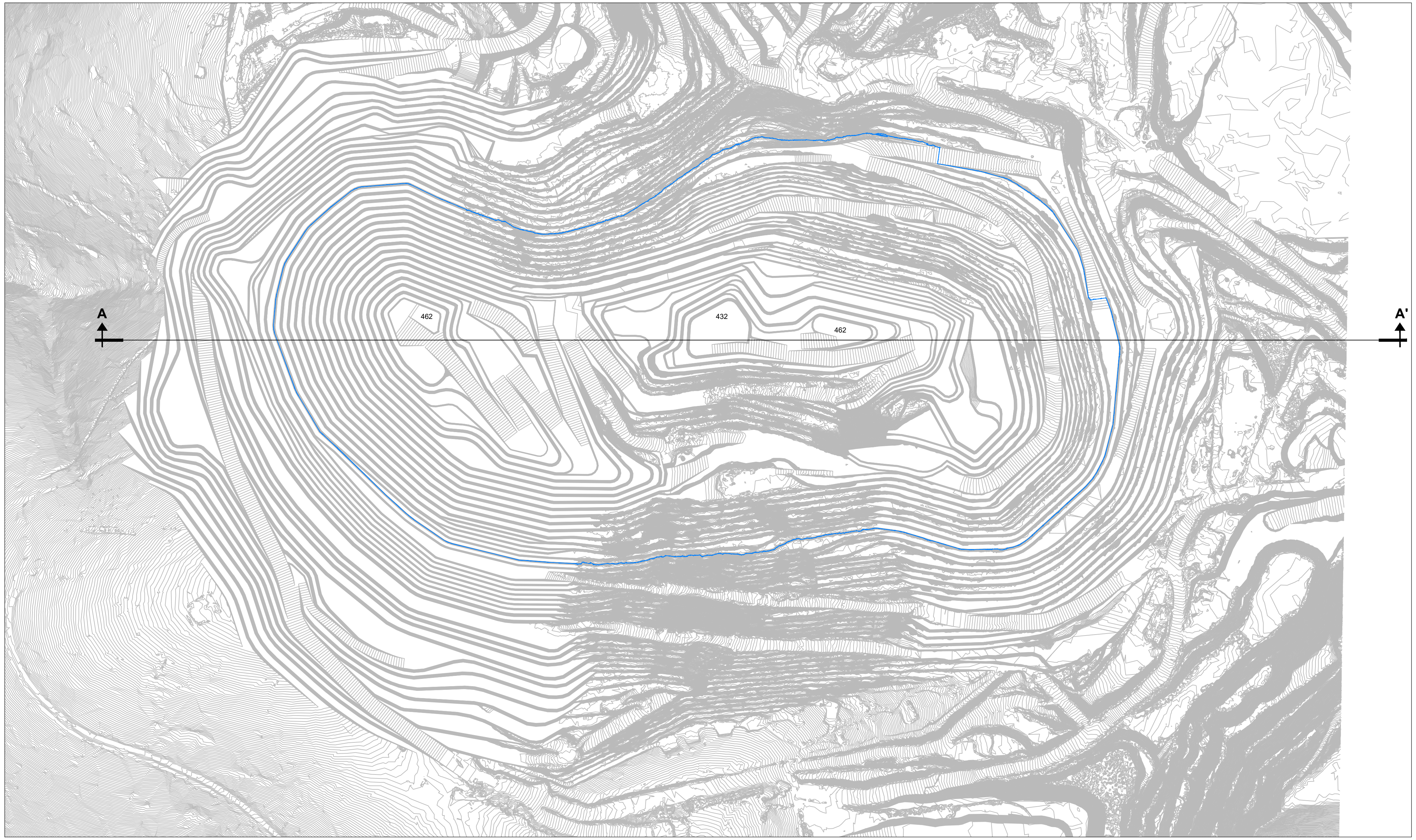
< = calculated value was less than typical laboratory reporting limit; value shown is the typical reporting limit
> = greater than
AC(a) = aquatic standard (acute)
AQ(c) = aquatic standard (chronic)
$CaCO_3$ = calcium carbonate
DW = drinking water standard
HH = human health criteria for noncarcinogens
IRR = irrigation standard
NA = not available or not applicable
s.u. = standard unit
TDS = total dissolved solids
WQS = Water Quality Standard

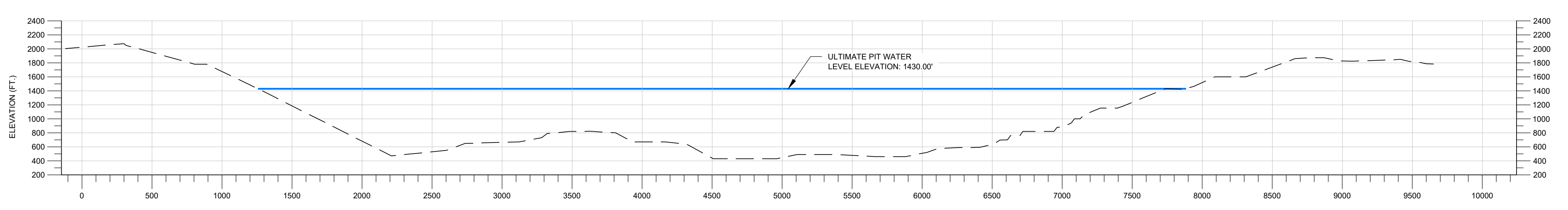
Table 13
Stratification Analyses Summary
Fairbanks Gold Mining, Inc.
Fort Knox Mine
Fairbanks, Alaska

Parameter	Description	Result in 2033	Unit	Indicators for Stratification
Density of pit wall runoff	Uses a temperature of 4 °C and pit wall runoff TDS of 152 mg/L to compute the maximum density of surface inflow.	1000.103	kg/m^3	N/A
Density of mixed operational inflows through 2032	Density of mixed operational water at 10 °C and mixed TDS of 466.5 mg/L to compute the density of the pit lake water in year 2032, when operational flows are no longer directed to the pit lake.	1000.09	kg/m^3	N/A
Density difference	Operational flow density at year 2032 minus pit wall runoff density	-0.0130	kg/m^3	Negative number indicates lighter water at depth, suggesting that the lake will likely turn over in the winter/spring due to the dense cold water from ice formation and cold, spring runoff.
Pit lake depth	Pit lake surface elevation minus pit lake bottom elevation.	476	feet	Relative to most natural lakes, the pit lake is deep (maximum depth of 1,000 feet once completely full). Deeper lakes are more likely to stratify than shallow lakes.
Reservoir length	Based on the pit lake area. Assumed the area was a circle to use average diameter.	3,090	feet	Used to determine thermocline depth and wind mixing.
Relative depth	Ratio of maximum depth to diameter of the reservoir.	15%	%	Smaller relative depths indicate greater influence of wind in disrupting thermal stratification.
Hydraulic residence time	Volume of the pit divided by net inflow rate	10	years	Once operational transfers are complete, the net inflow rate to the pit is very small compared to the total volume of water there, so residence time is long.
Flushing rate	Inverse of hydraulic residence time. Inflow rate to the pit divided by total volume of the pit.	0.11	day^{-1}	If flushing rate is less than 10 day^{-1}, the reservoir may stratify. The result for Fort Knox is very small, so this indicates that stratification is likely.
Storm event flushing rate	Flushing rate of a single storm event. Average inflow rate for a 5-inch, 1-day precipitation event divided by reservoir volume.	0.0065	day^{-1}	If flushing rate is less than 0.5, the storm may not mix the reservoir.
Wind mix depth	The maximum wind mixing depth given surface temperature and wind speed. Assumes no wind mixing during the winter when the lake is covered in ice.	14.8	feet	Lakes with depths greater than the wind mix depth will be likely to stratify.
Froude number	Ratio of inertial to buoyancy forces. The geometry of the system heavily influences this number, as well as the density gradient.	<0.1	unitless	Values less than 1/pi Indicates strong potential for stratification.
Thermocline depth	Thermocline thickness is a function of wind strength and duration, but the calculation used is an empirical estimate relating thermocline thickness to reservoir length.	14.9	feet	Compared to pit lake maximum depth, this number is small, indicating that the lake may stratify.
Wedderburn number	Comparison of density gradient to velocity shear.	0.0016	unitless	Values much less than 1 indicate that wind mixing is likely and low potential for stratification.

Acronyms and Abbreviations:
°C = degree Celsius
kg/m^3 = kilogram per cubic meter
mg/L = milligram per liter
N/A = Not applicable
TDS = total dissolved solids

Figures





CROSS SECTION A-A'

NOT TO SCALE

0 500' 1000'
HORIZONTAL GRAPHIC SCALE

0 1000' 2000'
VERTICAL GRAPHIC SCALE

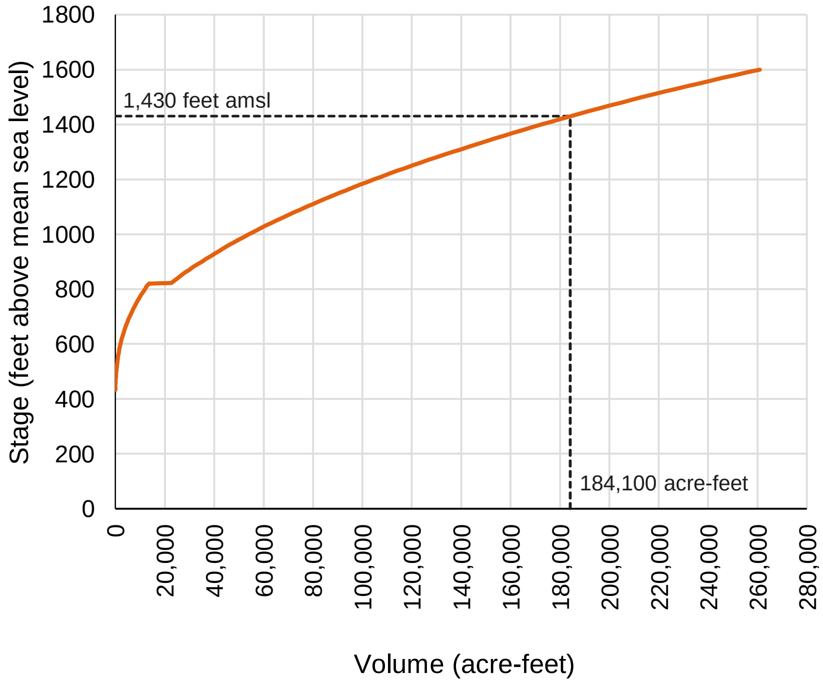
FAIRBANKS GOLD MINING, INC.
FORT KNOX MINE
FAIRBANKS, ALASKA

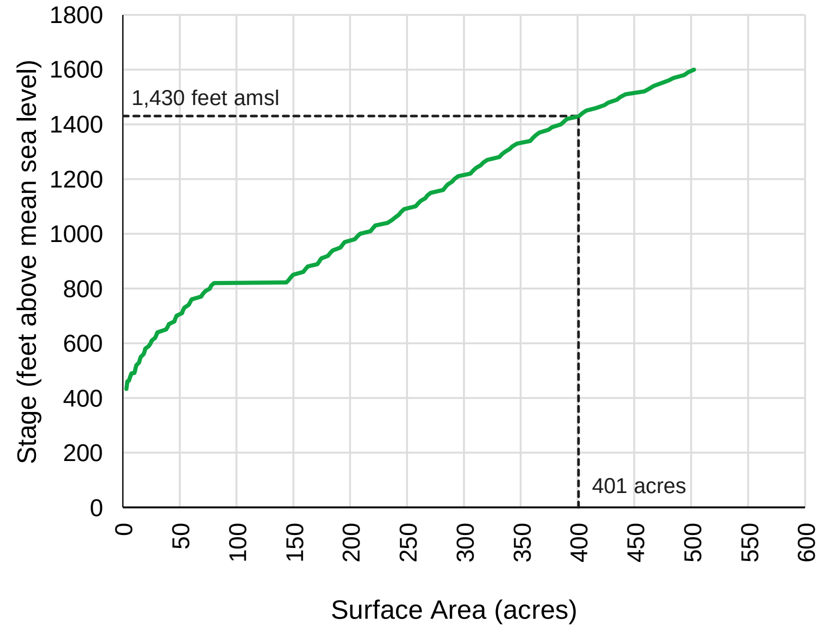
PIT LAKE CROSS SECTION

ARCADIS

FIGURE
1

C:\Users\tfatto\ACCDocs\Arcadis\AUS-FAIRBANKS GOLD MINING INC-FORT KNOX MINE-FAIRBANKS ALASKA Alaska\Project Files\2021\01-In Progress\01-DWG\GEN-PIT LAKE CRS SECT.dwg LAYOUT: 1 SAVED: 8/4/2021 11:44 AM ACADVER: 23.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 8/4/2021 1:14 PM BY: FATTO, TRACEY
XREFS: IMAGES: PROJECTNAME: ----





Legend

Stage-volume curve

Stage-surface area curve

Contact with alluvium

Note:
amsl = above mean sea level

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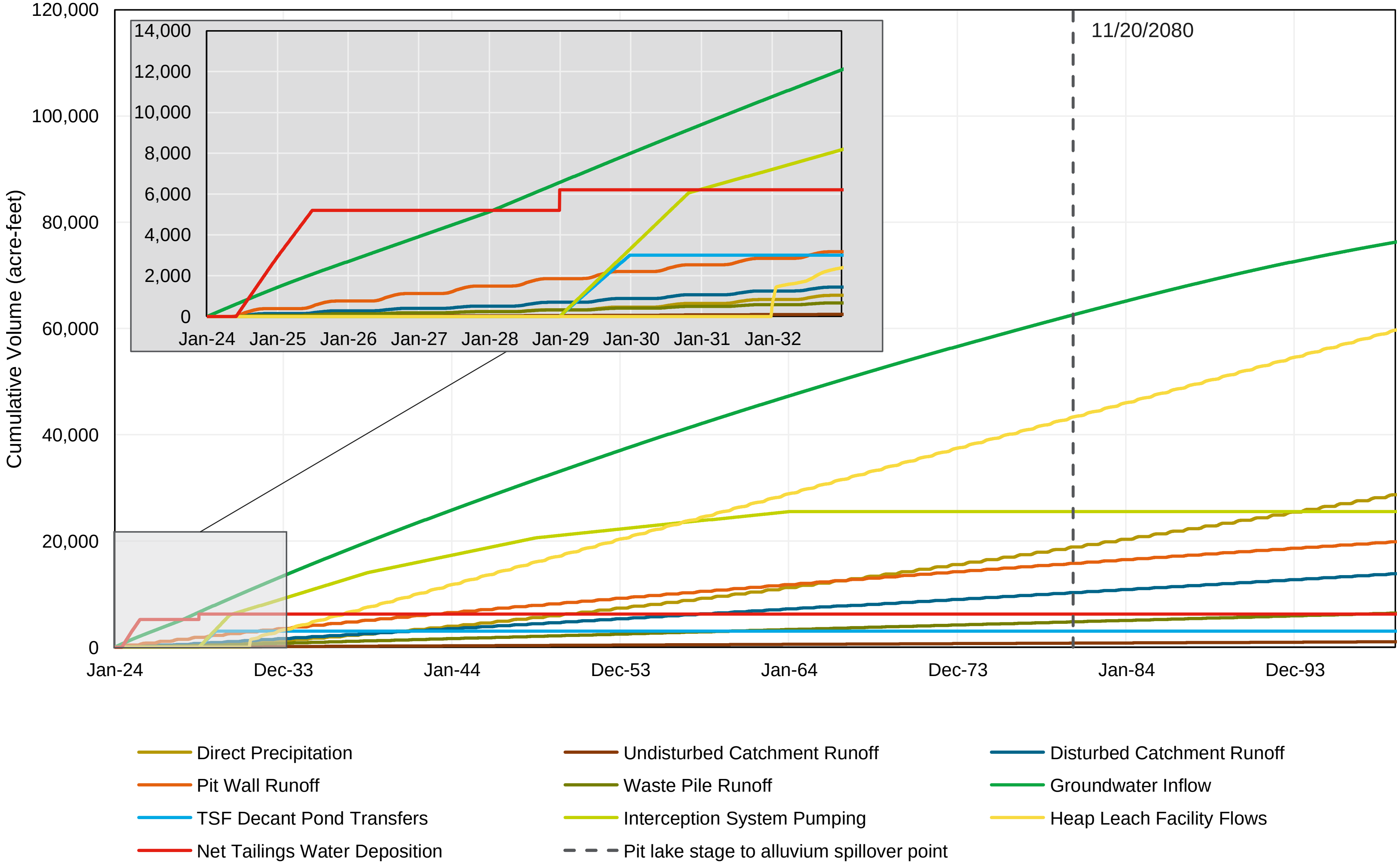
FAIRBANKS, ALASKA

PIT STAGE-VOLUME AND STAGE-SURFACE AREA CURVES

ARCADIS

FIGURE
2



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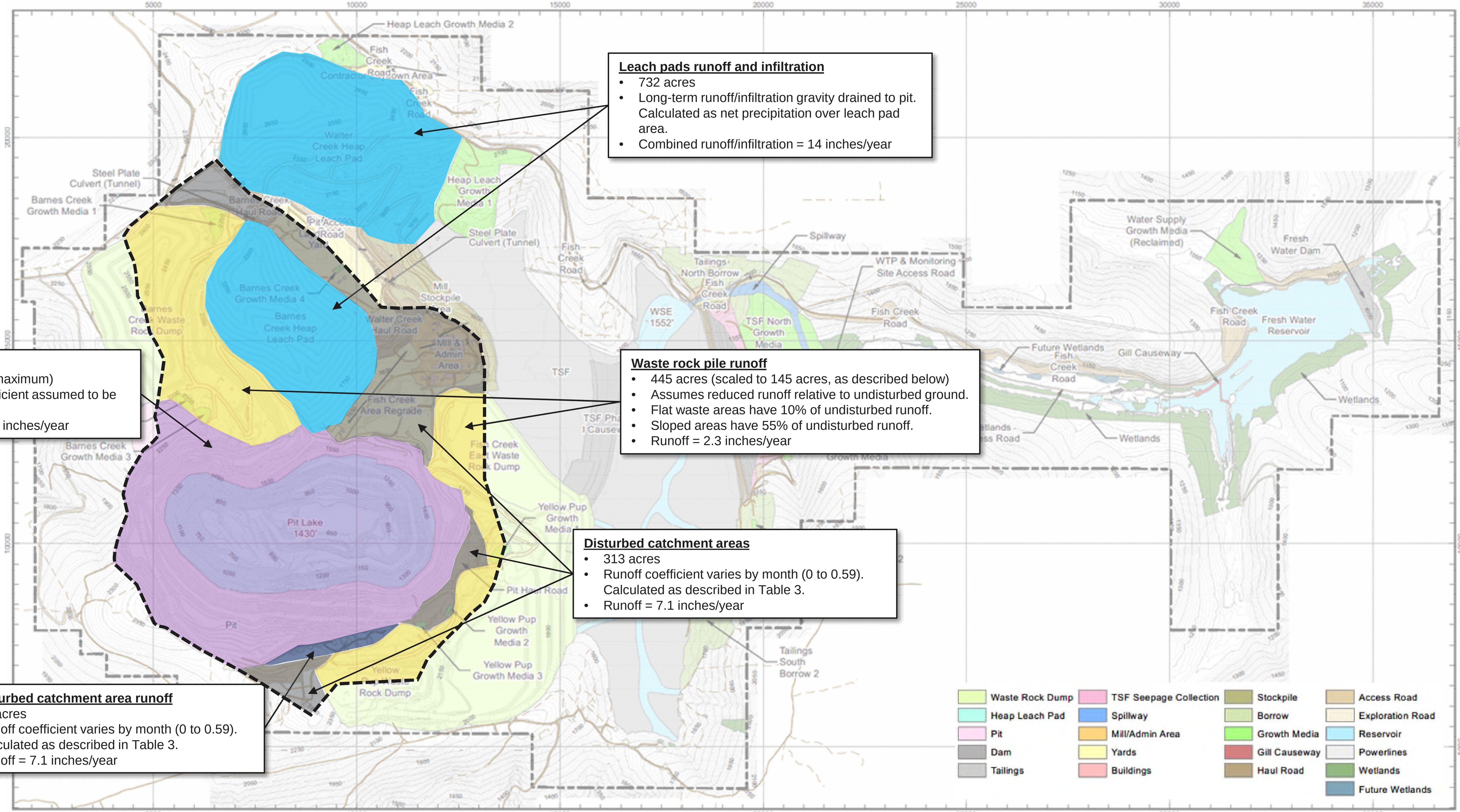
FAIRBANKS, ALASKA

PIT LAKE INFLOWS SUMMARY

ARCADIS

FIGURE
3



Legend

Pit drainage basin

Note:

1. Figure modified from Figure 2-3 of the Fort Knox Mine Reclamation and Closure Plan (Fairbanks Gold Mining, Inc. 2020).

Reference:

Fairbanks Gold Mining, Inc. 2020. Fort Knox Mine Reclamation and Closure Plan. January.

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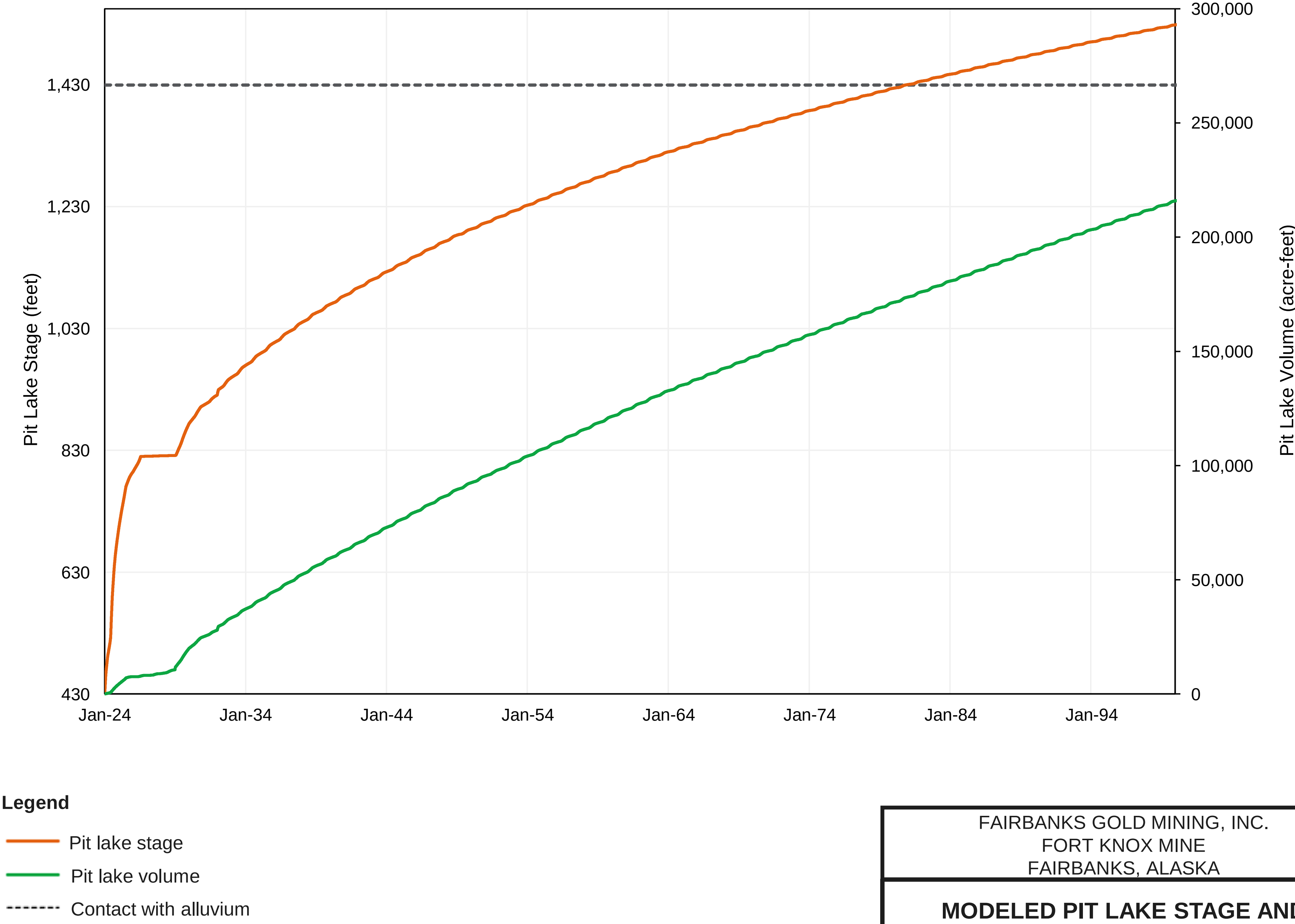
FORT KNOX MINE
FAIRBANKS, ALASKA

PIT LAKE CATCHMENT AREA

ARCADIS

FIGURE
4



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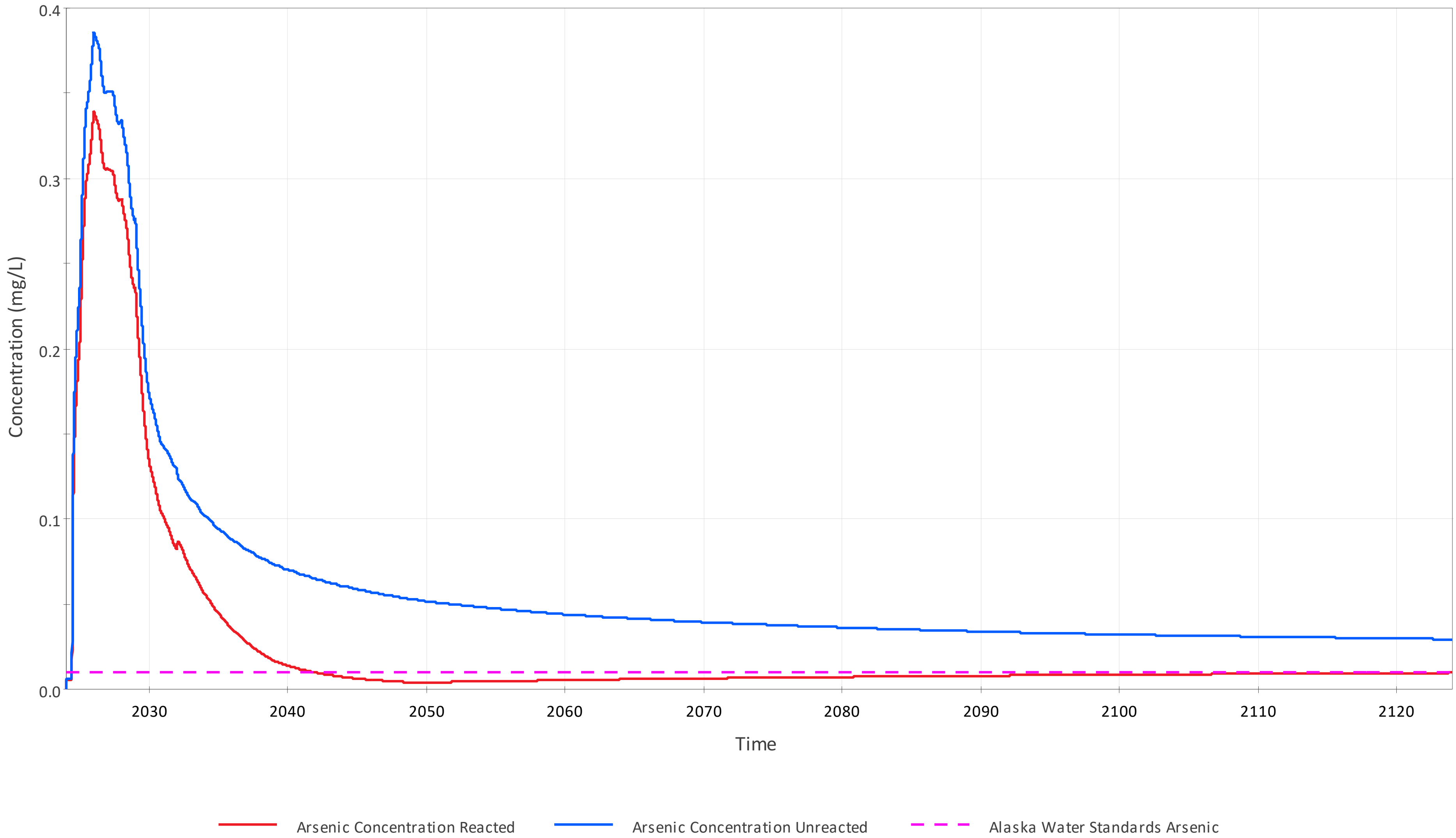
FAIRBANKS, ALASKA

MODELED PIT LAKE STAGE AND VOLUME

ARCADIS

FIGURE
5



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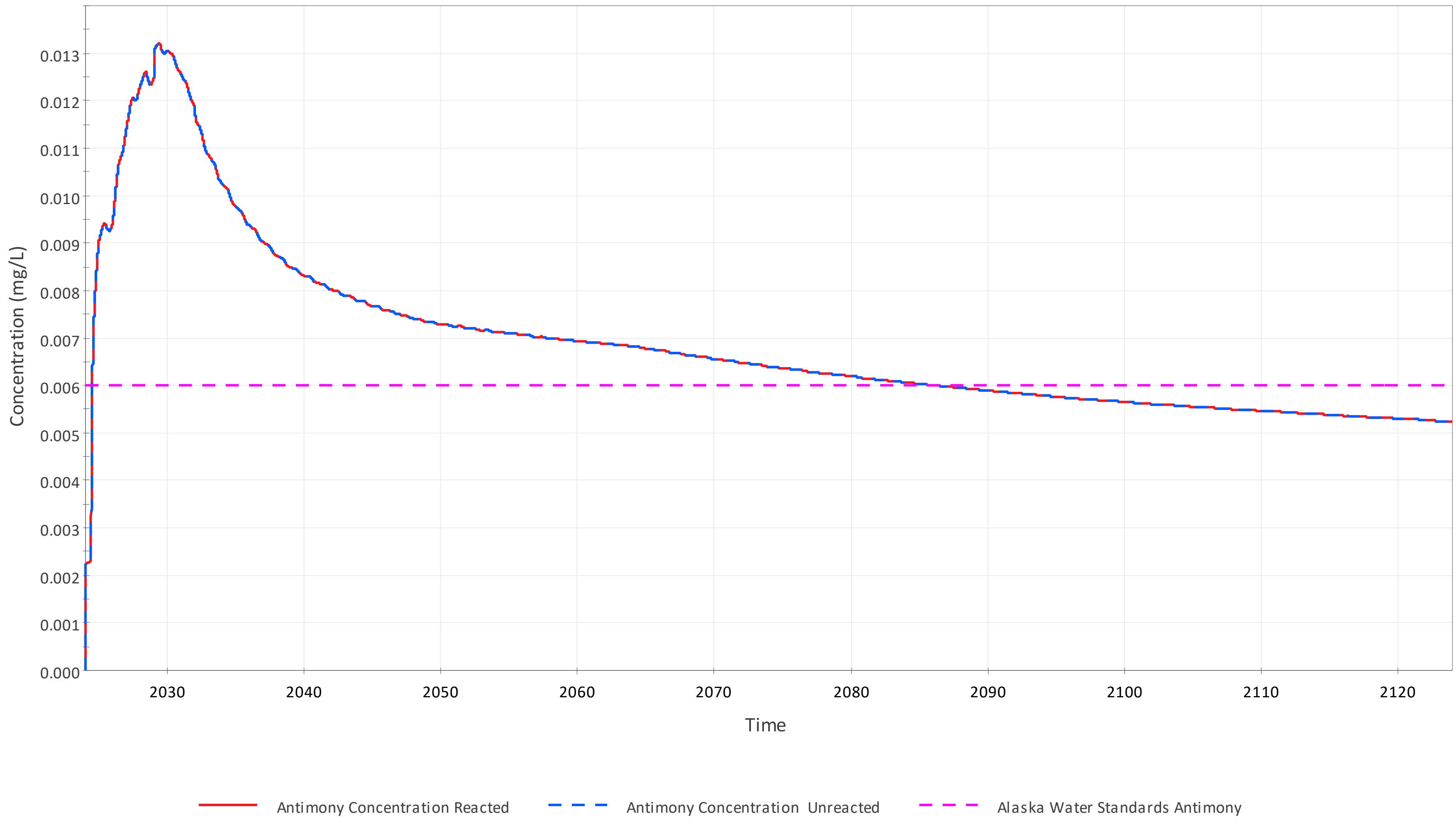
FORT KNOX MINE
FAIRBANKS, ALASKA

PIT LAKE ARSENIC CONCENTRATIONS

ARCADIS

FIGURE
6



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PIT LAKE ANTIMONY CONCENTRATIONS

ARCADIS

FIGURE
7

Appendix A

Pit Area Groundwater Chemistry Data

Appendix A
Pit Area Groundwater Chemistry Data
Fairbanks Gold Mining, Inc.
Fort Knox Mine
Fairbanks, Alaska

ARCADIS

Water Quality Modeling Input Data			Pit Area Groundwater (2019 Update)		Dewatering Wells - Pit Well Sectors (Piteau, 2018)									
					East Pit Granite / Lower East Wall Average	Lower West Wall Average	Monte Cristo Average	North Wall Average	Northeast Wall Average	Northwest Wall Average	South Wall Average	Upper West Wall Granite Average	Upper West Wall Schist Average	West Pit Granite Average
					112 gpm	30 gpm	200 gpm	10 gpm	158 gpm	16 gpm	20 gpm	66 gpm	19 gpm	329 gpm
Parameter	Alaska Water Quality Reference Standards		"RO Feed" from pit dewatering wells (geometric mean, 2016-2019)	Flow-weighted average 2016-2018 dewatering well samples	12%	3%	21%	1%	16%	2%	2%	7%	2%	34%
	Reference Standard	Basis			DW09-226; DW09-233; DW09-234; DW15-372; DW16-389	DW17-446	DW08-196; DW11-268; DW13-322; DW17-430	DW17-430	DW09-211; DW10-237; DW12-298; DW18-453	DW17-416; DW17-420	DW15-360; DW17-449	DW08-200; DW14-354; DW15-375; DW16-383; DW16-408; DW17-421	DW11-276; DW15-357; DW17-445	DW14-345; DW14-356; DW16-381; DW16-388; DW16-390
pH (su)	6.5 - 8.5	WQS	7.8	7.6	7.5	8.1	7.6	7.8	7.6	8.2	7.4	7.8	8.0	7.5
Alkalinity as CaCO3	> 20	AQ(c)	no data	80	83	83	91	83	83	83	83	88	83	70
Aluminum	0.087	AQ(a)	no data	0.016	0.016	0.016	0.015	0.016	0.016	0.016	0.016	0.020	0.015	0.015
Ammonia	1.82	AQ(c)	no data	0.027	0.028	0.028	0.025	0.028	0.028	0.028	0.028	0.035	0.025	0.025
Antimony	0.006	DW	0.0056	0.0060	0.0059	0.0137	0.00029	0.0073	0.013	0.0049	0.00020	0.0085	0.0069	0.0053
Arsenic	0.01	DW	0.021	0.016	0.029	0.018	0.0017	0.0006	0.0083	0.022	0.00036	0.025	0.0051	0.025
Barium	2	DW	no data	0.0034	0.0030	0.0030	0.0015	0.0030	0.0030	0.0030	0.0030	0.0039	0.0015	0.0050
Cadmium	0.00029	AQ(c)	0.000050	0.000050	0.000050	0.000050	0.000050	0.000050	0.000050	0.000050	0.000050	0.000050	0.000050	0.000050
Calcium	NA	NA	no data	33	33	33	27	33	33	33	33	36	31	37
Chloride	230	AQ(c)	0.54	1.4	0.8	1.2	1.0	1.2	4.1	1.2	1.2	0.39	0.80	0.82
Chromium	0.1	DW	0.00026	0.00072	0.00025	0.00025	0.00025	0.00025	0.00025	0.00037	0.00032	0.00025	0.02384	0.00025
Copper	0.0108	AQ(c)	0.00033	0.00035	0.00032	0.00066	0.00020	0.00020	0.00044	0.00058	0.00020	0.00040	0.00068	0.00035
WAD-cyanide	0.0052	AQ(c)	0	0	0	0	0	0	0	0	0	0	0	0
Fluoride	1	IRR	0.35	0.34	0.80	0.60	0.21	0.07	0.08	0.16	0.18	0.30	0.12	0.40
Iron	1	AQ(c)	no data	0.058	0.083	0.083	0.017	0.083	0.083	0.083	0.083	0.105	0.170	0.040
Lead	0.0032	AQ(c)	0.00033	0.0015	0.0005	0.0004	0.0025	0.00010	0.0023	0.00021	0.00024	0.00026	0.019	0.00031
Magnesium	NA	NA	no data	5.3	5.3	5.3	11.9	5.3	5.3	5.3	5.3	4.2	3.4	1.6
Manganese	0.200	IRR	0.014	0.023	0.017	0.020	0.007	0.058	0.065	0.046	0.006	0.017	0.10	0.010
Mercury	0.00005	HH	0	0	0	0	0	0	0	0	0	0	0	0
Nickel	0.062	AQ(c)	0.00085	0.0011	0.00030	0.00035	0.00030	0.0041	0.0030	0.00059	0.00036	0.00033	0.017	0.00030
Nitrate, as N	10	DW	2.3	0.93	0.63	0.63	0.39	0.63	0.63	0.63	0.63	0.30	0.080	1.75
Nitrite, as N	1	DW	no data	0.11	0.070	0.07	0.01	0.07	0.07	0.07	0.07	0.02	0.005	0.25
Phosphorus	NA	NA	no data	0.011	0.011	0.011	0.010	0.011	0.011	0.011	0.011	0.016	0.010	0.010
Potassium	NA	NA	no data	1.0	1.0	1.0	1.4	1.0	1.0	1.0	1.0	0.7	1.1	0.9
Selenium	0.0050	AQ(c)	no data	0.00049	0.00042	0.00042	0.00035	0.00042	0.00042	0.00042	0.00042	0.00033	0.00030	0.00070
Silver	0.0047	AQ(a)	no data	0	0	0	0	0	0	0	0	0	0	0
Sodium	NA	NA	no data	13	10	10	3.2	10	10	10	10	8.4	4.9	23
Sulfate	250	WQS	96	99	146	118	60	51	134	46	78	40	30	109
Zinc	0.14	AQ(c)	0.0025	0.0023	0.0020	0.0014	0.0041	0.0010	0.0019	0.0013	0.0013	0.0012	0.0048	0.0016
TDS	500	WQS	239	247	297	344	171	211	347	166	222	158	123	252

Notes:

Shaded cells indicate value exceeds Alaska water quality standards.

"<" Indicates calculated value was less than typical laboratory reporting limit. Value shown is the trypical reporting limit.

All data are in mg/L, unless otherwise noted.

The basis for Alaska water quality standards are summarized in Tables 8a and 8b.

Aquatic standards for cadmium, copper, lead, nickel, silver, and zinc are hardness-based. The estimated calcium and magnesium concentrations in the pit lake at the spill point elevation were used to calculate the hardness value of 124 mg/L as CaCO3.

The ammonia standard is based on the estimated pH and temperature of the pit lake. The pH was set equal to 8.19, which is the modeled pH of the pit lake at the spil point elevation. The temperature was assumed to be 10 degrees celsius, which is the long-term average of pit dewtaering welll groundwater.

Abbreviations:

-- = not applicable or not available
AC(a) - Aquatic standard (acute)
AQ(c) - Aquatic standard (chronic)
DW - Drinking water standard
HH - Human health criteria for non-carcinogens
IRR – Irrigation standard
NA - not available or not applicable

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