BACK RIVER PROJECT
Responses to Information Requests for Water Licence (2AM-BRP1831) Amendment

November 30, 2020

BACK RIVER PROJECT

Responses to Water Licence Amendment IRs

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1. Responses to Comments

1.1 RESPONSE TO KITIKMEOT INUIT ASSOCIATION

KIA-WLA-IR-01: Winter Ice Road Subbase Upgrade

Detailed Review Comment

Sabina indicates that the proposed WIR Subbase Upgrade footprint of approximately 15 ha combined with the quarry footprints, would remain within the previously assessed WIR area of impact (Local Study Area; WIR Sub-LSA) in the FEIS (83,310 ha) and represent only 0.02% of the WIR Sub-LSA. Sabina has determined that, with the proposed modification of the WIR subbase upgrade, the overall effect of the modification on all VECs/VSECs remains Not Significant.

However, considering that the material placement is most likely required in sensitive areas additional considerations should be made, in accordance with NIRB PC No. 007 Term and Condition No. 34. It is important to note that the KIA had indicated concerns regarding potential use of aggregates to comply with vertical alignment and associated impacts during the review of the FEIS (F-KIA-IR-20).

Recommendation/Request:

Sabina should complete a thermal analysis to illustrate that there are no significant thermal disturbances and associated long-term impacts on the permafrost and surface water flow in the permafrost. In addition, it is also recommended that the proponent provide a closure and monitoring program specifically addressing these new fill sections and additional quarries used.

Sabina Response:

Sabina acknowledges KIA's comment and clarifies most areas identified where WIR Subbase Upgrade would be completed are dense boulder fields or rocky terrain. In areas over bedrock outcrops, fill will be minimal and only placed to help establish the required grades (e.g., smooth out large undulations, transitions onto steeper slopes). In the bedrock areas, as there is not typically notable massive ice apparent, the long-term potential for permafrost degradation over bedrock is expected to be minimal and thus the majority of WIR Subgrade Upgrade areas are expected to have little long-term effect on the permafrost or surface water flow in said permafrost.

Sabina also confirms that no cutting into the tundra will occur as part of the WIR Subbase Upgrades; this practice would minimize any potential degradation in the few areas that are not in boulder fields or bedrock areas.

Each of the WIR Subbase Upgrade areas will be flown over during the snow free months for aerial inspection. Satellite or drone imagery may be used as part of regular inspections and associated reporting to help track to confirm that larger (i.e., greater than 10 m in extent) negative thermal conditions are not occurring (e.g., such as an increase in ponded water, blocking surface flow paths, or melting of massive ground ice from road disturbance). As rates of degradation would be expected to be slower, should any degradation occur, these minor sections could be monitored and mitigated as needed to limit any potential long-term effects on permafrost.

During the Closure Phase, fill placed in WIR Subbase Upgrade areas will be scarified if required but will otherwise remain intact to ensure preservation of permafrost as removing this material may cause more degradation then leaving in place. While unanticipated, WIR Subbase Upgrade areas that could affect surface flows will also be breached to ensure that no major surface water flow paths are impeded or blocked.

Given the nature of the ground conditions where the majority of fill will be placed, Sabina's existing commitments for monitoring and proposed mitigation, Sabina does not believe that any additional thermal analysis for WIR Subbase Upgrade sections is necessary at this time.

KIA-WLA-IR-02: Back River Winter Ice Road – Winter Ice Road Subbase Upgrade

Detailed Review Comment

Sabina is proposing a modification to the Project by upgrading select WIR sections through the placement of aggregate along key areas of the approximately 160 km alignment. This would include the placement of aggregate over approximately 15 km of the WIR. This length of road represents approximately 9% of the alignment. These upgrades are proposed to be approximately 10 m wide and 1 m thick and would be located in the same general location and orientation as the currently permitted WIR. In total, it is estimated that approximately 150,000 m3 of material will be used for this modification. This geochemically suitable material would be sourced from borrow pits and/or quarries located along the road alignment.

Potential effects of the proposed road upgrades relate to surface hydrology, water quality, archaeology, wildlife, vegetation, and landforms. The Road Management Plan and Borrow Pits and Quarry Management Plan describes mitigation measures, including setbacks from water, geochemical confirmation of material suitability and assessment of archaeological, vegetation, and/or wildlife status.

Additional information will be required to determine project effects and mitigation required for specific VCs. For example, information on the proportion of materials to be derived from various sources may be helpful in determining effects of road upgrades. Eskers may be sources of road fill material, for example, but are also features that provide important refuge habitat for caribou escaping biting flies, travel corridors for various wildlife species, and denning habitat for grizzly bear, Arctic fox, Arctic ground squirrel, and wolves. Permanently increasing the grade elevation of the road may also affect caribou movement patterns and influence surface hydrology to modify nearby ecosystems.

Recommendation/Request:

The KIA requests the following information:

- What percentage of the Special Landforms, including eskers, specifically, would be impacted by road upgrades as a result of quarry or borrow pits? How do these percentages differ from those predicted during the 2015 FEIS?
- What proportion of the WIR (if any) will be suitable for all-season travel after upgrades are completed? If the upgrades permit all-season road use, how will potential impacts to wildlife and vegetation be assessed?
- Please provide information on how the proposed road upgrades will change surface hydrology and existing ecosystems such as adjacent wetlands.
- Will any additional road crossing mitigation be implemented at high priority caribou crossings as a result of road upgrades?
- What percentage of vegetation would be impacted based on direct (footprint) and indirect (surface hydrology) impacts of the project modification?

Sabina Response:

The quarries and borrow sources sites for WIR Subbase Upgrade along the WIR will result in effects to an additional 0.3 ha of esker landforms in the previous assessed WIR Local Study Area (WIR Sub-LSA) in the FEIS (35,113ha). The percentage of esker landforms affected by the borrow sources and quarries in the LSA will not change from values predicted by the FEIS (FEIS Volume 5, Chapter 4, Table 4.1-1), remaining at 1.1% of the WIR Sub-base LSA. Direct effects of the WIR Subbase Upgrade modification to vegetation will increase by 18.9 ha (0.1% of the LSA); this is divided by 3.5 ha for quarry/borrow sources and 15.0 ha to subbase upgrades.

Although caribou and vegetation considerations do not form part of the Nunavut Water Board process Sabina is opting to provide a response to KIA. Sabina confirms that no portion of the WIR will be suitable for all-season road traffic, and that Sabina does not intend to use any portion of the WIR year-around. Sabina clarifies that these discontinuous upgrades along the WIR are not intended to provide a nice smooth, trafficable, continuous surface; the purpose is to fill in gaps in the WIR route to achieve required grades (e.g., smooth out large undulations, or transitions onto steeper slopes). Without the constructed WIR on top of these subbase upgrades, these unconnected sections would be useless by themselves to support any overland travel and serve only to act as a foundation for the WIR to be built on.

Measurable changes to surface hydrology are not expected because the subbase material will be restricted to drier locations on the landscape where the subbase is intended to flatten or reduce the slope of the surrounding topography for the road alignment; the sub-base will not be added to locations where surface flows, including those from ephemeral watercourses, may be impeded; follow-up inspections of the subbase segments and adjacent vegetation and terrain will be completed to determine whether corrective actions are needed to reduce environmental risks from the sub-base placement. Discernible wetlands and watercourses along the road alignment will be avoided to minimize overall impacts to hydrology and existing ecosystems as well as operational constraints. Any minor changes to surface hydrology are not expected to have large-scale indirect affects to the structure and function of adjacent ecosystems. However, inspections of the subbase segments and adjacent vegetation and terrain will be completed to determine whether corrective actions are needed to reduce environmental risks from the sub-base placement.

Although caribou considerations do not form part of the Nunavut Water Board process Sabina is opting to provide a response to KIA. The sections of the WIR Subbase Upgrade proposed along the alignment will include discontinuous fill placed at limited thicknesses that will facilitate caribou movement across the WIR surface. This may eliminate the need for crossing ramps for caribou. However, the Wildlife Mitigation and Monitoring Program Plan (WEMP Plan) already includes mitigation for hard surface roads. This mitigation includes:

- Road crossing structures will be built on permanent on-site roads at crossing locations identified by land users.
- Road crossing structures may include ramps, stretches of the road shoulder made of smaller rocks, or other methods identified through TK, land user information, scientific literature, or based on best practice.

KIA-WLA-IR-03: Upgraded WIR summer water and dust management

Detailed Review Comment

As part of the modifications proposed, Sabina proposes discontinuous upgrades to the WIR that represent less than 10% of the total length. These upgrades include the placement of aggregate over approximately 15 km of the WIR. While the upgrade does not change the scope of activities along with WIR nor necessarily introduce new impacts to the aquatic environment, additional clarity is required to ensure that potential impacts are mitigated. Water and dust management of the upgraded sections of the WIR are not discussed within the modification package.

Recommendation/Request:

Please clarify how runoff will be managed along with upgraded sections of the WIR during freshet when the ice road melts, and during precipitation events when the WIR is not in operation. Sabina to further clarify how the potential generation of dust from the upgraded portions of the WIR will be managed when the WIR is not in operation.

The requested clarifications should specifically address the concern that these upgraded sections of the WIR are not easily accessible by land during the summer months.

Sabina Response:

Sabina does not anticipate any impacts to the nearby aquatic environment due to runoff from the WIR sub-base upgrades. As is the case with all Project all-weather roads and rock fill pads, only geochemically suitable rock and borrow material will be used for these upgrades, based on the characterization program outlined in the Quarry Management Plan. This ensures the potential impacts to water from road runoff and seepage are minimized. Additionally, areas of sub-base upgrades will be located in areas of undulating rocky terrain where surface flows, including those from ephemeral watercourses, will not be impeded. The WIR will be surveyed annually by helicopter in years of WIR operation and at that time Sabina will survey upgrade sections for any potential drainage concerns including signs of sedimentation or erosion.

Upgraded gravel sections of the WIR will be negligible contributors of fugitive dust emissions. During wintertime, per road dust emissions guidance (ECCC 2020a) any days of sub-zero temperature, snow cover, or precipitation are considered to have zero road dust emissions. During periods where the road is not operating, vehicle induced fugitive road dust generation will not occur. Potential wind generated fugitive erosional dust emissions are considered to be negligible, as the gravelled areas are inactive during the non-frozen period, and wind erosion emissions are considered to be zero during inactive periods per guidance (ECCC 2020b). Wind erosion is also considered to be zero per guidance on any days of sub-zero temperature, snow cover, or precipitation, so the WIR will not contribute wind erosion dust emissions during the frozen period.

References:

ECCC (Environment and Climate Change Canada). 2020a. National Pollutant Release Inventory. Road dust emissions from unpaved surfaces: guide to reporting. Available at: *https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/report/sector-specific-tools-calculate-emissions/road-dust-unpaved-surfaces-guide.html.* Accessed November 2020.

ECCC. 2020b. National Pollutant Release Inventory. Stockpiles and exposed area wind erosion calculator: guide to reporting. Available at: *https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/report/tools-calculating-emissions/stockpiles-exposed-area-wind-erosion-calculator.html).* Accessed November 2020

KIA-WLA-IR-04: Winter Ice Road – Winter Ice Road Service/Emergency Camps

Detailed Review Comment

Sabina is proposing that three permanent WIR camps be installed along the approximately 160-km WIR alignment to replace a mobile camp/emergency shelter. Sabina anticipates that the WIR Service/Emergency Camps will be similar in size and layout to the mobile camp/emergency shelter employed during the 2019 WIR season (approximately 100 m x 100 m each). These camp installations would include a kitchen, sleeping, and office space, communication capabilities, fuel storage in secondary containment berms equipped with rain drain filters, equipment maintenance warming shop, incinerator, spill response equipment, and material and supply storage. These facilities would be placed on aggregate pads of geochemically suitable material. Sabina currently estimates that 20 to 50-person camps would be required. These proposed camp installations are anticipated to represent a total footprint area of approximately 3 ha. Pad material will be sourced from the same WIR quarry and borrow pits identified and assessed for WIR.

Construction of additional WIR camps will have potential direct, indirect, and cumulative impacts. There are now two major camps, with potentially one more, and 3 WIR camps. A total of 5 to 6 camps will result in a substantial human presence across the landscape. Depending on camp locations, human disturbance could have varying impacts on wildlife, vegetation, and water quality. Caribou movement patterns may be adversely affected by camp locations that are placed within known movement corridors. Vegetation and Special Land Features, including those that act as habitat for wildlife denning, may be affected due to direct interactions from camp footprints. Location and proximity of camps may also pose an issue as a bear attractant (especially if the camps are operational just prior to grizzly bears denning or just after grizzly bears emerging from their dens), which may require Sabina to amend management plans with consideration of BearWise recommendations. Additionally, there are potential effects on Freshwater Water Quality related to the discharge of camp greywater, berm water, and pad runoff.

Recommendation/Request:

The KIA requests the following:

- Please confirm the date by which winter ice road service/emergency camps would be erected and operational, and when they would cease operating each year;
- Please confirm whether road service/emergency camps would remain in place permanently for the life of the project, and if so, provide information on the date by which, and how, they would be secured from wildlife access during the period of non-use;
- Please identify locations of proposed WIR camps on maps that show their respective positions in relation to existing caribou habitat (particularly winter habitat and fall and spring migration routes/ice crossings) and potential denning habitat;
- Update management plans to incorporate all prior BearWise recommendations, as the issue of bear attraction will be greater and more spatially dispersed given the proposed change in winter ice road construction plans

Sabina Response:

The WIR service/emergency camps would be erected during the construction of the WIR. The WIR is planned to be constructed starting about December 1st, after the soil active layer has frozen. Following construction, camps will be operated during the period that the WIR is open, from construction starting on about December 1st until the planned closure date of April 15th. Should the camps need to remain operational after April 15th Sabina will issue a notification to relevant parties. This process is inline with the current Winter Ice Road operating timelines.

Although wildlife considerations do not form part of the Nunavut Water Board process Sabina is opting to provide a response to KIA. Camp structures would remain in place for the life of the Project and be opened seasonally during construction and operation of the WIR. Camps will be secured from wildlife access during the period of non-use following standard measures described in the Wildlife Mitigation and Monitoring Program (WMMP) Plan and the Waste Management Plan. Sabina has operated seasonal camps that are safe for wildlife in this area for over 10 years and will effectively manage the camps to limit attraction and injury to wildlife and damage to property. Standard measures include managing attractants such as food and wastes and hardening the camp infrastructure against entry by wildlife, as described in the WMMP Plan and Waste Management Plan.

Although caribou and vegetation considerations do not form part of the Nunavut Water Board process Sabina is opting to provide a response to KIA. Winter habitat for caribou does not overlap with the camps. The Island caribou (Dolphin and Union) winter on both east and west of Bathurst Inlet, but to the north of the Project (Figure KIA-04-A). Both the Bathurst and Beverly/Ahiak winter predominantly near the tree-line, far south of the Project while the WIR is operational (KIA-04-B and C). During spring migration, some animals from the Beverly/Ahiak herd migration through the route of the WIR. Note that the WIR is planned to be closed on April 15 each year prior to the spring migration, to reduce the number of animals that will interact with the operating WIR. To examine movement corridors and camp, Figure KIA-04-D displays the probability of a caribou collar moving through the Project area during spring migration using a Brownian Bridge model. This output produces a probability of observing a caribou moving through a particular part of the landscape with darker shades meaning higher probability a caribou has moved through that area. Figure KIA-04-D also displays the frequency of collared caribou crossing the WIR route during spring migration (black = zero crossings, green = 1 or 2 crossings, yellow = 3-5 crossings, and red is 6-7 crossings for the period 2012-2018. Figure KIA-04-D shows that the majority of caribou that cross the WIR route do so at the southern end of the WIR, near the Goose Site. The three road camps do not overlap with areas of higher movement or road crossing.

Sabina has already committed to updating management plans following prior BearWise recommendations in response to KIA comment #4 on the 2019 annual report to the NIRB:

> *"Sabina will be updating the management plans, including the Waste Management Plan, to incorporate recommendations made following the BearWise survey and report in 2019. Updated plans will be provided to the NIRB as part of the 2020 Annual Report."*

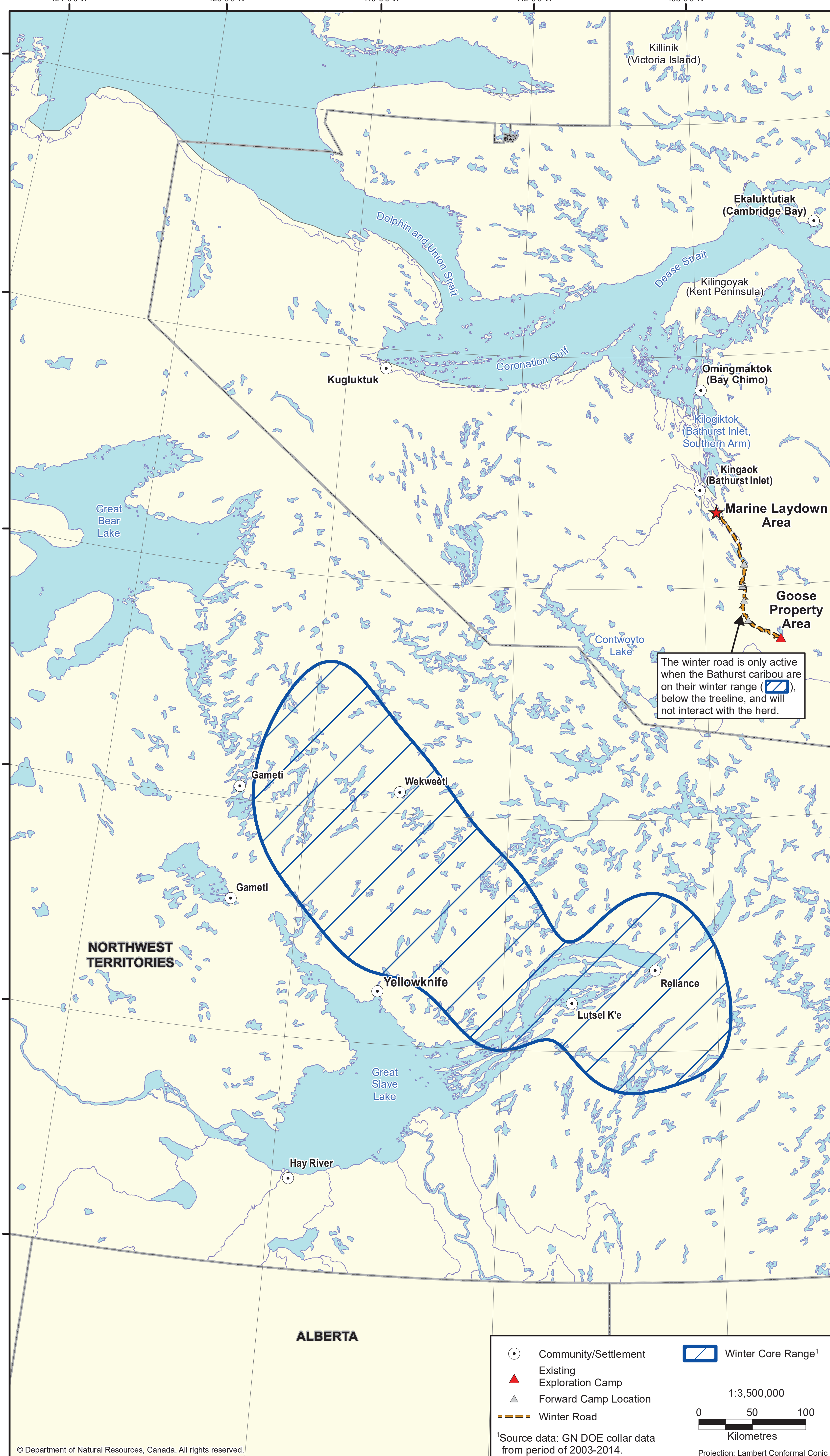


Figure KIA-04a: Winter Range of the Bathurst Caribou Herd and the Winter Ice Road

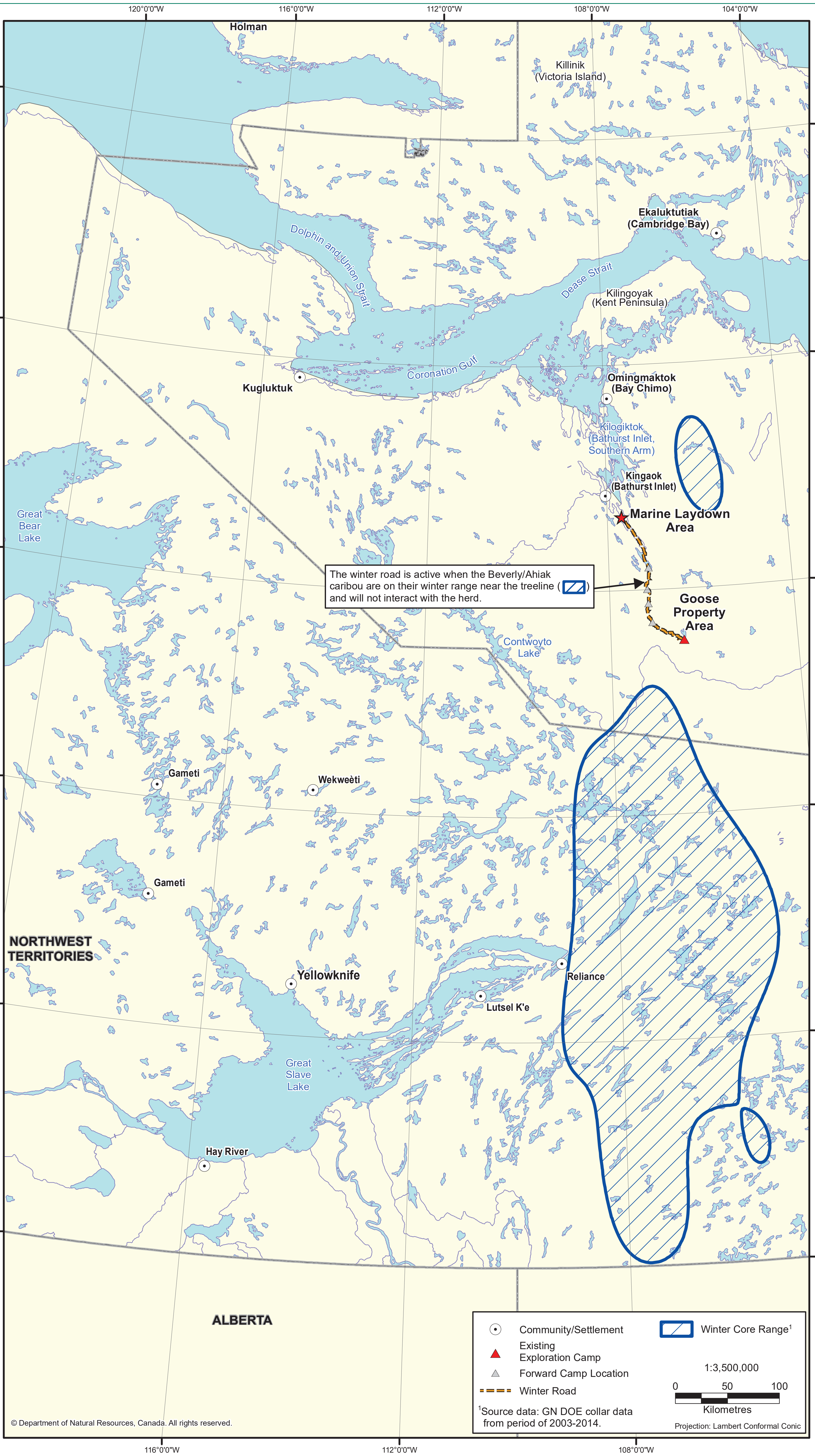


Figure KIA-04b: Winter Range of the Beverly/Ahiak Caribou Herd and the Winter Ice Road

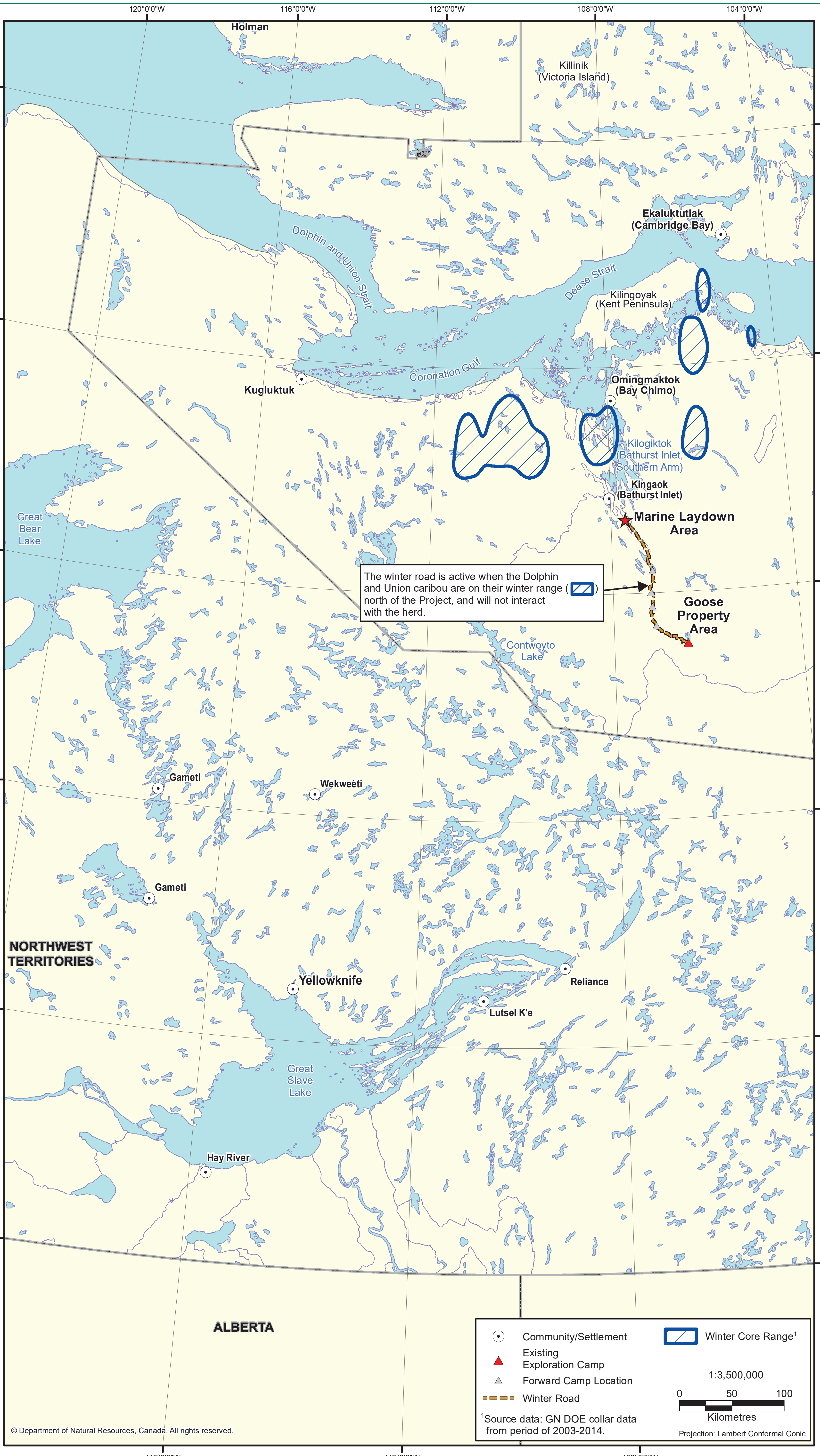


Figure KIA-04c: Winter Range of the Dolphin and Union Caribou Herd and the Winter Ice Road

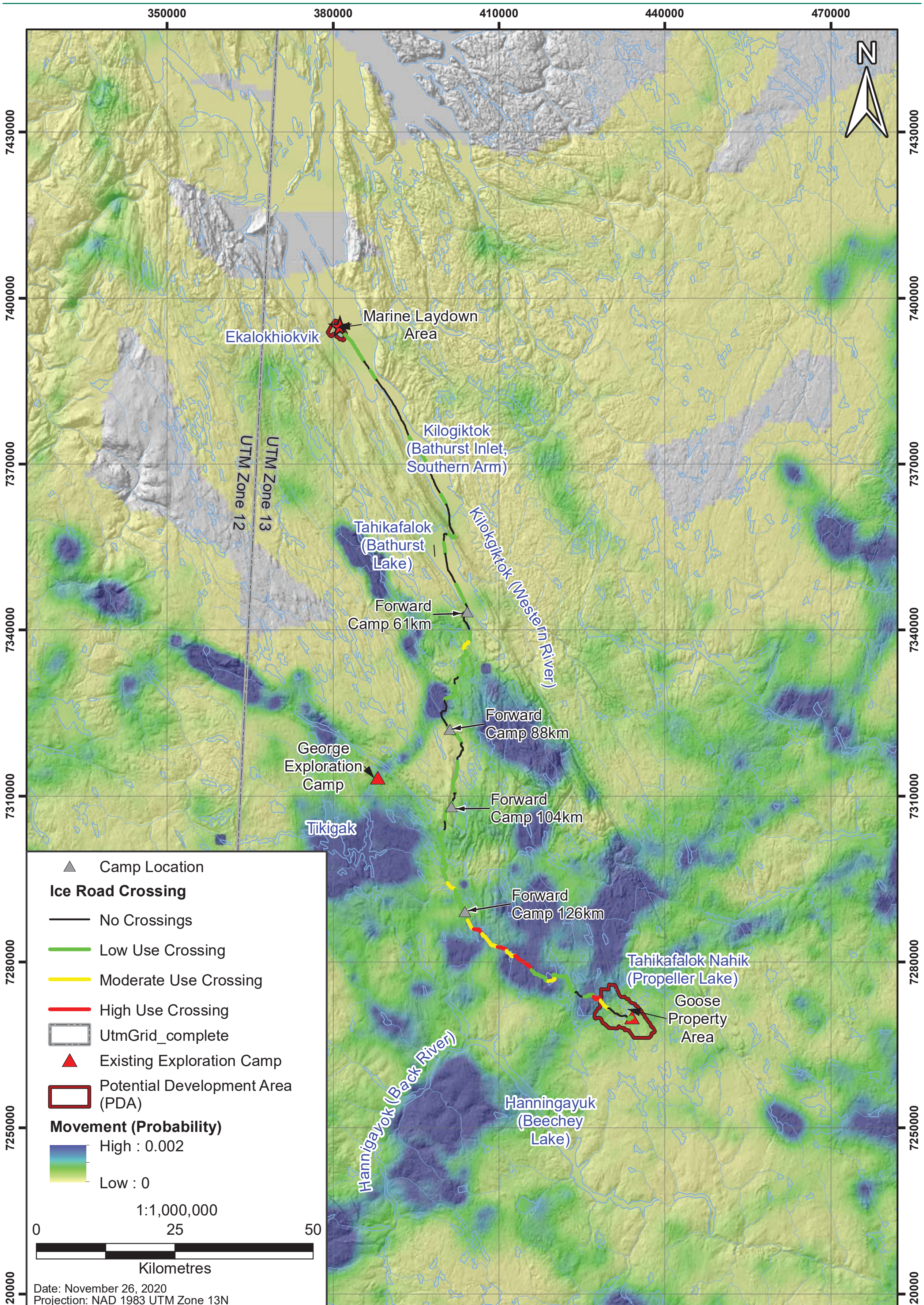


Figure KIA-04d: Movement Paths of Beverly/Ahiak Caribou During Spring Migration and Crossing Frequency of the Winter Ice Road Route

KIA-WLA-IR-05: Winter ice road mitigation

Detailed Review Comment

Section 8.1.8 of the Water Management Plan deals with the topic of stream diversions. Within this section, there is discussion of creating permanent impassable barriers to prevent fish access to upstream areas and avoiding adverse effects to fish in streams that may experience reduced discharge resulting in the potential for increased fish and egg stranding. As a permanent mitigation that eliminates passage in a fish bearing stream is not normally encountered, the KIA is wondering if this is misworded, and whether Sabina will be making an effort to re-establish connectivity after the mine has been de-commissioned.

Recommendation/Request:

The KIA requests/recommends the following:

- Please provide clarification on Sabina's intention for its construction of a barrier to prevent fish access upstream, as discussed in Section 8.1.8. Please clarify if Sabina plans to remove the barrier to fish passage after the mine has been decommissioned.

Sabina Response:

As described in Section 8.1.8 the Water Management Plan, the intention of the proposed barrier at the mouth of Goose Inflow East is to avoid upstream risks from planned mining activities that may affect fish health during Operations and Closure. For the purposes of the *Fisheries Act* Authorization application for the Project, the lengths of fish habitat in Rascal Stream East, Main Goose Pit Stream, Goose Inflow South, and Goose Inflow East were conservatively assumed as permanent habitat loss in the offsetting plan; additional details can be found in the Fish Offsetting Plan. When conditions are suitable for aquatic life during Post-Closure, the barrier may be removed to restore access to upstream spawning and rearing habitats for populations in Goose Lake, such as Arctic Grayling.

KIA-WLA-IR-06: Marine Laydown Area – Shoreline Pad Extension

Detailed Review Comment

Sabina is proposing a modification to the Project by extending the existing shoreline pad into the water to allow vessels to dock directly against it. This modification would extend the pad into the intertidal and shallow subtidal zone to a depth of 1 to 2 m. This extension will result in a sea-floor footprint of approximately 420 m^2 with a lesser above-water area, based on the bathymetry and side slopes of the pad. The anticipated loss of intertidal and subtidal habitat from the MLA Shoreline Pad Extension is approximately 0.04 ha. The MLA Shoreline Pad Extension would be constructed using clean quarried rock fill or concrete blocks placed on geogrid.

Sabina has indicated that the MLA Shoreline Pad Extension could result in direct fish mortality due to crushing or smothering if they are unable to escape the construction area. Mitigation methods proposed include timing construction within specific windows, use of sedimentation curtains, and working with ground-fast ice conditions. Additional mitigation measures should be included to address potential construction-related noise and barometric pressure impacts to fish and marine wildlife.

In-water work could cause short-term disruption and suspension of sediments, influence water quality, could alter fish habitat, and cause direct impacts to fish. Sabina has indicated that in-water blasting is not planned; however, conditions may arise where in-water blasting may be considered or required.

Sabina has indicated that in-water surface area of the MLA Shoreline Pad Extension will also be colonized by benthic invertebrates and algae naturally with no intervention, offsetting some of the lost fish habitat footprint. Habitat offsets should be discussed to determine equivalency ratios that consider habitat type and quality

Recommendation/Request:

The KIA requests the following:

- Please provide assurance that mitigation methods will include use of bubble curtains during relevant work windows, if works such as underwater blasting or pile driving is required. Bubble curtains are important in limiting noise, pressure, and vibration induced mortality to fish and marine wildlife. The KIA understands that such activities are not currently planned, but as Sabina also indicates that they may be required, providing mitigation for such contingencies will help to independently determine whether the amended impact predictions are reasonable.
- Sabina will develop plans for restoration/creation of habitat for fish and benthic invertebrates with DFO that adequately compensate (i.e., offset) for loss of existing habitat. Calculations for proposed offsetting equivalency ratios that consider habitat type and quality should be provided in the amendment application.

Sabina Response:

Sabina is committed to minimize potential effects to fish and fish habitat through the application of relevant Fisheries and Oceans Canada (DFO) mitigation measures and Best Management Practices. This approach may include the use of bubble curtains if the MLA Shoreline Pad Extension were to require underwater blasting or pile driving. However, Sabina reiterates there are currently no plans for underwater blasting or pile driving, neither of which are listed as planned activities within the Modification Package. The construction method and mitigation measures described in the Modification Package (Section 5.1.4 and Section 5.1.6) will result in negligible residual effects that are within the scale of those previously characterized for the MLA. Furthermore, the relatively small footprint of the MLA Shoreline Pad Extension (420 m^2) is not expected to trigger offsetting requirements under the

Fisheries Act as the proposed extension is not a significant modification to the existing shoreline pad. The natural habitat features of the affected shoreline and intertidal zone will be restored to the extent possible upon decommissioning of the shoreline pad in Closure. Sabina's assessment of the shoreline pad extension and commitment to fish habitat protection will be summarized and submitted to DFO for their review through the DFO Request for Review application process.

KIA-WLA-IR-07: Goose Property and MLA Airstrip Extension

Detailed Review Comment

Sabina is proposing a modification to the Project to allow an extension of the already permitted Goose Property all-weather 1,500 m (5,000 ft.) by 45 m (150 ft.) airstrip. Sabina intends to extend the permitted all-weather airstrip to 1,800 m (6,000 ft.) by 60 m (200 ft.), an increase in airstrip dimensions totaling approximately 4 ha, which would allow aircraft of different sizes to land year-round.

Sabina is also proposing a modification to the Project to allow an extension of the already permitted MLA all-weather 900 m (3,000 ft.) by 45 m (150 ft.) airstrip. Sabina intends to extend the permitted all-weather airstrip to 1,500 m (5,000 ft.) by 60 m (200 ft.), an increase in airstrip dimensions totaling approximately 5 ha.

The updated effects assessment (Section 2.1.6) appears to assess only the impacts of the two extended airstrips relating to its construction and the loss of vegetation, archeology, or wildlife values within the newly disturbed footprint. Sabina concludes that because the expanded footprint will be constructed within the area already assessed for potential development (the PDA), no additional residual effects to wildlife are anticipated. The effects assessment does not appear to consider noise and disturbance/habitat avoidance effects that could result if the expanded airstrips allow for larger aircraft to land within the MLA and/or Goose properties.

Aircraft noise and wildlife was an issue discussed extensively at the final EIS hearings. Sporadic and ongoing noise disturbance from aircrafts can result in indirect habitat loss due to the avoidance of overflight and surrounding areas by wildlife and may cause changes in movement patterns near flight paths (e.g., during migration). If the proposed airstrip extensions result in changes in the types of aircraft capable of landing, aircraft frequency, and/or overall numbers of flights, the related effects to wildlife may require re-assessment. Habitat loss in the October 2020 amendment package is still considered to be limited to the project footprint while disturbance due to noise is considered to be limited to the LSA; however, there is little supporting evidence supplied about aircraft use, seasonality, and flight frequency that would eliminate the possibility that indirect habitat loss may be expanded due to avoidance of aircraft beyond the project footprint, or that noise related disturbance may occur along flight paths outside of the LSA. Sufficient information does not appear to be explicitly supplied within the application to allow for an independent evaluation of this mode of potential impact or to determine whether changes to airstrips could alter the geographic extent of impacts to habitat loss (i.e. which include indirect habitat due to avoidance) and noise disturbance for caribou and other wildlife from previous FEIS predictions.

Recommendation/Request:

The KIA requests the following:

- Please provide more information about potential aircraft type/specifications and flight frequencies/seasonality that will be accommodated by larger runways, under likely and worst-case scenarios.
- Please describe why Sabina does not consider that runway extensions could alter predictions made in the FEIS about geographic extent (as captured in Table 1.6-1) to caribou and other wildlife for habitat loss and noise disturbance.
- Similar to aircraft noise reporting undertaken as a commitment to the FEIS, will Sabina keep and supply a log of all aircraft coming and going to/through the project area to be summarized within the annual Wildlife Effects Monitoring Plan reports, including noise models associated with flights, to test

Sabina Response:

Although caribou and vegetation considerations do not form part of the Nunavut Water Board process Sabina is opting to provide a response to KIA. The existing, permitted 5,000-ft by 150-ft airstrip is sufficient for a Hercules or similar sized aircraft. Sabina intends to expand this runway to 6,000 ft by 200 ft. to allow for aircraft of different types to land on the runway. This change would allow for Boeing 737 cargo aircraft to land, as well as increasing the range of smaller aircraft types that can land – e.g., which will increase the types of aircraft used for medivac.

As part of the Project Final Environmental Impact Statement (FEIS 2015), Sabina estimated the type and number of aircraft that would be required to operate the Project. Noise models were conducted to evaluate the intensity (noise level) and area affected by aircraft noise. The proposed larger runways will allow use of larger aircraft common to the Arctic, including Hercules and 737 Cargo aircraft with the objective of reducing the total number of flights to the Project site. Note that Hercules and 737 aircraft are already approved and used on the ice airstrip at the Goose Property periodically over the past 8 years.

Sabina intends to complete additional noise modeling due to the change in aircraft. Sabina is currently evaluating the number, frequency, and type of flights that will service the Goose Property and MLA for input into the model. Anticipated numbers are provided below. Sabina will use these data to evaluate if the change in flight profiles alters the predictions in the FEIS surrounding aircraft disturbance to wildlife. This information will be provided prior to the Goose Airstrip Extension or within the 2020 NIRB Annual Report. The FEIS (Sabina 2016) evaluated the potential for disturbance due to a variety of noise sources, including operations noise (such as vehicles and the mill), blasting in open pits and aircraft. Very conservative noise thresholds were used to model at what distances caribou (and other wildlife) may be disturbed by noise. It was determined that disturbance due to noise would likely be confined to the Local Study Area (LSA; Local extent) because the most modeling results suggested that caribou would not be disturbed beyond the LSA. In addition, the LSA extends 6-15 km from the Project footprint. A review of the literature of caribou zone of influence (ZOI) determined that the vast majority of reported were within 4-6 km. Hence, the extend of this effect was predicted to be within the LSA (Local extent). While a longer runway may allow for larger aircraft, the potential effect of disturbance to caribou is likely to be contained within the LSA.

The Wildlife Mitigation and Monitoring Program (WMMP) Plan already includes monitoring for the number and types of aircraft that visit the Project to be reported in the annual WMMP report (WMMP Plan; Section 7.2.1.9). Sabin will continue to adhere to all wildlife monitoring and mitigation practices associated with aircraft on the Project.

Sabina has provided updated estimated flight information anticipated at both the Goose Property and the MLA below.

Goose Aircraft Flight Summary

- Hercules: 10 -15/year on average
- ATRs: 1-2 times/week on average
- Dash 7/8: 2 times/week on average
- 737: 1 times/week on average
- Helicopter: 1/day (leave and arrive)

MLA Aircraft Flight Summary

- Hercules: 1/year on average
- ATRs: 1/month on average
- Dash 7/8: 1/week on average
- Dornier: 1/week on average
- Helicopter: 1/day (leave and arrive)

KIA-WLA-IR-08: Goose Property - Umwelt Underground Extension

Detailed Review Comment

Sabina anticipates that the change in its mine design and plan included in the October, 2020 application package will result in approximately 450,000 tonnes of additional waste rock (which includes a 46% increase in NPAG).

Recommendation/Request:

As the production of NPAG waste rock will be increasing by 46% based on the updated plans, please clarify the following:

- Will Sabina consider using that additional NPAG for a greater depth of tailings capping on closure? A thicker rock capping, as discussed during the FEIS, would reduce risks of localized failures and provide further assurance that wildlife will not be exposed to post-closure tailings over time.
- Will additional NPAG be used for road enhancements? If so, will it reduce the need for materials to be taken from other features (e.g., eskers), which are valuable wildlife habitat

Sabina Response:

Thermal modelling completed during the Environmental Assessment determined that a 5-m cover of NPAG material on all WRSAs, including the TSF WRSA, would be sufficient to achieve closure objectives. Sabina will monitor the freeze back and permafrost development through the installation of Ground Temperature Cables (GTCs) installed in WRSAs. Should the monitoring data identify that the permafrost is not aggrading into the WRSAs at the rate anticipated, Sabina will implement appropriate adaptive management measures, which could include increasing the thickness of the 5-m NPAG waste rock cover. Table 8-1 of the Waste Rock Management Plan outlines additional contingency strategies associated with the WRSAs.

Sabina would not want to over allocate additional NPAG cover material early in the mine life and risk a potential shortfall/deficiency of cover material later in the Operations.

For the WIR Subbase Upgrades, Sabina intends to use geochemically suitable material that would be sourced from borrow pits and/or quarries located along the WIR road alignment (Modification Package Section 6.1.3). At the MLA and the Goose Property, Sabina intends to use NPAG material sourced from open pits to construct site roads as much as feasible.

KIA-WLA-IR-09: Goose Property - Total Water Use Increase

Detailed Review Comment

The Goose Property Total Water Use Increase proposes that the total freshwater volume authorized in the Type A Water License at the Goose Property be increased to 882,450 m^3/yr. from the previously assessed volume of 518,000 m^3/yr. (FEIS) and currently authorized 468,000 m^3/yr. (Type A Water License). This amounts to a total increase of 414,450 m^3/yr.; of this total volume increase, 218,700 m^3/yr. is requested from Goose Lake and 195,750 m^3/yr. from Big Lake. The proposed increase would reduce water quantity within the Goose Lake and Big Lake drainages in the LSA.

The WIR Total Water Use Increase modification proposes updating the total volume of water authorized in the Type A Water License for WIR construction and operation to 324,000 m3 (2,025 m^3/km) from the currently authorized total volume of 108,000 m^3 (675 m^3/km). The WIR Total Water Use Increase represents an additional water volume of 216,000 m^3 (0.4% of the total identified available water volume) beyond the previously permitted water withdrawal volume of 108,000 m^3 (0.2%). Considering the magnitude of these amendments in water use needs, some information is missing from the October 2020 amendment application that would be useful in independently assessing the impacts of these proposed changes on the biological environment.

First, explicit information on the likely seasonality of water use would help in assessing impacts to fish, waterbirds, and the integrity of winter ice crossings for caribou. Water losses during seasons of particular importance for migration, spawning, rearing and overwintering can have very different impacts to various species. The typical seasons of higher versus lower water needs should be indicated in the application to enable an independent assessment of the life history phases that water use will most likely affect.

Second, climate change projections summarized in the Water Management Plan indicate increases in long-term air temperatures and precipitation; however, it is unclear as to how these projections are incorporated into hydrological models to determine potential impacts to drainage areas and seasonal water volumes in freshwater habitats (e.g., streams, wetlands, and lakes) affected by Project activities. It would be helpful to view hydrological models alongside several feasible climate change projection scenarios. Inuit have observed receding water levels and the loss of local lakes and streams due to shifts in weather and precipitation patterns. These observations indicate potential changes in seasonal ice accumulation, streamflow volume, and other conditions. These changes may result in different conditions than the baseline average and 1 in 20-year dry conditions used in the assessment of surface hydrology (streamflow, lake volumes, and outflows). Projected changes in streamflow at Goose Lake Outflow due to the Project exceed DFO guidelines of a 10% reduction in streamflow; it is unknown if potential climate change effects could exacerbate or buffer against this change.

Recommendation/Request:

The KIA requests/recommends the following:

- Please provide more details on the seasonal predictions for water volume needs and impacts to determine the life history periods of various fish and wildlife that would be impacted by decreases in volumes and flows;
- Please provide details for the assessment of potential Project effects on surface hydrology (stream flows, lake volumes and outflows) with details on the considerations of predicted future climate change scenarios (including the scenarios considered) that were used.

Sabina Response:

The proposed WIR withdrawals and assessed potential effects are based on the Fisheries and Oceans Canada (DFO) protocol for mitigating water withdrawal effects on fish habitat in ice-covered waterbodies in the North (DFO 2010). The calculated volumes also represent negligible risks for spawning habitat loss as per Golder's methods described in FEIS Addendum Appendix V6-6G (Sabina 2017). Sabina is confident that the overall approach for protecting fish and fish habitat from water withdrawals is a conservative approach building on the protections provided by the DFO protocol. Sabina also proposes to use an adaptive management approach for mitigating the potential effects to surface hydrology (fish habitat) under future climate change scenarios. Field verification plans, including water depth measurements and water use monitoring, as recommended in the published Method for Determining Available Winter Water Volumes for Small-Scale Projects in the NWT (MVLWB 2020), will be completed during WIR construction and operation to confirm waterbody suitability for the proposed withdrawals. Sabina confirms that proposed water withdrawals for the WIR, which are anticipated from December to April, will meet all applicable guidelines for the protection of fish and fish habitat.

Goose Lake water withdrawals, and the potential effects to surface hydrology throughout an annual hydrograph, are also assessed for the seasonal withdrawal schedule provided in Appendix C of the 2020 Modification Package. The assessment concluded the surface water hydrology impact classification in the FEIS would not change from the additional 400 m3/day during the months of June to October from Goose Lake and the additional 750 m3/day of year-round water withdrawal from Big Lake, specifically for effects to hydrological indicators (streamflows and lake volumes) at assessed waterbodies. In the previous assessment completed, all hydrological indicators had a low magnitude category for effects and the predicted changes remained within environmental guidelines (DFO 2010, 2013; and FEIS Addendum Appendix V6-6G [Sabina 2017]) for the protection of fish and fish habitat within the Local Study Area boundaries. This assessment conclusion was held for both an average flow scenario and an extreme dry 1-in-20 year condition. To demonstrate low risk to fish habitat at the Goose Lake outflow, Sabina will submit additional information on potential changes to fish habitat from the increased withdrawals in Goose Lake to DFO for their review through the DFO Request for Review application process. Sabina is committed to continue to engage DFO and the KIA in support of a management framework that minimizes risk to fish and fish habitat. In the Water and Load Balance Model (WLBM), the climate change predictions were developed using gridded modeled data, with the cell nearest to the mine chosen for the analysis. Three 30-year intervals (2020s, 2050s, 2080s) were chosen from the forecast data and compared to the baseline climate for the Project site and its noted that 30-year intervals are often used to evaluate changes to climate. For the 2020 Modification Package, Sabina evaluated the climatic change with respect to Project baseline from climate models from the Intergovernmental Panel on Climate Change Assessment Report 1-5. The maximum, of either the median result or the historical trend, was taken as the climate change prediction for each 30-year interval.

References:

DFO (Fisheries and Oceans Canada). 2010. DFO Protocol for Winter Water Withdrawal from Ice-Covered Waterbodies in the Northwest Territories and Nunavut. Prepared June 20, 2010. 3 pp.

DFO. 2013. Framework for Assessing the Ecological Flow Requirements to Support Fisheries in Canada, Science Advisory Report 2013/017, May 2013.

MVLWB (Mackenzie Valley Land and Water Board). 2020. Method for Determining Available Winter Water Volumes for Small-Scale Projects. April 2020.

Sabina. 2017. Final Environmental Impact Statement Addendum. Submitted to Nunavut Impact Review Board. February 2017.

KIA-WLA-IR-10: Temperature and precipitation model predictions

Detailed Review Comment

Sabina notes that "The long-term air temperature and precipitation trends are compared to a baseline set from 1979 – 2005 and provided in Table 5.1-4. These values were input into the Water and Load Balance model and interpolated linearly centered on 2025, 2055, and 2085 for the 2020s, 2050s, and 2080s periods, respectively." It is this reader's understanding that current climate models do not suggest a linear increase in air temperature and precipitation in comparison with historical observations between 1979 – 2005. Further, the Government of Nunavut suggests that "future warming will not be uniform across Nunavut; some areas (for example, Western Nunavut and the High Arctic) could warm much faster than other areas (South Baffin/Davis Strait)". Deviations from the temperature and precipitation predictions incorporated into the water and load balance model may increase interactions with underlying PAG in the WRSA and mobilize additional contaminants into the aquatic environment during the closure and post closure project phases than are currently predicted.

Reference: Climate change in Nunavut. Retrieved November 3, 2020 from www.climatechangenunavut.ca/en/understanding-climate-change/climate-change-nunavut

Recommendation/Request:

Please provide a sensitivity analysis within the water and load balance model to characterize potential impacts to water quality if temperature and precipitation do not increase linearly from the 1979-2005 period over the next 65 years. We recommend this sensitivity analysis evaluate 50% greater warming and precipitation falling as rain than currently incorporated into the water and load balance model.

Sabina Response:

Sabina notes KIA's comments and provides the following clarity. In the Water and Load Balance Model (WLBM) for the 2020 Modification Package, the climate change predictions were developed using gridded modeled data, with the cell nearest to the mine chosen for the analysis. Three 30-year intervals (2020s, 2050s, 2080s) were chosen from the forecast data and compared to the baseline climate for the Project site and its noted that 30-year intervals are often used to evaluate changes to climate. For the 2020 Modification Package, Sabina evaluated the climatic change with respect to Project baseline from climate models from the Intergovernmental Panel on Climate Change Assessment Report 1-5. The maximum, of either the median result or the historical trend, was taken as the climate change prediction for each 30-year interval. The temperature and precipitation increase over baseline are not necessarily linear to the end of the forecast period (i.e., the change between 2020s and 2050s is not the same as the change between 2050s and 2080s.). However, the trend between each interval was assumed to be linear in the WLBM for simplicity. The air temperature in the WLBM is forecast to increase by 5.3°C (from -10.6°C to -5.3°C) and the total precipitation is expected to increase by 16% (from 337 mm to 391 mm) by the 2080s.

KIA-WLA-IR-11: Water quality predictions and defining the mixing zone

Detailed Review Comment

Table 6.1-2 indicates that "Long-term steady state conditions are expected to meet MDMER limits during Operations and Closure at PN04 (Goose Neck), and will meet SSWQOs at PN03 (outlet of Goose Lake)." This modelling appears to suggest that the entirety of Goose Lake will be relied upon for physical mixing of effluent from the site. From our understanding, Goose Lake is fish bearing and water quality within it should be maintained at or below CCME WQOs or SSWQOs as applicable for the protection of aquatic life in that waterbody beyond a 100 m mixing zone. It is also our understanding that PN04 is not along the consolidated flow path from the site but within Goose Lake itself where aquatic life may be encountered and that MDMER limits apply at the end of pipe, not after initial mixing in the receiver. Table 6.1-2 indicates that arsenic, copper and zinc will be above SSWQO/CCME WQG at Goose Neck (PN04) at flooding. We also note that these model outputs are provided using average hydrologic conditions and concentrations are presented as monthly averages. Model outputs use relatively basic pH (8.1) and warm water temperature (15oC). While these conditions are conservative with respect to calculating the applicable ammonia guideline, a relatively basic pH used for modelling purposes may under predict concentrations that are present in effluent.

Recommendation/Request:

We request the following clarifications:

1. Where in Goose Lake will water quality meet a) MDMER effluent limits and b) SSWQO / CCME WQG PAL? Specifically, please define the extent of the mixing zone in Goose Lake. Please define the mixing zone under a) increased and decreased precipitation scenarios (i.e. wet vs dry year scenarios), b) increased warming conditions (i.e. a thickening of the active layer), c) under ice to determine the effect of cryoconcentration on water quality within Goose Lake. Note this scenario should assume 100% solute exclusion.
2. Do the "max" values provided in Appendix D of the Water and Load Balance Report represent maximum average monthly values or maximum values? It is important to understand potential water quality entering Goose Lake under a worse case scenario. We note that these values differ from those presented in Table 6.1-2 in the Water Management Plan.

Sabina Response:

MDMER effluent limits will be met at PN04 and PN05, which are locations immediately upstream of discharges to Goose Lake (i.e., these locations are not in Goose Lake). The locations at which relevant CCME chronic water quality guidelines for aquatic life and site-specific water quality objectives (SSWQOs) will be met in Goose Lake will be proposed based on the results of on-going hydrodynamic modelling and a mixing zone assessment, which will be completed after modelling results are available. As part of the mixing zone assessment, conservative model predictions (e.g., 95th or 99th percentiles of concentrations in the predicted time series) will be used to estimate the upper range of predicted concentrations in the lake, and determine the locations where relevant CCME guidelines and SSWQOs will be met. Using these conservative model predictions will result in a reasonably conservative estimate of the mixing zone. If overly conservative model scenarios are simulated (e.g., more extreme/less frequent events) and result in higher predicted concentrations in Goose Lake, this could potentially result in a larger proposed mixing zone, which is not the goal of the mixing zone assessment. The model does account for cryoconcentration; however, discharge during ice-covered conditions is not anticipated.

"Max" values provided in Appendix D of the Water and Load Balance Report are maximum monthly average concentrations. Table 6.1-2 in the Water Management Plan will be updated with the revised results in the Water and Load Balance Report; this update will be included in the next iteration of the Water Management Plan.

KIA-WLA-IR-12: Updated MDMER deleterious substance list

Detailed Review Comment

Parameter Group Code G addresses "MDMER Deleterious substances" but does not include total ammonia. Un-ionized ammonia as nitrogen is now included in Table 1 of Schedule 4 in MDMER and is associated with a Maximum Authorized Monthly Mean Concentration of 0.50 mg/L expressed as nitrogen, and a Maximum Authorized Concentration in a Grab Sample of 1.00 mg/L expressed as nitrogen.

Recommendation/Request:

Please update parameter group G to include total ammonia as nitrogen as well as pH and water temperature to calculate un-ionized ammonia as nitrogen.

Sabina Response:

Sabina commits to updating the parameter group G to include total ammonia as nitrogen as well as pH and water temperature to calculate un-ionized ammonia as nitrogen; this update will be included in the next iteration of the Water Management Plan.

KIA-WLA-IR-13: Defined Closure Period

Detailed Review Comment

Closure is currently defined as mine year 13 to 20, an 8-year period. However, "Goose Property mine workings and waste rock represent a moderate ARD/ML potential. Low to moderate bulk Neutralizing Potential (NP) contents could result in acidic drainage after a lag time of 14 to 20 years. Interaction with the deposit material and air/water could result in runoff/drainage exhibiting concentrations of arsenic and copper greater than MDMER limits."

Sabina notes that the water management plan "has been designed to minimize exposure time of the mine workings and waste rock to air/water and, wherever possible, to ensure the exposure time is less than the expected lag time." We are concerned that the lag time prior to encountering acid drainage exceeds the closure period; water quality from the site could degrade after the closure period has concluded if the mine plan fails to adequately isolate PAG rock.

Recommendation/Request:

Please clarify why closure has been defined as an eight year period when potential degradation of water quality from the site associated with gradual weathering of PAG rock may be encountered once the closure period has concluded and provide contingencies in the event that ARD is observed after the formal closure period.

Sabina Response:

Sabina acknowledges KIA's comment and provides the following visibility on closure timelines associated with the 2020 Modification Package. The potentially acid generating (PAG) waste rock within the WRSAs, including the TSF WRSA, will be progressively capped using non-potentially acid generating (NPAG) waste rock and overburden sourced from active open pits during Construction and Operations. Placement of waste rock will begin as follows: Umwelt WRSA in Year -2, Llama WRSA in Year 1, and TSF WRSA in Year 3. Information on 2020 Modification Package Project Timeline, including WRSA development and closure, can be found in Appendix E, Figure A-1 of the Water Management Plan.

The Llama and Umwelt WRSAs will be fully constructed and covered with NPAG material by the end of Year 5 such that most of the final reclamation activities can be undertaken progressively before the end of the Operations Phase. The exception is TSF WRSA, which will have the majority of NPAG waste rock cover placed by Year 6, and then waste rock placement will pause until the TSF supernatant is fully reclaimed through the Process Plant in Year 12. The small outstanding portion of NPAG waste rock cover will be placed at the TSF WRSA during Year 12 and 13. Sabina highlights that while PAG material may lead to acidic drainage after a lag time of 14 to 20 years, this lag time is expected to be longer than the amount of time required for the PAG waste rock, which will be covered with at least 5 m of NPAG material, will take to freeze. Sabina will install ground temperature cables (GTCs) in WRSAs during Operations to monitor the aggregation of permafrost into the piles. Sabina will also complete verification seepage monitoring in all WRSA ponds as outlined in Appendix B of the Water Management Plan.

By the end of the Closure Phase (Year 20), the Llama and Umwelt WRSAs will have been fully closed and monitored for 15 years, and most of TSF WRSA will have been closed and monitoring for 14 years, with except of a small area that will have 7 years of monitoring by that time.

Should the above monitoring identify that water quality from the WRSAs would not meet discharge criteria, Sabina would implement contingencies as outlined in Section 8 of the approved Waste Rock Management Plan. The adaptive management measures could include a longer closure period, additional cover material or alternative covers, or additional water treatment.

KIA-WLA-IR-14: Saline water management: additional meromictic lake storage

Detailed Review Comment

A relatively high degree of certainty is required for saline water modelling and management options at the Back River project given discharges of saline water are not possible within the local study area and available storage options may be limited on site. A key management option outlined by Sabina is:

"Management Option/Location: Exhausted open pits (Umwelt, Llama, Goose Main, or other open pits).

Discussion of Applicability: A possible option if the future pit lake could be managed to support meromictic conditions, resisting turnover due to pit lake geometry, and therefore unlikely to result in a discharge of saline water to local freshwater streams. Currently, Umwelt Pit is expected to be developed as meromictic, but depending on the developing mine plan, all pits could be considered for the possibility of temporary or permanent saline water storage. In-pit tailings disposal in all pits would be prioritized over disposal of saline water. The use of exhausted open pits, along with mined-out underground workings, provide the most suitable permanent saline water disposal locations; however, the timing of saline water discharges, relative to the availability of either as permanent storage, may not match."

Sabina's outlined adaptive management option relies on the capacity of future pit lakes to support meromictic conditions. It does not appear Sabina has conducted any preliminary modelling to demonstrate the viability of this storage option. This concern is highlighted by the potential implications of encountering an unexpected fault zone (i.e. an increased permeability zone) which may rapidly increase the volume of saline water requiring management.

Recommendation/Request:

Please provide preliminary modelling or other feasibility assessment (i.e. case studies) to demonstrate whether Llama and Goose Main pits could support meromixis and the conditions under which they could to support evaluation of Sabina's proposed approach to adaptively managing additional saline water on site.

Sabina Response:

The establishment of meromixis is dependent on the ability of the salinity gradient to resist mixing. Meromixis will initially develop in a pit in the spring after ice melt produces a freshwater cap, in addition to any water management structures that may be breached to increase runoff water captured. Subsequent runoff of freshwater will increase the thickness of the freshwater layer. The groundwater is expected to be very saline (similar to seawater) which will create a large density difference between the freshwater cap and the underlying saline layer.

The establishment of meromixis within any exhausted open pit at the Project would follow the same principles: a strong salinity gradient and freshwater cap that resist mixing. Any Project exhausted open pit will have similar favorable geometry for establishing meromixis conditions.

In the mine plan that was approved as part of the Type A Water Licence (2AM-BRP1831) process, meromixis in Llama Pit was presented, technically reviewed, and approved. In Llama Pit, the process is initiated with a large inflow of freshwater (839,700 m^3) and melting ice cover (estimated 1.1 m of ice) from breaching the surrounding Llama water management structures in Year 4. The melting ice and freshwater inflow result in a freshwater cap of approximately 7.5 m over the surface of the reservoir.

In the 2020 Modification Package, Umwelt Reservoir will have a similar ice thickness and similar surface area to Llama Reservoir. Umwelt Reservoir receives approximately 350,000 m^3/year of freshwater from the Primary Pond breach in Year 3. The epilimnion of freshwater at that time will be approximately 3 m thick and will continue to grow in thickness over Operations. The saline water at the Project has a much greater level of salinity (10x higher) when compared to other northerly meromictic pit lakes (Pieters and Lawrence 2014); as such, this increased density between the saline and freshwater is expected to resist mixing.

In regard to the exhausted Goose Main Pit being used for the permanent storage of saline water, the opportunity would not be available until at least Year 9 of Operations. As such, there would be sufficient time to observe and verify the success of meromixis at other flooded pits at the Project to ensure meromixis could be achieved at Goose Main Pit.

KIA-WLA-IR-15: Saline water management: man-made surface containment ponds

Detailed Review Comment

A relatively high degree of certainty is required for saline water modelling and management options at the Back River project given discharges of saline water are not possible within the local study area and available storage options may be limited on site. A key management option outlined by Sabina is:

"Management Option/Location: Man-made surface containment ponds

Discussion of Applicability: Similar to the modified natural containment area, man-made surface containment ponds could be constructed (or a current water management pond could be utilized) to temporarily or permanently store saline groundwater; this would be at a higher (than other options) cost and could increase the footprint of the surface disturbance within the Property. The man-made surface containment ponds would be designed and constructed to avoid additional impacts to fish or fish habitat."

Sabina does not indicate where these proposed man-made surface ponds may be constructed nor provide an estimate as to how much saline water they may hold and for how long storage may be necessary. Construction locations are necessary to evaluate whether the additional storage ponds can be added without expanding the overall project footprint while still avoiding additional impacts to fish or fish habitat. An estimate of the potential storage volume these additional man-made surface ponds may provide is required to determine their capacity to offset the need to implement additional adaptive saline water management options

Recommendation/Request:

Please provide a figure indicating where additional man-made surface ponds may be placed within the LSA to store saline water, and provide an associated water balance and discussion demonstrating how impacts to fish and fish habitat may be avoided. We also request an approximate estimate of the storage volume this management option may provide.

Sabina Response:

Sabina acknowledges KIA's comment and confirms that at this time, the contingency implementation of man-made surface containment ponds for saline water is not anticipated as part of the 2020 Modification Package mine plan.

Sabina reaffirms, as stated in Section 4.2 of the Saline Water Management Plan, that should contingency measures for saline water storage be required (other than those currently captured in the mine plan), Sabina is committed to provide the NWB at least 60 days' notice prior to implementation with the following: water disposal volumes, disposal timing, maximum pit/storage capacity, water quality effects from pit closure, and appropriate mitigation and monitoring plans. This commitment would apply to any man-made surface containment ponds.

It is almost certain that Sabina would have to avoid waters frequented by fish should additional ponds be required. If waters frequented by fish cannot be avoided the appropriate DFO or ECCC processes would have to be followed.

KIA-WLA-IR-16: Saline water management: Transport and disposal to Bathurst Inlet

Detailed Review Comment

A relatively high degree of certainty is required for saline water modelling and management options at the Back River project given discharges of saline water are not possible within the local study area and available storage options may be limited on site. A key management option outlined by Sabina is:

"Management Option/Location: Transport and disposal to Bathurst Inlet

Discussion of Applicability: Should on-site storage volumes be insufficient, saline water, or high salt brine from reverse osmosis treatment, could be transported to Bathurst Inlet and discharged via a diffuser. Should this option be required it is noted that significant additional regulatory requirements (including MDMER) may be required."

We agree with Sabina's assessment that additional regulatory approval would be required to implement this management option. We require clarification as to whether Sabina will be able to identify the need to implement the proposed management option and secure the necessary regulatory approvals in time to avoid running out of storage capacity on site.

Recommendation/Request:

Please clarify how Sabina will determine the need to transport and discharge saline water or high salt brine to Bathurst Inlet with sufficient lead time to secure the necessary regulatory approval.

Sabina Response:

As a part of regular operations, Sabina will monitor water quality and quantity at the Project. Should this monitoring suggest that the planned saline water storage at the Project site would be insufficient to meet the projected future requirements, Sabina would begin exploring contingencies for saline water management. Sabina highlights that, in Table 4.2-1 of the Saline Water Management Plan, contingencies for saline water management are listed in order of preference, and that many options would be explored and exhausted before the transport and disposal of saline water to Bathurst Inlet was the chosen option. These preferred options include, but are not limited to, temporary and/or permanent storage in dedicated storage facilities [open pits or undergrounds], water treatment at the Project site, and man-made surface management structures. The movement of saline groundwater from the Goose Property to the Bathurst Inlet would be an extremely expensive and a logistically challenging initiative. As such is highly unlikely this would occur.

KIA-WLA-IR-17: Background water quality inputs to water and load balance model

Detailed Review Comment

Sabina notes that "water quality median values for the Goose Lake outlet were used as inputs in the load balance model. The freshet values were applied for April through June and the open water season values were applied to all other months. Any measurement below the detection limit was taken to be equal to the detection limit."

We applaud Sabina for applying seasonal variation to model inputs. However, we are concerned the application of median water quality values may under predict interactions with mine water quality in Goose Lake.

Recommendation/Request:

Please model water quality in Goose Lake using 75th or 95th percentile water quality as inputs to better characterize the upper bounds of potential water quality impacts to Goose Lake during closure and in the long term.

Sabina Response:

Sabina notes KIA's comment and confirms that the 2020 Modification Package Water and Load Balance Model currently uses the median water quality as inputs. Sabina commits that the future revision of the Water and Load Balance Model will evaluate base case and upper case source terms, including the 75th or 95th percentile for water quality.

1.2 RESPONSE TO CROWN-INDIGNOUS RELATIONS AND NORTHERN AFFAIRS CANADA

CIRNA-WLA-IR-01: Groundwater Inflows Parameters Information

Detailed Review Comment

Section 5.1.3 of the Back River Water Management Plan states that:

Table 5.1-1 provides a summary of estimated annual groundwater inflows at the Goose Property. Linear interpolation was assumed for groundwater flow into Llama open pit during pit flooding, ranging from a maximum of 900 m^3/day to 0 m^3/day (Appendix E).

It is unclear how the refilling calculation has extrapolated groundwater inflow rate with other input values (tailings, climate, direct precipitation etc.) to determine the pit flooding time.

Recommendation/Request:

CIRNAC recommends that the Applicant provide a summary of the input and output parameters as well as the methodology used in the determination of the Llama Pit flooding. Commentary on how the more sensitive variables in the analysis could impact predicted water quantity and quality should also be provided to facilitate more effective technical review of this project component.

Sabina Response:

The Water and Load Balance Model for the 2020 Modification Package used the predicted groundwater inflow when the pit is at maximum extent (i.e., fully mined-out) and completely dewatered. Groundwater inflows are highest (900 m^3/day) when the pit is empty. Groundwater flow into Llama Pit is proportional to the gradient between the water level in the pit and the water table. As the pit floods, the gradient decreases. When the pit is fully flooded, the gradient between the water table elevation and the pit water elevation is close to zero and groundwater inflows are minimal.

The refilling calculation did not extrapolate groundwater inflow rate with other input values (e.g., tailings, climate, direct precipitation), these were based on the hydrology assumptions stated in the Water and Load Balance Report.

The inflows to Llama Pit flooding include: total runoff to the pit, water diverted to the pit, direct precipitation, groundwater inflows, tailings including supernatant water disposed with tailings, and industrial and treated sewage effluent discharge. The outflows from Llama Pit include: evaporation, Llama Pit dewatering to Saline Water Pond or Umwelt Reservoir, and reclaim water for the Process Plant.

The sensitivity of the time to flood the pit was assessed by running the Water and Load Balance Model as a Monte Carlo simulation with 100 realizations and applying a probability distribution to the annual precipitation in any given year to generate results for 5^{th}, 50^{th}, and 95^{th} percentiles. Changes to annual precipitation and freshet timing due to climate change were applied to the Monte Carlo simulation to generate the 5^{th}, 50^{th}, and 95^{th} percentile range of results.

CIRNA-WLA-IR-02: Methodology for Extrapolated Water Quantity and Quality Predictions

Detailed Review Comment

In Section 5.1.3 of the Back River Water Management Plan, it is stated that:

Multiple hypothetical scenarios were modelled to assess the sensitivity of groundwater model predictions to hydraulic conductivity (K) values, the potential presence of fault conduits, Jake sediment K values, and permafrost distribution. The hypothetical scenarios were used to contextualize the overall groundwater model in terms of both quantity and quality of water estimated to report to the mines; as part of the 2020 Modification Package, Sabina reviewed this historic data and applied reasonable engineering judgement to appropriately scale the groundwater quantity and quality inflows to the updated mine plan. Refer to the Hydrogeological Characterization and Modelling Report for the Project (Sabina 2017, Appendix F-5) for additional details on the original modelling.

Predictions of water quantity and quality are highly sensitive to the hydraulic properties and the degree of interconnectivity of the rock mass. Subsequently, the specific properties of the rock mass in the immediate vicinity of the proposed Umwelt Underground Extension should be considered in extrapolating quantity and quality predictions.

Recommendation/Request:

The management of saline water is a key issue for technical review, and the predictions of surface water quality and quantity depend on this groundwater model. CIRNAC recommends that the Applicant provide the methodologies applied, including assumptions and calculations, for the extrapolated water quantity and quality predictions for the Umwelt Underground Extension.

Sabina Response:

The initial groundwater modelling for the Project was completed for the Type A Water Licence Application; this approved mine plan included a 6,000 tonnes per day (tpd) Process Plant. As noted in the 2020 Modification Package, the updated mine plan included a reduced throughput Process Plant of 3,000 tpd. The underground mining rate would be reduced proportionally to the milling rates. Sabina completed an initial scaling exercise for the groundwater modelling to match the 3,000 tpd Process Plant and mining schedule; this initial scaling exercise and approach is documented in the memo “Scaling of 6,000 tpd Feasibility Study Groundwater Numerical Predictions” (JDS 2015).

To revise the quarterly groundwater predictions for the updated mine plan in the 2020 Modification Package, Sabina assumed the volume of groundwater inflow to the individual deposit workings was conservatively the same for both mine plans. The mass of total dissolved solids (TDS) was also maintained in both versions of the Water and Load Balance Model. An example of this scaling approach is outlined below:

Example calculation:

- A mining stage in the approved mine plan is modeled to last 30 days and has an inflow of 5,000 m^3/day with a concentration of 1,000 mg/L.
- The same mining stage for the updated mine plan takes 20 days as opposed to 30 days.
- The total volume of groundwater (5,000 m^3/day* 30 days = 150,000 m^3) is preserved with the updated mine plan flow range increased to 7,500 m^3/day as proportioned over a shorter duration (150,000 m^3/20 days = 7,500 m^3/day).

- The final TDS concentration remains the same, since the total volume of water and total mass of TDS are preserved.

The mine plan for the Umwelt Extension portion, which is the deepest portion of the underground mine (Figure CIRNAC-2-1) is still in final development. For the 2020 Modification Package, an allowance for the saline water inflows was made using the scaling approach described above. Specifically, the highest TDS concentrations were used for the Umwelt Extension area in the mine schedule (i.e., a quarterly inflow volume of 74,376 m^3 at a rate of 808 m^3/day was used for the inflow between Y2Q2 and Y3Q3). A TDS concentration of 59,011 mg/L was used in the 2020 Modification Package Water and Load Balance model.

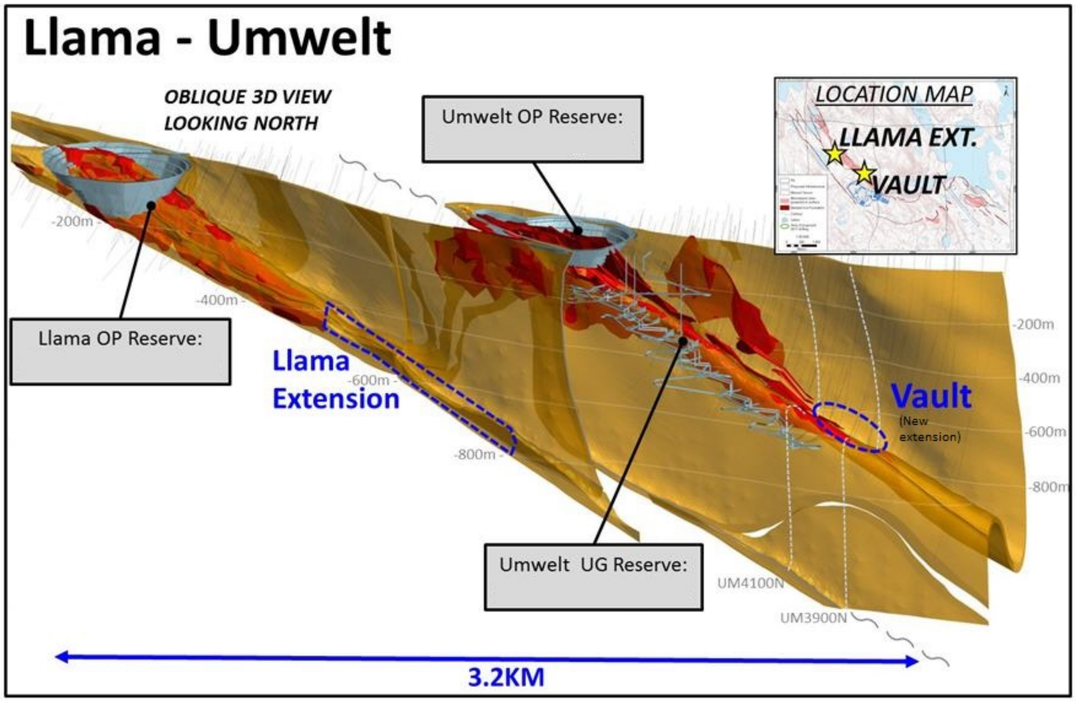


Figure CIRNA-2-1: Oblique long section of the Llama/ Umwelt trend target areas (showing Umwelt Extension or 'Vault')

References:

JDS (JDS Energy & Mining Inc). (2015). Technical Report and Feasibility Study for the Back River Gold Property, Nunavut. October 28, 2015 (Effective Date September 14, 2015).

CIRNA-WLA-IR-03: Unanticipated Groundwater Quantities

Detailed Review Comment

In Section 5.1.3 of the Back River Water Management Plan, it is stated that:

Sabina recognizes that there is a chance that flow in the mines may be dominated by specific fractures or features that are intercepted. This uncertainty exists for all mining projects and is never completely alleviated until structural geology and hydrogeology data is regularly collected from mining operations. The influx of water into a mine is a normal and well understood phenomenon and is regularly managed by standard operating procedures (SOPs) in operating mines.

It is agreed that encountering groundwater in unanticipated quantities is typical in mining projects and that SOPs are used to manage these situations. However, in Canada's north, much of the exploration work done during winter is from drill pads located on frozen lakes. An open exploration hole, when encountered underground, will form a direct connection between the lake and the underground with a corresponding potential for a high flow rate at a high pressure in excess of what would normally be encountered in a natural geological structure.

Recommendation/Request:

CIRNAC recommends that the Applicant provide details of Sabina's SOP used as a contingency in managing groundwater when unanticipated quantities are encountered.

Sabina Response:

Sabina acknowledges CIRNAC's comment and confirms that the while there are exploration holes drilled from frozen lakes at the Project, the location of these holes is very well understood. Sabina maintains an accurate drillhole database and 3-D model of historic exploration drillholes. Sabina will incorporate the locations of these drillholes into the future development of a Standard Operating Procedure used as a contingency in managing unanticipated quantities of groundwater. Table 7-1 of the Saline Water Management Plan outlines additional contingency measures.

CIRNA-WLA-IR-04: Treated Sewage Attenuation

Detailed Review Comment

Section 7.4.3.1 states that treated sewage:

"will be land discharged to maximise attenuation distance prior to entering an outflow watercourse ..."

Attenuation of treated sewage can be complex since multiple different mechanisms occur for different constituents of the treated sewage. A further complicating factor is that the ground is frozen for much of the year, limiting infiltration and attenuation through groundwater flow mechanisms.

It is unclear precisely how the discharge will physically occur, and how the magnitude of attenuation has been determined to meet surface water quality standards requirements at the outflow watercourse or alternative compliance point.

Recommendation/Request:

CIRNAC recommends that the Applicant provide supporting documentation, including applied methodologies, assumptions, and calculations to show that the treated sewage quality will have achieved the required attenuation when meeting a surface watercourse

Sabina Response:

Sabina notes that the discharge of treated sewage effluent to the terrestrial environment (only during Construction and Closure Phases) is not being newly introduced as part of this amendment application and was previously assessed within the NWB approved Project Type A Water Licence. However, as highlighted in Technical Comment No. WT-ECCC-TC-3 of Sabina's Back River Project Type A Water Licence Technical Comment Responses (April 2018), sewage treatment plant effluent was included and accounted for within the Water and Load Balance Model. Sabina confirms there are no changes to concentrations in STP effluent within the updated model and the slightly adjusted discharge location has been accounted for.

CIRNA-WLA-IR-05: Active Layer Groundwater Monitoring

Detailed Review Comment

Section 9.1 of the Water Management Plan states that:

"Pending further direction from the NWB, Sabina is committed to maintain a Water Management Plan designed to the above main objectives. The plan includes monitoring that demonstrates that contact water (runoff and shallow groundwater) from the ore storage and WRSAs is adequately captured and managed consistent with the MWRMP (2AM-BRP1831 Part F, Item 1)".

Monitoring of active layer (shallow groundwater) quality is challenging given the cyclical seasonal freeze-thaw of the layer.

Recommendation/Request:

CIRNAC recommends that the Applicant provide the methodology which will be used to monitor shallow groundwater near mine infrastructure.

Sabina Response:

Sabina provided details associated with shallow groundwater on the Project during the Technical Comment phase of the Type A Water Licence process. In the Final Submission Responses (July 2018), CIRNAC stated that they were satisfied with Sabina's approach to monitoring shallow groundwater flow associated with the TSF (INAC-TRC-6).

The WRSAs and the Ore Stockpile are located on permafrost terrain; seasonally, as a result of the presence of the active layer, there is a shallow perched water table. Sabina has assumed that all WRSA surface contact water will require containment and therefore water management infrastructure has been designed to contain this water (SRK 2020). Runoff containment from the WRSAs is captured in containment ponds; the dam faces of these containment ponds are lined, and keyed into the permafrost to ensure a seal between the permafrost foundation and the water management structure. The Plant Site Pond, which captures runoff from the Ore Stockpile, will also employ this methodology of contact water containment.

Sabina notes the presence of the TSF WRSA diversion berm, which is also keyed into the permafrost, is intended to capture any potential seepage from the TSF WRSA.

There is therefore no opportunity for the perched shallow groundwater from the active layer to impact the environment beyond the existing containments systems. As a result, there is no requirement for additional shallow groundwater monitoring at this time.

As part of regular Project operations, the WRSA diversion and containment structures will be monitored for seepage and runoff monthly, in addition to weekly during freshest (Table 7-1 of Mine Waste Rock Management Plan). Ground Temperature Cables (GTCs) will also be installed in WRSAs to monitor the rate of freeze back and permafrost development within the piles. All water containment dams will be inspected for erosion of, seepage through, or under the structures as a frequency of: (1) prior to freshet; (2) immediately after a major rain event; and (3) weekly for the remainder of the ice-free season. This is in addition to a seep survey conducted annually at all WRSAs and the Ore Stockpile each spring (Table 8.4-1 of Environmental Management and Protection Plan). Monitoring data will be reported to regulators in the Annual Water Licence Report (as per 2AM-BRP1831 Part B, Item 2); should monitoring identify that additional mitigation is required, Sabina will adaptively manage as appropriate to ensure runoff from these areas is properly captured within the Project site water management system.

References:

SRK (SRK Consulting (Canada) Inc.). 2020. Back River Project Water and Load Balance Report. Prepared for Sabina Gold & Silver Corp. REF No. 1CS020.018. June 2020.

CIRNA-WLA-IR-06: Design Criteria for Event Ponds

Detailed Review Comment

Tables 6.2-2 of Section 6.2 (Hydrotechnical Design Criteria) of the October 2020 Back River Water Management Plan (WMP) provide design criteria for event ponds. The criteria specify return periods from 10 to 100-years (depending on consequence), minimum dewatering time of 2 days (by pumping), and storage volume based on a 24- hour total rainfall volume plus snowmelt. In the same table, the storage volume for the Saline Water Pond is given as 1.1 Mm^3 based on the 95th percentile volume from the SRK 2015 Water Balance Report rather than the SRK 2020 Water Balance Report.

The 24-hour design criteria may be insufficient to achieve the performance targets that are expressed as a return period, such as once in 10 years. For example, the runoff volume from a 10-year 48-hour event will be larger than from a 10-year 24-hour event. Design events are rarely limited to an isolated 24-hour window, especially when snowmelt is involved. A pond sized for a 10-year 24-hour event will overflow during 10-year events with longer durations unless sufficient outflow (by pumping) is initiated during the initial 24-hour period. A minimum 2-day, or preferably 3-day, event duration should be considered. SRK's 2020 Water and Load Balance Report states that the Saline Water Pond 95th percentile volume is 1,473,000 m3 about 34% larger than the prior estimate.

Recommendation/Request:

6.1. CIRNAC recommends that the Applicant provide justification for designing the event ponds for a 24-hour duration or, alternatively, increase the duration to a more conservative period for achieving the return period criteria

6.2. CIRNAC also recommends that the Applicant update the 2020 Water Management Plan to incorporate updated information from the 2020 Water and Load Balance Report for the Saline Water Pond and other facilities as applicable

Sabina Response:

As part of the Type A Water Licence (2AM-BRP1831) process, event pond design criteria were presented, technically reviewed, and approved. Sabina previously provided additional details supporting the design of ponds, namely the Primary Pond and Saline Water Pond, in INAC-TRC-3 WTM in June 2018, and WF-INAC-02 in July 2018, which addressed the selection of the 24-hour event pond design duration.

As noted above in previous responses, Sabina acknowledges CIRNAC's concerns with respect to longer duration storm events, and is committed to constructing all containment ponds and dams in accordance with accepted best practice, including the Canadian Dam Association Dam Safety Guidelines which expressly stipulates inflow design flood criteria in accordance with selected dam hazard classifications for each pond or dam in question. These guidelines will inform the final selected inflow design flood, including assessing the requirement for any potential spillways.

The approved event ponds were sized for the 24-hour storm design criteria and conservatively assume dewatering pumps are not operating over the storm duration. Pumps were designed to dewater the event ponds over a 2-day period.

CIRNA-WLA-IR-07: Design Criteria for Diversion Berms And Culverts

Detailed Review Comment

Tables 6.2-3 and 6.2-4 of Section 6.2 (Hydrotechnical Design Criteria) of the 2020 WMP include conveyance design criteria for diversion berms and culverts. The criteria for diversion berm designs specify return periods from 10 to 100 years and conveyance capacity of "24-hr total rainfall volume + m3/s snowmelt" derived from "BMP". The criteria for culvert designs specify return periods from 50 to 100 years and conveyance capacity of "24-hour total rainfall volume" derived from "BMP, SRK (2014). Report references identify SRK (2014) as "Rascal Realignment Hydraulic Model." Table 6.5-1 presents culvert characteristics and 100-year design discharges for five culverts but does not include information on watershed characteristics.

Conveyance capacity should be given as a flow rate, not volume units. This comment was made during a prior review in 2018. The criteria are inconsistent in whether snowmelt is included in the conveyance design and are generally unclear as to how the design discharge is to be computed. Our comments below assume that the reference to SRK (2014), which we have not reviewed, is in error and that SRK (2015a) was intended.

Conveyance design methodology is described in the SRK Back River Project - Hydrology Report, dated September 2015 and published as Appendix V2-7B of the Back River Project Final Environmental Impact Statement Supporting Volume 2: Project Description and Alternatives. In Section 3.4, Peak Flows, it uses an Index Flood Method to present a conservative representation of (instantaneous) peak flows and achieves similar results with an SCS method for smaller watersheds less than 200 km2. It recommends that different methodologies be applied for (1) natural catchments versus (2) mine site catchments. The SCS curve numbers presented for natural catchments include snowmelt contributions whereas when the SGS method applied to mine site catchments "will need to be implemented using CN values for each type of infrastructure, extreme rainfall depths and snowmelt flows."

The hydrology report describes a methodology for computing daily snowmelt based on 30 years of NASA-derived daily meteorological data and snowmelt expressions from the US Army Corps of Engineers. Daily snowmelt was calculated for the 30 -year record. The maximum daily snowmelt values for each of the 30 years were averaged to produce an average maximum daily snowmelt of 28 mm/day. This rate was added to the peak flow determined for the mine site catchment using the SCS method.

Reviewers appreciate the innovative approach which utilized the NOAA-derived meteorological data and agree that a design rainfall event be coincident with an averaged maximum snowmelt rate rather than a melt rate with a specified return period. However, the results presented do not give the maximum daily snowmelt estimated for the 30-year period of assessment, which would reflect "sunny day" maximum snowmelt.

It also does not consider diurnal effects yielding peak snowmelt rates significantly higher than daily rates and which may be important for the basins being assessed

Recommendation/Request:

7.1. CIRNAC recommends that the Applicant elaborate on the criteria presented in the WMP to determine the design conveyance capacities for diversion dam berms and culverts. Specifically, clarity is requested on when and how snowmelt is to be included and how design discharges are to be computed. This information is needed for designs to be developed that are consistent with the criteria, and for reviewers to be assured that the criteria are followed.

7.2. CIRNAC also recommends that the Applicant provide the watershed areas for the five culverts presented in Table 6.5-1 and compare the listed 100-year design flows with the 100-year discharges from the index curve and SCS methods presented in Figures 3.7 and 3.8 from SRK's 2015 hydrology report. The comparison can provide a reasonableness check on the peak flows determined by other methods.

Sabina Response:

As part of the Type A Water Licence (2AM-BRP1831) process, diversion berm and culvert design criteria were presented, technically reviewed, and approved. Sabina previously provided additional details supporting the design of berms and culverts in WT-INAC-TRC-4 in April 2018, which addressed the conveyance capacity for diversions and culverts, included detailed hydraulic modeling results for culverts, and justification for design criteria selection.

Sabina reiterates that peak flow rates for diversion berm and culvert designs were evaluated using a rain-on-snow event. The rainfall component utilized an intensity-duration-frequency table and the SCS Curve Number method to transform the hydrograph and account for losses, and snowmelt was derived assuming a constant baseflow contribution equal to the 24-hour snowmelt depth. The 24-hour snowmelt depth was calculated using a daily snowmelt model, and represents the maximum daily snowmelt expected for the region, equal to 28 mm/day. Snowmelt baseflow is equal to the snowmelt depth multiplied by the catchment area, and assumes no losses to infiltration or sublimation, providing a constant flow throughout the 24-hour peak flow modeling period.

The resulting design flows for culverts are presented in Table CIRNA-7-1 and compared to regional flood numbers developed for the Project. The results used in the design of culverts are equal to or greater than the Index Flood peak flows in all cases, and similar to the results using the SCS Method.

Table CIRNA-7-1: Culvert Areas and Peak Flows

Culvert Description	Goose Culvert	Gander Pond Culvert	Goose Airstrip Culvert	Echo Culvert	Goose Neck Culvert
Area (km^2)	28.7	7.1	27.6	1.5	11.0
Design Flow (m^3/s)	19.3	9.6	18.8	2.0	10.5
Index Curve Flow[1] (m^3/s)	16	4	15	1.5	10.2
SCS Flow[2] (m^3/s)	20	6	18	1.8	10.5

1. Index Flood Method Envelope Curve results based on SRK 2015 Hydrology Report, Figure 3.7
2. SCS Method Regression Line results based on SRK 2015 Hydrology Report, Figure 3.8

Catchment areas for culverts are presented in Figure CIRNA-7-1.

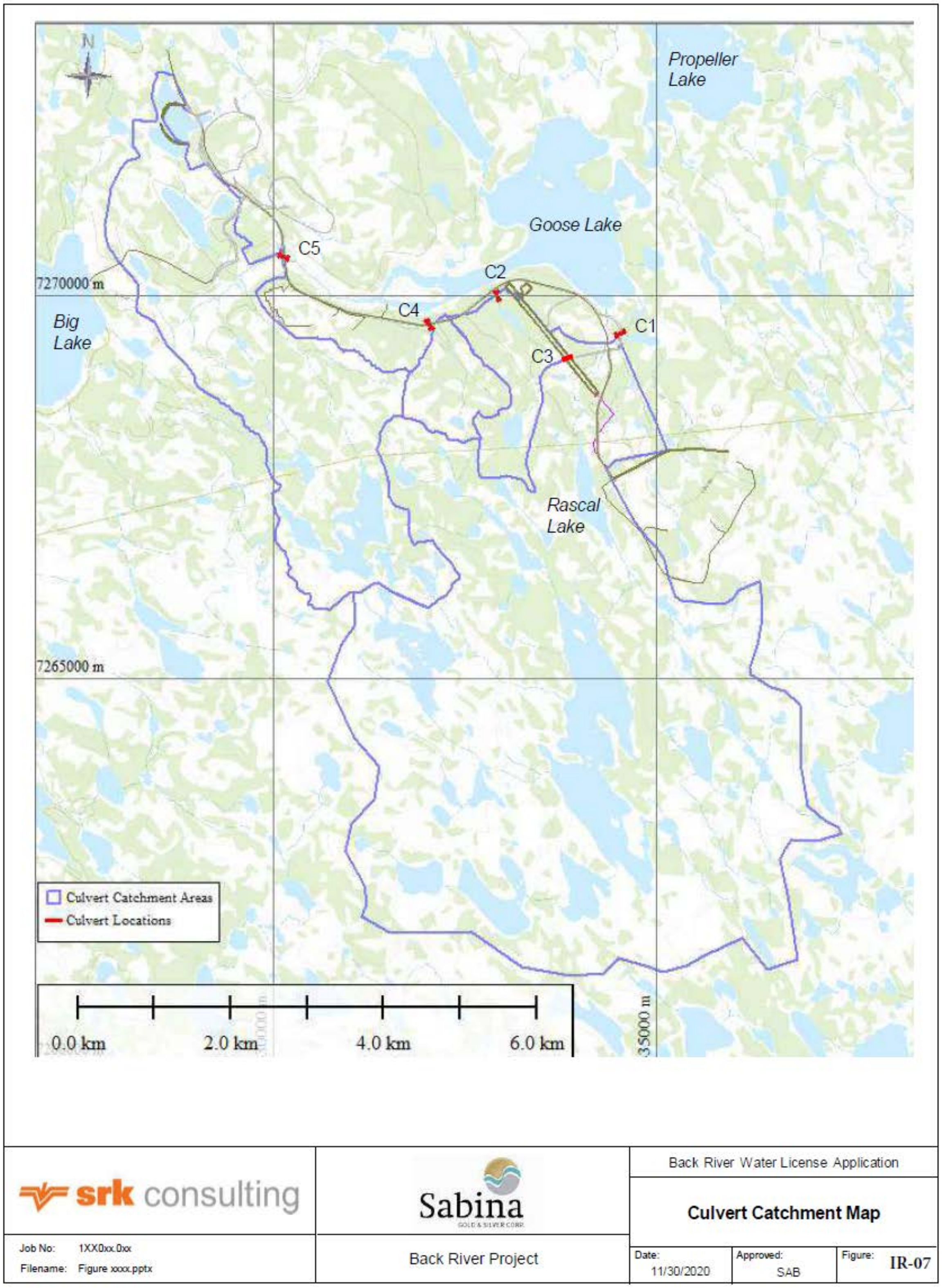


Figure CIRNA-7-1 Culvert Catchment Map

CIRNA-WLA-IR-08: Water And Load Balance Model 2020 Update

Detailed Review Comment

The prior Back River Water and Load Balance Model (WLBM) was dated April 2015 by SRK Consulting (Canada) Inc. The current WLBM is dated June 2020 by SRK Consulting (Canada) Inc. and published as Appendix E of the 2020 WMP.

The current WLBM does not identify or reference the prior WLBM and does not describe the history of model development or recent changes to model methodology or results. The study history is important as it allows reviewers to focus on changes to data and methodologies (presumably agreeable as submitted previously) rather than starting from the beginning. Similarly, to avoid duplication of prior reviews, it would be efficient for the study to include a summary of information that has changed since the prior submittal.

Recommendation/Request:

8.1. CIRNAC recommends that the Applicant provide a history of the WLBM documents previously submitted to support prior regulatory applications.

8.2. CIRNAC also recommends that the Applicant provide summaries of differences in model inputs, methods and outputs between the current (2020) and previous (2015) models.

Sabina Response:

Sabina notes CIRNAC's comment and has provided a summary table in Table CIRNA-8-1 that outlines changes between the previous Type A Water Licence Water and Load Balance Model (2015) and the 2020 Modification Package Water and Load Balance Model; Sabina highlights that these changes represent additional inputs that increases Sabina's confidence in the Water and Load Balance Model.

Table CIRNA-8-1: Water and Load Balance Model Changes – Type A Water Licence to 2020 Modification Package

Subject	Type A Water Licence	2020 Modification Package
Reservoirs for water storage	Saline Water Pond Umwelt Pit Llama Pit Goose Main Pit Echo Pit	Saline Water Pond Primary Pond Umwelt Pit Llama Pit Goose Pit
Saline water sources from underground workings	Umwelt Underground Llama Underground Goose Underground Echo Underground	Umwelt Underground
Saline water storage	Temporarily at Saline Water Pond in Umwelt Lake footprint Permanently at Llama Reservoir (meromictic) and underground workings once mining complete	Temporarily at Saline Water Pond in Umwelt Lake footprint Permanently at Umwelt Reservoir (meromictic) and underground workings once mining complete
Tailings deposition	TSF Umwelt TF Goose Main TF	TSF Llama TF
Freshwater source	Goose Lake Big Lake	Goose Lake Big Lake
Reclaim source	TSF Umwelt TF Goose Main TF	Primary Pond TSF Llama TF
Waste rock placement	Umwelt WRSA Llama WRSA TSF WRSA Echo WRSA	Umwelt WRSA Llama WRSA TSF WRSA
Lake Dewatering	Llama Lake Umwelt Lake	Llama Lake Umwelt Lake

Subject	**Type A Water Licence**	**2020 Modification Package**
Water Balance inputs	Annual runoff and precipitation volumes Open water evaporation rates Catchment areas Runoff coefficients Typical monthly hydrograph Open talik inflows Through talik inflows Open pit volumes Tailings and waste rock deposition (void volumes) Water content in ore Reclaim demand Freshwater requirement	Annual runoff and precipitation volumes Open water evaporation rates Catchment areas Runoff coefficients Typical monthly hydrograph Open talik inflows Through talik inflows Open pit volumes Tailings and waste rock deposition (void volumes) Water content in ore Reclaim demand Freshwater requirement Ice thickness Temperature Climate change data Snow melt rates
Ore process rate	6,000 tpd	3,000 tpd
Average reclaim rate	4,914 m^3/d	2,100 m^3/d
Average process freshwater demand	900 m^3/d	900 m^3/d
Other Load Balance changes		Revisited WRSAs source terms for ion charges balance Included brine residuals load modelling Included mill outflow load modelling Updated production rate schedule for tailings modelling Updated ore and waste rock tonnage schedules for ANFO load modelling
Other Water Balance changes		Updated hydrology (runoff, precipitation, and evaporation) Updated Catchment areas Included climate change projections

CIRNA-WLA-IR-09: Water And Load Balance Model Limitations and Climate Change Adjustments

Detailed Review Comment

Section 8.2 of the current WLBM discusses hydraulic hydrologic input limitations. These include climate change effects as follows "the intensity of snowmelt may increase as a result of higher temperatures'. These changes will be captured in the sizing of containment infrastructure." and "monthly and annual volumes of water produced on site from precipitation may increase” which has been addressed through incorporation of climate change rates of change.

Recommendation/Request:

CIRNAC recommends that the Applicant provide descriptive information on how the identified climate change impacts will be captured in the sizing of containment infrastructure, and has been addressed through incorporation of climate change rates of change.

Sabina Response:

Sabina acknowledges CIRNAC’s comment and confirms that climate change was incorporated in all water management infrastructure at the Project by increasing the rainfall events in the Index-Duration-Frequency table by 10%, as per Engineers and Geoscientists of British Columbia (EGBC) Guidelines (2018). This adjustment was incorporated for both diversion berm and culvert peak flows as well as containment pond design volumes.

Additional details for how climate change was assessed in the Water and Load Balance Model are provided in response to KIA-WLA-IR-10.

CIRNA-WLA-IR-10: Water Withdrawal Errors

Detailed Review Comment

Section 2.3.3 of the Modification Package shows an additional withdrawal request of 195,750 m3/yr from Goose Lake in Table 2.3-1, a value that agrees with the calculation of the total. However, the discussion states the same value as 145,750 m3/yr in the text. Some information may be missing on Table 6.4-1 include the available capacity of the Saline Water Pond and the Llama WRSA Pond.

Recommendation/Request:

Technical review of water management will require certainty regarding withdrawals and pond capacities. There are conflicting numbers and errors in the relevant tables. CIRNAC recommends that the Applicant confirm the correct values for the above referenced information.

Sabina Response:

Sabina confirms that numbers provided in Table 2.3-1 and the text in Section 2.3 of the Modification Package are correct. Sabina is requesting the maximum allowable water withdrawn from Big Lake to be increased to 195,750 m^3 annually.

Sabina also confirms the text in Section 2.3.3 of the Modification Package is correct. Sabina noted that water use at Big Lake was inadvertently reduced in the original Type A Water Licence Application relative to the volumes outlined in the FEIS by 50,000 m^3/yr from 128,000 m^3/yr (as illustrated in Table 2.3-1). Therefore, Sabina's statement that an additional 145,750 m^3/yr from Big Lake was being assessed as part of the NIRB's review of the Modification Package was correct.

CIRNA-WLA-IR-11: Hydrodynamic Model Scope

Detailed Review Comment

Section 6.1 of the Water Management Plan states that:

Sabina is required to provide an updated Hydrodynamic model. Sabina intends to submit this updated Hydrodynamic model as part of the NWB process associated with the 2020 Modification Package, or as part of the 2020 NWB Annual Report.

The requirement can be found in Part E, Item 15b of the Type A Water Licence (2AM- BRP-1831).

Recommendation/Request:

CIRNAC recommends that the Applicant confirm whether the Pieters and Lawrence report titled "Assessment of Stratification in the Proposed Back River Project Llama Pit Lake" is the updated hydrodynamic model referred to above. If not, please provide the terms of reference for the hydrodynamic modelling scope and the expected delivery date of the work for effective technical review by interested parties.

Sabina Response:

Sabina confirms that the Pieters and Lawrence report titled "Assessment of Stratification in the Proposed Back River Project Llama Pit Lake" is not the updated Hydrodynamic model.

The commitment to complete the Hydrodynamic model update (Part E, Item 15, 2AM-BRP1831) stems from the Type A Water Licence process and detailed including additional baseline data that better characterized natural variation as an input. The additional baseline data collection was submitted to the NWB in September 2020 and reviewed by parties in October 2020.

Sabina clarifies the Hydrodynamic model will be provided to the NWB and interested parties during the review process for this amendment application (i.e., in response to Technical Comments received prior to a Technical Meeting being held).

CIRNA-WLA-IR-12: Saline Water Pond Permafrost

Detailed Review Comment

The Back River Water Management Plan Section 7.1 states that a saline water pond will be used for saline water pumped out of Llama open pit and/or underground works. Umwelt Lake has a volume of ~0.24 Mm3• This is insufficient to store the estimated volume of saline water, so a dam will be constructed to form the Saline Water Pond with a higher capacity. The dam is specified as lined, but the pond as a whole is not to be lined and the management of saline soils after closure is discussed.

The following excerpts from the WMP highlight the uncertainty and risk regarding the storage of saline water:

"Sabina commits to continue looking for alternative strategies/locations for temporary storage of saline water, before pumping it to the Umwelt Reservoir.

Sabina also notes the potential exists for migration of saline water from the SWP to the surrounding environment. Sabina will therefore monitor the permafrost in the locations where seepage may occur as well as monitor the condition of vegetation in the vicinity of the SWP for effects due to the presence of saline groundwater".

The SWP with larger thermal mass and higher-salinity water may be much more effective in melting permafrost than the former Umwelt Lake.

Recommendation/Request:

CIRNAC recommends that the Applicant;

a) Provide detailed information on the current state of permafrost or talik beneath Umwelt Lake;
b) Explain how downward migration of saline water from the SWP and potential talik enlargement will be monitored;
c) Provide information on the degree the SWP is expected to freeze completely or partially to potentially create a more concentrated brine.

Sabina Response:

As part of the Type A Water Licence (2AM-BRP1831) process, storage of saline water in the Saline Water Pond (formerly Umwelt Lake) was presented, technically reviewed, and approved.

In the memo “Back River Project: Saline Water Pond Containment Dams Thermal Modeling” (Sabina 2017, Appendix F-I, Appendix C), Sabina demonstrated that permafrost thaw beneath the Saline Water Pond over the life of the facility was estimated to be 19 m at the at the end of 11.2 years. Sabina highlights that in the 2020 Modification Package, the Saline Water Pond will be utilized for approximately 4 years (i.e., approximately 60% less time); as such, it is expected that the talik formation would be notably less.

In the Hydrological Characterization Report submitted as part of the Type A Water Licence Application (Sabina 2017, Appendix F-5), Sabina concluded that there is a high likelihood that an open (through) talik exists under Umwelt Lake.

During the operational period of the Saline Water Pond, there will be a notable amount of dilution from freshwater (such as from natural surface water runoff, direct precipitation, and snow melt). When there is a sufficient pond water level (i.e., greater than 3 m depth), only the top approximate two meters of water is expected to freeze in the winter. This top portion of the lake is expected to freeze and thaw annually (similar to what naturally occurs on the larger lakes in the project area). Overall, this is not expected to have a notable impact on concentrating brine within the Saline Water Pond. Sabina will complete routine water sampling within this pond to confirm salinity levels, as outlined in Appendix B of the Water Management Plan.

References:

Sabina (Sabina Gold & Silver Corp). 2017. Revised Type A Water Licence Application for Sabina Gold & Silver Corp. Back River Project. Submitted to the Nunavut Water Board. October 4, 2017.

CIRNA-WLA-IR-13: Water and Load Balance

Detailed Review Comment

Appendix D of the SRK Water and Load Balance shows extreme maximum values for many water quality constituents in Umwelt Pond, aka the Saline Water Pond. It may be that these are spurious values, but if valid represent particularly toxic water. Further results on the expected quality of the Saline Water Pond are required to understand the potential evolution of the water chemistry and its salinity at the time of transfer to the pit lake.

Recommendation/Request:

CIRNAC recommends that the Applicant provide time series model predictions of the water quality in the Saline Water Pond for the same constituents plotted in the SRK Water and Load Balance Section 7.3.

Sabina Response:

Time series model projections for main water quality constituents during summer months in the Saline Water Pond are submitted as Attachment IR-A.

CIRNA-WLA-IR-14: Lake Mixing Model

Detailed Review Comment

The meromixis analysis (Pieters and Lawrence report) was provided a single value of bottom water salinity (31,400 mg/L) and simulated four mixing scenarios during filling of the pit lake. This salinity is comparable to the expected groundwater inflow to Llama Pit. The potential range in Saline Water Pond salinity is important to the final pit lake stability. A challenging scenario for the future pit lake stability would be a saline water pond that is unsafe to discharge, but not as saline as expected due to dilution with surface water, for example in the source pit.

Another potential problem would be a greater quantity of saline water than expected. For example, a pause in operations could change the quantity and salinity of SWP water. Water management at the mine site during an unexpected work stoppage event could result in a longer period of saline water accumulation than currently modelled.

Recommendation/Request:

CIRNAC recommends that the Applicant provide the specific reasoning for the choice of the Saline Water Pond salinity at the time of filling the pit lake, and discuss how the final salinity might vary in the SWP both under the present mine plan and in a situation where operations paused for a period of time. The response to this information request including water and load balance predictions in the SWP would address this information request for the present mine plan. A brief and qualitative comment on the potential evolution of SWP quantity and salinity (key inputs to the pit lake model) during a pause in operations would also aid the technical review.

Sabina Response:

Sabina acknowledges CIRNAC's comment and provides the following additional visibility. The saline water layer of Umwelt Reservoir will be filled with water from the Saline Water Pond, as well as Llama Open Pit, and Umwelt Underground. The timeseries of the combined total dissolved solids (TDS) concentration from the three sources for the saline portion of the lake is shown in Figure CIRNAC-14-1 alongside the freshwater sources. The TDS ranges between 43,000 mg/L and 22,000 mg/L as the Umwelt Pit is filled, compared to roughly 300 mg/L for the freshwater portion. The salinity differential between the two sources is very high, even at the low end of the hypersaline range. The salinity gradient is much more pronounced at Back River compared to other northern meromictic pit lakes in Canada (Pieters and Lawrence 2014).

The Saline Water Pond TDS concentration at the time of filling the Umwelt Reservoir is approximately 18,000 mg/L, as shown in Figure CIRNAC-14-2, and are relatively constant as Umwelt Reservoir is filled. A change in mine plan may result in additional saline water being stored in the Saline Water Pond. This additional water could be stored in the Umwelt Reservoir as long as a sufficient freshwater cap can be established. In the case of a pause in operations, saline water inflows would also be paused, and inflows would consist of freshwater from direct precipitation. This could dilute the TDS concentrations in the Saline Water Pond; however it is not anticipated that this dilution would be sufficient to alter the meromictic conditions of the ultimate deposition location within Umwelt Reservoir.

To manage additional inflow volumes into the Saline Water Pond during a temporary care and maintenance period, pumping systems could be put in-place to temporarily store water in the Goose Main Pit or Llama Pit. Once operations restart, this water would either be blended and used for process water, or stored until Umwelt Pit mining is complete and all saline water can be pumped into the final Umwelt Reservoir.

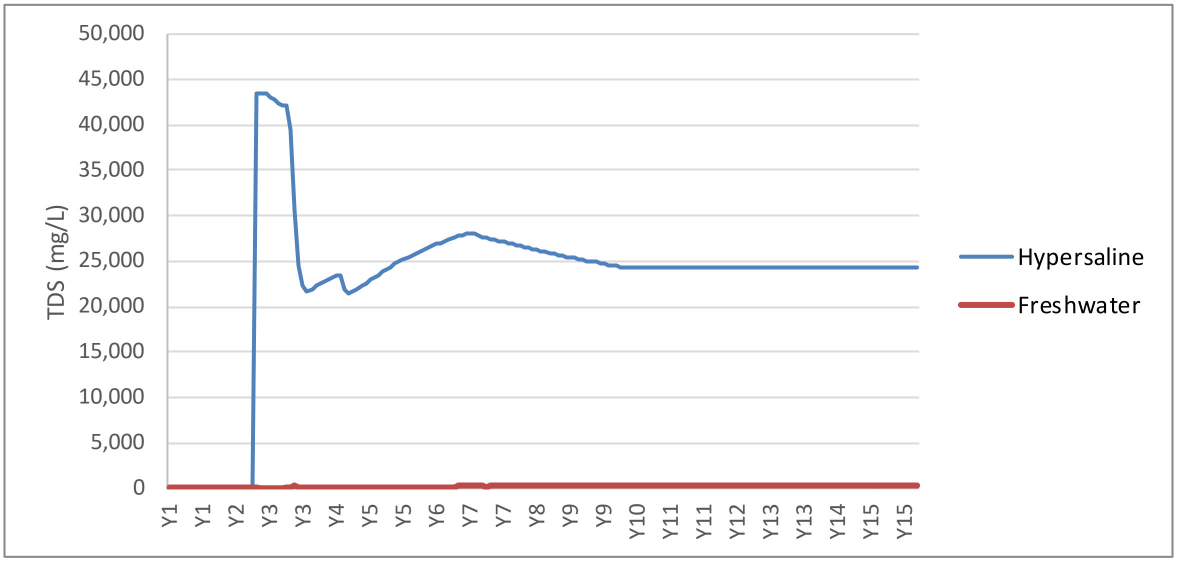


Figure CIRNAC-14-1. Total Dissolved Solids (TDS) of hypersaline and freshwater inflows to Umwelt Reservoir

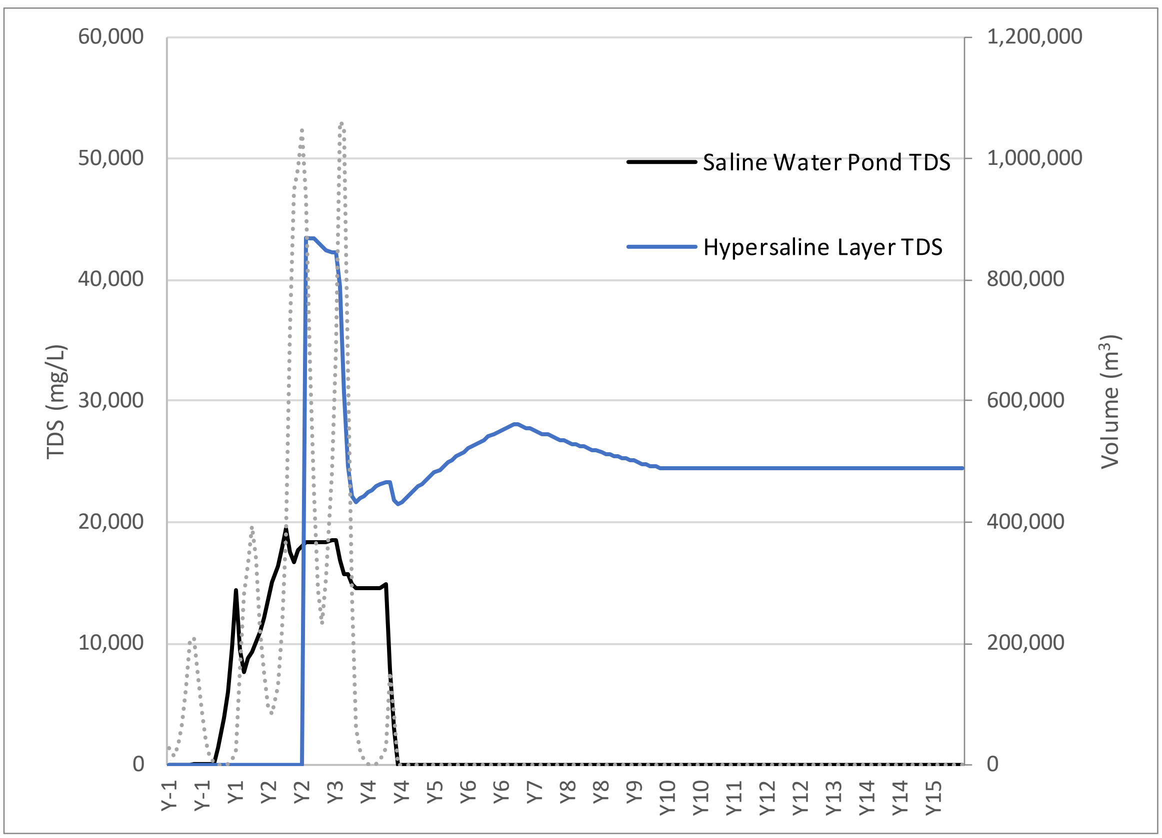


Figure CIRNAC-14-2. TDS of Saline Water Pond at time of filling of Umwelt Reservoir

CIRNA-WLA-IR-15: Missing Documents Sections And Details

Detailed Review Comment

The proposed Water Licence Modification include changes to the tonnages of tailings and waste rock. Waste rock increase by 27.6 Mt (47% increase) and tailings decreased by 7.4 Mt (37% decrease). The Tailings Management Plan and Waste Rock Management Plan will support effective review of mass balance changes in mine waste management associated with the requested Water Licence Modification:

The referenced documents below required for technical review appear not be included in the information Modification Package:

- WL SD-09 - Tailings Management Plan - referred to in the Modification Package
- WL SD-08 - Waste Rock Management Plan - referred to in the Modification Package.

Recommendation/Request:

CIRNAC recommends that the Applicant provide updated versions of the following documents to reflect the mass balance changes in mine waste management associated with the requested Water Licence Modification:

a) WL SD-09 - Tailings Management Plan - referred to in the Modification Package
b) WL SD-08 - Waste Rock Management Plan - referred to in the Modification Package

Sabina Response:

Sabina acknowledges CRINAC's recommendation and has provided updated versions of both the Tailings Management Plan and the Waste Rock Management Plan as part of this IR response package. These management plans can be found in Attachment IR-D and Attachment IR-E, respectively

CIRNA-WLA-IR-16: Goose Property Waste And Water Management

Detailed Review Comment

With reference to Table 3.1-1 Back River Project Mine Plan Comparison and Table 2.3-1 Back River Project Current and Proposed Water Summary, CIRNAC would like to understand what is driving the increase in freshwater usage as outlined in the Water Licence Modification request. Further, with the intended increase in water use, the process plant throughput is indicated as reducing from 6,000 tpd to 3,000 - 4,000 tpd. This proposed increase in freshwater usage for the Goose Property from 468,000 m^3/yr to 882,450 m^3/yr (nearly a 2-fold increase) will likely result in a proportionate increase of the wastewater to be discharged to the environment

Recommendation/Request:

16.1. CIRNAC recommends that the Applicant provide rationale on the step increase in amount of water to be used.

16.2. CIRNAC recommends that the Applicant provide information on how the proportionate increase of the wastewater due to increased water use has been captured in the Water Management Plan.

Sabina Response:

Sabina has learned through Detailed Engineering that additional freshwater is required for the Process Plant than originally anticipated and identified during the Feasibility Study; this study was the basis of the Type A Water Licence Application. Sabina is requesting additional water at this time as a proactive measure to ensure that, during Operations, Sabina does not need to make an emergency request.

Sabina clarifies that the increase in additional freshwater required, if utilized, will not have a reciprocal increase in wastewater at the Project. Wastewater volumes may marginally increase; however Sabina is now maximizing the available reclaim water and most of the freshwater will be utilized within the system and therefore will not generate much additional wastewater.

Sabina notes that all wastewater generated at the Project must be managed as per the Terms and Conditions of the NWB approved Type A Water Licence (i.e., treatment, discharge, and closure objectives are all set and will apply).

CIRNA-WLA-IR-17: Goose Property Waste Rock Management

Detailed Review Comment

With reference to Table 3.1-1 Back River Project Mine Plan - Comparison shows an increase in the waste rock from 59 Mt to 86 Mt an increase of approximately 27 Mt. It is not clear where and how the additional waste rock will be stored.

Recommendation/Request:

CIRNAC recommends that the Applicant provide clear information to explain where and how this additional tonnage of waste rock will be placed and stored

Sabina Response:

Sabina acknowledges CIRNAC's comments and provides the below visibility on WRSAs for the Project. As stated in Section 3.1.1 of the Modification Package, the originally permitted WRSAs footprints continue to provide sufficient storage capacity for waste rock, and the waste rock ratio of non-potentially acid generating (NPAG) to potentially acid generating (PAG) remains unchanged.

Sabina has confirmed the following below dimensions for the WRSAs based on final waste rock modelling associated with the Updated Interim Closure and Reclamation Plan and Cost Estimate. Table CIRNA-17-1 provides WRSA maximum footprints, heights, and approximate tonnes for each facility in the 2020 Modification Package, and Table CIRNA-17-2 provides the same details from the approved Type A Water Licence WRSAs. Sabina notes that while some individual WRSAs have changed footprints slightly, the overall total WRSA footprint has only increased by approximately 5 ha (i.e., approximate 2% increase). This limited footprint increase has been accommodated by increasing the overall height of some facilities, and Sabina notes these heights are within the previously approved Geotechnical Design Parameters for the Back River Project (Sabina 2017, Appendix F-2). Sabina also notes that these values have additional conservatism as overburden, which is non-potentially acid generating (NPAG) material, has been partially (Type A Water Licence) or fully (2020 Modification Package) included in these total volumes.

Table CIRNA-17-1. WRSA Dimensions - 2020 Modification Package

WRSA	Footprint (ha)	Height (m)	Tonnage (Mt)
Umwelt	33	34	15.4
Llama	42.8	76	30.4
TSF WRSA	154.8	23.5	47.3
TOTAL	230.6	~	93.1

Table CIRNA-17-2. WRSA Dimensions - Type A Water Licence

WRSA	Footprint (ha)	Height (m)	Tonnage (Mt)
Umwelt	39.5	34	20
Llama	37.5	30	16
Echo	3.3	15	1.2
TSF WRSA	145.1	14	27
TOTAL	225.4	~	64.2

References:

Sabina (Sabina Gold & Silver Corp). 2017. Revised Type A Water Licence Application for Sabina Gold & Silver Corp. Back River Project. Submitted to the Nunavut Water Board. October 4, 2017.

CIRNA-WLA-IR-18: Mass Balance Assessment

Detailed Review Comment

Modification package appendix B Water Management Plan, sub appendix E PAGE 17 states:

"Based on the tailings properties, the slurry discharge will consist of 3,400 m^3/d of water and 2,500 m^3/d of solids. The volume of water entrained in tailings voids is a function of the void ratio and tailings density and is equal to 1,458 m^3/d based on the average tailings disposal rate".

The calculation by the Applicant appears inaccurate for a production rate of 3,000 t/day. According to the tailings phase relationship CIRNAC calculated; Volume of Solids = Mass of Solids divided by the Solids Specific Gravity assuming the unit weight of water is ~1t/m^3. (i.e. (3,000/2.88)*1 = 1,014m^3/day, not the "2,500 m^3/day" quoted). Is it possible that the quoted value of 2,500m^3/day refers to the total slurry volume = Mass of Solids divided by the Tailings Settled Dry Density (i.e. 3000/1.2 m^3/day) not just the solids volume? Applicant is encouraged to confirm the referenced calculated values.

Recommendation/Request:

CIRNAC recommends that the Applicant confirm that the referenced values are accurate, and that appropriate values have been used in the site wide water and mass balance assessment.

Sabina Response:

Sabina appreciates CIRNA's careful review and confirms that this was correctly identified as a typographical error in the Water and Load Balance (WLBM) text. The 2,500 m^3/day value listed refers the total settled tailings volume (correctly identified as 3,000 t/day ÷ 1.2 t/m^3). This would include entrained water and not just the tailings solids. The tailings solids would in fact be 1,042 m^3/ day (i.e., 3,000 t/day ÷ 2.88 x 1 t/m^3 as noted) and the volume of the voids (or entrained water assuming saturated tailings) would be 1,458 m^3/day (2,500 m^3/day – 1,042 m^3/day).

Sabina further verifies that only the text included in the WLBM (Water Management Plan Appendix E) is in error and Sabina confirms that appropriate values have been used in WLBM. Specifically, that water in the tailings, the water loss to voids, and the water loss to ice entrainment (20% allowance) are accounted for.

CIRNA-WLA-IR-19: Reclamation Plan And Cost Estimate

Detailed Review Comment

The October 13, 2020 Amendment cover letter indicates that the Applicant is working with Kitikmeot Inuit Association and CIRNAC on an updated Interim Closure and Reclamation Plan (ICRP) and cost estimate.

Recommendation/Request:

CIRNAC recommends that the Applicant provide timing for when the updated ICRP and associated cost estimate will be available for review.

Sabina Response:

Sabina proposed a timeline for deliverables and upcoming steps to CIRNAC and KIA on October 30, 2020.

1.3 RESPONSE TO ENVIRONMENT AND CLIMATE CHANGE CANADA

ECCC-WLA-IR-01: Clarification of Saline Water Management

Detailed Review Comment

Groundwater is anticipated to be encountered in the Llama Open Pit and the Umwelt Underground Mine, which will require management via the saline water management pond on the surface of the mine site. Table 4.5-1 of the Saline Water Management provides a summary of saline water management activities for the project. These management activities include:

- Year -1: Saline Water Pond is constructed;
- Year 1: Saline water from Umwelt Underground Mine and Llama Open pit is pumped to the saline water pond;
- Year 3: Saline water from the Saline Water Pond will be pumped to the bottom of Umwelt Reservoir to create a meromictic Pond;
- Year 4: Decommissioning of the Saline Water Pond; and
- Year 10+: Saline Water is pumped from the Umwelt Reservoir into the Umwelt Underground Mine.

ECCC notes that there is a large gap in the overall saline water management plan, which does not describe management of groundwater encountered in the Umwelt Underground Mine after the decommissioning of the Saline Water Pond. Based on the flow diagram provided in the Water and Load Balance in Appendix D, it can be assumed that groundwater will be pumped to the Umwelt Reservoir; however, this should be explicitly described. Further, in section 8.2.3 of the Water Management Plan, the report states that, "groundwater accumulating in the underground workings will be pumped to the Saline Water Pond during the operational LOM (life of mine)." This statement is contradictory to statements throughout the Water Management Plan that indicate that the Saline Water Management Pond will be decommissioned in Mine Year 4.

Recommendation/Request:

ECCC recommends the Proponent provide a description of management of groundwater in Umwelt Underground Mine after the decommissioning of the Saline Water Pond in Mine Year 4.

Sabina Response:

Sabina appreciates ECCC's careful review and clarifies that after Year 4 of Operations, when the Saline Water Pond in decommissioned, all saline water collected at the Goose Property for the remainder of Operations will be pumped to the Umwelt Reservoir. Sabina will update Section 8.2.3 to include this clarity in the next iteration of the Water Management Plan.

ECCC-WLA-IR-02: Goose Property Groundwater Inflows

Detailed Review Comment

The 2020 Modification proposes the extension of the Umwelt Underground Mine from a previously approved depth of 650m to an extended depth of 900m with mining in the underground commencing in Year 1 and extending into Year 9 of operations. The Saline Water Management Plan states that Sabina has scaled the quantity and quality of groundwater inflows to match the new mine schedule, however no additional description of how this groundwater scaling was completed has been provided. In addition, no direct comparison has been provided on how groundwater quality or quantity will change between the previously approved project and the new modification.

Tables 4.1-1 and 4.1-2 of the Saline Water Management Plan (Appendix C) present the expected inflows and concentrations for the groundwater inflows in the 2020 modification, however, these differ from the inflows presented in Table 3-11 of Appendix E (Water and Load Balance) and the concentrations of TDS and chloride presented in Table 4-3 of Appendix E. There are also additional inconsistencies on the years of groundwater inflows listed. The Saline Water Management Plan presents predicted concentrations and volumes of inflows from year 1 to 5 for Llama Open Pit and for year 1 to 10 for Umwelt Underground Mine, while the Water and Load Balance provides predicted groundwater inflows and concentrations from year 1 to 5 for the Llama Open pit but only for year 1 to 7 for the Umwelt Underground Mine (Table 3-11).

Overall, due to the inconsistencies above, the Water Management Plan does not present a clear understanding of the potential implications of the Umwelt Underground Mine progressing further underground, potentially encountering increased volumes of groundwater, with higher TDS and chloride, requiring management on the surface of the mine.

Recommendation/Request:

ECCC recommends the proponent provide the following:

- Present a clear description of how groundwater scaling for the new mine schedule was completed;
- Provide clarification on the contradictory groundwater quality and quantity values used throughout the Water Management Plan and in the Water and Load Balance;
- Provide a comparison and discussion of predicted groundwater quantity and quality for the new mine schedule, as compared to the previously approved mine plan, including overall quality and quantity of saline water to be stored in the Umwelt Reservoir as compared to previous predictions; and
- Based on the responses to the above, discuss any implications for operational capacity, closure, and establishment of stratification within Umwelt Reservoir.

Sabina Response:

Sabina acknowledges ECCC's comment and has provided details on groundwater scaling completed as part of the 2020 Modification Package in response to CIRNA-WLA-IR-02.

ECCC-WLA-IR-03: Umwelt Reservoir

Detailed Review Comment

In the currently approved mine plan, Umwelt mined out pit serves as a tailings facility, and the mined out Llama pit serves as saline water management, ultimately becoming a meromictic lake upon closure. However, the 2020 Modification Package proposes Umwelt open pit to serve as mine water management and Llama open pit to serve as a tailings facility. This difference in mine waste and water management is only briefly mentioned in Table 3.1-1 of the modification package and no analysis of any potential implications of this proposed change is discussed. As per the Water and Load Balance (Appendix F), a stratification assessment was conducted for Llama Reservoir in 2015, but it is not clear whether this assessment is also applicable to Umwelt Reservoir. In relation to stratification of the Umwelt Reservoir, the Proponent has only stated that, "for the purpose of this water and load balance, the Umwelt Reservoir is stratified." A number of variables including the characteristics of the pit, estimated salinity, and ratio of fresh to saline water can influence establishment of meromixis. Analysis should be conducted to confirm that the results of the Llama Reservoir Stratification assessment are also applicable to Umwelt Reservoir stratification potential.

Recommendation/Request:

ECCC recommends the Proponent provide the following:

- Provide a discussion of why the end use of Umwelt Pit and Llama Pit were changed; and
- Provide an analysis of the potential for stratification within Umwelt Reservoir including whether the assumptions and results of the assessment of stratification for Llama Reservoir are applicable to Umwelt Reservoir.

Sabina Response:

The end use of Umwelt Pit and Llama Pit were changed as a consequence of changes to when open pits would be exhausted and available to store tailings or water, as well as based on the changed Process Plant throughput of the mine plan from 6,000 tpd to 3,000 tpd. In the approved mine plan, the TSF had capacity to store approximately 2 years of tailings, at which point, the only exhausted open pit available to become a Tailings Facility (TF) was Umwelt Pit. In the 2020 Modification Package, the TSF, which has not changed in size, had capacity to store approximately 5 years of tailings with the reduced Process Plant throughput, by which point the Llama TF was available for tailings deposition. In the 2020 Modification Package, Umwelt Pit begins receiving saline water to become Umwelt Reservoir and therefore was not available to store tailings.

The establishment of meromixis is dependent on the ability of the salinity gradient to resist mixing. Meromixis will initially develop in the spring after ice melt produces a freshwater cap, in addition to any water management structures that may be breached to increase runoff water captured. Subsequent runoff of freshwater will increase the thickness of the freshwater layer. The groundwater is expected to be very saline (similar to seawater) which will create a large density difference between the freshwater cap and the underlying saline layer.

In the approved mine plan, meromixis in Llama Pit (then called Llama Reservoir) is initiated with a large inflow of freshwater (839,700 m3) and melting ice cover (estimated 1.1 m of ice) from breaching the surrounding Llama water management structures in Year 4. The melting ice and freshwater inflow result in a freshwater cap of approximately 7.5 m over the surface of the reservoir.

In the 2020 Modification Package, Umwelt Reservoir will have a similar ice thickness and similar surface area to Llama Reservoir but will require an additional inflow of freshwater at surface to develop meromixis. Umwelt Reservoir receives approximately 350,000 m3/year of freshwater from the Primary Pond breach in Year 3. The epilimnion of freshwater at that time will be approximately 3 m thick, which will continue to grow in thickness over Operations. While this is less than the freshwater cap on Llama Reservoir, the saline water has a much greater level of salinity (10x higher) when compared to other northerly meromictic pit lakes (Pieters and Lawrence 2014) and is expected to resist mixing.

ECCC-WLA-IR-04: Updated Water and Load Balance

Detailed Review Comment

The water and load balance has been updated to account for the 2020 Modification Request. However, the report does not state how the assumptions or inputs to the water quality model have changed to include the modification, nor is there a description of how the updates to the model have changed the model outcomes for predicted water quality from the original water quality predictions. A summary table or summary description of the changes to the inputs, assumptions, and outputs should be provided to facilitate understanding how the overall water and load balance for the site will change due to the modification

Recommendation/Request:

ECCC recommends the Proponent provide a comparison and discussion of changes to the water quality modelling that were incorporated into the 2020 Modification Package, including a comparison of changes to the assumptions, inputs, and outputs from the original water quality predictions.

Sabina Response:

Sabina notes ECCC's comment and has provided a summary table that outlines changes between the previous Type A Water License WLBM (2015) and the 2020 Modification Package WLBM. Please see Table CIRNA-8-1 in response to CIRNA-WLA-IR-08.

ECCC-WLA-IR-05: Water Quality Prediction Results

Detailed Review Comment

The Water and Load Balance presents graphical results of the monthly water quality averages for a small subset of parameters (ammonia, chloride, sulphate, arsenic, and copper) for nodes PN03, PN04, and Goose Reservoir. For all other water quality parameters for all the nodes, the reviewer is referred to Appendix D.

Appendix D of the Water and Load Balance presents water quality predictions with and without treatment at the various assessment nodes for the project. ECCC notes that many of the values reported in these tables are unrealistically high, potentially indicating errors in the Water and Load Balance (for example, maximum selenium in Umwelt Pond of 1,742,000 mg/L). In addition, values listed in Appendix D do not correspond with the data and figures presented in Figures 4 through 18 of the Water and Load Balance. For example, Figure 7 (Chloride Prediction at PN04) indicates the highest average chloride concentration to be around 80 mg/L; however, Appendix D lists the maximum chloride concentration at PN04 at 0.0517 mg/L. Further, parameter concentrations that would be expected to be different with/without treatment are the same. For example, copper (expected to require treatment) at PN03, which is modelled with and without treatment, is 0.005814 mg/L in Appendix D. Finally, the only data that is presented in Appendix D for each node is the post-closure and maximum. It is unclear what is meant by post-closure, or what the range of predicted concentrations may be since no further summary statistics are provided. Overall, given the number of inconsistencies and abnormal values presented in Appendix D, it is difficult to interpret the information presented in the Water and Load Balance.

Recommendation/Request:

ECCC recommends the proponent provide the following:

- Provide an update to Appendix D of the Water and Load Balance addressing errors and inconsistencies in the data; and
- Provide a discussion on the validity of the conclusions presented in the Water and Load Balance based on the inconsistencies presented in Appendix D.

Sabina Response:

Sabina acknowledges ECCC's comment and confirms that inconsistencies in the Water and Load Balance Model (WLBM) Report between the data presented in the Appendix D and the graphical results of the monthly water quality averages have been corrected and are provided as Attachment IR-B. The inconsistencies stemmed from extreme elevated concentrations resulting from assuming cryoconcentration; in using this assumption in the WLBM, nearly all the water froze. The model simplistically then transferred all the mass to the remaining water volume which was extremely small. All parameters were assumed to behave conservatively (i.e., no solubility limits were applied). If these pockets of extremely concentrated brine did form, they would be isolated from the environment by a 2-m thick layer of ice; when the ice melts the concentrations would be diluted. It is also likely that these shallow ponds would freeze to the ground during the winter.

Additionally, the WLBM code for these reservoirs was reviewed and it was found that the load element corresponding to the Umwelt Underground Pad runoff was not triggered by the start date of the Umwelt Reservoir, and consequently, excess load was added to this facility. The WLBM was corrected so the load element was linked to the start date trigger, and concentrations were lowered to realistic values; the results have been updated in the attachment provided.

Sabina has provided an updated WLBM Appendix D for consideration in Attachment IR-C; this includes summarized, updated results for all prediction nodes.

Sabina notes that additional information regarding concentrations in the Saline Water Pond concentrations are addressed in the response to CIRNA-WLA-IR-13.

Attachment IR-A: Saline Water Pond: Water Quality

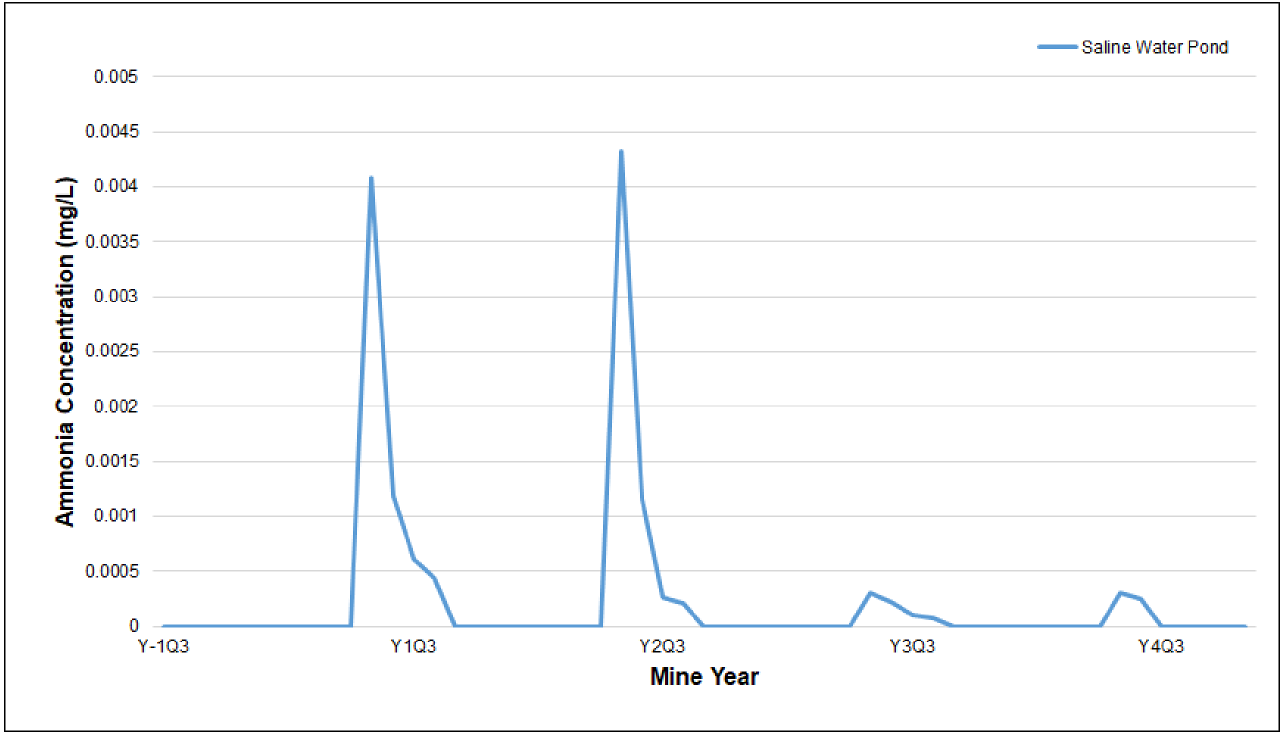
Saline Water Pond: Water Quality

Back River Project: Responses to Information Request for Water License (2AM-BRP1831) Amendment

srk consulting

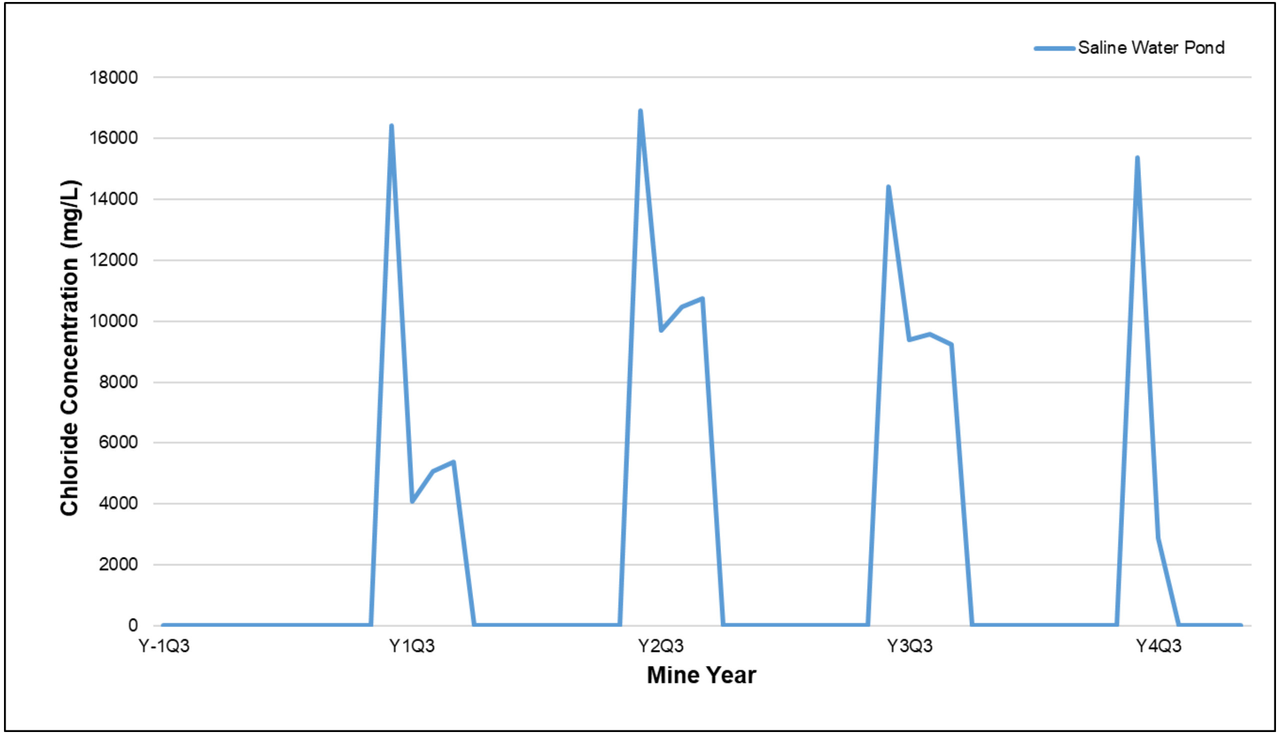
Source: \\srk.ad\dfs\na\van\Projects\01_SITES\Back River\1CS020.018_Type A Water License Water Mgmt\400_W&LBM\20_Appendices\ Back River Load Balance Results _20201124_IR _rev01_Imp.xlsx

Ammonia



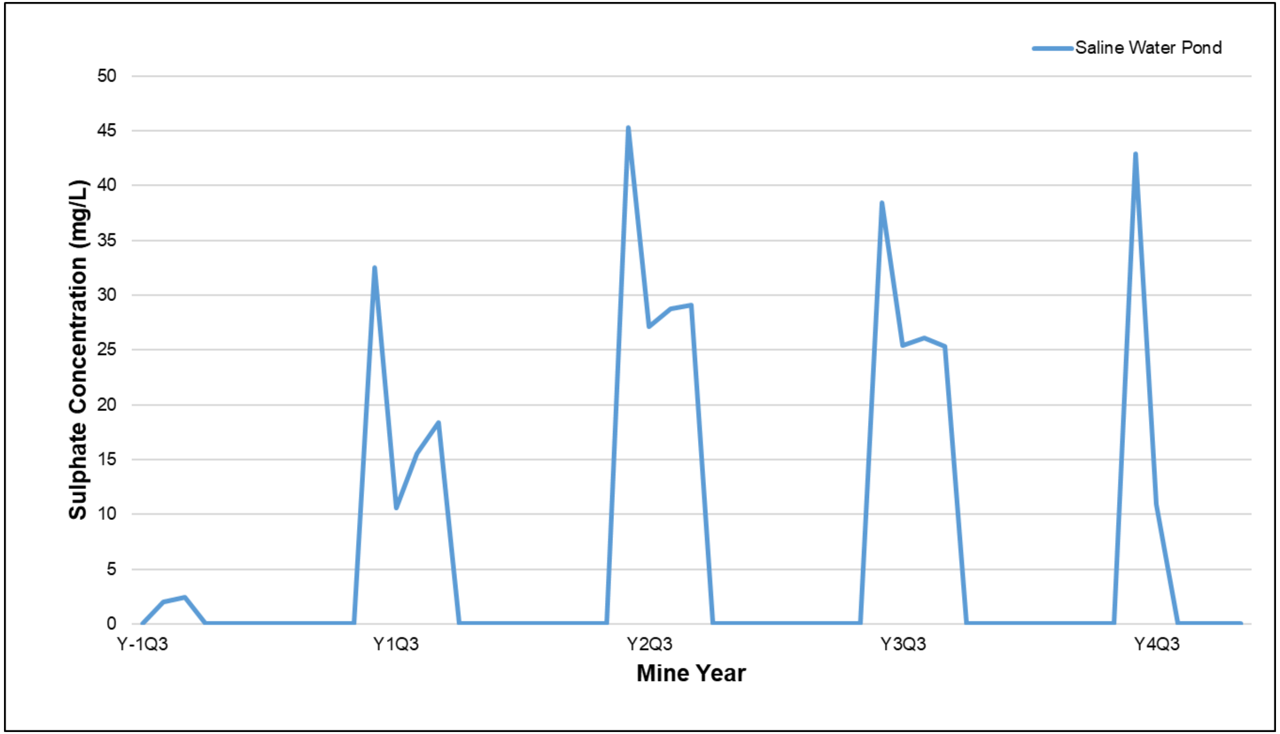
Saline Water Pond
Ammonia Concentration (mg/L)
0.005
0.0045
0.004
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
Y-1Q3
Y1Q3
Y2Q3
Y3Q3
Y4Q3
Mine Year

Chloride



srk consulting

Sulphate



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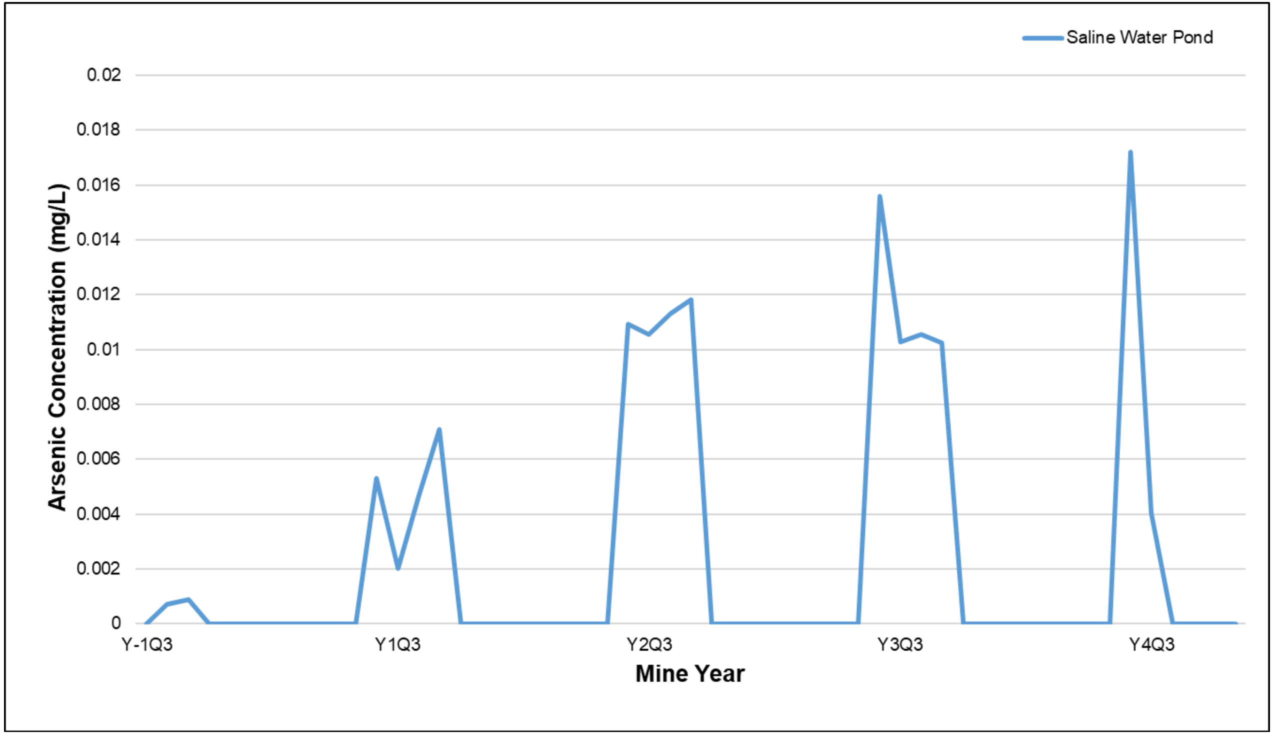
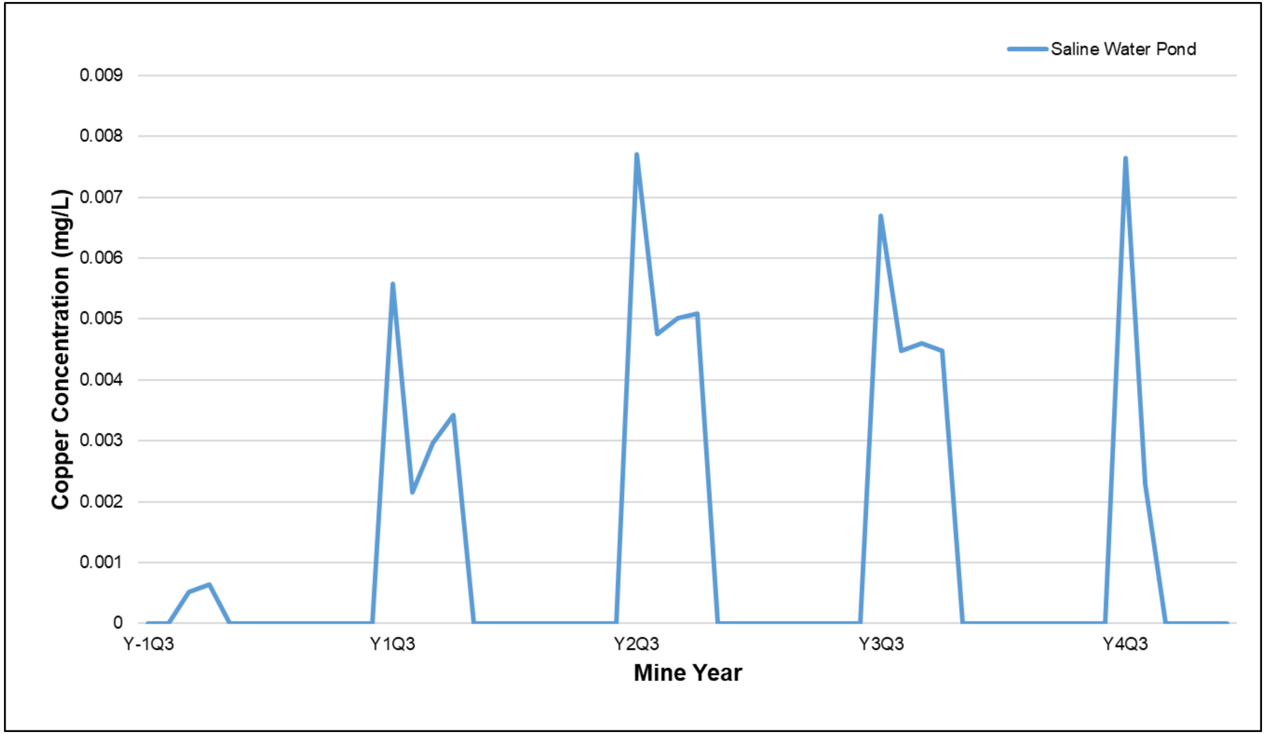
Arsenic



Saline Water Pond
Arsenic Concentration (mg/L)
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
Y-1Q3
Y1Q3
Y2Q3
Y3Q3
Y4Q3
Mine Year

Copper



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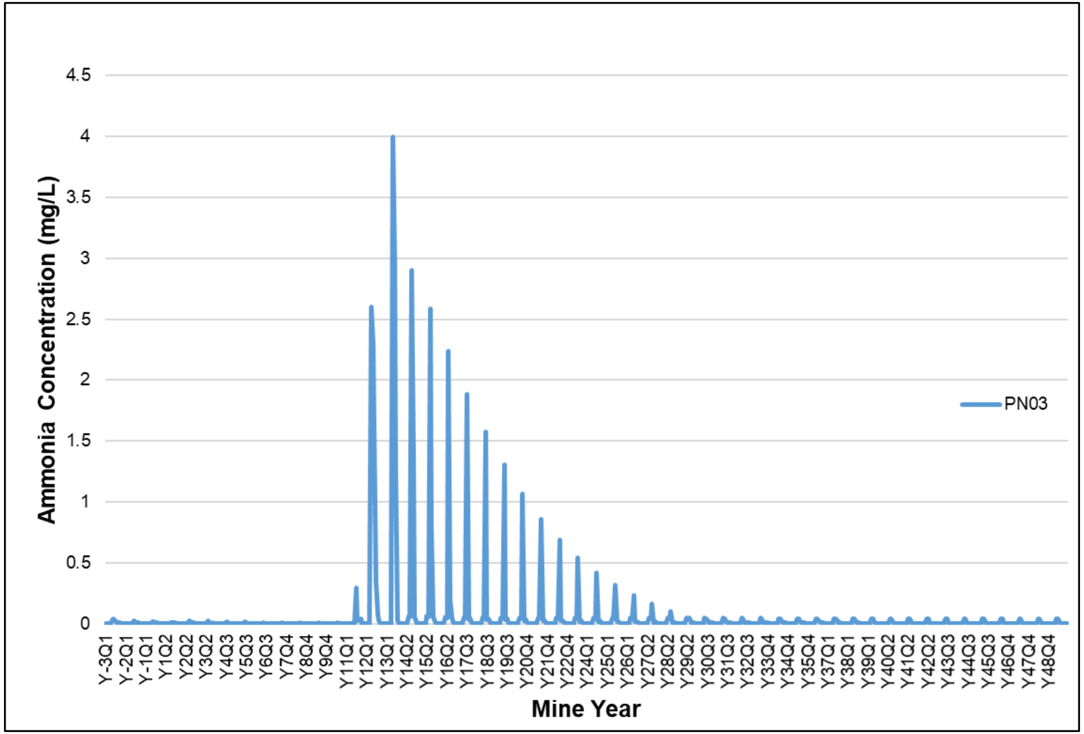
Attachment IR-B: Water Quality Results: Section 7 WLB Report

Water Quality Results: Section 7 WLB Report

Back River Project: Responses to Information Request for Water License (2AM-BRP1831) Amendment

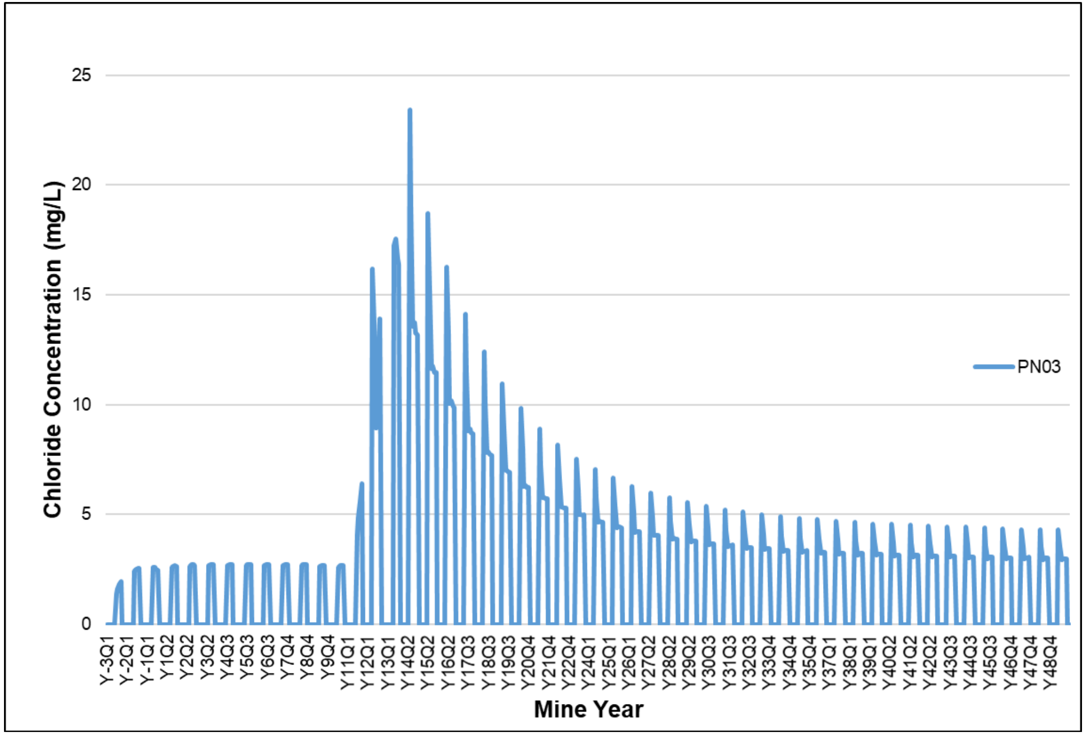
PN03

Ammonia



Ammonia Concentration (mg/L)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Y-3Q1
Y-2Q1
Y-1Q1
Y1Q2
Y2Q2
Y3Q2
Y4Q3
Y5Q3
Y6Q3
Y7Q4
Y8Q4
Y9Q4
Y11Q1
Y12Q1
Y13Q1
Y14Q2
Y15Q2
Y16Q2
Y17Q3
Y18Q3
Y19Q3
Y20Q4
Y21Q4
Y22Q4
Y24Q1
Y25Q1
Y26Q1
Y27Q2
Y28Q2
Y29Q2
Y30Q3
Y31Q3
Y32Q3
Y33Q4
Y34Q4
Y35Q4
Y37Q1
Y38Q1
Y39Q1
Y40Q2
Y41Q2
Y42Q2
Y43Q3
Y44Q3
Y45Q3
Y46Q4
Y47Q4
Y48Q4
Mine Year
PN03

Chloride



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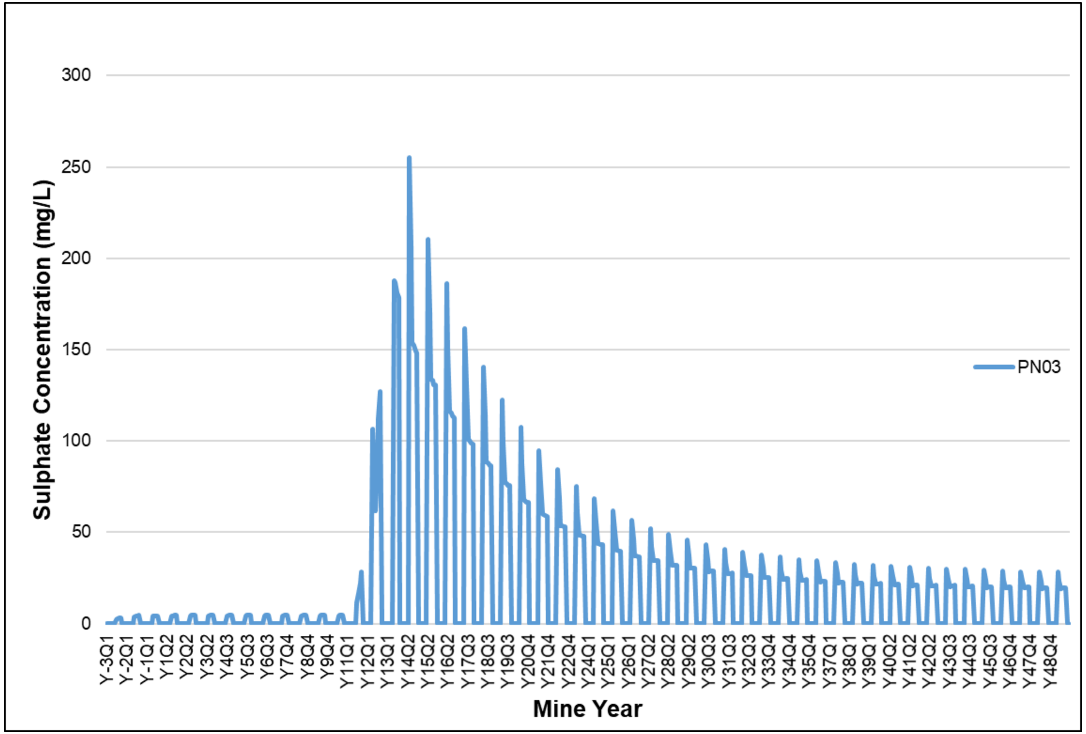
Sulphate



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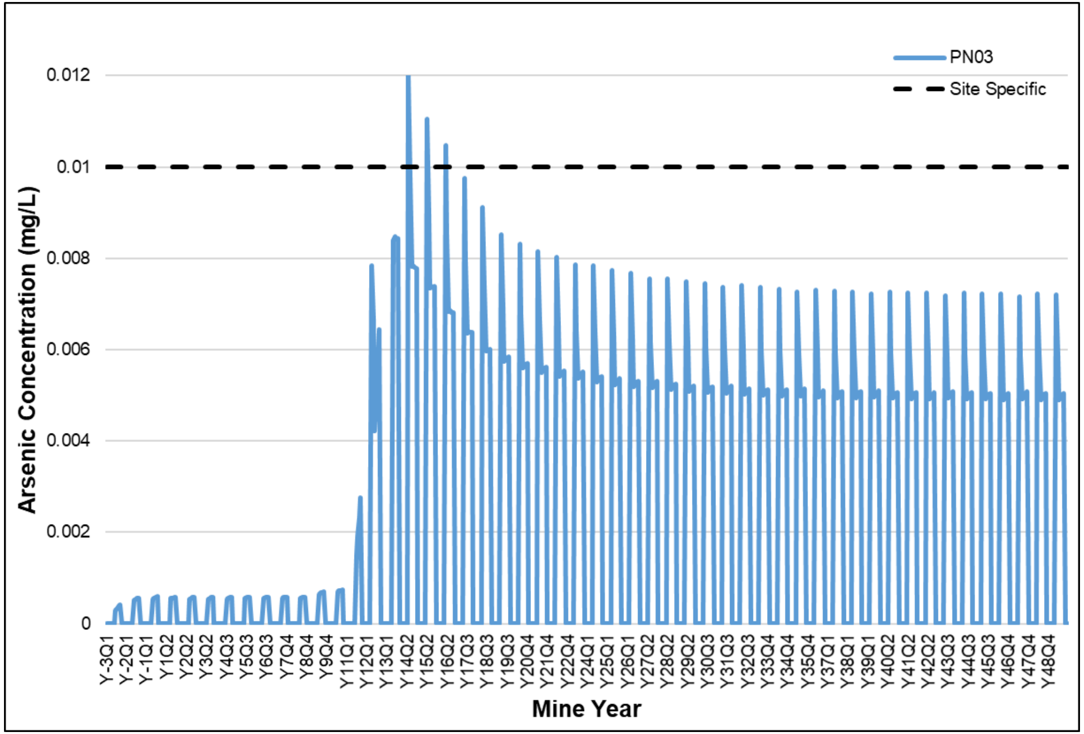
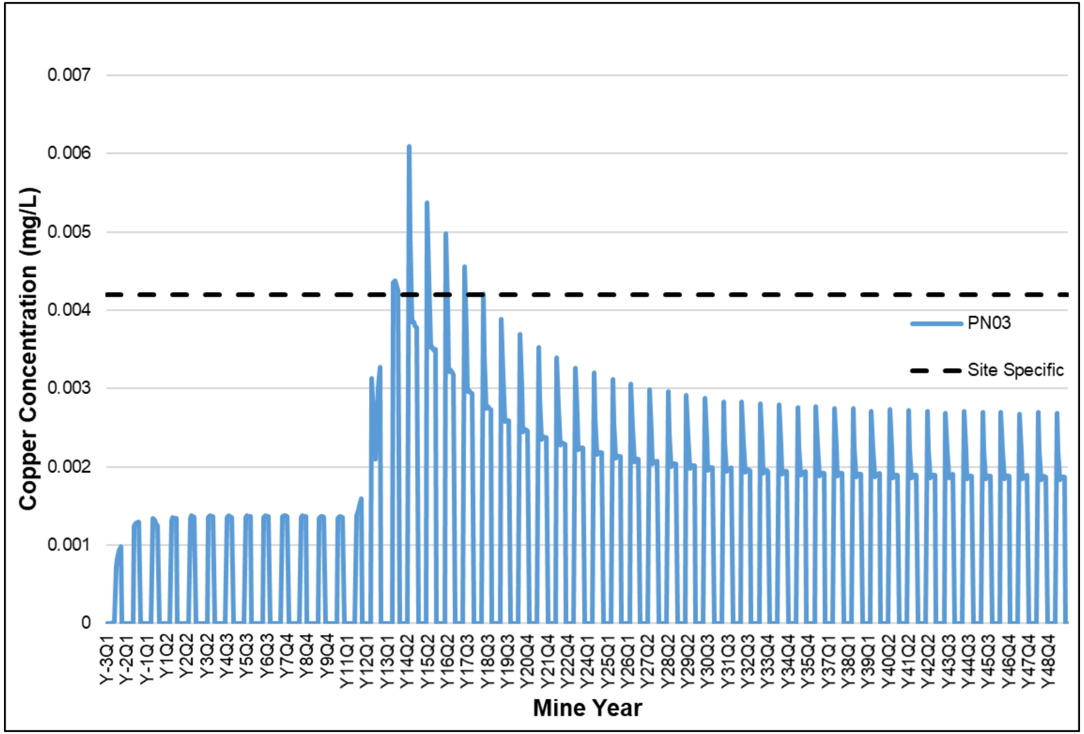
Arsenic



PN03
Site Specific
0.012
0.01
0.008
0.006
0.004
0.002
0
Arsenic Concentration (mg/L)
Y-3Q1
Y-2Q1
Y-1Q1
Y1Q2
Y2Q2
Y3Q2
Y4Q3
Y5Q3
Y6Q3
Y7Q4
Y8Q4
Y9Q4
Y11Q1
Y12Q1
Y13Q1
Y14Q2
Y15Q2
Y16Q2
Y17Q3
Y18Q3
Y19Q3
Y20Q4
Y21Q4
Y22Q4
Y24Q1
Y25Q1
Y26Q1
Y27Q2
Y28Q2
Y29Q2
Y30Q3
Y31Q3
Y32Q3
Y33Q4
Y34Q4
Y35Q4
Y37Q1
Y38Q1
Y39Q1
Y40Q2
Y41Q2
Y42Q2
Y43Q3
Y44Q3
Y45Q3
Y46Q4
Y47Q4
Y48Q4
Mine Year

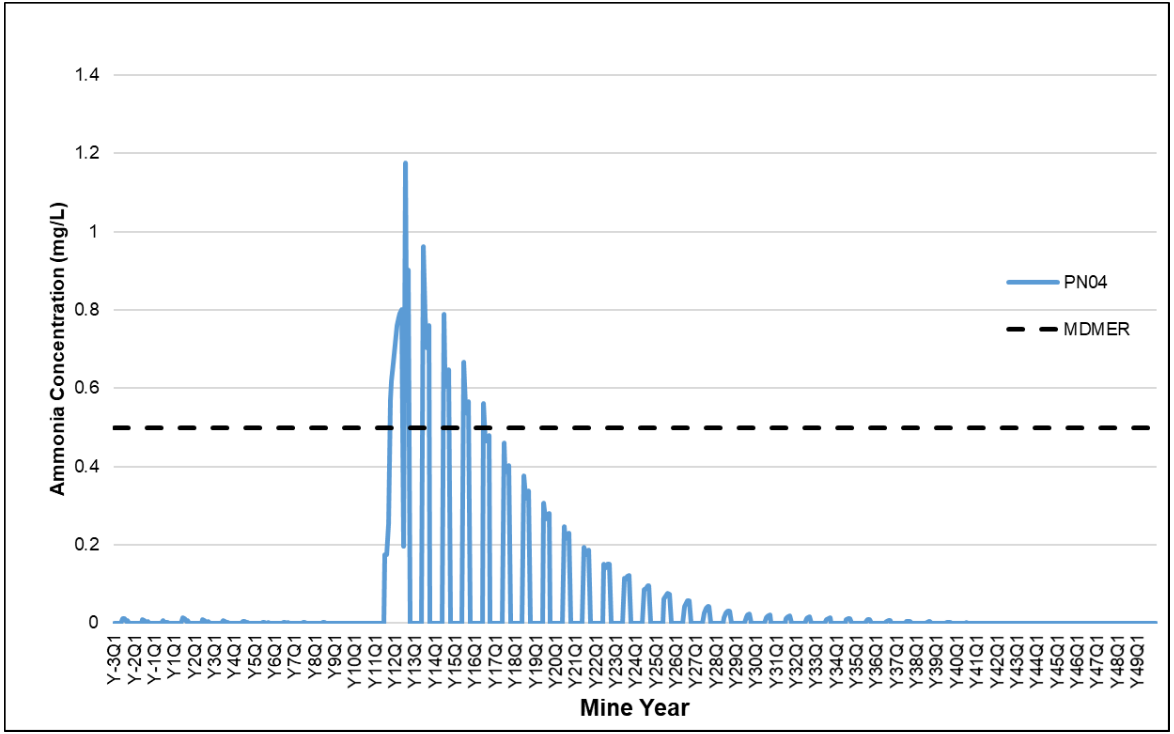
Copper



0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
Copper Concentration (mg/L)
Y-3Q1
Y-2Q1
Y-1Q1
Y1Q2
Y2Q2
Y3Q2
Y4Q3
Y5Q3
Y6Q3
Y7Q4
Y8Q4
Y9Q4
Y11Q1
Y12Q1
Y13Q1
Y14Q2
Y15Q2
Y16Q2
Y17Q3
Y18Q3
Y19Q3
Y20Q4
Y21Q4
Y22Q4
Y24Q1
Y25Q1
Y26Q1
Y27Q2
Y28Q2
Y29Q2
Y30Q3
Y31Q3
Y32Q3
Y33Q4
Y34Q4
Y35Q4
Y37Q1
Y38Q1
Y39Q1
Y40Q2
Y41Q2
Y42Q2
Y43Q3
Y44Q3
Y45Q3
Y46Q4
Y47Q4
Y48Q4
Mine Year
PN03
Site Specific

PN04

Ammonia



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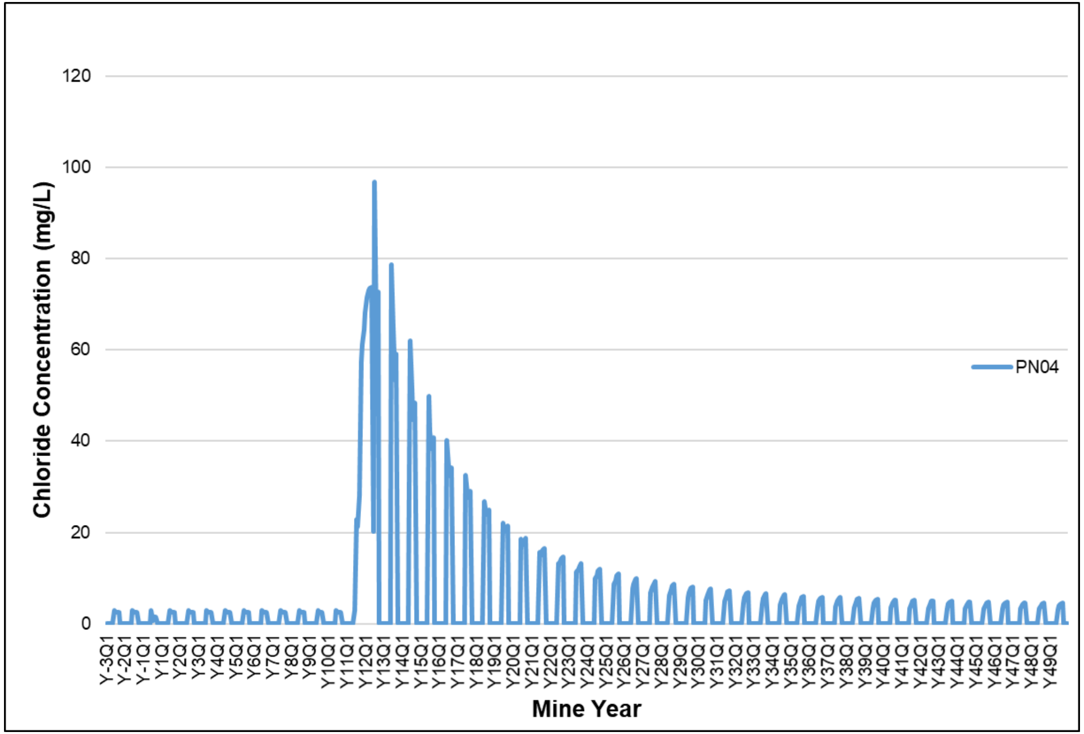
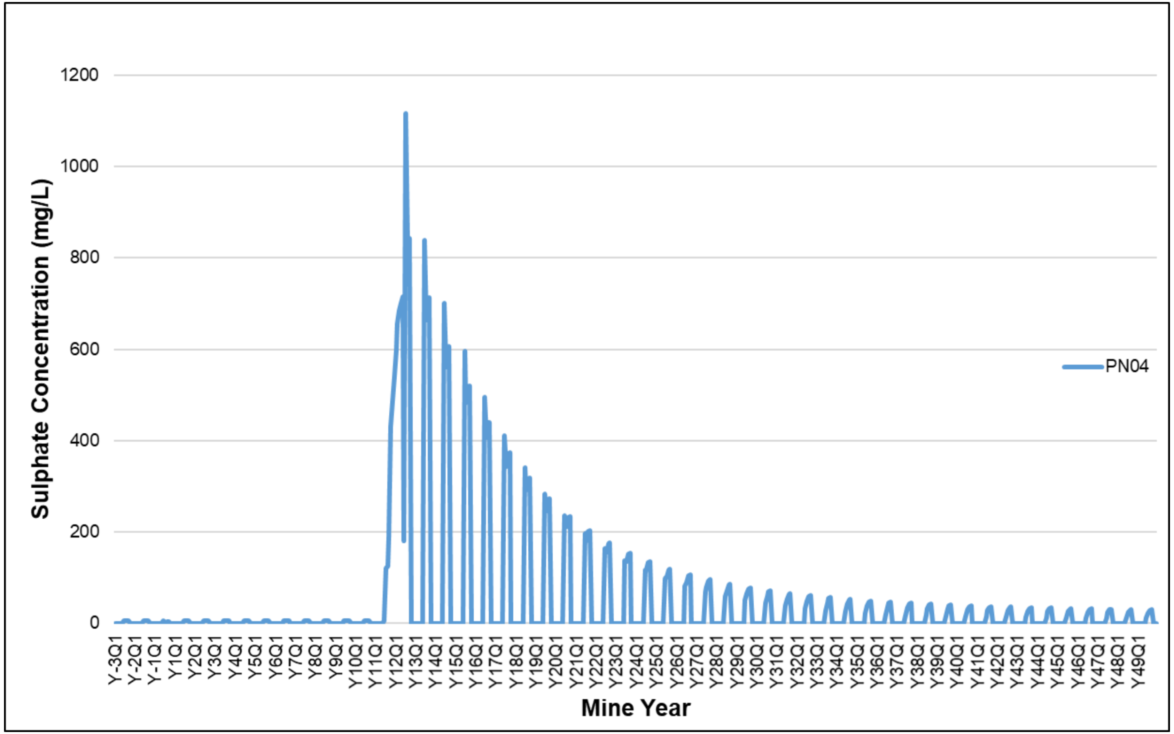
Chloride



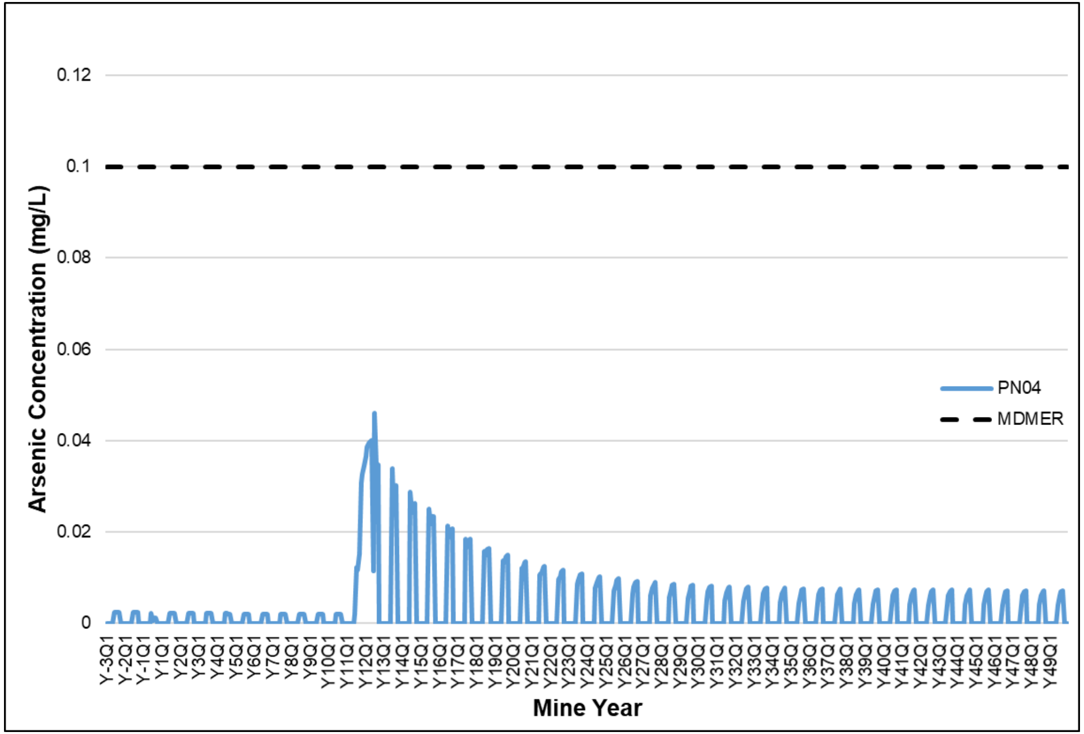
Chloride Concentration (mg/L)
120
100
80
60
40
20
0
PN04
Y-3Q1
Y-2Q1
Y-1Q1
Y1Q1
Y2Q1
Y3Q1
Y4Q1
Y5Q1
Y6Q1
Y7Q1
Y8Q1
Y9Q1
Y10Q1
Y11Q1
Y12Q1
Y13Q1
Y14Q1
Y15Q1
Y16Q1
Y17Q1
Y18Q1
Y19Q1
Y20Q1
Y21Q1
Y22Q1
Y23Q1
Y24Q1
Y25Q1
Y26Q1
Y27Q1
Y28Q1
Y29Q1
Y30Q1
Y31Q1
Y32Q1
Y33Q1
Y34Q1
Y35Q1
Y36Q1
Y37Q1
Y38Q1
Y39Q1
Y40Q1
Y41Q1
Y42Q1
Y43Q1
Y44Q1
Y45Q1
Y46Q1
Y47Q1
Y48Q1
Y49Q1
Mine Year

Sulphate



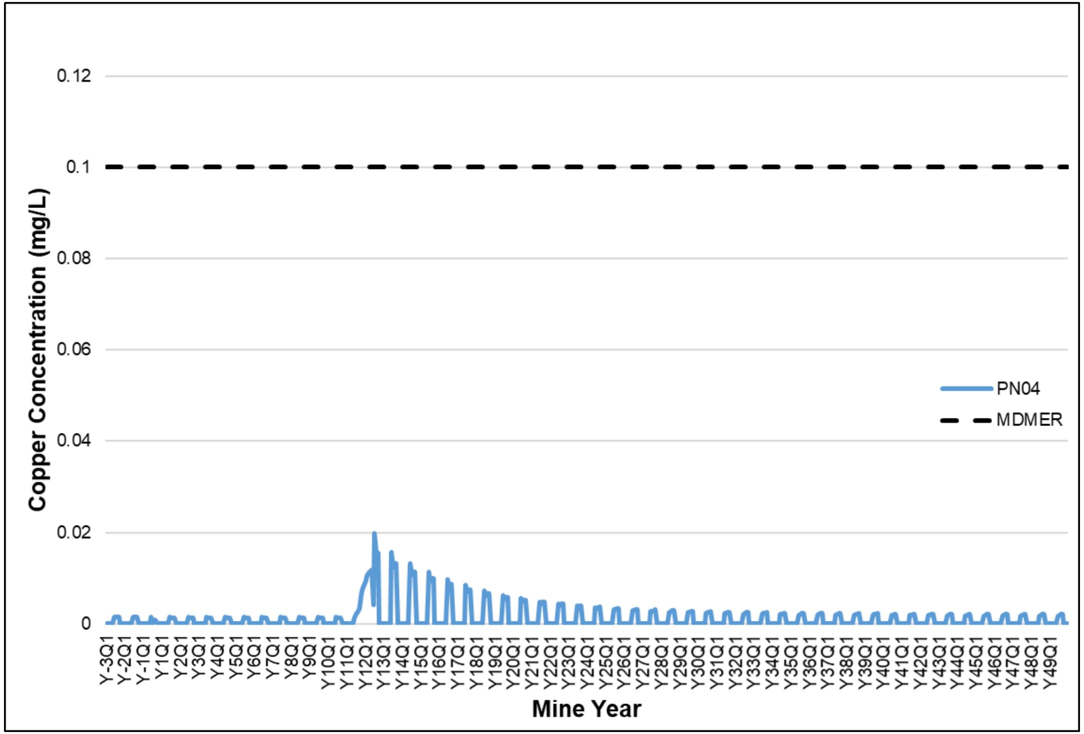
Sulphate Concentration (mg/L)
1200
1000
800
600
400
200
0
PN04
Mine Year
Y-3Q1
Y-2Q1
Y-1Q1
Y1Q1
Y2Q1
Y3Q1
Y4Q1
Y5Q1
Y6Q1
Y7Q1
Y8Q1
Y9Q1
Y10Q1
Y11Q1
Y12Q1
Y13Q1
Y14Q1
Y15Q1
Y16Q1
Y17Q1
Y18Q1
Y19Q1
Y20Q1
Y21Q1
Y22Q1
Y23Q1
Y24Q1
Y25Q1
Y26Q1
Y27Q1
Y28Q1
Y29Q1
Y30Q1
Y31Q1
Y32Q1
Y33Q1
Y34Q1
Y35Q1
Y36Q1
Y37Q1
Y38Q1
Y39Q1
Y40Q1
Y41Q1
Y42Q1
Y43Q1
Y44Q1
Y45Q1
Y46Q1
Y47Q1
Y48Q1
Y49Q1

Arsenic



srk consulting

Copper



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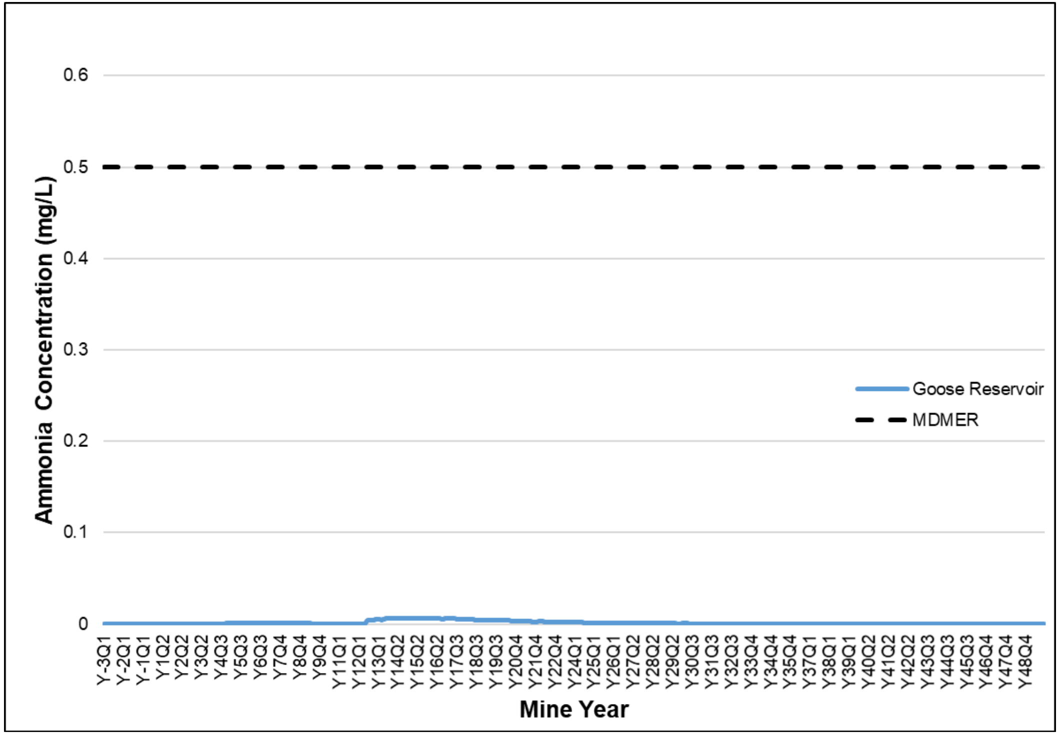
Goose Reservoir

Ammonia



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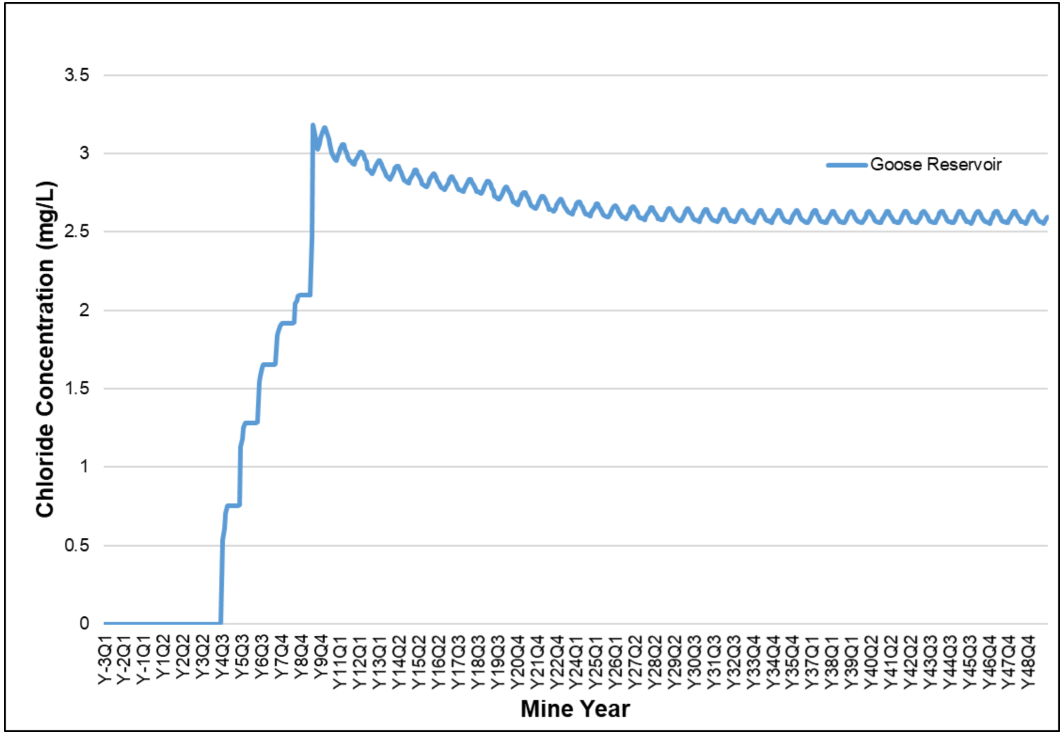
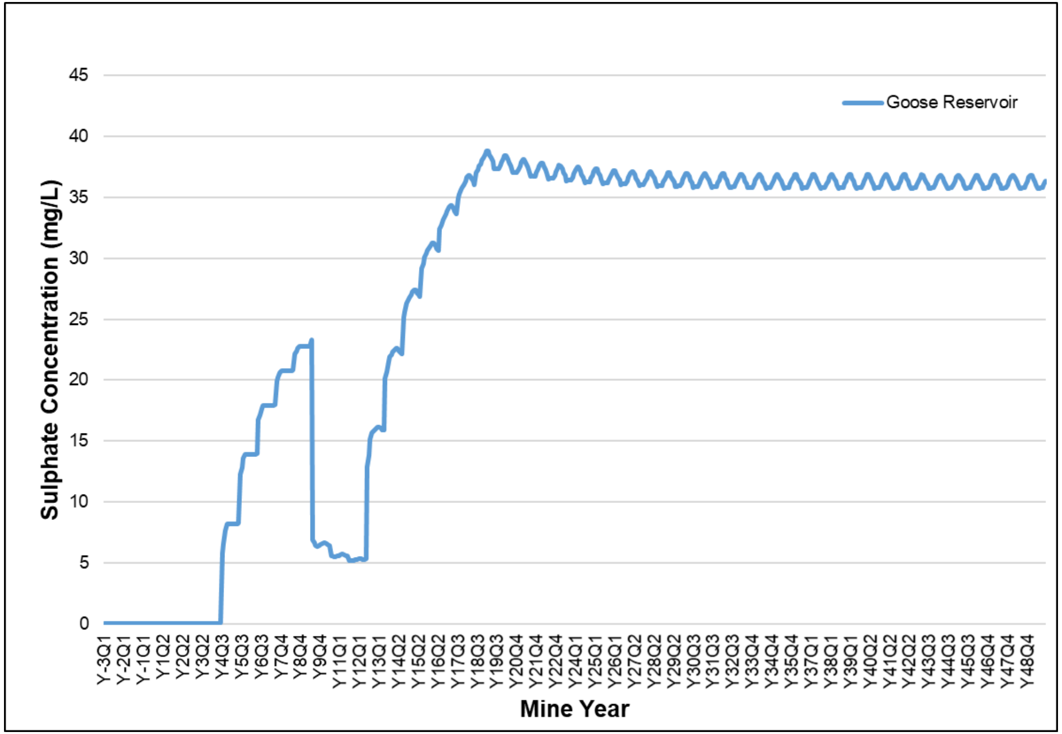
Chloride



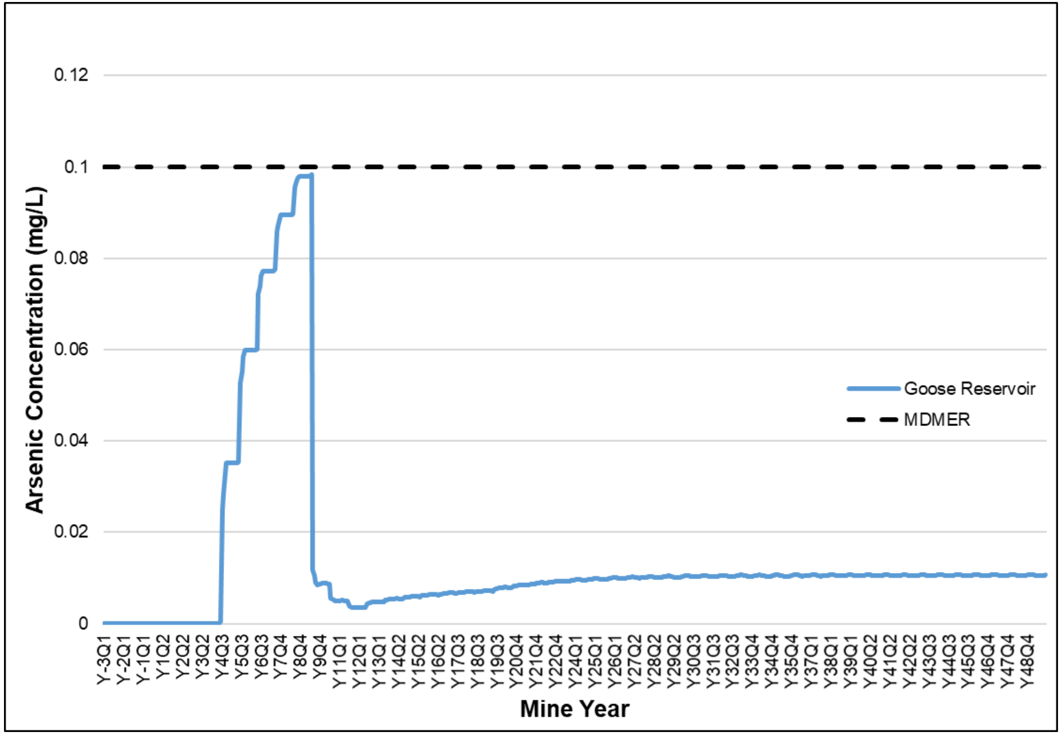
Chloride Concentration (mg/L)
3.5
3
2.5
2
1.5
1
0.5
0
Goose Reservoir
Y-3Q1 Y-2Q1 Y-1Q1 Y1Q2 Y2Q2 Y3Q2 Y4Q3 Y5Q3 Y6Q3 Y7Q4 Y8Q4 Y9Q4 Y11Q1 Y12Q1 Y13Q1 Y14Q2 Y15Q2 Y16Q2 Y17Q3 Y18Q3 Y19Q3 Y20Q4 Y21Q4 Y22Q4 Y24Q1 Y25Q1 Y26Q1 Y27Q2 Y28Q2 Y29Q2 Y30Q3 Y31Q3 Y32Q3 Y33Q4 Y34Q4 Y35Q4 Y37Q1 Y38Q1 Y39Q1 Y40Q2 Y41Q2 Y42Q2 Y43Q3 Y44Q3 Y45Q3 Y46Q4 Y47Q4 Y48Q4
Mine Year

Sulphate



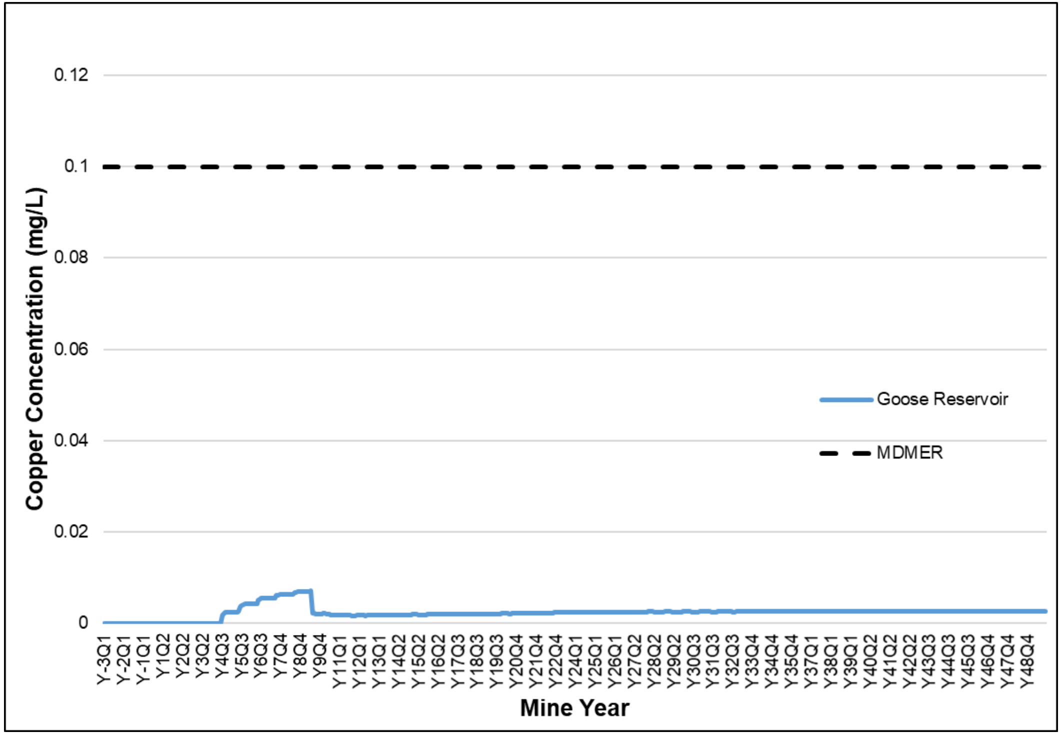
srk consulting

Arsenic



Arsenic Concentration (mg/L)
0.12
0.1
0.08
0.06
0.04
0.02
0
Goose Reservoir
MDMER
Y-3Q1
Y-2Q1
Y-1Q1
Y1Q2
Y2Q2
Y3Q2
Y4Q3
Y5Q3
Y6Q3
Y7Q4
Y8Q4
Y9Q4
Y11Q1
Y12Q1
Y13Q1
Y14Q2
Y15Q2
Y16Q2
Y17Q3
Y18Q3
Y19Q3
Y20Q4
Y21Q4
Y22Q4
Y24Q1
Y25Q1
Y26Q1
Y27Q2
Y28Q2
Y29Q2
Y30Q3
Y31Q3
Y32Q3
Y33Q4
Y34Q4
Y35Q4
Y37Q1
Y38Q1
Y39Q1
Y40Q2
Y41Q2
Y42Q2
Y43Q3
Y44Q3
Y45Q3
Y46Q4
Y47Q4
Y48Q4
Mine Year

Copper



Copper Concentration (mg/L)
0.12
0.1
0.08
0.06
0.04
0.02
0
Goose Reservoir
MDMER
Y-3Q1
Y-2Q1
Y-1Q1
Y1Q2
Y2Q2
Y3Q2
Y4Q3
Y5Q3
Y6Q3
Y7Q4
Y8Q4
Y9Q4
Y11Q1
Y12Q1
Y13Q1
Y14Q2
Y15Q2
Y16Q2
Y17Q3
Y18Q3
Y19Q3
Y20Q4
Y21Q4
Y22Q4
Y24Q1
Y25Q1
Y26Q1
Y27Q2
Y28Q2
Y29Q2
Y30Q3
Y31Q3
Y32Q3
Y33Q4
Y34Q4
Y35Q4
Y37Q1
Y38Q1
Y39Q1
Y40Q2
Y41Q2
Y42Q2
Y43Q3
Y44Q3
Y45Q3
Y46Q4
Y47Q4
Y48Q4
Mine Year

Attachment IR-C: Water Quality Prediction Results

Parameter	Goose Lake		Goose Pit		Llama TF		Primary Pond		TSF Reservoir		Saline Water Pond	
(mg/L)	Long-Term	Max	Long-Term	Max	Long-Term	Max	Long-Term	Max	Long-Term	Max	Long-Term	Max*
TDS	66	130	69	70	50	14000	NA	820	140	7900	NA	28000
TSS	3.9	6.3	2.7	3.1	2.9	3	NA	17	0.062	4.8	NA	2.5
Free_CN	DL	DL	DL	DL	DL	DL	NA	DL	DL	DL	NA	DL
Total_CN_N	0.0013	0.0021	0.0025	0.003	0.000029	0.49	NA	0.0024	DL	2.8	NA	0.0019
WAD_CN	0.000089	0.0077	DL	DL	0.000091	0.083	NA	DL	0.081	8.5	NA	DL
CNO_N	0.0016	0.52	0.0025	0.0029	0.00000027	16	NA	0.000013	DL	11	NA	0.000004
SCN_N	1E-25	0.26	DL	DL	DL	19	NA	DL	DL	12	NA	DL
Sulphate	29	400	36	39	19	3100	NA	570	1100	6200	NA	45
Chloride	4.4	36	2.6	3.2	3.9	8200	NA	2800	62	240	NA	17000
Ammonia_N	0.023	4	0.0048	0.2	0.000047	84	NA	44	5.2	57	NA	0.13
Nitrate_N	0.16	7.6	0.0049	0.32	0.12	47	NA	97	21	29	NA	0.84
Nitrite_N	0.13	0.76	0.00092	0.041	0.02	3.1	NA	4.9	1.4	2	NA	0.12
Alkalinity	13	21	17	17	10	31	NA	62	29	500	NA	15
Ortho_P	0.0054	0.016	0.00089	0.001	0.00099	0.15	NA	0.0058	0.0085	0.02	NA	0.052
Phosphate_P	0.0041	0.014	DL	DL	0.000036	0.52	NA	DL	0.0085	0.02	NA	0.18
TOC	5.5	8.7	3.9	4.7	4.2	4.3	NA	25	0.091	6.9	NA	3.5
Hardness	23	66	11	33	34	110000	NA	120	26	3900	NA	37000
Aluminum	0.26	0.39	0.35	2.2	0.18	2	NA	1.2	1.4	56	NA	0.37
Antimony	0.00024	0.00052	0.00031	0.0014	0.00018	0.01	NA	0.0011	0.0014	0.012	NA	0.0037
Arsenic	0.0073	0.019	0.011	0.098	0.0054	0.11	NA	0.092	0.065	0.49	NA	0.017
Barium	0.0096	0.025	0.0067	0.013	0.0094	14	NA	0.038	0.022	0.25	NA	5
Beryllium	0.00027	0.00042	0.00018	0.00022	0.00021	0.0026	NA	0.0012	0.0001	0.0043	NA	0.001
Bismuth	0.00066	0.0011	0.00045	0.00055	0.0005	0.1	NA	0.0029	0.00026	0.001	NA	0.037
Boron	0.019	0.029	0.0013	0.049	0.067	9.3	NA	0.25	0.055	2.2	NA	3.2
Cadmium	0.000015	0.000026	0.0000091	0.000058	0.000015	0.0021	NA	0.000058	0.000019	0.0012	NA	0.00074
Calcium	9.6	71	10	11	7.3	38000	NA	1600	130	1200	NA	13000
Chromium	0.00048	0.0011	0.00048	0.0027	0.00047	0.015	NA	0.0019	0.0026	0.049	NA	0.0053
Cobalt	0.002	0.0081	0.0024	0.0078	0.0015	0.054	NA	0.0097	0.024	0.36	NA	0.0083
Copper	0.0027	0.0095	0.0026	0.0071	0.0021	0.053	NA	0.0087	0.034	2.3	NA	0.0077
Iron	0.25	0.64	0.29	1.8	0.18	9	NA	1.8	2.5	140	NA	3.3
Lead	0.00012	0.00044	0.000058	0.00025	0.00021	0.01	NA	0.0012	0.00094	0.0044	NA	0.0037
Lithium	0.0019	0.01	0.00067	0.0081	0.0042	17	NA	0.022	0.0061	0.14	NA	5.9
Magnesium	2.7	10	2.4	3	1.9	2400	NA	51	18	280	NA	830
Manganese	0.043	0.065	0.06	0.061	0.029	6.9	NA	0.16	0.16	5	NA	2.4
Mercury	0.058	0.089	0.083	0.62	0.04	0.41	NA	0.25	0.2	4.7	NA	0.069
Molybdenum	0.00054	0.013	0.00059	0.00062	0.00046	0.11	NA	0.001	0.037	0.49	NA	0.035
Nickel	0.01	0.015	0.01	0.024	0.0073	0.04	NA	0.032	0.015	0.34	NA	0.017
Phosphorus	0.0091	0.018	0.0029	0.015	0.0087	7.8	NA	0.034	0.012	0.2	NA	2.7
Potassium	1.4	13	0.39	2.7	3.6	570	NA	13	31	65	NA	200
Selenium	0.00027	0.00083	0.0003	0.0011	0.00021	0.021	NA	0.00089	0.002	0.022	NA	0.0075
Silicon	1.2	2.1	0.87	5.9	2.3	10	NA	10	5	95	NA	1.4
Silver	0.000016	0.000029	0.000013	0.000027	0.000012	0.0021	NA	0.00006	0.000031	0.0004	NA	0.00074
Sodium	3.1	190	0.57	2.9	3.8	16000	NA	6.5	480	1000	NA	5600
Strontium	0.029	0.4	0.014	0.063	0.036	780	NA	0.19	0.24	3.2	NA	270
Tellerium	0.000027	0.000042	0.0000001	0.0016	0.0001	0.0014	NA	0.00069	0.000079	0.00095	NA	0.00016
Thallium	0.000068	0.00011	0.000045	0.000055	0.000056	0.01	NA	0.00029	0.000011	0.00037	NA	0.0037
Thorium	0.0000095	0.000024	0.000011	0.000085	0.000013	0.00016	NA	0.000064	0.000078	0.0013	NA	0.000011
Tin	0.00021	0.00033	0.000089	0.00026	0.0004	0.021	NA	0.0012	0.00038	0.01	NA	0.0074
Titanium	0.0044	0.0069	0.0059	0.048	0.0037	0.26	NA	0.024	0.021	0.32	NA	0.093
Uranium	0.00034	0.00053	0.000012	0.00069	0.0012	0.0021	NA	0.0049	0.00013	0.0043	NA	0.00077
Vanadium	0.00054	0.00084	0.00014	0.0022	0.0016	0.078	NA	0.0092	0.00035	0.016	NA	0.028
Zinc	0.0028	0.0043	0.0029	0.0057	0.002	0.71	NA	0.0089	0.0056	0.17	NA	0.25
Zirconium	0.00011	0.00017	0.000054	0.00033	0.00018	0.00029	NA	0.00062	0.000043	0.0045	NA	0.000081

Source: \\srk.ad\DFS\na\van\Projects\01_SITES\Back River\1CS020.017_2019 Water Mgmt & Earthworks Design\1100_Water_Load_Balance\Model\Results\Final_Back_River_PN_WQ_Results_2020-11-23_IR_LMP.xlsx

*Note: Maximum concentrations for Saline Water Pond are for summer months only (baseline). Results with cryoconcentration model are overestimated during other seasons.

Parameter	Umwelt Reservoir		PN01		PN02		PN03		PN04		PN05	
(mg/L)	Long-Term	Max	Long-Term	Max	Long-Term	Max	Long-Term	Max	Long-Term	Max	Long-Term	Max
TDS	200	360	18	91	20	91	25	91	16	270	21	66
TSS	1.4	8.8	1.5	3.9	1.5	3.9	1.5	3.9	0.9	2.9	0.88	3
Free_CN	DL	DL	DL	DL	DL	DL	DL	DL	DL	DL	DL	DL
Total_CN_N	0.0000039	0.0091	0.00098	0.0031	0.00088	0.0031	0.00058	0.0021	0.00051	0.033	0.00082	0.0031
WAD_CN	0.0031	0.015	0.000013	0.0049	0.000019	0.0049	0.000033	0.0049	0.000066	0.023	DL	DL
CNO_N	0.000000034	2.7	0.00022	0.2	0.00034	0.2	0.0006	0.52	0.000000082	5.4	0.00073	0.0025
SCN_N	DL	1.8	1.6E-26	0.091	1.9E-26	0.092	3.5E-26	0.26	DL	4.9	DL	DL
Sulphate	240	810	5.6	260	7.2	260	11	260	8	1100	11	35
Chloride	22	100	1.5	23	1.6	23	1.6	23	1.4	97	0.85	3
Ammonia_N	0.0000063	65	0.0052	2.6	0.0053	2.6	0.0081	4	0.001	35	0.0016	0.22
Nitrate_N	5.2	200	0.024	4.9	0.035	4.9	0.059	4.9	0.11	24	0.0016	0.35
Nitrite_N	0.38	10	0.021	0.52	0.026	0.52	0.047	0.52	0.0098	1.6	0.0003	0.018
Alkalinity	42	70	3.2	13	3.7	13	5	13	3	21	5.1	15
Ortho_P	0.0016	0.0058	0.0011	0.0092	0.0013	0.0092	0.0019	0.0092	0.00033	0.0089	0.00029	0.001
Phosphate_P	0.0012	0.0058	0.00062	0.008	0.00078	0.008	0.0014	0.008	0.000026	0.0088	DL	DL
TOC	2	14	2	5.4	2.1	5.4	2.1	5.4	1.2	4.6	1.3	4.8
Hardness	140	150	7.2	42	7.5	42	8.4	42	9.4	130	3.7	13
Aluminum	1.2	5.7	0.041	0.25	0.059	0.25	0.096	0.25	0.072	0.59	0.11	0.33
Antimony	0.00099	0.0047	0.00005	0.00033	0.000062	0.00033	0.00009	0.00033	0.00006	0.0011	0.000095	0.00029
Arsenic	0.041	0.4	0.0011	0.012	0.0016	0.012	0.0027	0.012	0.002	0.046	0.0032	0.0098
Barium	0.026	0.049	0.0032	0.016	0.0033	0.016	0.0036	0.016	0.0027	0.04	0.0022	0.007
Beryllium	0.0002	0.001	0.0001	0.00027	0.0001	0.00027	0.000099	0.00027	0.000064	0.0002	0.000059	0.0002
Bismuth	0.00042	0.0056	0.00026	0.0007	0.00025	0.0007	0.00025	0.0007	0.00016	0.00062	0.00015	0.0005
Boron	0.37	0.39	0.003	0.019	0.0043	0.019	0.007	0.019	0.016	0.06	0.00043	0.0024
Cadmium	0.000037	0.00022	0.0000054	0.000017	0.0000054	0.000017	0.0000056	0.000017	0.0000043	0.00002	0.000003	0.000011
Calcium	61	170	2.2	46	2.7	46	3.6	46	2.7	190	3.2	9.8
Chromium	0.0023	0.0064	0.00011	0.00068	0.00013	0.00068	0.00018	0.00068	0.00015	0.002	0.00015	0.00046
Cobalt	0.0097	0.047	0.00037	0.0052	0.00051	0.0052	0.00077	0.0052	0.00058	0.02	0.00074	0.0023
Copper	0.007	0.03	0.00082	0.0061	0.00088	0.0061	0.001	0.0061	0.00066	0.02	0.0008	0.0025
Iron	1	8.9	0.054	0.41	0.067	0.41	0.094	0.41	0.075	1.3	0.089	0.27
Lead	0.001	0.0028	0.000033	0.00028	0.000037	0.00028	0.000045	0.00028	0.000059	0.001	0.000019	0.000057
Lithium	0.023	0.08	0.00048	0.0065	0.00056	0.0065	0.00072	0.0065	0.0011	0.025	0.00022	0.0009
Magnesium	10	26	0.82	6.7	0.87	6.7	0.99	6.7	0.71	24	0.75	2.3
Manganese	0.14	0.35	0.008	0.042	0.011	0.042	0.016	0.042	0.009	0.078	0.018	0.056
Mercury	0.29	0.89	0.0081	0.057	0.012	0.057	0.022	0.057	0.016	0.089	0.025	0.078
Molybdenum	0.0063	0.022	0.000092	0.0081	0.00013	0.0081	0.0002	0.0081	0.00019	0.037	0.00018	0.00055
Nickel	0.025	0.16	0.0025	0.0098	0.0029	0.0098	0.0038	0.0098	0.0025	0.0079	0.0033	0.01
Phosphorus	0.041	0.049	0.0019	0.013	0.0023	0.013	0.0033	0.013	0.0023	0.019	0.00091	0.0028
Potassium	22	22	0.33	8.1	0.39	8.1	0.54	8.1	0.94	35	0.13	0.44
Selenium	0.0009	0.0037	0.00007	0.00053	0.000079	0.00053	0.000099	0.00053	0.000063	0.0018	0.000093	0.00028
Silicon	12	19	0.25	1.3	0.32	1.3	0.47	1.3	0.62	4	0.27	0.83
Silver	0.000022	0.00011	0.0000055	0.000018	0.0000056	0.000018	0.0000059	0.000018	0.0000038	0.000031	0.0000043	0.000013
Sodium	76	330	0.64	120	0.8	120	1.2	120	1.9	550	0.19	0.65
Strontium	0.26	0.83	0.0091	0.26	0.0096	0.26	0.011	0.26	0.012	1.1	0.0046	0.016
Tellerium	0.00057	0.0039	0.0000038	0.000027	0.0000057	0.000027	0.00001	0.000027	0.000024	0.000093	0.00000003	0.000039
Thallium	0.000072	0.00025	0.000026	0.000067	0.000025	0.000067	0.000025	0.000067	0.000017	0.000053	0.000015	0.00005
Thorium	0.000086	0.0002	0.0000013	0.000015	0.000002	0.000015	0.0000035	0.000015	0.000004	0.00006	0.0000032	0.0000098
Tin	0.0018	0.0018	0.000062	0.00021	0.000066	0.00021	0.000078	0.00021	0.0001	0.00042	0.000029	0.0001
Titanium	0.026	0.11	0.00067	0.0044	0.00098	0.0044	0.0017	0.0044	0.0014	0.011	0.0018	0.0055
Uranium	0.007	0.0074	0.000051	0.00034	0.000074	0.00034	0.00013	0.00034	0.0003	0.0011	0.0000038	0.000023
Vanadium	0.0084	0.013	0.000093	0.00054	0.00013	0.00054	0.0002	0.00054	0.00041	0.0015	0.000045	0.00014
Zinc	0.0072	0.038	0.0007	0.0027	0.00082	0.0027	0.001	0.0027	0.00069	0.0035	0.00091	0.0028
Zirconium	0.00074	0.00095	0.000035	0.00011	0.000037	0.00011	0.000041	0.00011	0.000048	0.00017	0.000018	0.000066

Source: \\srk.ad\DFS\na\van\Projects\01_SITES\Back River\1CS020.017_2019 Water Mgmt & Earthworks Design\1100_Water_Load_Balance\Model\Results\Final_Back_River_PN_WQ_Results_2020-11-23_IR_LMP.xlsx

Parameter	PN06		PN07		PN08		PN09		PN10	
(mg/L)	Long-Term	Max	Long-Term	Max	Long-Term	Max	Long-Term	Max	Long-Term	Max
TDS	9.1	33	DL	DL	9.2	33	9.3	33	9.1	33
TSS	0.99	3	DL	DL	0.98	3	0.98	3	0.99	3
Free_CN	DL	DL	DL	DL	DL	DL	DL	DL	DL	DL
Total_CN_N	0.00082	0.0031	DL	DL	0.00082	0.0031	0.00082	0.0031	0.00082	0.0031
WAD_CN	DL	DL	DL	DL	DL	DL	DL	DL	DL	DL
CNO_N	DL	DL	DL	DL	DL	DL	DL	DL	DL	DL
SCN_N	DL	DL	DL	DL	DL	DL	DL	DL	DL	DL
Sulphate	1.5	4.8	DL	DL	1.6	5	1.6	5	1.5	4.8
Chloride	0.91	3	DL	DL	0.91	3	0.91	3	0.91	3
Ammonia_N	0.0016	0.15	DL	DL	0.0016	0.022	0.0016	1.4	0.0016	0.075
Nitrate_N	0.0016	0.24	DL	DL	0.0016	0.35	0.0016	2.2	0.0016	0.12
Nitrite_N	0.00033	0.013	DL	DL	0.00033	0.018	0.00033	0.11	0.00033	0.0067
Alkalinity	1.3	4.5	DL	DL	1.3	4.6	1.4	4.6	1.3	4.5
Ortho_P	0.00033	0.001	DL	DL	0.00033	0.00099	0.00033	0.00099	0.00033	0.001
Phosphate_P	DL	DL	DL	DL	DL	DL	DL	DL	DL	DL
TOC	1.3	4.8	DL	DL	1.3	4.8	1.2	4.8	1.3	4.8
Hardness	4	13	DL	DL	4	13	4	13	4	13
Aluminum	0.0056	0.035	DL	DL	0.0095	0.046	0.011	0.052	0.0047	0.032
Antimony	0.000017	0.000051	DL	DL	0.000018	0.000055	0.000019	0.000057	0.000016	0.00005
Arsenic	0.000083	0.00025	DL	DL	0.00014	0.00044	0.00017	0.00053	0.000069	0.00021
Barium	0.0019	0.0069	DL	DL	0.0019	0.0069	0.0019	0.0069	0.0019	0.0069
Beryllium	0.000066	0.0002	DL	DL	0.000065	0.0002	0.000065	0.0002	0.000066	0.0002
Bismuth	0.00016	0.0005	DL	DL	0.00016	0.0005	0.00016	0.0005	0.00016	0.0005
Boron	0.00039	0.0017	DL	DL	0.00038	0.0017	0.00038	0.0017	0.00039	0.0017
Cadmium	0.0000033	0.00001	DL	DL	0.0000033	0.00001	0.0000033	0.0000099	0.0000033	0.00001
Calcium	0.9	3.1	DL	DL	0.92	3.2	0.93	3.2	0.9	3.1
Chromium	0.000042	0.0002	DL	DL	0.000046	0.00022	0.000048	0.00022	0.000041	0.0002
Cobalt	0.000091	0.00067	DL	DL	0.00012	0.00074	0.00013	0.00078	0.000085	0.00065
Copper	0.00044	0.0015	DL	DL	0.00045	0.0015	0.00045	0.0015	0.00044	0.0015
Iron	0.02	0.068	DL	DL	0.023	0.077	0.024	0.081	0.019	0.066
Lead	0.000016	0.00005	DL	DL	0.000017	0.00005	0.000017	0.000051	0.000016	0.00005
Lithium	0.00022	0.00082	DL	DL	0.00022	0.00082	0.00022	0.00081	0.00022	0.00082
Magnesium	0.45	1.4	DL	DL	0.46	1.4	0.46	1.4	0.45	1.4
Manganese	0.0021	0.012	DL	DL	0.0023	0.013	0.0024	0.013	0.002	0.012
Mercury	0.00024	0.00072	DL	DL	0.0013	0.004	0.0018	0.0056	0.0000003	0.0000014
Molybdenum	0.000017	0.000051	DL	DL	0.000018	0.000054	0.000018	0.000056	0.000016	0.00005
Nickel	0.0011	0.0054	DL	DL	0.0012	0.0056	0.0012	0.0057	0.0011	0.0053
Phosphorus	0.00064	0.002	DL	DL	0.00065	0.002	0.00065	0.0021	0.00063	0.002
Potassium	0.12	0.4	DL	DL	0.12	0.4	0.12	0.4	0.12	0.4
Selenium	0.000033	0.0001	DL	DL	0.000033	0.0001	0.000033	0.0001	0.000033	0.0001
Silicon	0.074	0.37	DL	DL	0.082	0.39	0.085	0.4	0.072	0.36
Silver	0.0000033	0.00001	DL	DL	0.0000033	0.00001	0.0000033	0.00001	0.0000033	0.00001
Sodium	0.2	0.63	DL	DL	0.2	0.63	0.2	0.63	0.2	0.63
Strontium	0.005	0.016	DL	DL	0.005	0.016	0.005	0.016	0.005	0.016
Tellerium	2.2E-10	6.7E-10	DL	DL	1.2E-09	3.7E-09	1.7E-09	5.2E-09	DL	DL
Thallium	0.000016	0.00005	DL	DL	0.000016	0.00005	0.000016	0.00005	0.000016	0.00005
Thorium	0.00000003	0.000000091	DL	DL	0.00000017	0.0000005	0.00000023	0.0000007	DL	DL
Tin	0.000033	0.0001	DL	DL	0.000033	0.000099	0.000033	0.000099	0.000033	0.0001
Titanium	0.000058	0.00026	DL	DL	0.00013	0.00048	0.00017	0.00059	0.000042	0.00021
Uranium	0.0000033	0.00001	DL	DL	0.0000033	0.00001	0.0000033	0.00001	0.0000033	0.00001
Vanadium	0.000018	0.000058	DL	DL	0.00002	0.000061	0.00002	0.000063	0.000018	0.000057
Zinc	0.00032	0.0014	DL	DL	0.00034	0.0015	0.00035	0.0015	0.00031	0.0014
Zirconium	0.00002	0.00006	DL	DL	0.00002	0.00006	0.00002	0.00006	0.00002	0.00006

Source: \\srk.ad\DFS\na\van\Projects\01_SITES\Back River\1CS020.017_2019 Water Mgmt & Earthworks Design\1100_Water_Load_Balance\Model\Results\Final_Back_River_PN_WQ_Results_2020-11-23_IR_LMP.xlsx

Water Quality Prediction with Treatment

Parameter	Goose Lake		Goose Pit		Llama TF		Primary Pond		TSF Reservoir		Umwelt Pond	
(mg/L)	Post-Clos	Max	Post-Clos	Max	Post-Clos	Max	Post-Clos	Max	Post-Clos	Max	Post-Clos	Max
Alkalinity	9.463	20.56	16.34	16.79	10.01	31.67	0	66.45	22.7	498.5	0	992.9
Aluminum	0.1824	0.3943	0.3429	2.15	0.1754	2.348	0	1.441	1.069	55.65	0	25.16
Ammonia_N	0.00786	2.014	0.004562	0.1996	7.48E-05	144.7	0	185.6	4.035	57.3	0	0.889
Antimony	0.0001694	0.0005179	0.0003094	0.001348	0.0001753	0.006119	0	0.001156	0.001118	0.01221	0	0.2222
Arsenic	0.005131	0.01875	0.01047	0.09796	0.005191	0.2145	0	0.09859	0.05038	0.4936	0	1.166
Barium	0.006847	0.02512	0.006603	0.01224	0.009059	6.755	0	0.03754	0.01746	0.2507	0	287.8
Beryllium	0.000187	0.0004221	0.0001768	0.0002401	0.0002028	0.001221	0	0.001163	8.07E-05	0.004264	0	0.06353
Bismuth	0.0004651	0.001088	0.0004424	0.0006014	0.0004907	0.04876	0	0.002909	0.0002056	0.001041	0	2.114
Boron	0.01353	0.02917	0.001331	0.04858	0.06495	4.32	0	0.2368	0.04274	2.244	0	184.2
Cadmium	1.05E-05	2.56E-05	8.98E-06	5.68E-05	1.44E-05	0.0009867	0	5.83E-05	1.51E-05	0.001241	0	0.04289
Calcium	6.702	71.74	10.34	10.62	6.848	17717	0	1570	105.3	1224	0	753961
Chloride	3.075	36.49	2.564	3.474	3.657	3847	0	2768	48.67	217	0	1044000
Chromium	0.0003464	0.001066	0.0004782	0.002626	0.0004594	0.01115	0	0.002123	0.002022	0.04854	0	0.3224
CNO_N	0.001142	0.3932	0.002456	0.002912	3.08E-06	35.5	0	6.71E-05	0	10.06	0	0.0001991
Cobalt	0.001453	0.00807	0.002378	0.007701	0.001409	0.1056	0	0.01126	0.0187	0.3623	0	0.5527
Copper	0.00192	0.009474	0.002525	0.006919	0.001968	0.1049	0	0.00872	0.02679	2.261	0	0.5152
Free_CN	0	0	0	0	0	0	0	0	0	0	0	0
Hardness	16.02	66.12	11.2	31.18	33.31	49830	0	116.3	19.99	3862	0	2121000
Iron	0.1784	0.6379	0.2841	1.749	0.1686	6.791	0	1.929	1.914	137.7	0	201
Lead	8.47E-05	0.0004384	5.72E-05	0.0002469	0.0002009	0.005534	0	0.001184	0.0007325	0.004414	0	0.2139
Lithium	0.001365	0.01013	0.0006636	0.008002	0.004064	7.863	0	0.0211	0.004793	0.142	0	334.8
Magnesium	1.863	10.45	2.359	2.851	1.849	1107	0	54.01	14.02	282.6	0	47212
Manganese	0.03048	0.06525	0.05911	0.06064	0.02831	3.213	0	0.1761	0.1242	4.954	0	137.9
Mercury	0.04084	0.08911	0.08225	0.62	0.0388	0.3762	0	0.2683	0.1526	4.694	0	4.624
Molybdenum	0.0003622	0.01272	0.000587	0.0006144	0.0003886	0.2268	0	0.001071	0.02912	0.4904	0	1.99
Nickel	0.007192	0.01525	0.01032	0.02297	0.007131	0.03351	0	0.03761	0.01139	0.3425	0	1.107
Nitrate_N	0.09924	7.606	0.004651	0.3217	0.0907	46.8	0	300.9	16.19	28.9	0	55.11
Nitrite_N	0.06426	0.7473	0.0008958	0.04106	0.01776	3.196	0	15.05	1.113	1.995	0	8.284
Ortho_P	0.002789	0.01485	0.000884	0.001025	0.0009479	0.06865	0	0.005816	0.006662	0.02017	0	2.974
Phosphate_P	0.001872	0.01285	0	0	1.99E-05	0.2436	0	0	0.006646	0.02004	0	10.36
Phosphorus	0.00541	0.01807	0.002833	0.01477	0.008471	3.654	0	0.03316	0.009577	0.1973	0	155.7
Potassium	1.022	12.68	0.3828	2.665	3.432	265.8	0	12.19	24.12	65.02	0	11347
SCN_N	1.92E-29	0.3186	0	0	0	40.36	0	0	0	11.44	0	0
Selenium	0.0001875	0.0008274	0.0002988	0.001094	0.0001976	0.01089	0	0.0009453	0.00158	0.02154	0	0.4335
Silicon	0.8985	2.095	0.8578	5.849	2.264	20.1	0	10.44	3.907	95.31	0	92.03
Silver	1.12E-05	2.87E-05	1.33E-05	2.56E-05	1.15E-05	0.000986	0	6.00E-05	2.44E-05	0.0004026	0	0.04268
Sodium	1.967	188.1	0.56	2.858	2.781	7530	0	6.171	372.2	1008	0	320385
Strontium	0.02021	0.4024	0.01388	0.06053	0.03357	365.4	0	0.1763	0.1862	3.194	0	15549
Sulphate	19.93	398	35.81	38.84	16.98	6369	0	606.7	879.6	6246	0	2902
TDS	46.99	130.4	68.09	69.88	48.28	6412	0	877.8	112	7907	0	1742000
Tellerium	1.93E-05	4.17E-05	8.73E-08	0.001628	0.0001003	0.001306	0	0.0006576	6.14E-05	0.0009504	0	0.01091
Thallium	4.77E-05	0.0001056	4.46E-05	6.13E-05	5.46E-05	0.004873	0	0.0002913	8.92E-06	0.0003708	0	0.2102
Thorium	6.72E-06	2.36E-05	1.04E-05	8.46E-05	1.23E-05	0.0003179	0	7.22E-05	6.13E-05	0.001309	0	0.000741
Tin	0.0001482	0.0003269	8.84E-05	0.0002492	0.0003876	0.009861	0	0.001176	0.0002935	0.01018	0	0.4265
Titanium	0.003152	0.006859	0.005801	0.0477	0.003627	0.1226	0	0.02863	0.01635	0.3241	0	5.576
TOC	3.959	8.687	3.864	4.614	4.063	4.33	0	24.88	0.07064	6.944	0	226.2
Total_CN_N	0.001183	0.001855	0.002507	0.002983	4.40E-05	1.059	0	0.002324	0	1.372	0	0.07411
TSS	2.756	6.332	2.652	3.076	2.787	2.986	0	17.45	0.04848	4.758	0	159.3
Uranium	0.0002426	0.0005251	1.15E-05	0.0006911	0.0012	0.001286	0	0.004654	0.0001042	0.004255	0	0.04749
Vanadium	0	0	0	0	0	0	0	0	0	0	0	0
WAD_CN	0.000384	0.0008343	0.0001418	0.002215	0.001569	0.03665	0	0.008829	0.0002736	0.01592	0	1.599
Zinc	5.25E-05	0.007695	0	0	5.00E-05	0.1859	0	0	0.06349	8.498	0	0
Zirconium	0.001995	0.004263	0.002881	0.005497	0.00198	0.3323	0	0.01021	0.0044	0.1737	0	14.27

Parameter	Umwelt Reservoir		PN01		PN02		PN03		PN04		PN05	
(mg/L)	Post-Clos	Max	Post-Clos	Max	Post-Clos	Max	Post-Clos	Max	Post-Clos	Max	Post-Clos	Max
Alkalinity	42.17	5453	5.512	10.16	7.254	10.16	9.463	10.16	7.463	20.6	11.69	15.47
Aluminum	1.199	615.2	0.05997	0.1949	0.1141	0.1949	0.1824	0.1949	0.1797	0.5684	0.2457	0.3255
Ammonia_N	9.89E-06	3380	0.005088	1.478	0.006057	1.482	0.00786	1.594	0.002294	14.87	0.003484	0.2573
Antimony	0.000977	0.2214	8.31E-05	0.0002545	0.0001212	0.0002545	0.0001694	0.0002545	0.0001492	0.0008622	0.0002209	0.0002914
Arsenic	0.03972	9.674	0.001549	0.009219	0.003134	0.009219	0.005132	0.009219	0.005075	0.03982	0.007409	0.009775
Barium	0.02535	1.975	0.006073	0.01232	0.006409	0.01232	0.006849	0.01232	0.006456	0.03199	0.004973	0.006962
Beryllium	0.0001962	0.0002288	0.0001992	0.0002142	0.0001934	0.0002142	0.000187	0.0002138	0.0001475	0.0001961	0.0001353	0.0001995
Bismuth	0.0004167	0.001643	0.0004973	0.0005491	0.0004821	0.0005491	0.0004651	0.0005491	0.0003596	0.0005979	0.0003387	0.0004986
Boron	0.3741	0.3874	0.00453	0.01441	0.008517	0.01441	0.01353	0.01441	0.04146	0.05717	0.001003	0.002329
Cadmium	3.68E-05	0.0002857	1.03E-05	1.29E-05	1.03E-05	1.29E-05	1.05E-05	1.31E-05	1.03E-05	1.80E-05	6.87E-06	1.08E-05
Calcium	55.86	3624	3.835	35.21	5.101	35.21	6.705	35.21	6.64	154.7	7.416	9.814
Chloride	19.79	90.84	2.89	17.95	2.968	17.95	3.077	17.95	3.276	82.22	1.957	2.992
Chromium	0.002295	0.6729	0.0001858	0.0005237	0.0002568	0.0005237	0.0003464	0.0005237	0.0003703	0.001574	0.0003475	0.0004645
CNO_N	4.08E-07	2.543	0.0003055	0.173	0.0006725	0.1798	0.001142	0.3887	8.74E-07	4.002	0.001707	0.002515
Cobalt	0.009369	3.98	0.0005824	0.003971	0.0009682	0.003971	0.001454	0.003971	0.001424	0.01516	0.001712	0.00229
Copper	0.006366	0.8001	0.001519	0.004088	0.001691	0.004088	0.001913	0.004088	0.001537	0.01272	0.001851	0.002454
Free_CN	0	0	0	0	0	0	0	0	0	0	0	0
Hardness	142.1	147.8	13.43	32.48	14.56	32.48	16.03	32.48	23.17	98.93	8.554	12.96
Iron	0.9914	466.1	0.0912	0.3138	0.1297	0.3138	0.1784	0.3138	0.1822	1.046	0.2058	0.2722
Lead	0.001007	0.02645	6.01E-05	0.0002155	7.09E-05	0.0002155	8.48E-05	0.0002155	0.0001481	0.000773	4.31E-05	5.69E-05
Lithium	0.02239	0.0288	0.0008597	0.004957	0.001083	0.004957	0.001366	0.004957	0.00274	0.01927	0.0005037	0.000887
Magnesium	9.241	968.8	1.527	5.25	1.673	5.259	1.863	5.494	1.701	23.87	1.737	2.286
Manganese	0.1438	33.04	0.01282	0.03225	0.02063	0.03225	0.03048	0.03225	0.02235	0.07572	0.04196	0.05582
Mercury	0.2942	167.4	0.01109	0.04405	0.02425	0.04405	0.04084	0.04405	0.0412	0.08857	0.05886	0.07765
Molybdenum	0.005634	0.1796	0.0001354	0.006241	0.0002361	0.006241	0.0003633	0.006241	0.0004748	0.02769	0.0004144	0.0005468
Nickel	0.0247	13.08	0.004357	0.007535	0.00561	0.007535	0.007192	0.007535	0.005969	0.009163	0.007525	0.01009
Nitrate_N	4.563	5520	0.03026	4.116	0.06076	4.125	0.09922	4.377	0.2938	23.02	0.003547	0.4142
Nitrite_N	0.3411	276	0.01759	0.3215	0.03713	0.3215	0.06427	0.3215	0.02564	1.397	0.000685	0.02146
Ortho_P	0.001462	0.005777	0.00148	0.004757	0.002021	0.004757	0.002789	0.005814	0.0007439	0.006957	0.0006767	0.0009973
Phosphate_P	0.001058	0.005774	0.0004889	0.00377	0.001064	0.00377	0.001872	0.004902	6.61E-05	0.0066	0	0
Phosphorus	0.04149	2.228	0.002876	0.007358	0.003957	0.007358	0.00541	0.007624	0.00591	0.01529	0.002112	0.002792
Potassium	21.38	77.34	0.557	6.224	0.763	6.224	1.023	6.224	2.419	26.43	0.2905	0.4359
SCN_N	0	1.695	3.10E-30	0.08295	9.52E-30	0.1444	1.90E-29	0.3136	0	3.558	0	0
Selenium	0.0008699	0.0738	0.0001251	0.0004063	0.0001526	0.0004063	0.0001876	0.0004063	0.0001545	0.001396	0.0002152	0.0002839
Silicon	12.28	1207	0.4054	1.029	0.6237	1.029	0.8986	1.029	1.59	3.194	0.6231	0.8334
Silver	2.12E-05	0.003248	1.05E-05	1.41E-05	1.08E-05	1.41E-05	1.12E-05	1.41E-05	8.76E-06	2.59E-05	9.87E-06	1.30E-05
Sodium	66.44	330.9	0.9927	92.28	1.43	92.28	1.982	92.28	4.866	411.4	0.4281	0.6452
Strontium	0.2363	0.7567	0.01679	0.1978	0.01829	0.1978	0.02024	0.1978	0.02948	0.8219	0.0106	0.01625
Sulphate	216	7955	8.879	195.4	13.77	195.4	19.96	195.4	20.21	832.1	25.35	35.05
TDS	188.9	19333	33.28	80.33	39.3	80.43	46.99	83.14	37.78	272.9	49.39	65.57
Tellerium	0.0005767	0.001429	5.22E-06	2.06E-05	1.14E-05	2.06E-05	1.93E-05	2.06E-05	6.41E-05	8.85E-05	6.24E-08	3.88E-05
Thallium	7.20E-05	0.0008933	5.01E-05	5.39E-05	4.89E-05	5.39E-05	4.77E-05	5.38E-05	3.95E-05	5.25E-05	3.42E-05	4.99E-05
Thorium	8.58E-05	0.02117	1.83E-06	1.16E-05	3.99E-06	1.16E-05	6.73E-06	1.16E-05	1.04E-05	4.59E-05	7.44E-06	9.82E-06
Tin	0.001778	0.001842	0.0001144	0.0001607	0.0001292	0.0001607	0.0001482	0.0001607	0.0002557	0.0003573	6.77E-05	0.0001014
Titanium	0.02575	11.49	0.0009495	0.00339	0.001924	0.00339	0.003152	0.00339	0.003573	0.01054	0.004157	0.00549
TOC	2.004	3.182	3.901	4.792	3.922	4.58	3.959	4.382	2.739	4.595	2.931	4.787
Total_CN_N	5.84E-06	0.005635	0.002099	0.003084	0.001699	0.002618	0.001183	0.001694	0.001153	0.006764	0.001903	0.003091
TSS	1.373	1.989	2.974	3.148	2.872	3.147	2.756	3.139	2.044	2.872	2.03	2.992
Uranium	0.0071	0.007348	7.31E-05	0.0002594	0.0001482	0.0002594	0.0002426	0.0002594	0.0007803	0.001078	8.67E-06	2.33E-05
Vanadium	0	0	0	0	0	0	0	0	0	0	0	0
WAD_CN	0.00856	0.1946	0.0001452	0.0004117	0.0002509	0.0004117	0.000384	0.0004117	0.001049	0.001444	0.0001039	0.0001368
Zinc	0.002646	0.01444	1.42E-05	0.00379	3.15E-05	0.00379	5.32E-05	0.00379	0.0001652	0.01693	0	0
Zirconium	0.0072	3.32	0.001241	0.002104	0.001574	0.002104	0.001995	0.002104	0.001669	0.003505	0.002099	0.002805

Parameter	PN06		PN07		PN08		PN09		PN10	
(mg/L)	Post-Clos	Max	Post-Clos	Max	Post-Clos	Max	Post-Clos	Max	Post-Clos	Max
Alkalinity	3.017	4.519	0	0	3.085	4.606	3.117	4.648	3.003	4.5
Aluminum	0.01308	0.03461	0	0	0.02209	0.04649	0.0264	0.05218	0.0111	0.032
Ammonia_N	0.003763	0.1764	0	0	0.003747	0.02517	0.003739	1.646	0.003767	0.08776
Antimony	3.83E-05	5.09E-05	0	0	4.14E-05	5.50E-05	4.29E-05	5.70E-05	3.77E-05	5.00E-05
Arsenic	0.0001892	0.0002512	0	0	0.0003309	0.0004393	0.0003987	0.0005293	0.0001582	0.00021
Barium	0.004315	0.006902	0	0	0.004325	0.006911	0.004331	0.006915	0.004313	0.0069
Beryllium	0.0001505	0.0001998	0	0	0.0001498	0.0001989	0.0001495	0.0001985	0.0001507	2.00E-04
Bismuth	0.0003763	0.0004996	0	0	0.0003747	0.0004974	0.0003739	0.0004964	0.0003767	5.00E-04
Boron	0.0008928	0.001699	0	0	0.0008899	0.001693	0.0008885	0.00169	0.0008933	0.0017
Cadmium	7.53E-06	9.99E-06	0	0	7.50E-06	9.95E-06	7.49E-06	9.94E-06	7.53E-06	1.00E-05
Calcium	2.068	3.113	0	0	2.113	3.17	2.134	3.198	2.059	3.1
Chloride	2.092	2.997	0	0	2.083	2.984	2.079	2.978	2.094	3
Chromium	9.74E-05	0.0002027	0	0	0.0001069	0.000215	0.0001115	0.0002209	9.53E-05	2.00E-04
CNO_N	0	0	0	0	0	0	0	0	0	0
Cobalt	0.0002146	0.0006664	0	0	0.0002723	0.0007414	0.0002999	0.0007773	0.0002019	0.00065
Copper	0.001021	0.001502	0	0	0.001028	0.001511	0.001032	0.001516	0.001019	0.0015
Free_CN	0	0	0	0	0	0	0	0	0	0
Hardness	9.232	12.99	0	0	9.192	12.93	9.171	12.9	9.24	13
Iron	0.0451	0.06794	0	0	0.05177	0.07676	0.05496	0.08098	0.04363	0.066
Lead	3.77E-05	5.01E-05	0	0	3.79E-05	5.04E-05	3.81E-05	5.05E-05	3.77E-05	5.00E-05
Lithium	0.000501	0.0008193	0	0	0.0004989	0.0008157	0.0004978	0.000814	0.0005015	0.00082
Magnesium	1.037	1.403	0	0	1.047	1.416	1.051	1.422	1.035	1.4
Manganese	0.004882	0.01213	0	0	0.005347	0.01272	0.005571	0.01301	0.004779	0.012
Mercury	0.0005412	0.0007189	0	0	0.003006	0.003991	0.004186	0.005557	7.06E-07	1.40E-06
Molybdenum	3.82E-05	5.07E-05	0	0	4.07E-05	5.40E-05	4.19E-05	5.56E-05	3.77E-05	5.00E-05
Nickel	0.002539	0.005351	0	0	0.00272	0.005584	0.002807	0.005695	0.002499	0.0053
Nitrate_N	0.003763	0.283	0	0	0.003747	0.4088	0.003739	2.667	0.003767	0.1392
Nitrite_N	0.0007526	0.0149	0	0	0.0007493	0.02119	0.0007478	0.1341	0.0007533	0.00771
Ortho_P	0.0007526	0.0009991	0	0	0.0007493	0.0009947	0.0007478	0.0009927	0.0007533	0.001
Phosphate_P	0	0	0	0	0	0	0	0	0	0
Phosphorus	0.001457	0.002008	0	0	0.001484	0.002043	0.001496	0.002059	0.001451	0.002
Potassium	0.2847	0.4	0	0	0.2846	0.3997	0.2846	0.3996	0.2847	0.4
SCN_N	0	0	0	0	0	0	0	0	0	0
Selenium	7.55E-05	0.0001002	0	0	7.62E-05	0.0001012	7.66E-05	0.0001017	7.53E-05	1.00E-04
Silicon	0.1719	0.3668	0	0	0.1889	0.3889	0.1971	0.3994	0.1681	0.362
Silver	7.53E-06	1.00E-05	0	0	7.55E-06	1.00E-05	7.56E-06	1.00E-05	7.53E-06	1.00E-05
Sodium	0.4663	0.6297	0	0	0.4651	0.628	0.4645	0.6272	0.4666	0.63
Strontium	0.01149	0.01599	0	0	0.01144	0.01592	0.01142	0.01588	0.0115	0.016
Sulphate	3.539	4.83	0	0	3.64	4.964	3.689	5.029	3.516	4.8
TDS	21.03	33.05	0	0	21.22	33.29	21.32	33.4	20.99	33
Tellerium	5.02E-10	6.66E-10	0	0	2.79E-09	3.70E-09	3.88E-09	5.15E-09	0	0
Thallium	3.76E-05	5.00E-05	0	0	3.75E-05	4.98E-05	3.74E-05	4.97E-05	3.77E-05	5.00E-05
Thorium	6.84E-08	9.07E-08	0	0	3.80E-07	5.05E-07	5.29E-07	7.03E-07	0	0
Tin	7.53E-05	9.99E-05	0	0	7.49E-05	9.95E-05	7.48E-05	9.93E-05	7.53E-05	1.00E-04
Titanium	0.0001344	0.0002591	0	0	0.0003032	0.0004828	0.000384	0.0005899	9.73E-05	0.00021
TOC	2.894	4.796	0	0	2.882	4.775	2.875	4.765	2.897	4.8
Total_CN_N	0.001891	0.003097	0	0	0.001883	0.003084	0.001879	0.003077	0.001893	0.0031
TSS	2.258	2.997	0	0	2.248	2.984	2.243	2.978	2.26	3
Uranium	7.54E-06	1.00E-05	0	0	7.59E-06	1.01E-05	7.62E-06	1.01E-05	7.53E-06	1.00E-05
Vanadium	0	0	0	0	0	0	0	0	0	0
WAD_CN	4.21E-05	5.78E-05	0	0	4.48E-05	6.13E-05	4.61E-05	6.30E-05	4.15E-05	5.70E-05
Zinc	0	0	0	0	0	0	0	0	0	0
Zirconium	0.0007327	0.001413	0	0	0.0007785	0.001472	0.0008004	0.0015	0.0007227	0.0014

Attachment IR-D: Tailings Management Plan

BACK RIVER PROJECT
Tailings Management Plan

November 2020

BACK RIVER PROJECT
TAILINGS MANAGEMENT PLAN

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List of Appendices

Revision Log

Date	Section	Page	Revision
November 2015	All	All	Supporting Document for Final Environmental Impact Statement; submitted to Nunavut Impact Review Board (NIRB).
October 2017	All	All	Supporting Document for Type A Water Licence Application; submitted to Nunavut Water Board (NWB).
November 2020	All	All	Revisions to address requirements and commitments of Project Certificate, No. 007, and Water Licence, 2AM-BRP1831 and updated to reflect Type A Water Licence Amendment Application to the NWB.

Acronyms

ARD	acid rock drainage
CDA	Canadian Dam Association
FEIS	Final Environmental Impact Statement
GCL	geosynthetic clay liner
HDPE	high-density polyethylene
ICRP	Interim Closure and Reclamation Plan
MAC	Mining Association of Canada
MDMER	Metal and Diamond Mining Effluent Regulations
ML	metal leaching
Mt	million tonnes
NIRB	Nunavut Impact Review Board
NPAG	non-potentially acid generating
NWB	Nunavut Water Board
OMS	Operation, Maintenance, and Surveillance
PAG	potentially acid generating
PGA	peak ground accelerations
Project	Back River Project
ROM	run-of-mine
Sabina	Sabina Gold & Silver Corp.
TF	Tailings Facility
TMP or Plan	Tailings Management Plan
TSF	Tailings Storage Facility
TSM	Towards Sustainable Mining
WRSA	Waste Rock Storage Area

Executive Summary

This Tailings Management Plan describes Sabina's approach to managing tailings that will be produced in the development and operation of the Project. The main environmental concerns related to tailings storage are the potential for dust to spread to the surrounding land and water, as well as potential effects of runoff and seepage on local water quality. This plan ensures that: 1) potential adverse environmental effects are identified and promptly mitigated 2) mitigation measures are proven successful, and 3) relevant laws and regulations are complied with. This plan does not address discharge from the tailings storage facilities which will occur at Project Closure; those activities are addressed in other plans.

Uyaraktaqnikut Aulatauni Parnaut (TMP) Ataniqnut Nainaqhimayuq

Una parnaut unniqtuqtai Sabina-kut pityuhi aulaninut kuviraqvit hanayauyukhat atuqtitlugu tamna pivaliatitni aulatauni taphuma Havaguhia. Tamna aturniqhaq avatiliqutit piyai turangani kuviraqviknut tutqumavia atuqtitlugu una pivikha pityutaulat puyuqnut hiamaknia avatigiyainut nunat immatlu tapkualuttauq aktualaqni kuukviunit maqinitlu nunagiyaini imaq nakuunai. Una parnaut hugiangitai kuvititauni talvanga kuviraqviuyuq tutqumavik havagutai tapkuat atuqniat talvani Havaguhia Umikniq; tahapkuat huliniit hugiaqtauyut ahiini parnautit. Una Parnaut atuqpiaqtai tapkuat 1) ihuityutaulat avatiliqutinut aktuanit naunaiqtauyut qilamiklu ihuaqhigiaqtauyut 2) ihuaqhigiaqni piyauyut naunaiqtauyutlu atuttiaqni tamnalu 3) turangayut maligait maligauyutlu katitauyut tapkununga.

TMP ᐃᓱᒪᑕᐅᓂᕐᓂᑦ ᓇᐃᓈᖅᓯᒪᔪᖅ

ᐸᕐᓇᐅᑎ ᐅᕐᑲᐅᓯᕐᑲᖅᑐᖅ ᓴᐲᓇᒃᑯᑦ ᐊᑐᖅᑕᖓᓐᓂᒃ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᕿᒪᒃᑎᑦᑐᓂᒃ ᐱᑕᕐᑲᓕᕐᑲᑦᑕᖅᑐᑦ ᐱᕙᓪᓕᐊᓂᕐᑲᖅᑎᓪᓗᒋᑦ ᐊᒻᒪᓗ ᐊᐅᓛᖅᑎᑦᑎᓂᕐᑲᖅᑎᓪᓗᒋᑦ ᐱᓕᕆᐊᕐᒥᑦ. ᐊᕙᑎᓕᕆᓂᕐᒧᑦ ᐃᓱᒫᓘᑕᐅᓗᐊᖅᑐᖅ ᕿᒪᒃᑎᑦᑐᑦ ᑐᖅᑯᖅᑕᐅᓯᒪᓂᖏᓐᓄᑦ ᒦᓇᐅᔪᖅ ᐳᔪᕐᑲᑖᒃ ᓯᐊᒻᒪᑐᐃᓐᓇᓇᐊᕐᑲᕐᓂᖓ ᕐᑲᓂᑕᖓᓄᑦ ᓄᓇᒧᑦ ᐊᒻᒪ ᐃᒪᕐᒧᑦ ᐊᒻᒪ ᕐᑲᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᓐᓇᖅᑐᑦ ᑯᕕᔪᓂᒃ ᕐᑲᓂᑦᑐᒥᑦ ᐃᒪᐅᑉ ᕐᑲᓄᐃᓐᓂᖓᓄᑦ. ᐸᕐᓇᐅᑎ ᐱᓕᕆᐊᕐᑲᖏᑦᑐᖅ ᑯᕕᔪᓂᒃ ᕿᒪᒃᑎᑦᑐᓄᑦ ᑐᖅᑯᖅᓯᓯᒪᕝᕕᖕᓂᑦ ᑕᐃᒪᐅᕐᑲᑦᑕᕐᓂᐊᖅᑐᖅ ᐱᓕᕆᐊᖅ ᐅᒃᑯᐊᖅᑎᓪᓗᒍ; ᕐᑲᓄᐃᓕᐅᕈᑕᐅᔪᑦ ᐊᓯᖏᓐᓂᑦ ᐸᕐᓇᐅᑎᓃᑦᑐᑦ. ᐸᕐᓇᐅᑎ ᐃᒪᓐᓇᐃᑎᑦᑎᔪᖅ 1) ᐊᖏᔪᒥᒃ ᐊᒃᑐᖅᓯᓂᐅᔪᓐᓇᖅᑐᑦ ᐊᕙᑎᒧᑦ ᕐᑲᐅᔨᔭᐅᓗᑎᒃ ᐊᒻᒪᓗ ᐊᖕᒋᓗᐊᖕᒋᒋᐊᖅᑎᑕᐅᓗᑎᒃ 2) ᐊᖕᒋᓗᐊᖕᒋᒋᐊᖅᑎᑦᑎᓂᕐᒨᖕᒐᔪᑦ ᓇᓗᓇᐃᖅᓯᔾᔪᑕᐅᔪᑦ ᐱᐊᓂᑦᑎᐊᖅᓯᒪᓂᕐᒧᑦ ᐊᒻᒪᓗ 3) ᑕᒪᒃᑯᓄᙵ ᒪᓕᒐᐅᔪᑦ ᐊᒻᒪᓗ ᒪᓕᒐᕋᓛᑦ ᒪᓕᒃᑕᐅᓗᑎᒃ.

1. Introduction

The Back River Project (the Project) is a gold project owned by Sabina Gold & Silver Corp. (Sabina) within the West Kitikmeot region of southwestern Nunavut. It is situated approximately 400 kilometres (km) southwest of Cambridge Bay, 95 km southeast of the southern end of Bathurst Inlet, and 520 km northeast of Yellowknife, Northwest Territories. The Project is located predominantly within the Queen Maud Gulf Watershed (Nunavut Water Regulations, Schedule 4).

The Project is comprised of two main areas with interconnecting winter ice roads; the Goose Property and the Marine Laydown Area (MLA). The majority of annual Project resupply will be completed via sealift using the MLA situated along the western shore of southern Bathurst Inlet, which is connected seasonally to Goose Property by an approximately 160-km long Winter Ice Road. Both the Goose Property and the MLA make use of a local networks of all-weather roads.

The Tailings Management Plan (Plan or TMP) outlines the approach for managing and monitoring tailings produced at the Goose Property. No tailings will be generated at the MLA.

The Plan has been constructed in consideration of all applicable guidelines and requirements, including those of the Type A Water Licence, 2AM-BRP1831, and Project Certificate, No. 007 as well as the Metal and Diamond Mining Effluent Regulations (MDMER). This plan will be reviewed and updated as needed to reflect changes in regulatory requirements, facility operation and/or technology, approach, monitoring results, management reviews, incident investigations, best practice updates or other Project specific protocols.

Any updates to this plan will be filed with the Nunavut Water Board (NWB) and the Nunavut Impact Review Board (NIRB) as per the requirements of the Project Certificate, No. 007 and Water Licence, 2AM-BRP1831.

It should be noted that the scope of this plan prescribed by the NWB overlaps with the scope and content of a future Operation, Maintenance, and Surveillance (OMS) Manual that Sabina will develop as a member of the Mining Association of Canada (MAC) and in consideration of the requirements of the International Cyanide Management Code. It is Sabina's preference to replace this plan with a future OMS Manual that is compliant with MAC requirements as well as any relevant requirements of the Type A Water Licence, 2AM-BRP1831. This future OMS Manual will be provided 60 days prior to operation of any tailings management facility.

2. Scope and Objectives

This Plan is one of the documents that forms part of Sabina's overall Waste Management Program developed for the Project. This plan describes Sabina's approach to managing tailings that will be produced in the development and operation of the Project. This Plan includes details on the Back River Projects Tailings Management Facilities: the Tailings Storage Facility (TSF), and the Llama Tailings Facility (TF). This Plan includes where and how tailings will be stored and managed, tailings characteristics, and details related to the TSF design, operation, closure, and monitoring. This Plan does not address runoff from the TSF following facility closure. This runoff and associated monitoring are addressed in Sabina's Water Management Plan and closure approach is addressed in Sabina's Closure and Reclamation Plan.

The Plan applies to the Construction and Operations phases of the Project during which time tailings will be produced and has relevance to the Closure/Post-Closure phases as tailings will be permanently disposed of on the Property. The purpose of the Plan is to document the tailings management approach for the Project so that potential adverse environmental effects are identified and promptly mitigated, mitigation measures are proven successful, and relevant laws and regulations are complied with. Closure and reclamation of the tailings management facilities are addressed in detail in the Interim Closure and Reclamation Plan (ICRP).

The main environmental concerns related to tailings storage are the potential for dust to spread to the surrounding land and water, as well as potential effects of runoff and seepage on local water quality. The measures identified in this plan are intended to protect groundwater and permafrost, and the Project's Valued Ecosystem Components including air quality, surface water, water quality, sediment quality, aquatic habitat, fish, migratory birds, and terrestrial mammals.

2.1 RELATED PLANS AND STUDIES

This Plan is to be implemented in conjunction with various other Sabina management, mitigation, and monitoring plans. Plans that have relevance to this Plan include:

- Environmental Management and Protection Plan;
- Water Management Plan;
- Waste Rock Management Plan;
- Interim Closure and Reclamation Plan;
- Aquatic Effects Management Plan;
- Air Quality Monitoring and Management Plan; and
- Thermal and Geotechnical Monitoring Plan (*in prep.).*

The following reports and studies have also informed the development of this Plan:

- Tailings Management System Design Report (Sabina 2017a, Appendix F-4);
- Waste Rock Storage Area (WRSA) Design Report (Sabina 2017a, Appendix F-3);
- Geochemical Characterization Report (Sabina 2017a, Appendix E-3);

- Water and Load Balance Report (Sabina 2017a, Appendix E-2);
- Site Wide Water Management Report (Sabina 2017a, Appendix F-1);
- Multiple Accounts Analysis, submitted during FEIS Information Requests (Sabina 2016);
- Back River Project: Considering Climate Change in Tailings Storage Facility and Waste Rock Storage Areas Closure Strategy (Sabina 2017b, Appendix V4-3D); and
- Peer Review of the Back River Project Waste Rock and Tailings Closure Strategy (Sabina 2017b, Appendix V4-3E).

This plan is based on the tailings management system design report submitted as part of the Water Licence submission package (Sabina 2017a, Appendix F-4), which includes the following design details:

- Site Description, including topography, geology, climate, permafrost, hydrology, hydrogeology, and seismicity;
- Tailings Management System Concept, including storage requirements, and tailings physical and geochemical properties;
- TSF Containment Dam Design Criteria, including dam hazard classification, design life, tailings beach slope, stability criteria, inflow design flood, wave run-up, and freeboard and earthquake design;
- TSF Containment Dam Design, including foundation conditions, containment concept, geomembrane liner choice, and containment dam geometry;
- TSF Containment Dam components, including construction material specifications, seepage collection, and monitoring instrumentation;
- TSF Design Studies and considerations, including stability analysis, seepage analysis, thermal analysis, consolidation analysis, settlement, deformation (creep), dam break, and TSF water balance;
- Construction of TSF Containment Dam and South Dyke, including equipment, scheduling, material quantities and material geochemistry;
- Operation of the TSF and mined-out open pits used as TF, including a tailings deposition plan for the TSF; and
- Closure and reclamation of the Tailings Management Facilities.

3. Applicable Legislation and Guidelines

The TMP has been prepared to comply with existing regulations and follow the applicable guidelines provided by the federal government and the Government of Nunavut. The applicable regulations include:

- *Fisheries Act* (1985), including the *Metal and Diamond Mining Effluent Regulations* (SOR/2002-22);
- *Nunavut Environmental Protection Act* (1988);
- *Nunavut Land Claim Agreement Act* (1993);
- *Nunavut Waters and Nunavut Surface Rights Tribunal Act*, S.C. 2002, c 10 (Canada 2002); and
- *Nunavut Waters Regulations* (2013).

The Project is also bound by the requirements of Project Certificate, No. 007 and Type A Water Licence, 2AM-BRP1831.

In addition, Sabina commits to meeting the requirements of the Towards Sustainable Mining (TSM) Initiative. A component of the TSM Initiative is adherence to the TSM Tailings Management Protocol, which includes the following elements:

- Development of a tailings management policy and commitment (either as a stand-alone policy or as part of an overall environmental policy);
- Development of a tailings management system;
- Assignment of accountability and responsibility for tailings management;
- Conducting an annual tailings management inspection; and
- Preparation of an OMS Manual.

Sabina will also refer to the following Guidance Documents during Project development:

- TSM Tailings Management Protocol (MAC 2019a);
- A Guide to the Management of Tailings Facilities (MAC 2019b);
- A Guide to Audit and Assessment of Tailings Facility Management (MAC 2011c);
- 2013 Canadian Dam Safety Guidelines (Canadian Dam Association [CDA] 2013);
- 2014 Application of Dam Safety Guidelines to Mining Dams (CDA 2014); and
- Developing an Operation, Maintenance, and Surveillance Manual for Tailings and Water Management Facilities (MAC 2011d).

4. Roles and Responsibilities

The General Manager is ultimately responsible for the success of the Tailings Management Plan and approves all relevant policies and documents, auditing, action planning, and the verification process.

The General Manager along with his/her direct reports is responsible for specifics of this Plan including:

- Overall management and execution of the Plan;
- Operational aspects; and
- Internal reporting.

The Environmental Superintendent along with his/her direct reports is responsible for:

- Monitoring;
- External reporting; and
- Verifying compliance and adaptive management.

Further definition of the site management structure, organizational chart, and a list of designated personnel responsible for aspects of this Plan will be provided in future revisions of the Plan or a replacement OMS Manual in compliance with MAC requirements.

5. Planning and Implementation

5.1 TAILINGS PRODUCTION AND STORAGE

Approximately 12.4 Mt of tailings will be produced over the 12-year life of mine. All tailings will be deposited as slurry. Initially, tailings will be deposited in the TSF, which is the only purpose-built tailings management facility on-site. Tailings deposition will transition Llama Open Pit once mining operations have ceased in that location (called Llama TF). As permitted under Water Licence 2AM-BRP1831, other site effluent will also be directed to these facilities, including effluent from the WRSAs, the Ore Stockpile, and the ANFO Plant and Primary Water Pond water, as well as sewage and effluent from other facilities that do not meet their discharge criteria.

The Operations Phase is described in stages according to the tailings storage and water management plans, as follows:

- Stage 1 – Tailings Storage Facility – For the first five years of Operations (Years 1 to 5), a purpose-built TSF will be utilized; and
- Stage 2 – Llama Tailings Facility (Llama TF) – From Year 5 onward, tailings will be disposed of in the mined-out Llama Open Pit.

The tailings management strategy has been developed based on the principle of maximizing the use of open pits for tailings storage. To that end, tailings will be stored in mined-out open pits as soon as the pits are available for tailings deposition. The purpose-built TSF is located on Crown land and in the area of a natural depression about 2 km south of Goose Main Open Pit. Containment will be achieved with construction of a frozen foundation dam with a geosynthetic clay liner (GCL) on the northern end of the facility (TSF Containment Dam), and a small control structure at the south end of the facility (TSF South Dyke). Three small streams and four ponds are located within the footprint of the TSF and will be covered by the facility as shown on 2020 Modification Package Appendix A, Figure 3. A plan view of the TSF Containment Area is shown in Figure A-01.

Tailings deposition will begin in the TSF at the start of Operations for approximately five years. Tailings deposition will then transition from the TSF to in-pit deposition in the mined-out Llama Pit for the remaining seven years of the mine life. A summary of the Tailings Management System storage requirements is outlined in Table 5.1-1.

Table 5.1-1. Back River Property Tailings Management System Storage Requirements

Location	Period (Year and Quarter)	Tailings (Mt)	Tailings (Mm^3*)
TSF**	Y1 Q1 to Y5 Q1	4.4	3.8
Llama TF	Y5 Q2 to Y12 Q4	8.0	6.7
Total Project	Y1 Q1 to Y10 Q2	12.4	10.3

**The tailings density is 1.2 t/m^3.*

***this could occur as early as Y-1 Q4.*

After tailings deposition transitions from the TSF to the Llama TF in Year 5, the TSF will be converted to a waste rock storage area (namely, the TSF WRSA) and used to dispose of waste rock from the Goose Main Pit. Potentially acid-generating (PAG) waste rock will be placed over the tailings and eventually covered with a non-potentially acid generating (NPAG) waste rock cover for closure (Figure A-02 and A-08). Placement of waste rock over the tailings will provide protection of the tailings from the active layer and promote permafrost aggredation into the tailings.

5.1.1 Tailings Physical Characteristics

Physical properties of the tailings include the following:

- Solids Content: 49% solids (by weight);
- Tailings Solids Specific Gravity: 2.9;
- Settled Density: 1.2 t/m^3;
- Plasticity: non-plastic; and
- Particle size (P_{80}): approximately 50 µm.

5.1.2 Tailings Geochemical Characteristics

Tailings geochemical characterization confirms that tailings will be PAG and metal leaching (ML) (Sabina 2017b, Appendix E-3). The projected lag to onset of acid generation in mixed Goose Main and Llama tailings deposited in the TSF is anticipated to be greater than 10 years in site-specific conditions; nonetheless, tailings will be managed to reduce the potential for acid rock drainage (ARD) and manage ML. Process water discharged as supernatant water with the tailings has the potential to contain elevated metal concentrations, including arsenic (As), copper (Cu) and iron (Fe). There is currently no planned discharge of tailings supernatant water during Operations. Should a controlled discharge be required during Operations the requirements for doing so will include the development of a Temporary Tailings Effluent Discharge Plan to be submitted 120 days prior to release as required by Part F, Item 16 of the Licence and discussed in Section 8.

Exposed tailings beaches may be an ongoing source of sulphate and arsenic leaching; pH changes may result in increased concentrations of other trace elements if tailings are left exposed for an extended period of time (estimated to be decades). However, the development of acidic conditions is expected to be delayed considerably by the cold temperatures, with the alkalinity from the deposition of fresh tailings helping to maintain neutral pH conditions. In addition, exposed tailings beach runoff accounts for approximately 8 to 11% of the water entering the tailings supernatant pond, and therefore it is expected to have a relatively small effect on pond water quality. At Closure, NPAG waste rock will be used to cover tailings material in the purpose-built TSF. The resulting aggradation of permafrost will minimize infiltration and development of ML/ARD conditions. Tailings in the Llama TF will be deposited sub-aqueously and flooded with a permanent water cover at Closure, which will prevent acidic conditions from developing.

Sabina commits to test a mixture of tailings and water treatment plant sludges to evaluate the potential for remobilization of arsenic from this material. Tests will be conducted in the first year that water treatment plant sludges are produced. Sabina commits to provide their proposed testing method to the KIA for review and approval prior to initiating these tests, and will provide the results of the testing in the annual monitoring report.

5.2 TAILINGS STORAGE FACILITY

5.2.1 Tailings Storage Facility Design Basis

The design of the TSF has incorporated the following requirements:

- Applicable Legislation and Guidelines;
- Permanent storage of tailings solids within an engineered disposal facility;
- Control, collection, and recovery of tailings process water and runoff water from within the TSF for recycling to the Process Plant as reclaim water;
- Minimizing seepage losses from the TSF, conducting seepage monitoring, and constructing a seepage collection system downstream of the TSF Dam to minimize adverse downstream water quality impacts;
- Integration of the tailings management facilities into the overall mine site water management requirements;
- Designing for closure;
- The inclusion of freeboard allowance for ice entrainment, storm water management, wave run-up, potential embankment settlement, and other contingencies such as varying tailings deposition slopes; and
- The inclusion of monitoring features for all aspects of the facility.

The design basis is summarized in Table 5.2-1.

Table 5.2-1. Tailings Storage Facility Design Basis Summary

Component	Criteria
Dam Hazard Classification	High
Design Life: Active use period as water retaining structure Use as active water retaining structure Total life until breach	 5 years 7 years 12 years
Dam staging	None
Tailings production rate	Ramp up period, with a maximum rate of 3,000 t/d
Tailing slurry content	49% solids (by weight)
Tailings solids specific gravity	2.9
Tailings settled density	1.2 t/m^3
Tailings storage requirement: By Mass By Volume	 4.4 Mt 3.8 Mm^3
Ice entrainment allowance: Percentage of tailings capacity By Volume	20% 0.73 Mm^3
Contact water storage requirement	Average during operations 0.8 Mm^3 95^{th} percentile during operations 1.1 Mm^3 Maximum at TSF closure 0.174 Mm^3 (1:100-year)

Component	Criteria
Total TSF storage requirement (tailings, ice entrainment, and contact water)	Average during operations 5.1 Mm^3 95^{th} percentile during operations 5.4 Mm^3
Tailings beach slope Subaerial tailings Subaqueous tailings	 1% 1%
Tailings deposition method	Single point spigot subaerial discharge (five locations over the life of facility)
Maximum design earthquake	1:2,475 year recurrence event; PGA* of 0.036 g
Inflow design flood	probable maximum precipitation depth, approx. 221 mm
Freeboard requirement: Wind Setup and Wave run-up allowance Probable maximum flood storage allowance Total freeboard (sum of above)	 1.2 m 0.6 m 1.8 m
Stability Factors of Safety (Static)	1.3 during construction 1.5 during operation and closure
Stability Factors of Safety (Pseudo-Static)	1.0

**PGA = peak ground accelerations*

5.2.2 Dam Hazard Classification

The design, construction, operation, and monitoring of dams, including tailings dams, will be completed in accordance with appropriate Provincial and Federal regulations and industry best management practices. The primary industry guidance documents as developed by the CDA, including the 2013 Canadian Dam Safety Guidelines (CDA 2013), and the dam safety guidelines specific to mining dams (CDA 2014), were used by Sabina in defining a Dam Hazard Classification for the TSF Containment Dam.

Assessment of the dam hazard classification was carried out to determine the appropriate design earthquake and flood events for the TSF. Selection of the design earthquake is based on the classification criteria provided by the CDA and summarized in Table 5.2-2. The TSF Dam classification was carried out by considering the potential incremental consequences of an embankment failure. The incremental consequences of failure were defined as the total damage from an event with dam failure minus the damage that would have resulted from the same event had the dam not failed. Three categories of losses were considered: loss of life; environmental and cultural values; and infrastructure and economics, as shown on Table 5.2-2.

The Property is located in an extremely remote area with no major development other than those associated with the Project itself. The potential for loss of life due to a dam failure is therefore very low. A Dam Classification of “High” has been selected for the TSF based on the impact to environmental and cultural values (i.e., expected loss or deterioration of fish or wildlife habitat where restoration or compensation in kind is highly possible).

Table 5.2-2. Tailings Storage Facility Dam Classification

Dam Class[2]	Population at Risk	Incremental Losses[1]		
		Loss of Life[3]	**Environmental and Cultural Values**	**Infrastructure and Economics**
Low	None	0	Minimal short-term loss. No long-term loss.	Low economic losses; area contains limited infrastructure or services.
Significant	Temporary only	Unspecified	No significant loss or deterioration of fish or wildlife habitat. Loss of marginal habitat only. Restoration or compensation in kind highly possible.	Losses to recreational facilities, seasonal workplaces, and infrequently used transportation routes.
High	Permanent	10 or fewer	Significant loss or deterioration of *important* fish or wildlife habitat. Restoration or compensation in kind highly possible.	High economic losses affecting infrastructure, public transportation, and commercial facilities.
Very High	Permanent	100 or fewer	Significant loss or deterioration of *critical* fish or wildlife habitat. Restoration or compensation in kind is possible but impractical.	Very high economic losses affecting infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances).
Extreme	Permanent	More than 100	Major loss of *critical* fish or wildlife habitat. Restoration or compensation in kind impossible.	Extreme losses affecting critical infrastructure or services (e.g. hospital, major industrial complex, major storage facilities for dangerous substances).

1) Reproduced from Table 2-1 of the Canadian Dam Association's Dam Safety Guidelines (CDA 2013).
2) Definitions for Population at Risk:
***None** - There is no identifiable population at risk, so there is no possibility of loss of life other than through unforeseeable misadventure.*
***Temporary** – People are only temporarily in the dam-breach inundation zone (e.g., seasonal cottage use, passing though on transportation routes, participating in recreational activities).*
***Permanent** – The population at risk is ordinarily located in the dam-breach inundation zone (e.g., as permanent residents); three consequence classes (High, Very High and Extreme) are proposed to allow for more detailed estimates of potential loss of life (to assist in decision-making if the appropriate analysis is carried out).*
3) Implications for Loss of Life:
***Unspecified** - The appropriate level of safety required at a dam where people are temporarily at risk depends on the number of people, the exposure time, the nature of their activity, and other conditions. A higher class could be appropriate, depending on the requirements. However, the design flood requirement, for example, might not be higher if the temporary population is not likely to be present during the flood season.*

Inflow Design Flood

The selection of an Inflow Design Flood is governed by the dam classification. Based on the dam hazard classification of High, the guidelines (CDA 2014) recommend the use of an operational inflow design flood of 1/3 between the 1:1,000 return period 24-hour duration precipitation event and the probable maximum precipitation for this region. Notwithstanding this criterion, the TSF has been conservatively designed to maintain a minimum freeboard below the top of the liner to contain 100% of the probable maximum precipitation depth of 221 mm. The TSF Dam crest has also been designed to maintain freeboard that accounts for wind setup and wave run-up, which is an additional 1.2 m. The total freeboard allowance is 1.8 m and has been designed to avoid the requirement of a constructed permanent spillway for a facility with such a short lifespan. Figure A-06 and A-07 show the required freeboard for the TSF above the pond full supply level.

Design Earthquake

Based on the dam hazard classification of High for the TSF, the Dam Safety Guidelines (CDA 2013, 2014) recommend the seismic stability analysis be completed assuming the peak ground accelerations (PGA) for 1:2,475 year event, which resulted in a PGA of 0.036 g. Further details on seismic analysis can be found in Appendix F-4 of the Type A Water Licence Application (Sabina 2017a).

5.2.3 Seepage Analysis

The water retention capability of the TSF Containment Dam relies on the GCL being keyed into the permafrost foundation or competent bedrock. Thermal modeling indicates that the foundation of the dam will remain frozen, thus the seepage through the foundation is expected to be negligible.

Sabina commits to a quality assurance/quality control (QA/QC) program during liner installation. Properly installed liner combined with swelling of the bentonite in the liner as it is hydrated is expected to seal most defects such that seepage is controlled by the hydraulic conductivity of the GCL. A comprehensive calculation of the seepage through the liner was completed, and with the TSF at full supply level (FSL), seepage is estimated to be up to 1,210 m^3/year; this equates to seepage rates of 10^{-5} m^3/s (Sabina 2017a, Appendix F-4). Seepage is expected to decrease as the supernatant pond is removed.

During the 2015 drill program, small zones of fractured bedrock (2 to 3 m thick) were found in some of the drill holes near the west abutment of the dam, which may provide a pathway for seepage through the foundation of the dam. However, the thickness of dam bulk fill present in this specific portion of the TSF Dam, as well as along most of the TSF Dam alignment, will far exceed the minimum thermal cover requirement to maintain the underlying overburden materials in a frozen state; therefore seepage is unlikely to occur.

Sabina commits to undertake an infill geotechnical program that will include drillholes to further characterize foundation conditions at the TSF Containment Dam, as well as areas where fractured bedrock zones were identified in the west abutment of the dam, and along the western ridge of the facility that will constrain tailings. It is intended that drillholes will recover frozen overburden core and extend sufficiently to characterize bedrock; a subset of the core will be collected for geotechnical analysis. Packer testing will also be completed in select drillholes to evaluate bedrock hydraulic conductivity. This information will be used to inform updated seepage analyses and thermal modelling along critical cross-sections of the TSF Containment Dam, and, if appropriate, the western ridge; this infill geotechnical program is in accordance with NIRB PC T&C 13 and 18.

Where the results of this program show the potential for seepage, Sabina commits to the establishment of a monitoring program with the capability of determining that contaminants are being contained within the facility. Sabina will provide sufficient justification where the program results determine that additional monitoring is not required beyond what is currently planned for the TSF.

5.2.4 Stability Analyses

A comprehensive stability analysis was carried out to confirm whether the TSF meets the appropriate design requirements outlined above. The stability assessment took into consideration the location and layout of the GCL as the potential weakest element of the dam associated with upstream slope stability.

Analysis was completed on two models; the first (Model A) assumed the TSF was empty (i.e. immediately following construction), and the second (Model B) considered the TSF operations phase with the pond at the full supply level. Both static and pseudo-static scenarios were assessed for each model using a PGA of 0.036g (1:2,475 year seismic event). The results indicate that in all cases the design Factor of Safety complies with the minimum required (Sabina 2017a, Appendix F-4).

As precedent, both the Meliadine Project and the Diavik Mine are located in the same low-seismicity central part of Canada and have completed the comparable level of seismic analysis of their tailings storage facilities. A site-specific seismic assessment was not considered to be required for those facilities. Based on the TSF design completed to date, no further site-specific stability assessment is considered to be required.

5.2.5 Climate Change

Climate change considerations were incorporated into the design of the Project, including the TSF and TF (Sabina 2017a, Appendix F-3 and Appendix F-4). The life of the Project is relatively short such that climate change impacts will be most relevant to these project components in the Post-Closure Phase.

The TSF cover consisting of 5 m of NPAG waste rock is expected to promote permafrost aggredation into the tailings and PAG waste rock, and to maintain frozen conditions in the tailings even under conservative climate change models (Sabina 2015, Appendix V4-3B). For additional information refer to FEIS Addendum Volume 4, Appendix V4-3D and Appendix V4-3E (Sabina 2017b).

Other climate change impacts such as increased precipitation, are not expected to meaningfully impact the Tailings Management Facilities in the Post-Closure Phase.

5.2.6 Tailings Storage Facility Embankment Construction

Construction Schedule

The TSF Dam will be constructed prior to the Goose Process Plant starting production. The key trench excavation and backfill will be completed in the winter to eliminate potential issues caused by thawing of the soft overburden soils in the TSF Dam foundation. The horizontal liner below the upstream portion of the dam, and a minimum of 2 m of the dam bulk fills, will also be placed in the winter to provide a thermal blanket to protect permafrost in the foundation.

Site and Foundation Preparation

Prior to construction of the TSF, some preparation work is necessary, specifically the foundations of the TSF embankments. Organic material will be stripped and disposed of in a WRSA. Excavation of the key trench must be completed in the winter when the ground is completely frozen. This is necessary to keep the foundation as cold as possible to limit the potential for thawed ground within the dam foundation. Drill and blast methods will be required to excavate the key trench, and due to the possible high ice content and nature of the soils, a tight drill pattern and high blast load factor is expected to be required. The excavated material will be hauled away and disposed of in a WRSA.

Figure A-03 shows a plan and profile of the TSF including foundation conditions and zones of expected shallow and deep bedrock.

For the shallow bedrock foundation zone (Figure A-04), the key trench will terminate on clean exposed bedrock. If fractured rock is encountered, it will be examined and tested, and if deemed highly permeable, it will be excavated. In the deep overburden foundation zones (Figure A-05), the key trench will terminate on frozen overburden soil; however, should any massive ice or high interstitial ice zones (more than 10% visible ice or greater than 30% water content) be encountered, the key trench will be deepened until the massive ice has been removed.

Tailings Storage Facility foundation preparation will require establishing sediment and erosion control best management practices throughout the construction area. Other preparation work will include the construction of a downstream berm, seepage collection and recycling measures, and TSF access roads.

Embankment Components

The figures in Appendix A present plan views and typical cross sections of the TSF. The main components of the TSF embankments are as follows:

- Key Trench:
  - The key trench will be excavated in the frozen overburden underlying the dam to a depth up to 4 m.
  - For the shallow bedrock foundation zone, the key trench will terminate on clean exposed bedrock. In the deep overburden foundation zones, the key trench will terminate on frozen overburden soil.
- Pony Wall:
  - In the shallow bedrock foundation zone, a reinforced concrete pony wall will be cast to attach the GCL to bedrock. The pony wall will be doweled to the bedrock to provide a good bond and will span the length of the shallow foundation zone.
- Geosynthetic Clay Liner:
  - The GCL will be the low permeability element of the dam and will be placed into the frozen foundation key trench to provide a continuous low permeability cut-off. The top edge of the GCL will be terminated in an appropriately sized anchor trench within the dam bulk fills and covered with 1 m of fill.
  - Where the pony wall is present, the GCL will be attached to the pony wall with a metal strip and anchor bolts.
  - In the base of the key trench, the GCL will be placed directly onto the prepared and clean foundation, with imperfections filled with granular bentonite.

  - In all other areas, the GCL will be sandwiched between two compacted layers of crushed gravel (pea gravel size).

- Dam Bulk Fill:

  The bulk fill of the TSF Dam, including the key trench, will consist of run-of-mine (ROM) waste rock. The waste rock will be well graded and have a maximum particle size of 600 mm.

- Transition Zone:

  - The GCL is protected using a fine crushed gravel (pea gravel) produced from ROM waste rock. To provide filter compatibility, a transition zone of 150 mm minus crushed ROM waste rock will be placed between the liner bedding and dam bulk fill zones.

- Bedding Layer:

  - The GCL will be sandwiched between two 0.3 m-thick compacted layers of bedding material for protection. This material will be crushed ROM waste rock. The gravel will be pea gravel size.

- Upstream Dam Shell:

  - The upstream dam shell will be constructed using the same ROM waste rock as the dam bulk fill. Consideration will be given to using more uniformly graded material on the upstream face, with less fines to reduce the potential for erosion.

- South Dyke:

  - A small retaining dyke is required along the southern end of the TSF to contain the tailings within the TSF and the Potential Development Area. This structure will be a saddle dyke built of ROM waste rock with a length of approximately 200 m, a maximum height of just over 3 m, and a crest width of 6 m.
  - No key trench is planned for this structure and no impermeable liner is planned because tailings will be deposited against the dyke and are expected to push the water away from the structure and direct it downstream towards the north end of the facility. Careful deposition, including active monitoring, will be conducted during initial tailings deposition adjacent to the South Dyke to confirm the structure is performing as designed.

Borrow material and aggregate for embankment construction will be sourced from waste rock storage areas, local borrow pits, the Airstrip Quarry, or the Umwelt Quarry. Refer to the Borrow Pits and Quarry Management Plan for additional detail.

Instrumentation

A series of ground temperature cables will be installed at the TSF Containment Dam to monitor the thermal regime in the dam, key trench, and foundation under the Thermal and Geotechnical Monitoring Program. Vertical ground temperature cables will be installed in bore holes drilled through the dam fill after the completion of the dam and will extend through the downstream side of the key trench and through the foundation soils. Horizontal ground temperature cables will be placed within the liner cover zone along the upstream side of the key trench. Survey prisms will be installed on the dam crest and downstream slope to monitor deformation.

The instrumentation will assess embankment performance and help identify if conditions differ from those assumed during design and analysis. Amendments to the designs and/or remediation work can be implemented to respond to changed conditions, should the need arise. Refer to Section 7 for monitoring requirements, and Section 8 for contingencies, mitigation and adaptive management.

5.2.7 Tailings Storage Facility Operations

Tailings water from the TSF supernatant pond will be recycled and reused in the Process Plant as reclaim water, with no planned discharge from the TSF during Operations. Should a controlled discharge be required during Operations, all effluent will meet relevant regulations or site specific water quality objectives. The tailings distribution system is designed for a daily production rate of 3,000 tonnes per day. Water will be reclaimed from the TSF through the reclaim barge at an average rate of 2,100 m^3/d. The water balance is presented in the Water Management Plan.

To address the concern of potential seepage from the TSF, a seepage collection system will be constructed downstream of the TSF Dam. The seepage collection system includes a downstream berm with a low permeability liner keyed into the permafrost. Depending on the water quality, seepage may be directed to sumps, from where it will be pumped back into the TSF.

The design of the TSF has incorporated a freeboard allowance for ice entrainment, storage of the inflow design flood and wind setup in addition to the operating pond. Construction of the TSF Dam is planned to be completed in one stage with the supernatant water progressively reclaim through the Process Plant until end of Operations. As such, the TSF is only expected to be near its design capacity for a short period of time immediately prior to transitioning to the next tailings facility.

For additional details on operational monitoring, refer to Section 7.

<u>TSF Tailings Deposition Plan</u>

The TSF tailings deposition plan proposes discharge from multiple points within the TSF over the life of the facility, representing multiple periods in the deposition and tailings beach development. As part of this deposition plan, tailings will be deposited from the crest of the South Dyke to fill in the southern end of the TSF, which will create a sloped surface that will direct the tailings and the water away from this structure. Tailings discharge locations can be seen in Figure A-01.

5.2.8 Tailings Storage Facility Closure

Closure approach and activities are described in the Interim Closure and Reclamation Plan. In general, Closure of the TSF will begin as progressive reclamation while the facility is still in operation. PAG and NPAG waste rock from open pit developments will be used to cover the tailings surface. This entire covered surface, whether PAG waste rock or tailings, will receive a final NPAG waste rock cover at least 5 m thick (Figures A-02 and A-08). This cover is expected to promote permafrost aggredation into the tailings, and to maintain frozen conditions in the tailings in the long term. The majority of the NPAG waste rock cover will be placed by Year 6, and then waste rock placement will pause, with material being stockpiled within the footprint of the TSF, until the supernatant pond is fully reclaimed through the Process Plant in Year 12. The small outstanding portion of NPAG waste rock cover will then be moved into final placement at the TSF WRSA. The Project phases and stages, along with waste rock disposal scheduling, is outlined in the ICRP.

5.2.9 Tailings Management Alternatives

Using the Guidelines for the Assessment of Alternatives for Mine Waste Disposal (ECCC 2011), Sabina completed a multiple accounts analysis for tailings locations and disposal technologies. The chosen TSF location was selected based on proximity to the plant site and local topography, foundation conditions, and input from the landowners. The assessment also concluded that the most appropriate tailings deposition method is conventional slurry tailings. Details of the assessment are found in the Integrated Mine Waste Disposal Alternatives Assessment that was submitted February 2016 as part of the FEIS

Information Request Response Package (Sabina 2016). Sabina received notice that the Schedule 2 listing required under the MDMER for the Tailings Storage Facility was completed in June, 2020.

5.3 TAILINGS FACILITIES IN OPEN PITS

The exhausted Llama Open Pit will be converted into a TF and be used for the storage of tailings when the TSF has ceased operations .

5.3.1 Tailings Facility Construction and Operation

The open pits will be readily convertible to store tailings and will operate similarly to conventional above-ground tailings storage facilities.

Tailings will be deposited subaqueously in the mined-out open pits by using a single spigot discharge point. This discharge location within the TF will be changed over the life of deposition so that a near struck tailings surface is created. A reclaim barge will be located within each TF during its operation; water (supernatant) contained in the TF will be reclaimed and reused in the Process Plant.

Water from the Llama TF will be treated year-round during the Operations phase beginning in Year 5; this treated water will be withdrawn from Llama TF and discharged back into Llama TF. Based on the Water and Load Balance Report, water treatment is not required in the Closure Phase to meet discharge water quality objectives for the external receiving environment. See the Water Management Plan for additional details.

The TF will be filled to a maximum of 5 m below their overflow elevations to provide sufficient storage for water to passively accumulate in the TF to form a permanent water cover.

Details on water storage capacity of TF, and water treatment can be found in the Water Management Plan.

5.3.2 Tailings Facility Closure

Closure approach and activities are described in the Interim Closure and Reclamation Plan. The Llama TF will be closed once tailings deposition in this location ceases. The closure will entail a permanent water cover of 5 m which is deemed sufficient to limit resuspension of tailings solids due to wave action, surge following storm events, and ice scour. Water treatment is expected to only be necessary during Operations. The Llama TF may also be used to store non-hazardous waste from the final mine closure activities; further details can be found in the ICRP.

6. Environmental Protection Measures

6.1 MANAGEMENT OF SEEPAGE FROM THE TAILINGS STORAGE FACILITY

The overburden soils downstream of the TSF Dam are not considered conducive to constructing seepage collection ditches or drains. Therefore, seepage collection will be completed by constructing a berm downstream of the dam. The berm will incorporate a low permeability liner keyed into the permafrost. Depending on the quality of seepage water, it may be directed to sumps from where it will be pumped back into the TSF. Additional details on ditches and berms can be found in the Water Management Plan.

The above described seepage management process will continue, as required, into the Closure Phase but seepage is expected to significantly reduce over time with the cessation of tailings deposition and removal of the supernatant pond. In addition, placement of waste rock over the tailings will promote the aggradation of permafrost into the tailings over time. The TSF will be instrumented to monitor foundation temperatures below the TSF Dam, within the tailings, and within the final waste rock cover (see Section 7).

6.2 EFFLUENT DISCHARGES

Supernatant water contained in the TSF and the TF will be reclaimed and reused in the Process Plant. Discharges from the TSF and TF are not planned while they are operational, and supernatant will be removed from the TSF prior to it being converted into a WRSA. Discharges from the TF are not possible until the pits have passively filled as part of intended closure.

Water treatment details, reclaim rates, discharge criteria, and Post-Closure discharges from the TF are discussed in the Water Management Plan and the ICRP.

6.3 DUST MANAGEMENT

The possible sources of dust related to tailings management during the construction, operation, and closure of the tailings management facilities include:

- TSF Dam foundation construction prior to placement of tailings;
- Wind erosion of fine particles from the TSF surface;
- Vehicle traffic dislodging fine particles from the TSF/TF associated service and haul roads; and
- Placement of closure and capping layers.

Dust suppression measures typical of the current mine practices (i.e., Meliadine Project and Meadowbank Mine), and consistent with best management practices, will be considered through the Construction, Operations, and Closure phases of the Project to control dust.

Minimal site preparation is required for TSF construction; therefore, dust is not expected to be problematic during the Construction Phase. While the TSF is in operation, dust is not expected to have a significant impact; however, dust will be monitored and managed to the best extent possible through Sabina's Air Quality Management and Monitoring Plan (AQMMP). While a supernatant pond will cover a portion of the tailings surface, a tailings beach will be exposed that can generate wind-blown tailings. Dust related to TSF operation during the winter season is expected to be minimal due to snow cover over the tailings and a frozen crust over areas that are not near the active deposition. The summer season is expected to have the highest potential for dust generation, and will be managed by limiting the volume of tailings surface not under water. Dust mitigation measures will be applied as identified in the AQMMP.

After the operational life of the TSF, the supernatant pond will be progressively reclaim through the Process Plant until the end of Operations. Waste rock will also begin being placed over tailings while the TSF is in use; this waste rock cover will limit the amount of time the tailings beach will be susceptible to wind erosion. The TSF will be fully covered by early Closure to prevent further wind erosion of the tailings. The need for dust control during cover placement will be further evaluated during closure activities.

Dust in not expected to be an issue during the operation and closure of the Llama TF as the facility will maintain a permeant water cover during Operations and Closure, and as such, no wind erosion is anticipated at these facilities.

7. Monitoring Program

Routine inspections of the TSF during the construction and operations of the facility will include:

- Regular monitoring of the tailings disposal and tailings beach formation;
- Regular monitoring of the tailings supernatant water level;
- Visual inspections of the tailings embankment including seepage, during periods of flow, etc.;
- Grab sampling of tailings and treatment sludges as they are produced to confirm the potential for remobilization of arsenic from these materials remains within predicted levels; and
- An annual third-party geotechnical inspection of all earthworks including the TSF and TF is included under the Thermal and Geotechnical Monitoring Plan.

All testing will be completed in a certified laboratory and appropriate quality assurance/quality control measures will be applied.

A Field Characterization Program will also be conducted prior to the construction of the TSF dam. The information from the field characterization will ensure that the design meets the required intent of managing seepage through both the foundation and the body of the TSF Dam. If, based on this additional characterization, Sabina believes that there remain areas where seepage could occur, Sabina will install the necessary monitoring instrumentation to confirm the performance of the TSF Dam and the TSF WRSA Diversion Berm. This program will include an infill geotechnical characterization program of the western ridge adjacent to the TSF Containment Dam to determine the extent of the fractured bedrock contact zone and apply proposed mitigation as necessary. This will include permeability testing, seepage analysis, and planning for thermal monitoring of the western ridge, where appropriate. Percolation testing will include a series of shallow drillholes (approximately 10 m deep) which are completed using a blast hole drill at close spacing (about 25 m) along both the upstream and downstream extent of the key trench. The drill cuttings from each of the drill holes are collected, logged, sampled. In addition, select samples are tested for salinity and water content (which indicates ice content). Next, a falling head hydraulic conductivity test is completed on each drill hole, using heated water if conditions require it. This is a standard construction procedure for any frozen dam and the information collected in this fashion confirms foundation excavation depth.

A portion of the initial infill geotechnical drilling targeting the western ridge and the TSF Containment Dam has already been completed. The remaining infill geotechnical drill program will be completed as part of further characterization carried out immediately prior to TSF Dam construction.

Geotechnical and thermal monitoring instrumentation installed in the TSF Dam embankment and foundation (ground temperature cables and survey prisms) over the life of the Project will be conducted under the Thermal and Geotechnical Monitoring Plan. The instrumentation will be monitored to assess embankment thermal and stability performance, and to identify if conditions differ from those assumed during design and analysis. Amendments to the designs and/or remediation work can be implemented to respond to the changed conditions, should the need arise. A monitoring response framework will be developed as part of the Operation, Maintenance, and Surveillance Manual that will include quantitative performance objectives (threshold values, required actions, and personnel responsibilities).

Additional details on monitoring frequency, inspection plans, mine site water quality monitoring and receiving water quality monitoring can be found in the Water Management Plan, Appendix B.

Runoff water quality monitoring will be conducted as described in the Water Management Plan and prescribed in the Type A Water Licence. For details on TSF monitoring during Closure, please refer to the ICRP.

8. Contingencies, Mitigation, and Adaptive Management

The mine design, including the Tailings Management Facilities' designs, has been carefully prepared taking into consideration the vast database of site characterization data gathered for the Project, coupled with rigorous engineering analysis. Where data was limited, conservative assumptions were consistently applied. There is therefore a high level of comfort that the plans are viable and realistic. It is however understood that mining activities by nature have inherent uncertainty. Additional mitigation or adaptive management may be required as an outcome of conditions observed during the monitoring activities described in Section 7. This may include changes to TSF or TF operation as a result of operational, engineering, and environmental monitoring.

Possible tailings scenarios that could be encountered during Operations, and possible contingency strategies to address are outlined Table 8-1. Additional details on TSF WRSA closure and waste rock management contingency strategies can be found in the Mine Waste Rock Management Plan.

Table 8-1. Tailings Management Contingency Strategies

Possible Scenario	Contingency Strategy
The total volume of tailings might be greater than expected.	There is contingency built into the TSF capacity and additional capacity is available in the open pits to accommodate greater volumes of tailings.
The slope of the tailings beach might be different than expected.	Additional tailings discharge (spigot) points may be considered.
The tailings dry density may be different than expected.	Less dense tailings will occupy more space; however the TSF has contingency storage and additional capacity is available in the open pits.
The total volume of seepage might be greater than expected.	Larger return pumps may be considered. The tailings deposition plan may be modified to push the pond away from the TSF Dam to reduce seepage.
The impact to the underlying permafrost might be greater than expected from thermal modelling.	Retroactive design changes to the TSF Dam could include tailings deposition upstream of the dam, placement of GCL over original ground upstream of the dam to lengthen the seepage path through the foundation, and/or installation of vertical thermosiphons.
The tailings material might oxidize faster than expected.	Some additional water treatment may be required until the tailings freeze.

Should contingency measures be implemented in the form of using other open pits as TFs (i.e., Llama and Echo pits), Sabina intends to provide the NWB at least 60 days' notice prior to the disposal of waste in the TFs and will present the following information: waste disposal quantities, volumes, disposal timing, maximum pit capacity, effects to pit closure, and appropriate mitigation and monitoring plans.

Should temporary discharge be required from a tailings facility to the environment for any reason, a Temporary Tailings Effluent Discharge Plan would be submitted to the NWB at least 120 days prior to this discharge, as required by Part F, Item 16 of the Licence. This plan would include the following: justification for temporary discharge; volume, rate, and quality of discharge; final discharge point and characteristics of the receiving environment; proposed effluent quality limits; and mitigation options to avoid future discharges.

9. Environmental Reporting

Monitoring results will be reported in the annual reports filed with the NIRB and the NWB. Results of water quality or waste monitoring required under the Water Licence will be reported monthly and/or annually to the NWB, in accordance with the requirements of Water Licence 2AM-BRP1831.

As required by Part D, Item 4, of the Licence, the results of the infill geotechnical characterization program as discussed during permitting of the Project will also be reported. This submission shall include a description of the necessary monitoring instrumentation to confirm performance of the TSF Dam.

10. References

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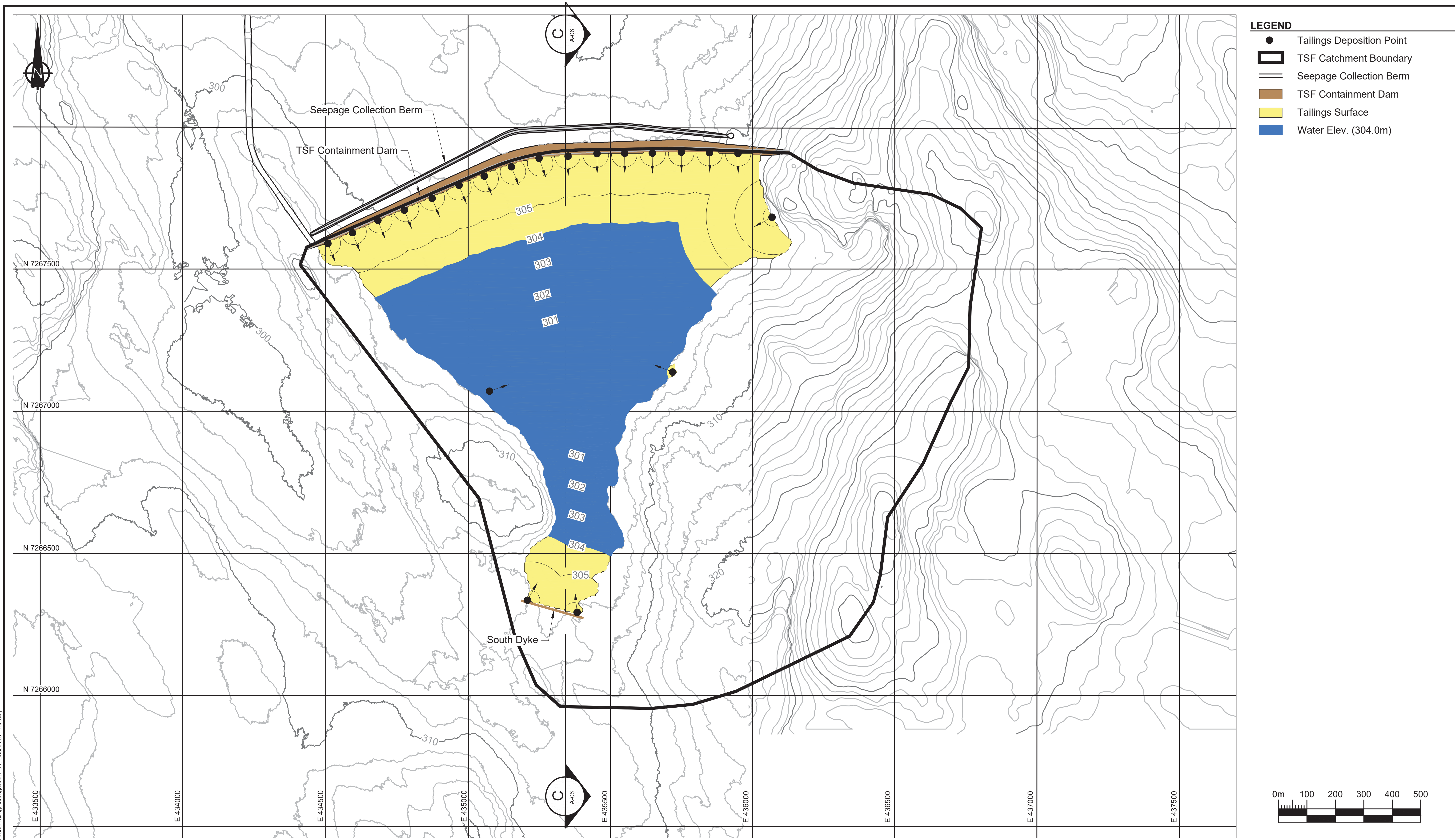
Appendix A. Figures



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B	ISSUED FOR PERMIT	CP	EMR	17/08/29
A	ISSUED FOR PERMIT	CP	EMR	16/05/26

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FILE NAME: 1CS020.020 - TSF.dwg

BACK RIVER PROJECT

SRK JOB NO.: 1CS020.020

TAILINGS MANAGEMENT PLAN

DRAWING TITLE:
TSF Containment Area
Plan View (Year 5)

REVISION NO. C | SHEET 1 OF 8 | FIGURE NO. A-01

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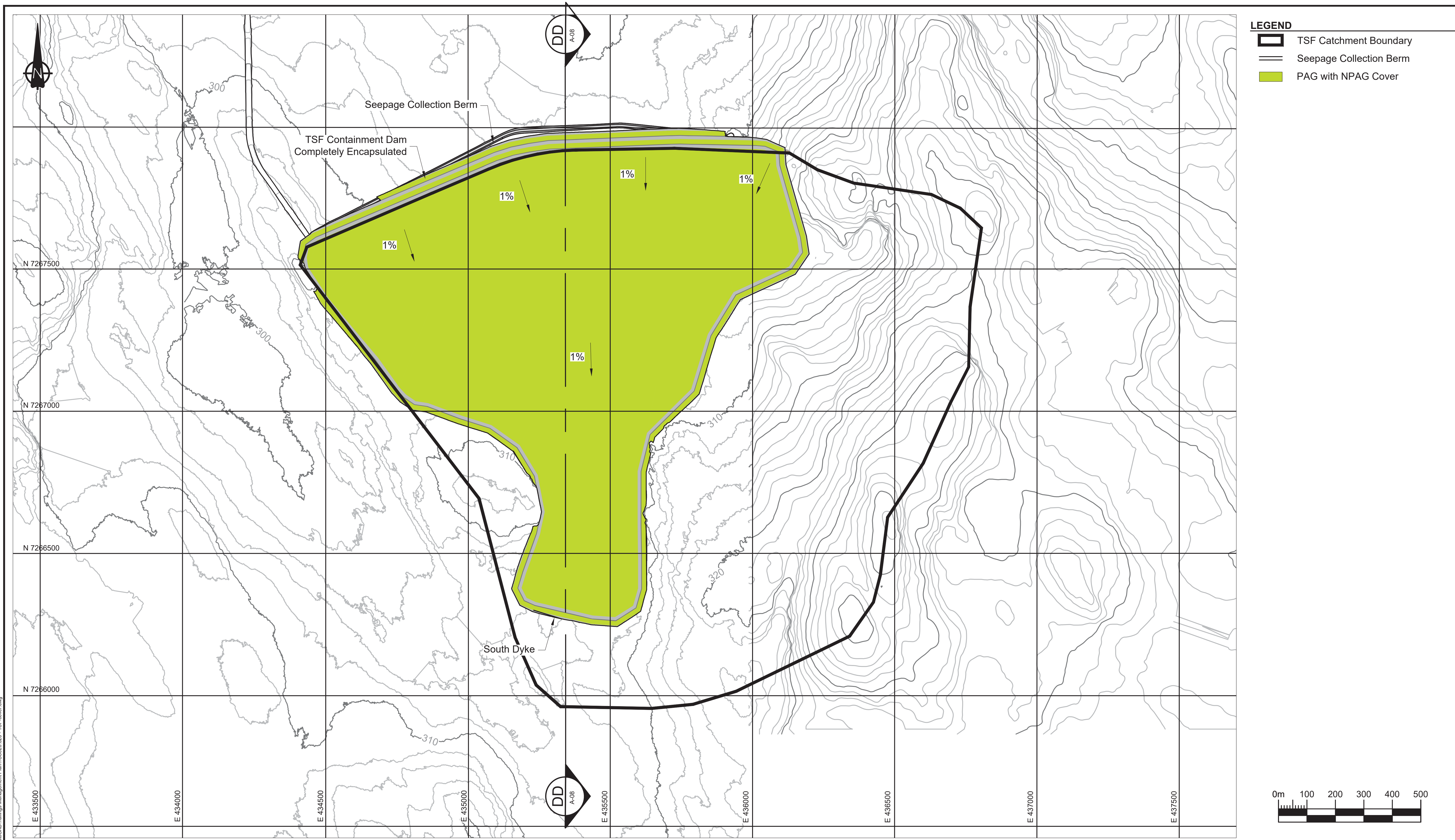

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FILE NAME: 1CS020.020 - TSF-cover.dwg

Sabina GOLD & SILVER CORP.

BACK RIVER PROJECT

SRK JOB NO.: 1CS020.020

TAILINGS MANAGEMENT PLAN

DRAWING TITLE:

TSF Containment Area
Plan View (Year 13)

REVISION NO. C

SHEET 2 OF 8

FIGURE NO. A-02

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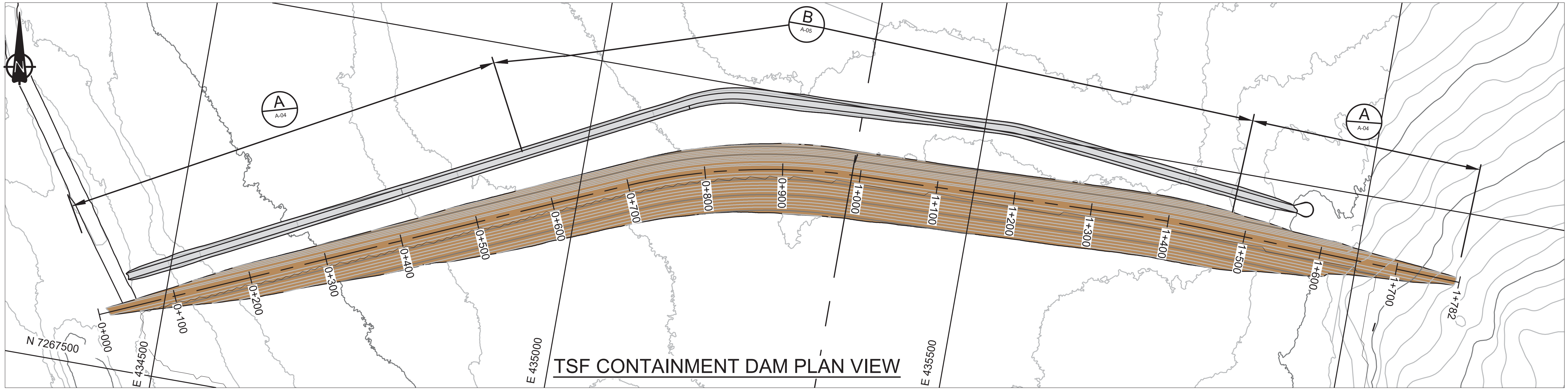
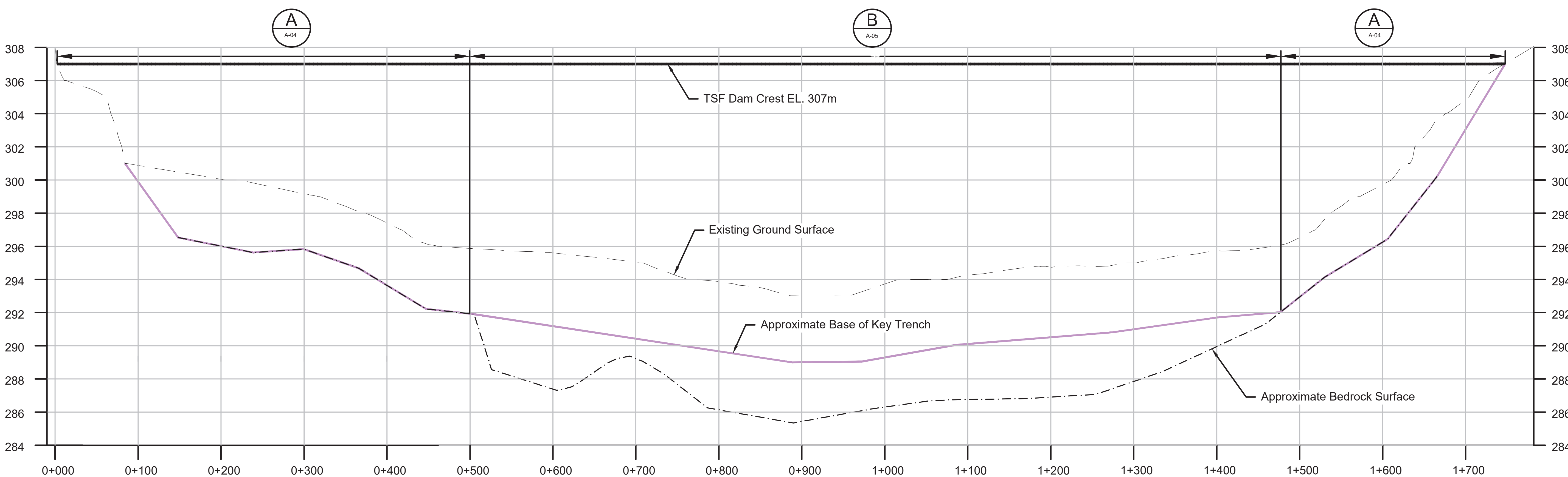


TSF CONTAINMENT DAM PLAN VIEW



CENTRELINE TSF CONTAINMENT DAM PROFILE VIEW

20x Exaggeration

LEGEND

TSF Containment Dam

0m 50 100 150 200

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BACK RIVER PROJECT

SRK JOB NO.: 1CS020.020

TAILINGS MANAGEMENT PLAN

DRAWING TITLE:

TSF Containment Dam
Plan View and Profile View

REVISION NO. C | SHEET 3 OF 8 | FIGURE NO. A-03

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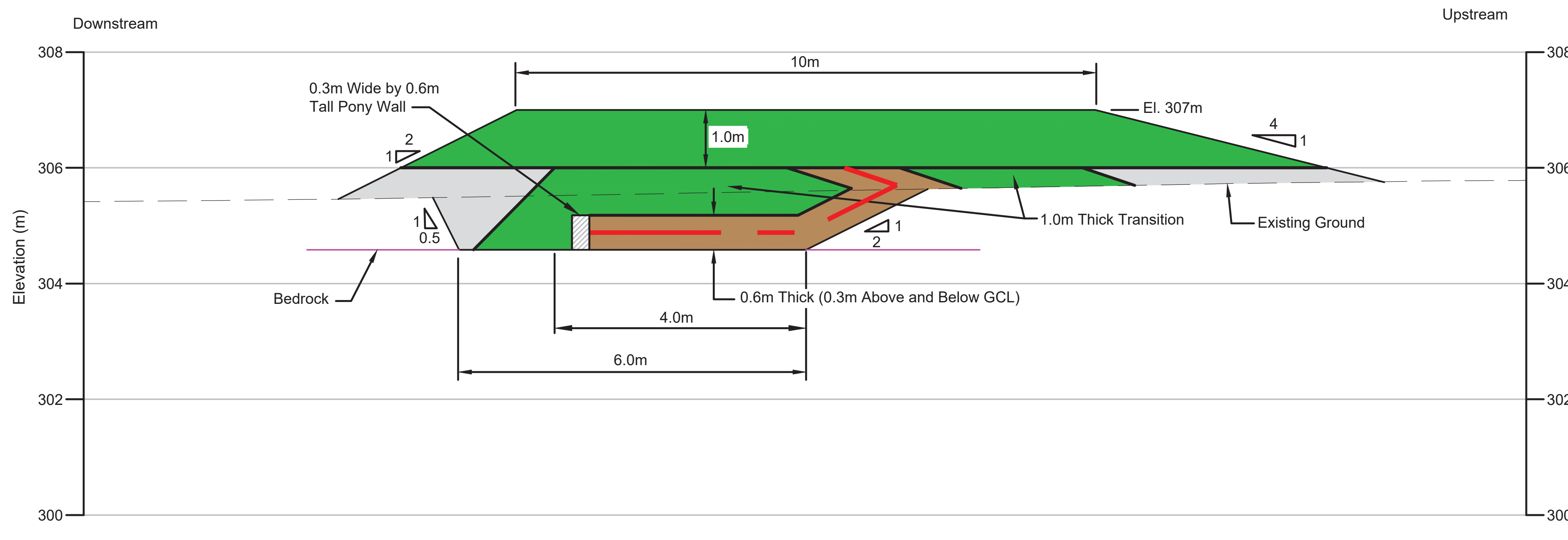
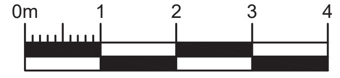
LEGEND

- GCL Liner
- Bulk Fill (ROM)
- Transition Fill
- Bedding Fill
- Ground Surface



A
A-03
TYPICAL CROSS-SECTION - SHALLOW BEDROCK



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BACK RIVER PROJECT

SRK JOB NO.: 1CS020.020

TAILINGS MANAGEMENT PLAN

DRAWING TITLE: TSF Containment Dam Typical Cross Section A - Shallow Bedrock (Year 1)

REVISION NO. C | SHEET 4 OF 8 | FIGURE NO. A-04

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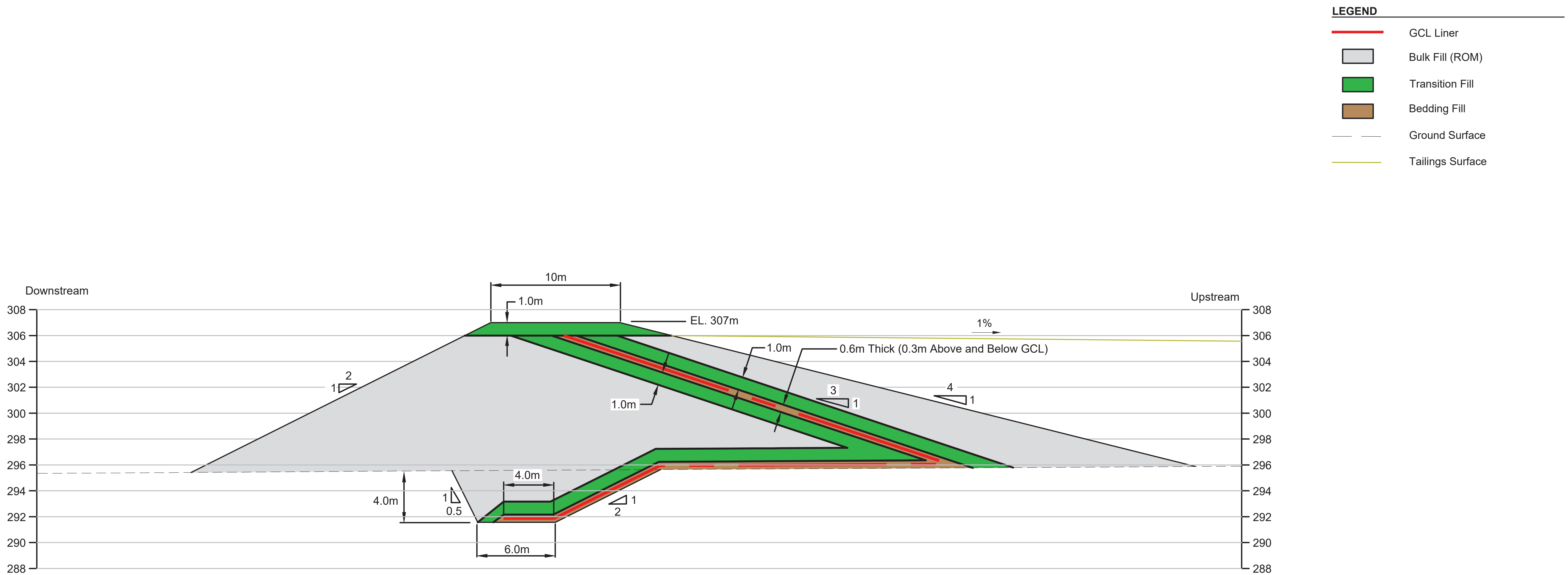

B
A-03
TYPICAL CROSS-SECTION - DEEP OVERBURDEN

0m 3 6 9 12

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FILE NAME: 1CS020.020 - TSF- xs.dwg

Sabina

BACK RIVER PROJECT

SRK JOB NO.: 1CS020.020

TAILINGS MANAGEMENT PLAN

DRAWING TITLE:
TSF Containment Dam
Typical Cross Section B -
Deep Overburden (Year 1)

REVISION NO. C | SHEET 5 OF 8 | FIGURE NO. A-05

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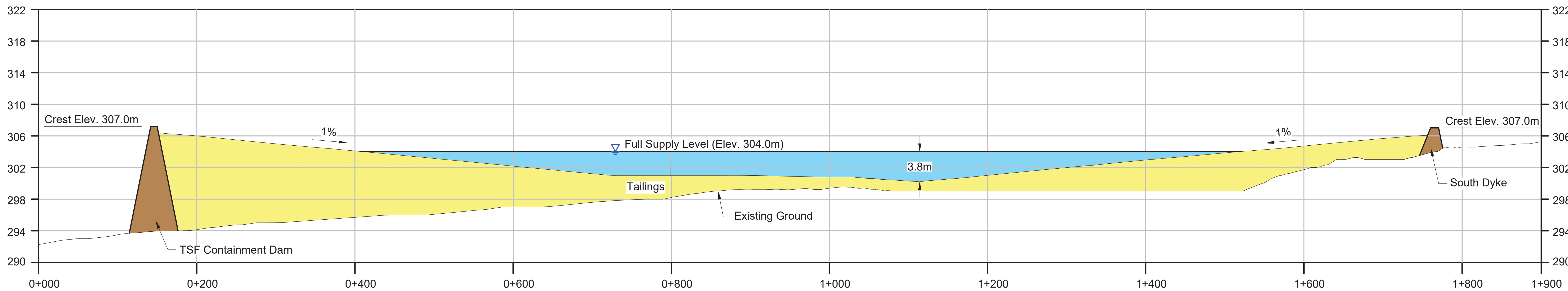
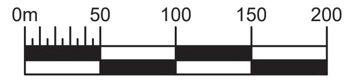
LEGEND

- TSF Containment Dam
- Tailings
- Pond



CC (A-01) TYPICAL TSF CROSS SECTION

10x Exaggeration



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BACK RIVER PROJECT

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TAILINGS MANAGEMENT PLAN

DRAWING TITLE: TSF Typical Cross Section with Full Supply Level

REVISION NO. C | SHEET 6 OF 8 | FIGURE NO. A-06

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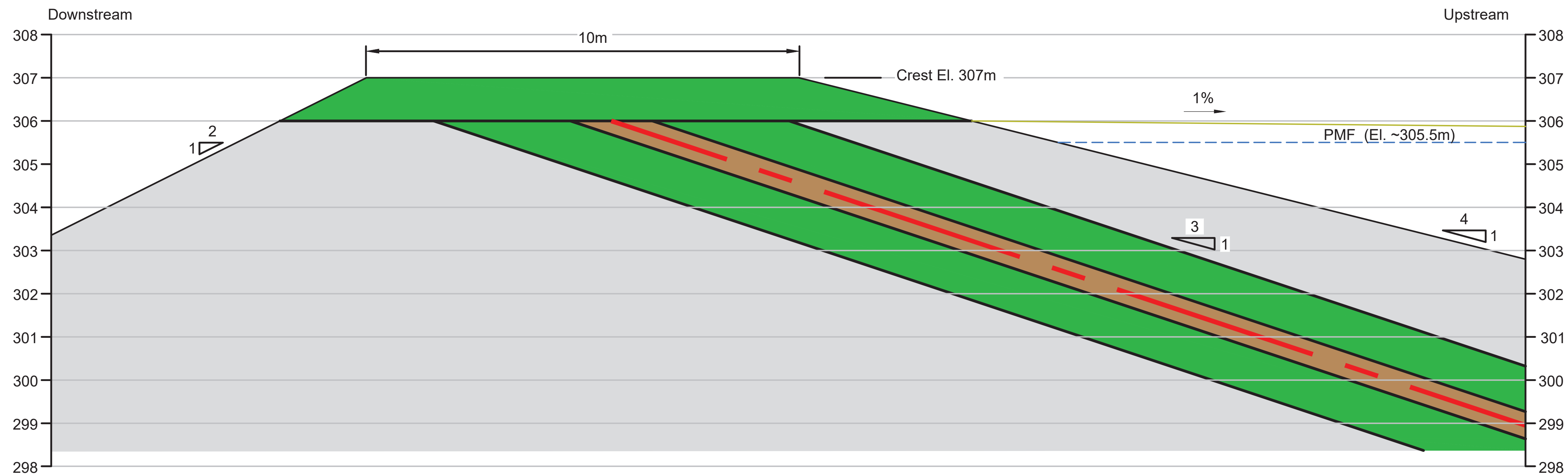
LEGEND

- GCL Liner
- Bulk Fill (ROM)
- Transition Fill
- Bedding Fill
- Ground Surface
- Tailings Surface



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TAILINGS MANAGEMENT PLAN

DRAWING TITLE: TSF Containment Dam Typical Freeboard Cross Section

REVISION NO. C | SHEET 7 OF 8 | FIGURE NO. A-07

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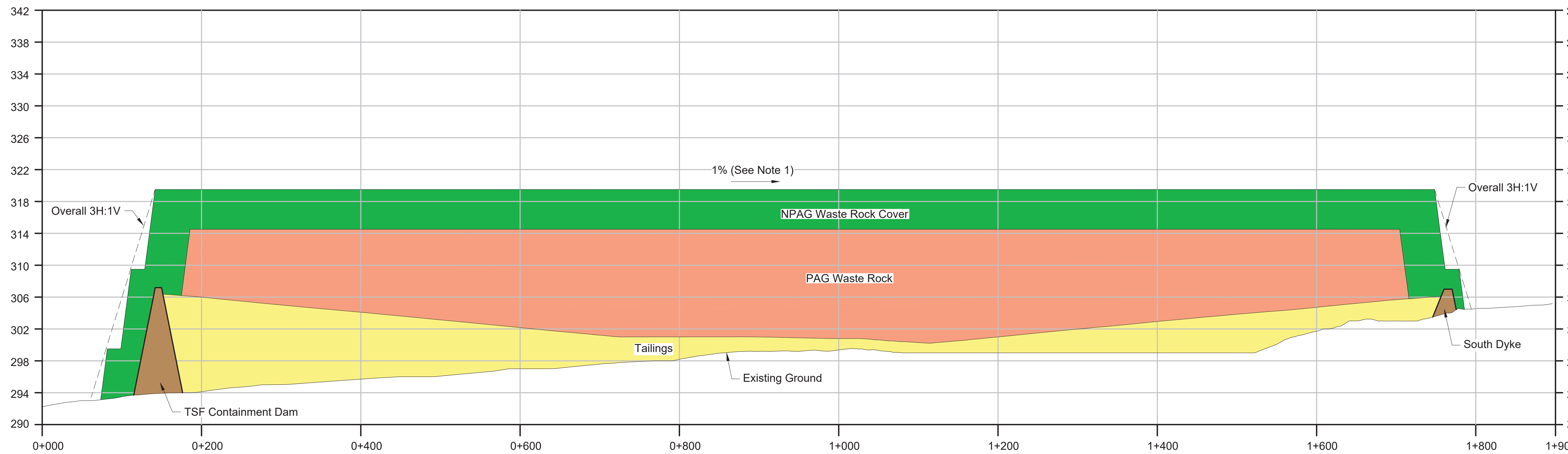
LEGEND

- TSF Containment Dam
- Tailings
- PAG Waste Rock
- NPAG Waste Rock Cover

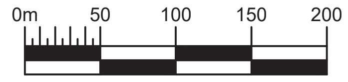
NOTES

1. Top surface will be sloped to the south at 1% away from the TSF Containment Dam; slope not shown in section.



DD A-02 **TYPICAL TSF WRSA CROSS-SECTION**

10x Exaggeration



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Sabina

BACK RIVER PROJECT

SRK JOB NO.: 1CS020.020

TAILINGS MANAGEMENT PLAN

DRAWING TITLE: TSF Typical Cross Section at Closure

REVISION NO. C — SHEET 8 OF 8 — FIGURE NO. A-08

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Attachment IR-E: Waste Rock Management Plan

BACK RIVER PROJECT
Waste Rock Management Plan

November 2020

BACK RIVER PROJECT

MINE WASTE ROCK MANAGEMENT PLAN

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Revision Log

Date	Section	Page	Revision
November 2015	All	All	Supporting Document for Final Environmental Impact Statement; submitted to Nunavut Impact Review Board (NIRB).
October 2017			Supporting Document for Type A Water Licence Application; submitted to Nunavut Water Board (NWB).
November 2020	All	All	Revisions to address requirements and commitments of Project Certificate, No. 007, and Water Licence, 2AM-BRP1831 and updated to reflect 2020 Type A Water Licence Amendment Application to the NWB.

Acronyms

ABA	Acid base accounting
AP	Acid generation potential
ARD	Acid rock drainage
ICRP	Interim Closure and Reclamation Plan
kt	Kilotonne
ML	Metal leaching
ML/ARD	Metal leaching/acid rock drainage
MLA	Marine Laydown Area
Mt	Million tonnes
NAG	Net Acid Generation test
NP	Neutralizing potential
NPAG	Non-potentially acid generating
NWB	Nunavut Water Board
PAG	Potentially acid generating
Project	Back River Project
Sabina	Sabina Gold & Silver Corp.
TSF	Tailings Storage Facility
WRMP or Plan	this Waste Rock Management Plan
WRSA	Waste Rock Storage Area

Executive Summary

The Waste Rock Management Plan describes the procedures and monitoring to be undertaken at the Back River Project relevant to the management of waste rock. The Plan is one of the documents that forms part of Sabina's overall Waste Management Program for the Project. This plan ensures that: 1) the procedures for the management of waste rock during Project Construction and Operations are defined, 2) relevant laws and regulations are appropriately adhered to, and 3) potential impacts related to waste rock generation and storage are minimized and monitored.

Uyarakhiuqvik Iqakut Uyaqat Aulatauni Parnaut (WRMP) Ataniqnut Nainaqhimayuq

Una Uyarakhiuqvik Iqakut Uyaqat Aulatauni Parnaut (WRMP) unniqtuqtai tapkuat pityuhit muariyaunilu havariyakhat talvani Hanningayuq Kuugaq Havagihia turangayuq tapkununga aulatauni tapkuat Iqakut Uyaqat. Tamna Parnaut ilagiyat tapkuat titiqat ilagiyai tapkuat Sabina-kut tamaitnut Iqakut Aulatauni Havagutai taphuma Havaguhia. Una Parnaut atuqpiaqtai tapkuat 1) tapkuat pityuhit tapkuat aulatauni iqakut uyaqat atuqtitlugu Havaguhia Hanayaunia Aulataunialu unniqtuqnit, 2) turangayut maligait maligauyutlu naamaktumik naalaktauni tapkuatlu 3) aktualaqnit turangayut tapkununga iqakut uyaqat pinguqtauni tutqumanilu mikhigiaqni munariyaunilu.

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ᐅᔭᕋᒃᑕᕆᐊᕐᒥᙵᒑᖅᑐᓂᒃ ᐊᒃᑰᖅᑕᐅᔪᑦ ᐅᔭᖅᑲᓂᒃ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐸᕐᓇᐅᑎ (WRMP) ᐅᖃᐅᓯᖃᖅᑐᖅ ᐊᑐᖅᑕᐅᔭᕆᐊᓕᓐᓂᒃ ᐊᒻᒪᓗ ᖃᐅᔨᓴᐃᓂᕐᓂᒃ ᓴᓐᓂᖕᒐᔪᕐᒥᑦ ᐱᔾᔪᑎᖃᖅᑐᓂᒃ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐊᒃᑰᖅᑕᐅᔪᑦ ᐅᔭᖅᑲᓂᒃ. ᐸᕐᓇᐅᑎ ᐃᓚᒋᔭᐅᔪᖅ ᑎᑎᖅᑲᐅᑎᓂᒃ ᐋᖅᑭᒃᓯᐅᑉᓗᓂ ᐃᓚᖕᒋᓐᓂᑦ ᓵᐲᓇᒃᑯᑦ ᑕᒪᐃᓐᓅᖕᒐᔫᒃᑯᑦ ᐊᒃᑕᑯᓂᒃ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᑐᕌᖕᒐᔪᖕᒐᓐᓂᑦ ᐱᓕᕆᐊᕐᒧᑦ. ᐸᕐᓇᐅᑎ ᐃᒪᓐᓇᐃᑎᑦᑎᔪᖅ 1) ᐊᑐᖅᑕᐅᔭᕆᐊᖄᑦ ᐊᐅᓚᑦᑎᓂᐊᕐᓗᓂ ᐊᒃᑰᖅᑕᐅᔪᓂᒃ ᐅᔭᖅᑲᓂᒃ ᐱᓕᕆᐊᖅ ᓴᓇᔭᐅᕝᕕᓕᐊᑎᓪᓗᒍ ᐊᒻᒪᓗ ᐊᐅᓛᖅᑎᑕᐅᑎᓪᓗᒍ ᑐᑭᓕᐅᖅᑕᐅᓗᑎᒃ, 2) ᐊᑐᖅᑐᑦ ᒪᓕᒐᐃᑦ ᐊᒻᒪᓗ ᒪᓕᒐᕋᓛᑦ ᒪᓕᒃᑕᐅᑦᑎᐊᕐᓗᑎᒃ ᐊᒻᒪᓗ 3) ᐊᒃᑐᖅᓯᓂᐅᔪᓐᓇᖅᑐᑦ ᐊᒃᑯᙳᖅᐸᓪᓕᐊᔪᓄᑦ ᐅᔭᖅᑲᓂᒃ ᐱᔪᓂᒃ ᐊᒻᒪᓗ ᑐᖅᑯᖅᑕᐅᓯᒪᓂᖕᒋᓐᓄᑦ ᒥᑭᓛᒃᑰᖅᑎᓪᓗᒋᑦ ᐊᒻᒪᓗ ᖃᐅᔨᓴᖅᑕᐅᓗᑎᒃ.

1. Introduction

The Back River Project (the Project) is a gold project owned by Sabina Gold & Silver Corp. (Sabina) within the West Kitikmeot region of southwestern Nunavut. It is situated approximately 400 kilometres (km) southwest of Cambridge Bay, 95 km southeast of the southern end of Bathurst Inlet, and 520 km northeast of Yellowknife, Northwest Territories. The Project is located predominantly within the Queen Maud Gulf Watershed (Nunavut Water Regulations, Schedule 4).

The Project is comprised of two main areas with interconnecting winter ice roads; the Goose Property and the Marine Laydown Area (MLA). The majority of annual Project resupply will be completed using the MLA situated along the western shore of southern Bathurst Inlet, which is connected seasonally to Goose via an approximately 160 km long winter ice road. Both the Goose Property and the MLA make use of a local networks of all-weather roads.

The Waste Rock Management Plan (the Plan or WRMP) outlines the approach for managing waste rock and overburden produced at the Back River Project. No mine waste rock will be generated at the MLA.

This Plan has been constructed in consideration of all applicable guidelines and requirements, including those of the Type A Water Licence, 2AM-BRP1831, and Project Certificate, No. 007. This plan will be reviewed and updated as needed to reflect changes in regulatory requirements, facility operation and/or technology, approach, monitoring results, management reviews, incident investigations, best practice updates or other Project specific protocols.

Any updates to this plan will be filed with the Nunavut Water Board (NWB) and the Nunavut Impact Review Board (NIRB) with the submission of annual reports as per the requirements of the Project Certificate, No. 007 and Water Licence, 2AM-BRP1831.

2. Scope and Objectives

The WRMP is one of the documents that forms part of Sabina's overall Waste Management Program for the Project. This plan describes Sabina's approach to managing mine waste rock and overburden. Goose Property quarry rock and overburden identified as being waste will also be disposed of as outlined in this Plan.

The scope of the Plan covers operational procedures, implementation of environmental protection measures, and monitoring and reporting of the effectiveness of mitigation. The purpose of the Plan is to: outline procedures and processes for Construction and Operations of the Project as proposed; meet relevant laws and regulations; mitigate potential adverse environmental effects; and monitor potential mitigation measures for success.

The Plan applies to the Construction and Operations phases of the Project during which time waste rock will be produced and has relevance to the Closure and Post-Closure phases as waste rock will be permanently stored at the Property. Progressive reclamation as well as the closure and reclamation of Waste Rock Storage Areas (WRSA), is addressed in detail in the Interim Closure and Reclamation Plan (ICRP).

The main environmental concerns related to waste rock storage are the potential effects of metal leaching/acid rock drainage (ML/ARD) and release of nutrients from explosives use (ammonia and nitrate) on local water quality, as well as deposition of dust from the WRSAs on the surrounding land and water.

The measures identified in this plan and related management and monitoring plans are intended to protect permafrost and the Project Valued Ecosystem Components, including, air quality, surface water, water quality, sediment quality, aquatic habitat, and fish.

2.1 ADDITIONAL APPROVED DEVELOPMENT INFRASTRUCTURE/MINING AREAS

Project components previously assessed and permitted but not a part of the current mine plan may be reintroduced into the mine plan in future based on market considerations and engineering advancement. As these components were assessed and approved by NIRB, reintroduction of these mining areas to the mine plan in future would not constitute a modification to the Project under Part G of the existing Type A Water Licence, 2AM-BRP1831. Similarly, NIRB's letter, Direction Regarding the "Back River Project 2020 Modification Package" submitted by Sabina Gold & Silver Corp. in relation to the Back River Project (K. Kaluraq to M. Pickard, dated August 11, 2020, NIRB File No. 12MN036), the NIRB determined that the Back River Project 2020 Modification Package would not constitute a significant modification that requires further assessment by the NIRB, including "the use of mined-out open pits as tailings storage" (NIRB 2020).

The mining areas and associated support infrastructure that may be reintroduced and reintegrated into the mine plan, and subsequently future ICRPs, are listed below:

- Llama Underground;
- Goose Main Underground;
- Echo Open Pit;
- Echo Underground;

- o Echo WRSA;
- o Any associated Underground laydown pads, water pumps and pipelines;
- o All associated water or tailings pumps and pipelines, and diversion berms and ponds, including but not limited to:
  - o Echo WRSA Containment Dam; Echo WRSA Diversion Berm; West Echo Diversion Berm; East Echo Diversion Berm; East Echo Containment Dam;
  - o Umwelt WRSA Containment Dam; Umwelt WRSA Diversion Berm;
  - o Saline Water Pond Diversion Berm; Saline Water Pond East Containment Dam;
  - o West Llama Reservoir Diversion Berm; East Llama Reservoir Diversion Berm; South-West Llama Reservoir Diversion Berm, South Llama Reservoir Diversion Berm; Llama WRSA Diversion Channel; and
  - o Ore Stockpile Diversion Berm; Tailings Storage Facility (TSF) WRSA Pond.

Should Sabina choose to reintegrate any of these components into the mine plan a notice of modification prior to the disposal of waste would be provided to the NWB (per 2AM-BRP1831 Part B, Item 17) and would include information on: waste disposal quantities, volumes, disposal timing, maximum pit capacity, effects to pit closure, and appropriate mitigation and monitoring plans. Any necessary plans that may need updating, including this ICRP, would also be updated.

2.2 RELATED DOCUMENTS

This plan is to be implemented in conjunction with various other Sabina management, mitigation, and monitoring plans. Plans that have relevance to this plan include:

- o Environmental Management and Protection Plan;
- o Water Management Plan;
- o Aquatic Effects Management Plan;
- o Road Management Plan;
- o Thermal and Geotechnical Monitoring Plan;
- o Air Quality Monitoring and Management Plan; and
- o Interim Closure and Reclamation Plan.

The following reports and studies have also informed the development of this plan:

- o WRSA Design Report (Sabina 2017b, Appendix F-3);
- o Geochemical Characterization Report (Sabina 2017b, Appendix E-3);
- o Site-Wide Geotechnical Characterization Report (Sabina 2017b, Appendix F-2);
- o Water and Load Balance Report (SRK 2020); and
- o Site Wide Water Management Report (Sabina 2017b, Appendix F-1).

This plan is based on the waste rock design report submitted as part of the Water Licence submission package (Sabina 2017b, Appendix F-3), which includes the following design details:

- Waste Rock Storage Area (WRSA) Management Approach;
- WRSA Thermal Analysis;
- WRSA Stability Analysis;
- WRSA Design Criteria;
- WRSA Foundation Conditions; and
- WRSA Construction Sequencing.

3. Applicable Legislation and Guidelines

The Plan has been prepared to comply with existing regulations and follow the applicable guidelines provided by the federal government and the government of Nunavut.

Specific legislation, regulations, and guidelines related to waste rock management in Canada, and specifically within Nunavut, are summarized in Table 3-1.

The Project is also bound by the requirements of the Back River Project Certificate, No. 007, the Type A Water Licence, 2AM-BRP1831, and various land use permits. Sabina will also be bound by the terms and conditions of its land use permits issued by the Kitikmeot Inuit Association for Inuit Owned Land.

Table 3-1. Applicable Legislation to Waste Management in Nunavut

Acts	Regulations	Guidelines
Federal		
Canadian Environmental Protection Act (CEPA; 1999)		
Nunavut Waters and Nunavut Surface Rights Tribunal Act (2002)	Nunavut Water Regulations (2013)	
Territorial Lands Act (1985)	Territorial Land Use Regulations (CRC, c.1524) Northwest Territories and Nunavut Mining Regulations (CRC, c.1516)	Implications of Global Warming and the Precautionary Principle in Northern Mine Design and Closure (BGC 2003)
Fisheries Act (1985)	Metal and Diamond Mining Effluent Regulations (SOR/2002-220)	
Territorial – Nunavut		
Nunavut Environmental Protection Act (1988)	Spill Contingency Planning and Reporting Regulations (NWT Reg (Nu) 068-93)	Canada-Wide Standards for Petroleum Hydrocarbons (PHC) In Soil (CCME 2008)
Mine Health and Safety Act (SNWT (Nu) 1994, c.25)	Mine Health and Safety Regulations (NWT Reg (Nu) 125-95)	

Plan development also considered the Guidelines for the Closure and Reclamation of Advanced Mineral Exploration and Mine Sites in the Northwest Territories issued by the MVLWB and AANDC (MVLWB/INAC/GNWT 2017).

4. Roles and Responsibilities

The General Manager is ultimately responsible for the success of the Plan and approves all relevant policies and documents, auditing, action planning, and the verification process.

The Mine Manager, along with their direct reports, is responsible for specifics of this plan including:

- Overall management of plan;
- Operational aspects; and
- Internal reporting.

Mine Operations is responsible for the implementation of this plan including:

- Monitoring;
- External reporting; and
- Ensuring compliance and adaptive management.

It is expected that successful implementation of this plan will require dedicated support by the Geology, Engineering, Site Services, Mine Operations, and Environment Departments.

5. Planning and Implementation

5.1 OVERVIEW

A total of 93.1 million tonnes (Mt) of overburden and waste rock comprised of the following will be generated from open pit and underground operations:

- Non-potentially acid generating (NPAG) waste rock = 36.2 Mt (~42 %).
- Potentially acid generating (PAG) waste rock = 50.4 Mt (~58 %).
- NPAG Overburden = 6.5 Mt.

The majority of waste rock and all overburden produced will be stored in engineered WRSAs located close to each of the open pits (2020 Modification Package Appendix A, Figure 3). Approximately 5 Mt of waste rock will be used for other purposes, including approximately 3.5 Mt of geochemically suitable waste rock for general site construction activities and approximately 1.5 Mt for construction of the TSF Containment Dam. Beyond this, a minor volume of PAG waste rock will be used for backfill in the underground mine.

There will be three WRSAs at the Goose Property as follows:

- Umwelt WRSA: Located to the East of the proposed Umwelt open pit mine.
- Llama WRSA: Located to the East and South of the proposed Llama open pit mine.
- TSF WRSA: Located to the South of the proposed Goose Main open pit, where waste rock is placed on top of the TSF once it is no longer in use. All of the waste rock placed in the TSF WRSA will come from the Goose Main open pit mine.

Figure A-01 shows the associated water management facilities associated with the WRSAs and nearby receiving waterbodies. See the Water Management Plan for more details.

Approximately 6.5 Mt of overburden, which is geochemically suitable for use as cover or construction material, will be stripped during development and the top organic layer may be stockpiled for use during reclamation. Depending on the physical characteristics of the overburden, it may be incorporated within the WRSAs, used for specific construction purposes, or used as WRSA cover material.

The WRSAs have been designed to progressively encapsulate the PAG waste rock during Operations such that a minimum 5-m thick NPAG waste rock cover is created on the top and sides of each WRSA. See the ICRP for more details. Over time, it is expected that permafrost will aggrade into the PAG rock, which will reduce oxidation rates and contact with seepage and runoff (Sabina 2017b, Appendix E-3). Results from the water quality assessment indicate that at Closure, the water in contact with the NPAG cover material will meet water quality criteria acceptable for direct discharge to the environment. Additional details on the water quality assessment can be found in the Water Management Plan, the Water and Load Balance Report, and Interim Closure and Reclamation Plan.

The following sections provide details on the physical and geochemical characteristics of the waste rock; the waste rock production schedule; the WRSA design layouts, stability and thermal analyses completed in support of the design; and waste rock and overburden management alternatives considered.

5.2 WASTE ROCK PHYSICAL CHARACTERISTICS

Physical characterization of run-of-mine waste rock was not carried out for the purpose of completing a stability assessment due to the practical limitations of suitable test methods for this type of material. Instead, and per standard practice, literature values supported by engineering judgement were used. Table 5.2-1 summarizes the material properties adopted for run-of-mine waste rock for the Project; this table is sourced from the Site-Wide Geotechnical Characterization Report (Sabina 2017b, Appendix F-2).

Table 5.2-1. Typical Run of Mine Waste Rock Physical Properties

Parameter		Value
Moist Unit Weight (kN/m^3)		20
Degree of Saturation (%)		30
Porosity, n		0.3
Volumetric Water Content		0.09
Frozen	Apparent Cohesion, c' (kPa)	5
	Friction Angle, ϕ (^{o})	38 to 40
Unfrozen	Apparent Cohesion, c' (kPa)	0
	Friction Angle, ϕ (^{o})	38 to 40

kN/m^3 = kilonewtons per cubic metre; kPa = kilopascal; % = percent.

5.3 WASTE ROCK AND OVERBURDEN GEOCHEMICAL CHARACTERISTICS

Detailed geochemical characterization studies were completed between 2007 and 2015 to determine the ML/ARD potential of waste rock and overburden from the Project (Geochemical Characterization Report; Sabina 2017b, Appendix E-3). The results of the geochemical characterization program, specifically the quantities of PAG and NPAG waste rock that will be produced during mining activities, and water quality predictions for each of the WRSAs, were key considerations in developing the waste rock and water management plans for the Project.

Approximately 700 waste rock samples and 60 overburden samples from the Goose Property were analyzed, including acid base accounting (ABA) and trace element analyses, during this characterisation study; details of this sampling program and the subsequent results can be found in the Geochemical Characterization Report (Sabina 2017b, Appendix E-3). A brief summary of the testing program and results for waste rock and overburden associated with the Goose Property is provided below, see the Geochemical Characterization Report (Sabina 2017b, Appendix E-3) for details and sampling methodologies.

The Umwelt, Llama, and Goose Main deposits are located within a sequence of turbiditic meta-sedimentary rocks. This sequence is cut by felsic dykes (quartz feldspar porphyry) and gabbroic dykes. From oldest to youngest, the stratigraphic sequence is composed of the following units: lower greywacke, deep iron formation, lower iron formation, middle mudstone, upper iron formation, phyllite, upper greywacke, and upper sediments/overburden. The deposits are overlain by glacial till. Gold mineralization tends to be hosted in the lower greywacke, lower iron formation, and upper iron formation.

Geochemical characterization indicates that overburden has a negligible potential for ML/ARD and is classified as NPAG. For waste rock, appreciable proportion of the waste rock is classified as PAG according to the geochemical analysis results. PAG and uncertain waste rock are found in all of the stratigraphic units except for the gabbro dykes, but are more common in the lower iron formation, and to a lesser extent in the upper iron formation units.

Seep testing results indicated under neutral pH conditions, metal concentrations tend to be much lower than if conditions were acidic, but there is still some potential for leaching of aluminum and arsenic from the NPAG rock. The kinetic tests indicate that metal leaching, notably aluminum, cadmium, copper, iron, nickel, and zinc, is greatly enhanced when acidic conditions are allowed to develop. Based on the kinetic test results and seep surveys, specific measures will be necessary to control ML/ARD potential in the PAG waste rock. For management purposes, Sabina has assumed that all rock that is PAG, or rock which has an uncertain potential for ARD, will be managed as PAG which will also address the potential for metal leaching related to acidic conditions.

5.3.1 Geochemical Criteria for Material Management

Site-specific classification criteria were developed based on the results of geochemical testing of overburden and waste rock for the purpose of material management during Construction and Operations. The classification criteria presented in Table 5.3-1 are supported by the results of ABA, NAG testing, and kinetic testing. Rock is classified based on the ratio of neutralization potential (NP) to acid generation potential (AP, calculated using total sulphur content). Refinement of the classification criteria can be considered in the future based on the ongoing collection of geochemical testing data and site-specific monitoring data collected during the Construction and Operations phases of the Project.

Table 5.3-1: Site-specific Geochemical Classification Criteria

Acid Generation Potential	Criteria	Comments
Non-Potentially Acid Generating	NP/AP > 3 or total S <0.15%	These samples are not expected to generate acidity
Potentially Acid Generating	NP/AP < 3	Potentially acid generating or uncertain acid generation potential owing to uncertainty in availability and reactivity of bulk NP

5.3.2 Waste Rock Classification

The criteria for geochemical classification of mine materials presented in Table 5.3-1 was used to determine the relative number of PAG samples in the geochemical dataset by mine area. As presented in Figure 5.3-1 and Figure 5.3-2, the Umwelt and Llama deposits have the highest proportion of PAG samples, while the Goose Main deposit has the lowest proportion.

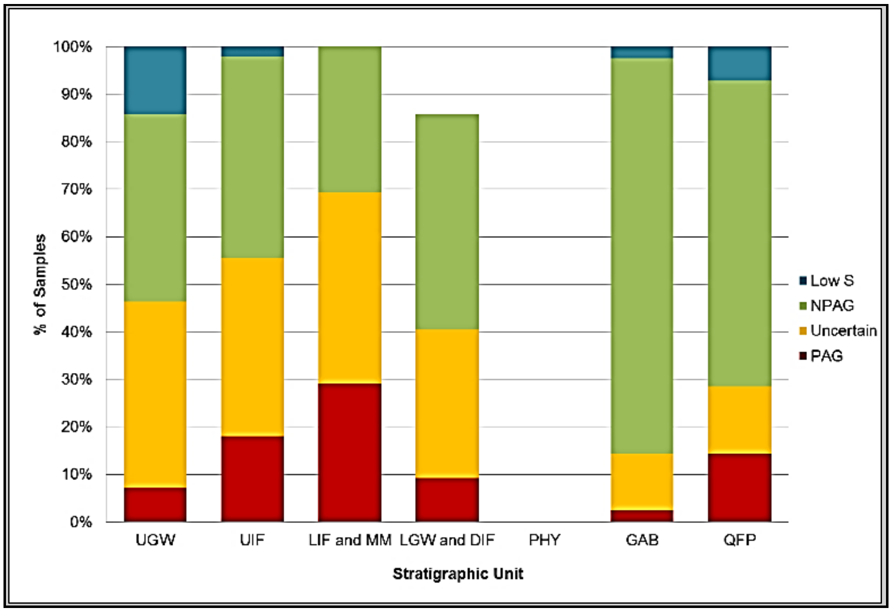

Figure 5.3-1: Distribution of PAG, Uncertain, NPAG, and Low Sulphur Waste Rock Samples According to Stratigraphic Unit and Deposit Groupings – Umwelt & Llama Deposits

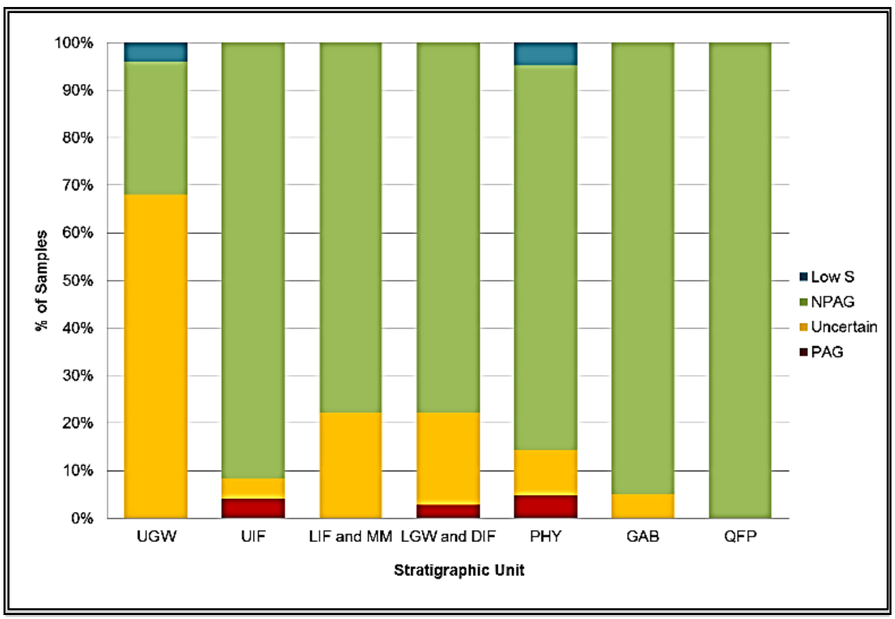

Figure 5.3-2: Distribution of PAG, Uncertain, NPAG, and Low Sulphur Waste Rock Samples According to Stratigraphic Unit and Deposit Groupings – Goose Main Deposit

In-situ quantities of PAG and NPAG rock were determined based on the proportion of PAG and NPAG samples present in each of the modelled stratigraphic and intrusive units, and the quantities of waste rock present in each of these units. The in-situ quantities were then conservatively adjusted to reflect inefficiencies in the segregation process. Estimates of PAG/NPAG waste rock quantities are presented in Table 5.3-2, and further details on each WRSA are found in Section 5.4.1.

Table 5.3-2. Quantities and Proportions of Waste Rock by ARD Classification – Goose Property Deposits (ktonnes)

Scenario	Pit	Quantity (000s)			Distribution (%*)	
		PAG	NPAG	OVB	PAG	NPAG
In-situ Quantities	Umwelt	7,338	6,909	1,178	52%	48%
	Llama	14,933	14,178	1,278	51%	49%
	Goose Main	8,163	35,104	4,019	19%	81%
	Total	**30,434**	**56,191**	**6,474**	**35%**	**65%**
75% of NPAG recovered except 0% in LIF and 50% in Umwelt/Llama UIF	Umwelt	10,106	4,141	1,178	71%	29%
	Llama	21,047	8,064	1,278	72%	28%
	Goose Main	19,271	23,996	4,019	45%	55%
	Total	**50,424**	**36,201**	**6,474**	**58%**	**42%**

** Distribution does not include overburden (OVB), which is NPAG.*

The distribution of PAG and NPAG waste rock is not closely linked to stratigraphy nor to lithology. Therefore, identification and subsequent segregation of these materials will require a dedicated blast hole monitoring program which is outlined in Section 7.1.

Preliminary calculations indicate that acidic conditions are not expected to develop in the majority (>95%) of the waste rock during an approximately 10-year freeze-back period. Although acidic conditions could occur more rapidly in some of the waste rock, average pH conditions in seepage and runoff would be expected to remain buffered until WRSA freeze back conditions develop. Nonetheless, due to the potential for somewhat elevated metal and/or nutrient (ammonia and nitrate) concentrations during the freeze-back period, seepage and runoff water will be managed throughout Operations, as described in Section 6.2.

5.4 WASTE ROCK STORAGE AREA DESIGN

The locations of the WRSAs were chosen based on consideration of the environmental, social, economic, and technical aspects of waste rock management, which included the following:

- minimize the overall footprints of the WRSAs while maintaining the short-term and long-term stability of the facilities;
- avoid or minimize impact to fish bearing lakes (details regarding fish-bearing waters can be found in the Section 7.1.8 of the Main Application Document in the Type A Water Licence Application (Sabina 2017b);
- minimize the haul distance from the open pits to the WRSAs;
- minimize the number of water catchment areas potentially affected by drainage from the WRSAs;
- when feasible, divert the upstream clean natural non-contact run-on water away from the WRSAs;
- facilitate the collection and management of contact water from the WRSAs during Operations to avoid potential impacts on the surrounding environment;
- maintain a minimum distance of 100 m between the toe of the WRSAs and the open pits;
- maintain a minimum distance of 100 m between the toe of the WRSAs and adjacent lakes that will not be disturbed by mine activities; and

- build the WRSAs to maximize progressive reclamation and minimize dedicated closure activities during Closure.

Considering the WRSA management strategy and the results of the thermal and stability analyses, the following WRSA design criteria will be adopted for the Project:

- The WRSAs will be constructed in benches using a bottom-up technique.
- The lift thickness is not critical for freeze back or stability and can therefore be determined based on constructability requirements of the mine haul truck fleet. Based on the proposed 64 t haul trucks, lift heights of around 5 to 8 m can reasonably be expected.
- The final overall slope (measured bench crest to bench crest) of the WRSAs will be 3H:1V or less. Individual bench slopes can be at angle of repose with bench setbacks designed to allow for an overall slope at the desired grade. The design slope geometry is not a requirement due to stability but rather a reasonable long-term slope considering overall landscape design. Final landscape design of the WRSAs will also consider, where practical, a configuration that will promote shedding of snow to minimize its insulating effects.
- The designs of the WRSAs include complete encapsulation of PAG material with a minimum 5 m of NPAG waste rock. Placement of the NPAG cover is planned to be concurrent with PAG waste rock placement as the WRSAs develop. No appreciable amount of NPAG stockpiling and handling is planned due to the progressive reclamation approach, and the closure of the WRSAs is intended to be appreciably completed prior to the end of the Operations Phase.
- In general, overburden is not expected to be widely useable for either construction or structural reclamation material (frozen chunks in winter and water-saturated silt in summer). However, some sand and gravel overburden is expected to be present at the Property and would be geotechnically suitable as a portion of the 5 m NPAG cover and for construction of key infrastructure during the Construction Phase. This will need to be reviewed and assessed during Construction and Operations. As noted previously, the top organic layer from overburden stripping during development at site may be stockpiled for use during reclamation. The overburden that is not deemed geotechnically suitable as cover material will be placed in interior cells of the WRSAs with a 20 m minimum set-back from the outer edge of the WRSA.

5.4.1 Waste Rock Storage Area Descriptions

Each of the three WRSAs is described in further detail below; Figures A-02 and A-03 show WRSA plan views and typical cross-sections of the facilities at Closure.

5.4.1.1 Umwelt Waste Rock Storage Area

The proposed Umwelt WRSA will permanently occupy an area of approximately 33 ha, have a height of approximately 34 m, and will be located East of the proposed Umwelt open pit. The Umwelt WRSA will be used to store the majority of waste rock and overburden from the Umwelt open pit. Some geochemically suitable waste rock from Umwelt Pit may also be used for the construction of site roads and pads and the construction of the TSF dam. One small stream and two ponds are located within the footprint, or immediately upstream, of the Umwelt WRSA and will be covered by the facility (2020 Modification Package Appendix A, Figure 3). The stream and ponds are less than 2 m deep and freeze to the bottom annually during winter. To manage slope stability, overburden will be placed within areas surrounded, and ultimately covered, by waste rock. The Umwelt WRSA is expected to reach its design capacity at the end of Year 2.

5.4.1.2 Llama Waste Rock Storage Area

The proposed Llama WRSA will permanently occupy an area of approximately 43 ha, have a height of approximately 76 m, and will be located East and South of the proposed Llama open pit. It will store waste rock and overburden from the Llama open pit. There are no ponds or streams located within the footprint of the Llama WRSA (2020 Modification Package Appendix A, Figure 3). To manage slope stability, overburden will be placed within areas that will be surrounded by waste rock. The Llama WRSA is expected to reach its design capacity at the end of Year 3.

5.4.1.3 Tailings Storage Facility Waste Rock Storage Area

The proposed TSF WRSA will permanently occupy an area of approximately 155 ha. The height of waste rock will be approximately 24 m and will be located South of the proposed Goose Main open pit. The waste rock and overburden from the Goose Main open pit will be placed in the TSF WRSA, on top of the TSF once it is no longer in use. Three small streams and four ponds are located within the footprint of the TSF WRSA and will be covered by the facility (2020 Modification Package Appendix A, Figure 3). Except for one pond, these streams and ponds are less than 2 m deep and freeze to the bottom annually in winter. To manage slope stability, overburden will be placed within areas that will be surrounded by waste rock. The TSF WRSA is expected to reach its design capacity early in Year 6.

5.4.2 Waste Rock Storage Area Foundation Conditions and Construction Sequencing

Geotechnical field investigations have confirmed that the proposed locations of the Llama, Umwelt, and within the TSF Containment Dam Foundation to inform the TSF WRSA. WRSAs are underlain by less than 2 m of overburden. Waste rock from Goose Main will be placed on the TSF WRSA, which is underlain by overburden of variable thickness ranging from 2 to 11 m (Sabina 2017b, Appendix F-2).

The permafrost soils will provide suitable foundation conditions for WRSAs provided the foundations remain frozen. To maintain frozen conditions in the foundations, the first lift of all new WRSAs will be constructed during the winter season, where possible. In the event the first lift of waste rock has to be constructed during the summer months, the WRSA may be subject to differential settlement during the first summer due to consolidation settlement of the active layer. However, since there is less than 2 m of overburden under the WRSAs, such settlement does not pose any substantial risk or concern.

In all cases, whether WRSA construction is started in summer or winter, once freeze back has been achieved in the foundation, and the active layer is demonstrated to remain within the waste rock stockpile, there will likely not be restrictions on the maximum lift thickness used for WRSA construction. The overall maximum height (i.e., total vertical thickness) of the WRSA will be limited to 80 m unless appropriate analysis is completed to confirm otherwise.

The WRSAs may experience creep deformation as a result of ice rich foundation soils. High ice content soils generally carry more load on the ice phase and the ice creeps under load, resulting in creep behaviour of the soil. Creep rates in frozen soils are dependent upon the loading rate and temperature, with higher creep rates observed at higher temperatures and under greater shear loading conditions. Maximum creep rates occur at near-thawed conditions. Due to the relatively thin layer of overburden soils, creep deformation is not expected to be a significant concern. A discussion of WRSA creep is provided in the WRSA Design Report (Sabina 2017b, Appendix F-3).

In areas where the WRSA foundation is on exposed bedrock, no significant issues are expected; therefore, placement on exposed bedrock is preferred and can proceed during any season provided adequate clearing of snow and ice has been completed.

Waste rock storage areas will be constructed using a bottom-up approach. Haul trucks will end dump waste rock in horizontal layers (bubble dumps). A dozer will be used to level out these dumps, prior to starting a new lift. No dedicated waste rock compaction will be completed; however, haul trucks will continuously traffic over previously placed areas providing wheel traffic compaction.

Table 5.4-1 provides an overview of WRSA development and closure for the Project by year. Waste rock will be placed in accordance with its ARD classification, with PAG waste rock placed in the central part of the WRSA, and NPAG waste rock placed along the outer margins. Upon completion, the entire outer surface of the WRSA will be clad in a minimum 5-m thick layer of NPAG rock. Over time, permafrost is expected to aggrade into the WRSAs, but an active layer will remain in the NPAG cover.

As far as practical, WRSA construction will be done to minimize re-handling by placing NPAG waste rock concurrently as an outer shell around the PAG waste rock. However, based on material sequencing, there may be periods when small volumes of NPAG waste rock will have to be separately stockpiled and re-handled so that there is sufficient NPAG waste rock for the minimum 5 m cover.

Water management around the WRSAs will be completed in accordance with the Water Management Plan.

Table 5.4-1. Project Timeline and Stages (Construction to Closure)

2020 Modification Package	Project Year	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Phase	1: Construction			2: Operations												3: Closure							
	Stage/Active Tailings Facility				1: TSF					2: Llama TF							1: Active		2: Passive					
Mining	Umwelt Open Pit																							
	Llama Open Pit																							
	Goose Main Open Pit																							
	Umwelt Underground [1]																							
Milling	Goose Process Plant [2]																							
Tailings	TSF																							
	Llama TF																							
Waste Rock Placement	Construction & TSF																							
	Umwelt WRSA																							
	Llama WRSA																							
	TSF WRSA [3]																							

1: Light red denotes Underground Development (decline) in advance of Production.

2: Milling, tailings deposition, and reclaim anticipated to start Year -1 Q4.

3: Final portion of waste rock cover paused to allow TSF reclaim to finish. Once TSF supernatant reclaim is complete, then final portion of waste rock cover will be placed.

5.5 WASTE ROCK STORAGE AREA STABILITY ANALYSIS

Slope stability analyses for the WRSAs were carried out during the feasibility study. Using the material parameters presented in Section 5.2 and the geometries described in Section 5.4, the results of the stability analysis indicate that the calculated minimum factors of safety for the WRSAs meet or exceed the acceptable factors of safety. Information on stability studies for the WRSAs is described in the Appendix F-3 of the Type A Water Licence Application (Sabina 2017b).

As precedence, both the Meliadine Project and the Diavik Mine are located in the same low-seismicity central part of Canada and have completed comparable levels of analysis of their tailings storage facilities. Based on the TSF design completed to date, no further site-specific seismic assessment is required.

5.6 WASTE ROCK STORAGE AREA THERMAL MODELLING

Thermal analyses were conducted to estimate the thermal regime of the WRSAs and foundations during Operations and after Closure. Multiple sensitivity scenarios based on a range of conditions were considered during thermal modelling including material saturation, thermal properties, variable boundary conditions, material composition, as well as convection and conduction. All modelling was done taking climate change into consideration. The thermal modelling completed to date is considered reasonable and appropriately conservative. For additional information refer to FEIS Addendum Volume 4, Appendix V4-3D and Appendix V4-3E (Sabina 2017a).

Freeze back of the WRSAs is considered to be validated if the temperature throughout the PAG waste rock remains below 0°C. Under these conditions, freeze back at the Property is estimated to be less than five years with no allowance for convective cooling in the winter, and less than 2.5 years with allowance for convective cooling.

The WRSA thermal modelling was also developed to account for projected influences of climate change. The modelling results indicate that the active layer thickness for the assumed base case is expected to be less than 5 m (i.e., it will remain in the NPAG waste rock cover) assuming convection facilitates cooling.

Further Information on thermal studies relating to the WRSAs is provided in the WRSA Design Report (Sabina 2017b, Appendix F-3). The results of this analysis will be confirmed and refined during Operations and Closure of the Project. As additional site-specific data is collected, this information will be used to further enhance or modify the closure of WRSAs, associated water treatment, and closure monitoring.

5.7 WASTE ROCK AND OVERBURDEN MANAGEMENT ALTERNATIVES

Sabina applied the Guidelines for the assessment of alternatives for waste rock disposal to complete a multiple accounts analysis for waste rock storage locations and disposal technologies. The analysis concluded that the most appropriate waste rock management alternative is the WRSAs as shown on the 2020 Modification Package Appendix A, Figure 3, and encapsulation of PAG waste rock with the placement of a NPAG waste rock thermal cover was the most appropriate disposal technique. A summary of the alternatives assessment can be found below. For more details, refer to the WRSA Design Report (Sabina 2017b, Appendix F-3), and the Multiple Accounts Analysis that was updated in February 2016 as part of the FEIS Information Request Response Package (Sabina 2016).

5.7.1 Waste Rock Storage Alternatives Analysis Design Basis

The proposed locations of the WRSAs were selected based on capacity, proximity to mine workings, elevation changes, footprints, suitability of ground conditions, associated costs, as well as the ease with which runoff from the WRSAs can be collected within runoff collection ponds. Consideration was also given to identify important terrestrial habitat, special landscape features, and rare vegetation, and to archeology.

Geochemical characterization of samples from the Project resulted in grouping the rock into two reportable categories based on acid rock drainage generating potential: PAG and NPAG. The geochemical study (Sabina 2017b, Appendix E-3) concluded that 35% of the waste rock in-situ is PAG; however, due to operational recovery estimates and conservative waste segregation practices, it is assumed that 58% will be categorized as PAG with the remainder (42%) being NPAG.

Preliminary calculations indicate acidic conditions are not expected to develop in >95% of the waste rock during the freeze-back period. Although acidic conditions could occur more rapidly in some of the waste rock, average pH conditions in seepage and runoff would be expected to remain non-acidic until complete freeze back of the WRSAs.

The geochemical study (Sabina 2017b, Appendix E-3) indicated that blending of the PAG and NPAG waste rock to take advantage of the buffering offered by the NPAG to neutralize the PAG would not be viable.

5.7.2 Waste Rock Storage Alternatives Analysis Assessment Results

The assessment of alternative methods for managing PAG/ML mine waste material considered the following disposal technologies:

- freeze back with a thermal NPAG waste rock cover;
- low permeability covers;
- co-mixing of mine waste material;
- co-disposal of mine waste rock and tailings; and
- subaqueous disposal in lakes and/or open pits.

Sub-aqueous disposal can include disposal in an engineered structure, in a natural waterbody, in a mined-out open pit, or in an exhausted underground development. Construction of a permanent, water retaining, engineered structure was ruled out since it would not be considered best practice. Deposition in a natural waterbody was also ruled out as the lakes around the Property are either shallow, thus offering limited capacity or are larger lakes, thus providing good aquatic habitat.

The underground mining methods employed on the Project require a portion of material from open pit development as mine backfill. As such, this backfill material will be composed, as much as practical, of PAG waste rock, either sourced locally from underground development or backhauled from surface development. Consideration was given to storing PAG waste rock in mined-out open pits; however, the current mine scheduling, and the need to use the pits for tailings and water management, made this a less desirable option. If future mine scheduling allows for in-pit disposal of waste rock, this option will be reconsidered.

For the remaining PAG waste rock on the surface, consideration was given to low permeability covers. Generally, the use of low permeability covers would be the most cost effective; however, no suitable natural materials are generated by Project activities and as such, this would not be a cost-effective option. Therefore, the only viable low infiltration cover would be geosynthetic liners. The initial capital costs and long-term replacement costs of these liners make them an unsustainable option.

Based on technical, environmental, socio-economic, and economic considerations, encapsulation of PAG waste rock with the placement of a NPAG waste rock thermal cover was found to be the preferred methodology. During progressive reclamation and in Closure, the PAG waste rock will be surrounded and capped by NPAG material to protect the underlying waste rock from seasonal thawing and promote the aggregation of permafrost into the PAG waste rock.

6. Environmental Protection Measures

6.1 WASTE ROCK MANAGEMENT

The location of waste rock disposal will be dependant on waste rock type (i.e., NPAG vs PAG) as determined by the waste rock monitoring program outlined in Section 7.1. Waste rock will be monitored as it is produced through a blast hole sampling program. Based on this monitoring, all waste rock will be identified as either PAG or NPAG. All PAG will be placed in the WRSAs in a manner that will allow the encapsulation of this material by NPAG rock on closure such that PAG rock will become fully frozen and inactive following closure. Overburden on the Property is considered NPAG material, and as such may be segregated for use as a cover material. Overburden which is not structurally suitable (e.g., high silt content) will be co-disposed with waste rock, with ultimate placement at least 20 m from the outer edge of the WRSAs to maintain overall pile stability. This management approach will facilitate a long term chemically and physically stable closure state.

If a single sample or a cluster of samples are classified as PAG or to be metal leaching, the area from which the sample(s) were collected will all be considered PAG and will not be used for WRSA cover material. After blasting, dig limits will be flagged and documented based on monitoring results to ensure waste rock is clearly identified and segregated as necessary for placement as part of the 5-m NPAG cover in WRSAs. Waste rock placement quantities (in tonnes) and locations will be tracked and tied to sample results, this data will be used to verify closure predictions and conditions and will be included in the annual report. Only waste rock confirmed to be NPAG and non-metal leaching may be used as construction material, per Water Licence 2AM-BRP1831 Part D, Item 5.

6.2 WATER MANAGEMENT ASSOCIATED WITH WRSAS

The water management objectives for the Project are to minimize potential impacts to the quantity and quality of surface water at the site. Water management and monitoring is detailed in the Water Management Plan, and overview of the activities related to WRSAs is provided below.

Prior to closure of the WRSAs, seepage and runoff is expected to contain elevated levels of some parameters; as such, all WRSA seepage and runoff will be collected in perimeter berms and directed to collection ponds. These berms will be strategically located to take advantage of topography to limit water ponding. During Operations, runoff from the WRSAs at the Goose Property will be pumped to the TSF or active Tailings Facility and treated as necessary prior to discharge; any discharge locations will be located so as to limit the potential for erosion. The collection ponds constructed for the WRSAs will apply appropriate design criteria in terms of managing extreme flows. Seepage and runoff volumes as well as extreme events were accounted for in the Project Water and Load Balance Report (SRK 2020); details on water treatment, WRSA catchments, and runoff criteria can be found in the Water Management Plan.

During Closure, collection ponds will continue to operate and collect runoff from the WRSAs, until the collected runoff meets discharge criteria and applicable receiving water quality criteria. During the Active Closure Stage and while the collection ponds remain operational, collected runoff at the Goose Property will be directed to a tailings management facility or reservoir. Once runoff is demonstrated to meet applicable limits, the ponds will be decommissioned in accordance with the ICRP.

6.3 DUST MANAGEMENT

The possible sources of dust related to the waste rock and overburden during Construction, Operations, and Closure include:

- Site preparation prior to placement of waste rock or overburden (i.e., stripping, excavation and/or placement of foundation pad);
- Wind erosion of fine particles from the WRSA;
- Vehicle traffic dislodging fine particles from the surface of the WRSAs, and associated service and haul roads to the WRSAs;
- Waste rock and overburden handling and transfer (i.e., loading, hauling, unloading, placement, and compaction); and
- Placement of closure and capping layers.

Dust suppression measures typical of current practices at other operating mines (i.e., Meliadine and Meadowbank mines), and consistent with best management practices, will be used through design, operation, and closure activities to control dust.

Minimal site preparation is required for the WRSA during the Construction Phase, and therefore, dust from these areas is not expected to be problematic.

Dust is expected to be a minor issue during the operation of the WRSAs as the waste rock produced at the Project site will generally comprise large pieces of rock that will not be susceptible to wind erosion. The overburden contains material that is fine-grained and thus more susceptible to wind erosion. The plan is to store overburden material away from the WRSA surfaces. Therefore, dust from the overburden material is not expected to be an issue. However, should dusting become an issue, dust control measures such as spraying water and/or other approved chemical dust suppressants will be used as necessary.

Dust generated from vehicles travelling on the surface of the WRSAs and associated service roads will be controlled principally by spraying water on the traffic areas, which will be carried out regularly by mine services during dry periods in the summer. The water used for dust suppression during the summer is estimated to be approximately 400 m^3/day and is accounted for in the Water Management Plan and will remain within licenced limits. Watering the haul and service roads is only possible when temperatures are above freezing. When the temperature is below freezing, dust suppression using water or an approved chemical may pose a safety hazard for travel; if warranted, reducing speed limits will be considered as the principal way of controlling dust during these periods.

Other control measures considered in design and Operations related to dust generation by vehicle travel include:

- Roads will be designed as narrow and short as possible while maintaining safe construction and operational practices;
- Coarse size rock will be used as much as possible for road construction;
- Roads will be regularly graded to mix the fines found on the road surface with coarser material located deeper in the roadbed; and
- As required, roads and travel areas will be topped with additional aggregate.

Dust from material handling is not expected to be problematic on-site. Front-loading and end-dumping will be employed to dump waste rock and overburden in lifts, and materials will be spread with a dozer. Long end dumps, which can generate significant amounts of dust, is not currently intended at site. Where possible, multiple handlings of materials that have the potential to generate dust will be avoided. However, should dust related to material handling occur on-site, specific control measures will be evaluated and applied, as required.

7. Monitoring and Reporting Program

This section describes the routine inspections, monitoring, and waste rock confirmatory testing that will take place under this Plan during waste rock generation and disposal.

Additional monitoring related to waste rock management is undertaken and reported under separate Project monitoring and management plans. To avoid plan overlap and the resulting potential for conflicting information, these monitoring details are not repeated in this Plan. Instead, relevant monitoring has been identified below and the appropriate management plan(s) referenced.

The additional waste rock-related monitoring and reporting that supplements the monitoring and reporting described in this Plan includes:

- dust monitoring (see the Air Quality Management and Monitoring Plan);
- wildlife monitoring (see the Wildlife Monitoring and Management Plan);
- runoff and seepage water monitoring at WRSAs (see the Water Management Plan and the Aquatic Effects Monitoring Plan);
- noise monitoring (see the Noise Abatement Plan);
- geotechnical monitoring (see the Thermal and Geotechnical Monitoring Plan); and
- WRSA Closure monitoring (see the Interim Closure and Reclamation Plan).

The monitoring to be conducted under the WRMP is detailed in the sections below.

7.1 WASTE ROCK MONITORING

7.1.1 WRSA Inspections – Daily and Monthly

During the active development of the WRSAs, personnel will carry out daily visual inspections in relation to the performance and condition of the WRSA. The purpose of these inspections is to identify and document any potential hazards or risks to the facility, safety, or the environment. These include deformations, unusual seepage, slumping, local failure, pooling water, etc.

In addition, containment of surface runoff and seepage from the WRSAs will be monitored during the Construction and Operations phases. This will be done through monthly visual inspections (weekly during freshet) along the downgradient side of the diversion berms and containment structures during the open water season. Daily inspections will be carried out during extreme rainfall events (e.g., 1:100 year 24-hour rainfall event), if safe to do so. The detailed information on the monitoring of surface runoff and seepage from the WRSAs is described in the Water Management Plan.

These inspections will be recorded, and any issues addressed adaptively.

7.1.2 WRSA Monitoring – Annual

Each WRSA which have been active in a given year will also be subject to an annual elevation and geometry survey to verify the overall volume placed. These annual surveys may be conducted in concert with the Annual Geotechnical Inspection (as per 2AM-BRP1831 Part I, Item 10) and as part of the Thermal and Geotechnical Monitoring Plan.

Inactive WRSAs may also be visually inspected on an annual basis to confirm geotechnical stability under the Thermal and Geotechnical Monitoring Plan.

A spring seep survey along the toe of the waste rock storage areas, as well as regular monitoring of the collection ponds, will also be completed to verify and refine the water quality predictions for each of the WRSAs. The locations of seeps will be marked in the field and recorded using a portable GPS. Field measurements of pH, electrical conductivity, oxidation-reduction potential, and temperature will be recorded, and samples will be submitted for acidity/alkalinity (as appropriate), sulphate, dissolved major cations (calcium, magnesium, sodium, and potassium), as well as a full suite of dissolved metals. Further details on water quality monitoring in the collection ponds are provided in the Water Management Plan.

The results of these inspections will be recorded, and any issues addressed adaptively.

7.1.3 Blast Monitoring

Blast hole sampling will be conducted in open pits to identify PAG and NPAG materials and allow the direction of each material to the appropriate location within each of the WRSAs. As discussed in Section 5.3, the distribution of PAG and NPAG waste rock is not closely linked to stratigraphy nor to lithology. Therefore, identification and subsequent segregation of these materials will require a dedicated blast hole monitoring program similar to the procedures that are used to identify and segregate ore in the mining operation and quarry rock during quarrying.

Waste rock drill core samples will be collected from exploration or blast holes drilled prior to blasting. These samples will be collected based on blasting plans which will be reviewed by trained mine geology personnel to select potential blast holes or areas for sample collection based on known geologic conditions. Samples will be analyzed as outlined below to determine geochemical characteristics on which monitoring and management actions will be based.

7.1.4 Waste Rock Confirmatory Testing and Segregation

All waste rock generated will be identified and segregated as being either NPAG or PAG prior to disposal in the WRSA and will be placed in accordance with this Plan. Waste rock placement will be documented by blast and location within the WRSA and will be tied to sampling results. To confirm that there is sufficient NPAG for WRSA cover construction, quantities of the NPAG and PAG waste rock and overburden produced and placed in WRSAs and used for construction will be recorded on a monthly basis as per 2AM-BRP1831 Part I Item 9b.

Waste rock samples collected in advance of, or concurrent with, mine development will be geochemically analyzed to ensure to characterize these materials. At a minimum, 8 samples will be collected for every 100,000 tonnes of material to be excavated (MEND 2009). Samples will be collected from blast holes drilled in the rock quarries prior to waste rock excavation. Samples will be as follows:

- Each sample will weigh no less than 1 kg.
- Each sample will be labeled with a unique sample identification number.
- Each sample will be documented in terms of sample depth and location and the blast hole number.
- Composite samples (more than one lithology) will be avoided where possible.

All samples will be submitted for total sulphur and total inorganic carbon analysis at an off-site, accredited laboratory, using LECO furnace analyser or a similar appropriate technique. Analytical methods must achieve a suitable detection limit for classification. Total sulphur will be used to calculate acid potential (AP) and TIC will be used to calculate neutralization potential (NP).

Additional laboratory testing on a subset of the samples collected will include ABA and net acid generation (NAG) testing to confirm geochemical the ARD classification. Short-term leach testing following the shake flask extraction (SFE) method will be conducted on subset to confirm the metal leaching (ML) potential of NPAG material; this testing is not required for PAG samples, as PAG waste rock will not be used for construction.

Classification of Material

Sample results will be evaluated against the following criteria:

- o Materials classified as NPAG (NP/AP greater than 3) or low sulphur (total sulphur content less than 0.15%) are suitable for placement anywhere within the WRSAs and will be the only material to be used for the WRSA cover and construction purposes.
- o Materials classified as uncertain (NP/AP between 1 and 3) or PAG (NP/AP less than 1) will not be placed within the 5 m waste rock cover zone and placement may be additionally constrained to promote chemically stable closure conditions.

The testing programs described in the Geochemical Characterization Report (SRK 2016) show that these criteria provide an appropriate level of conservatism for waste rock classification.

NPAG samples analyzed for SFE will be compared against 10x CCME guidelines for aquatic life to confirm metal leaching potential. Material with a high metal leaching potential will also not be used for WRSA cover material.

In future, Sabina may install an on site LECO furnace for sample analysis. This would provide a faster turnaround time for results and minimizes double handling of waste rock. As a quality assurance and quality control measure, 10% of samples will be split and sent to an external laboratory for verification testing to confirm site-generated results.

As-built volumes of waste rock used in construction and placed in the WRSAs will be recorded daily in a manner such that rock disposal location is tied to sampling results.

7.2 REPORTING

Environmental reporting will be conducted as defined in permits, approvals, and authorizations relevant to mine waste management, with the primary regulatory instrument governing mine waste management for the Project being the Type A Water Licence, 2AM-BRP1831.

As required by Schedule B of the Water Licence, the following information will be reported annually to the NWB as part of the Water Licence Annual Report:

- o All monitoring data with respect to geochemical analyses including acid/base accounting and associated test work conducted for the PAG/NPAG waste rock characterizations;
- o As-built volumes (in tonnes) of Waste Rock used in construction and placed in the WRSAs with estimated balance of acid generation to acid neutralization capacity in a given sample as well as metal toxicity;
- o Any geochemical outcomes or observations that could imply or lead to environmental impact.

8. Adaptive Management

The mine design, including the WRSA design, has been carefully prepared taking into consideration the vast database of site characterization data gathered for the Project, coupled with rigorous engineering analysis. Where data was limited, conservative assumptions were consistently applied. While there is a high level of comfort that the plans are viable and realistic, it is understood that mining activities are by nature inherently uncertain. Therefore, additional mitigation or adaptive management may be required as an outcome of monitoring activities described in Section 7. This may include changes to WRSA development as a result of operational, engineering, and/or environmental monitoring. Any additional mitigation or adaptive management that is found to be required will be implemented in a timely manner.

Possible waste rock scenarios and contingency strategies are outlined Table 8-1.

Table 8-1. Waste Rock Management Contingency Strategies

Possible Scenario	Contingency Strategy
The total volume of waste rock might be smaller or greater than expected.	Provided the ratio of PAG to NPAG remains unchanged, this will have no material effect. A greater total volume of waste rock might require a small increase on event pond sizing during Operations.
The ratio of PAG to NPAG waste rock might be different than expected.	If the amount of NPAG increases, there is no negative effect. If the amount of PAG increases leaving a shortfall of NPAG to cover the PAG, management options could include a portion of the PAG may have to be covered with a geosynthetic liner, or a portion may have to be disposed of in an open pit upon closure, or additional NPAG material may have to be locally sourced as cover material.
The PAG material might oxidize faster than expected.	This may require increased Operations Phase and/or Closure Phase water treatment capacity. It will however not change the overall closure strategy as the WRSA is still expected to freeze. If the heat from oxidation is preventing freezing of the pile, a portion of the pile may need to be covered with a geosynthetic liner to reduce infiltration or a portion of the PAG may need to be relocated to an open pit.
Neutral metal leaching from the NPAG material may be greater than expected.	This may require the WRSAs be covered with a geosynthetic liner, or relocation of waste rock into an open pit upon closure, or earlier initiation of water treatment, or extended water treatment until control methods are in place.
Freeze back of the waste rock pile may take longer than expected.	Depending on the runoff water quality, this may require a longer active closure period.
The active layer thickness of the WRSA, and therefore the required cover thickness, might be greater than expected.	If there is insufficient NPAG to make up the difference, this may require that a portion of the PAG be covered with a geosynthetic liner, or additional NPAG may have to be locally sourced, or a portion of PAG may have to be relocated to an open pit upon closure, or earlier initiation of water treatment, or extended water treatment until control methods are in place may be required.

The Plan will be reviewed on a regular basis to incorporate any lessons learned, major changes to facility operation or maintenance, and environmental monitoring results. Any updates will be filed with the Annual Report submitted under the Type A Water Licence, 2AM-BRP1831.

This plan represents an adaptive approach to understanding the effects of the Project on the landscape and the species that live there. In this context, the Plan is part of a continually evolving process that relies not only on the efficacy of data collection and analytical results, but is also dependent on feedback from the communities, government, Indigenous groups, and the public. Having an adaptive and flexible program allows for appropriate and necessary changes to the design of monitoring studies, and the mitigation and monitoring plans.

9. Reclamation

The majority of WRSA closure activities will occur as progressive reclamation. The WRSAs have been designed to progressively encapsulate the PAG waste rock during Operations such that a minimum 5-m thick NPAG waste rock cover is created on the top and sides of each WRSA. The WRSAs will be progressively capped in the Operations Phase using NPAG waste rock sourced from adjacent or nearby active open pits. The majority WRSAs will be fully developed within a timeframe such that the final cover of NPAG waste rock over the WRSA can be mostly completed during the Operations Phase. Closure and Post-Closure water quality monitoring will be conducted in the WRSA areas, under the ICRP, to confirm that runoff meets applicable receiving water quality objectives. Additional details pertaining to reclamation and closure are provided in the ICRP.

10. References

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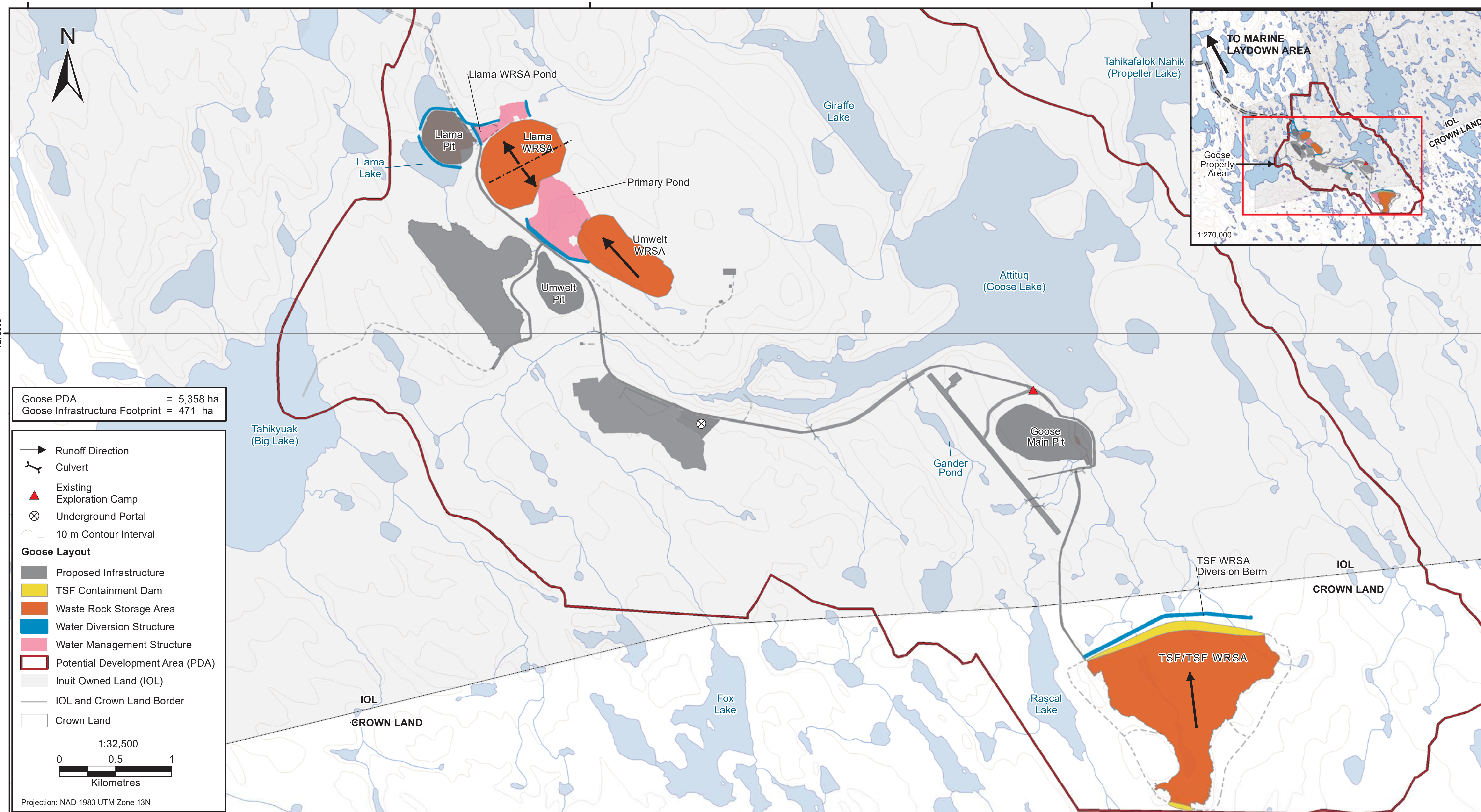
SRK (SRK Consulting (Canada) Inc.). 2020. Back River Project Water and Load Balance Report. Prepared for Sabina Gold & Silver Corp. REF No. 1CS020.018. June 2020.

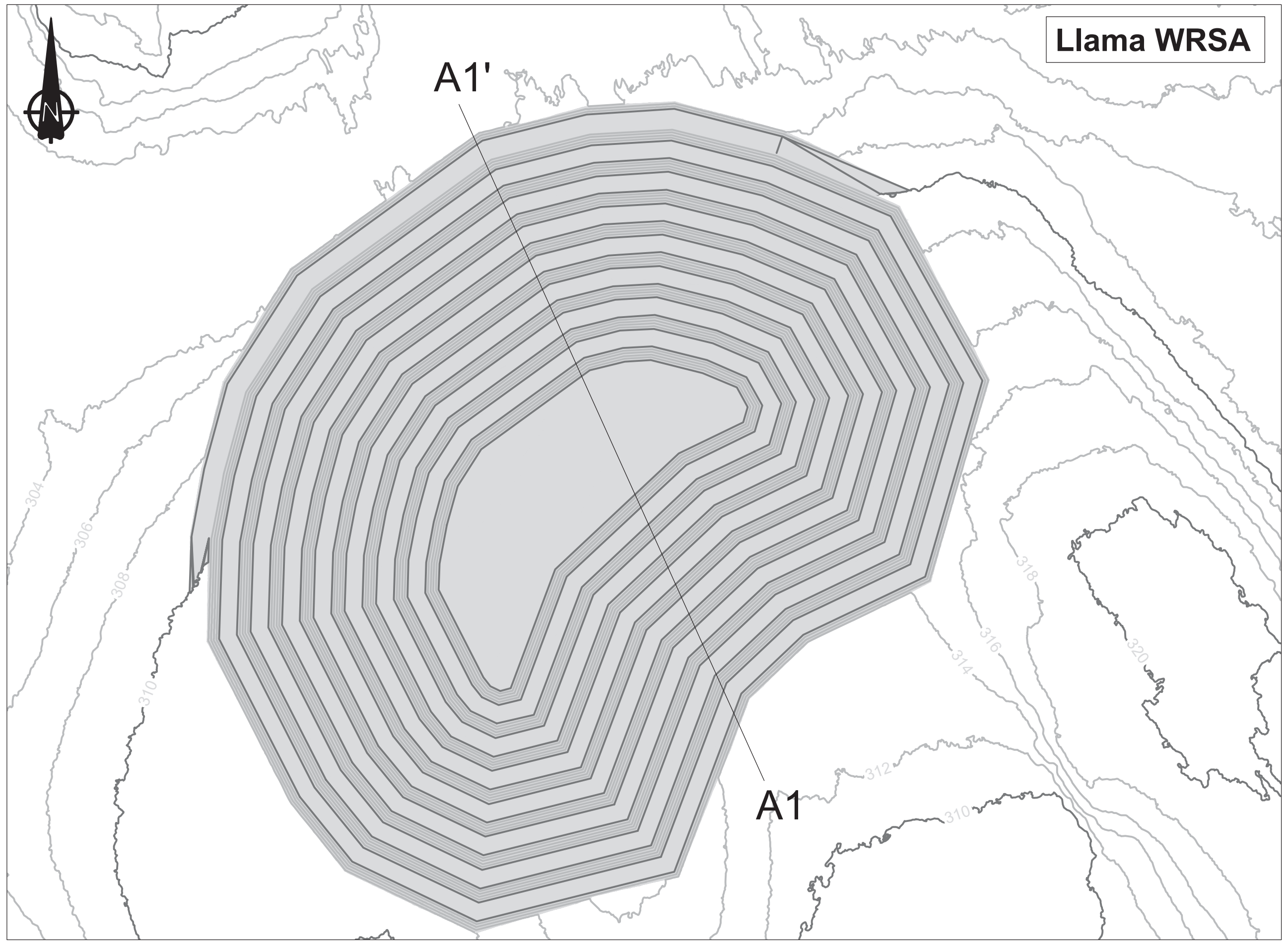
Appendix A. Drawings

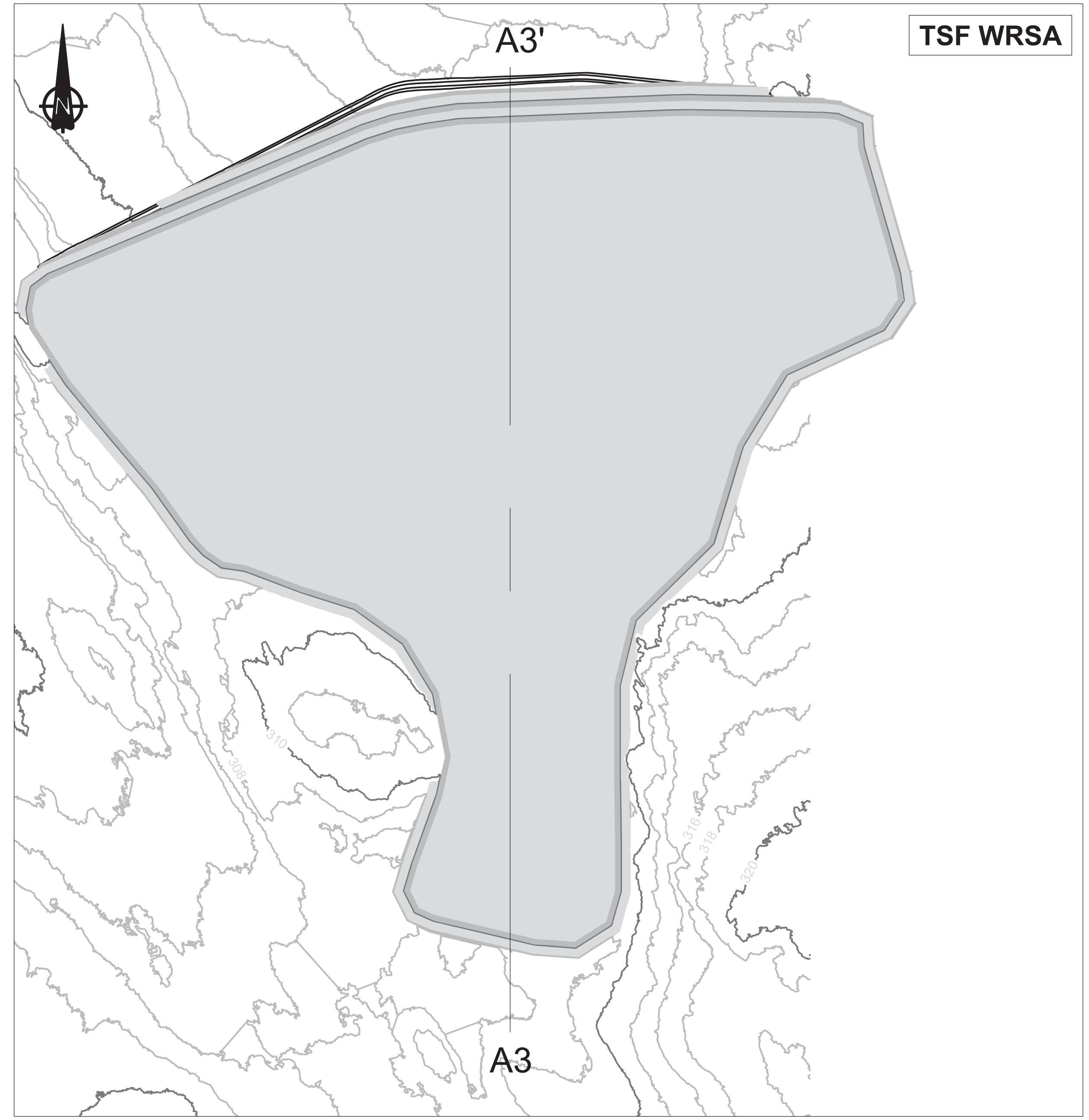


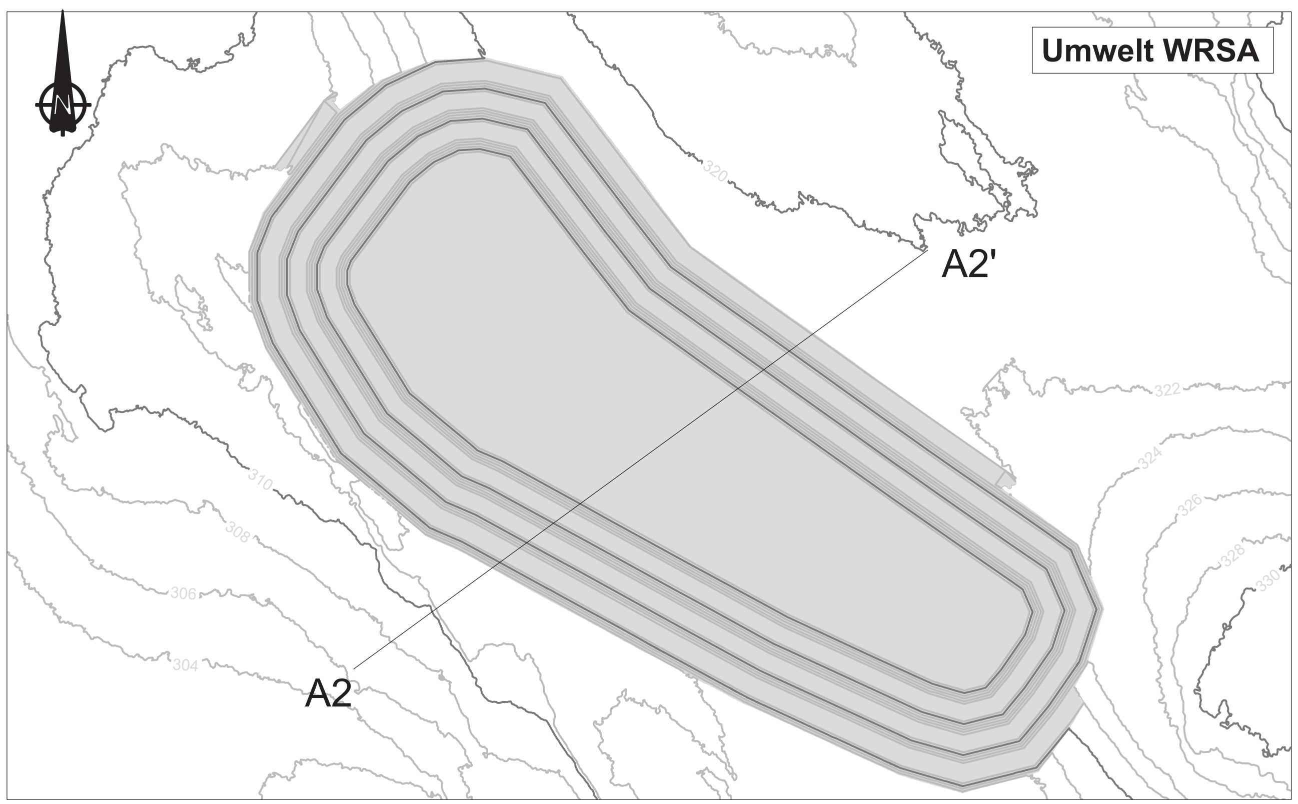
Sabina GOLD & SILVER CORP.

Figure A-01

Goose Property
Waste Rock Storage Areas and WRSA Water Diversions and Ponds







NOTES

1. NPAG (waste rock and overburden) cover with PAG waste rock core.
2. See Figure A-03 for Typical Cross-Sections of all WRSA's.
3. Waste rock layouts for permitting purposes. Not for construction.
4. WRSA = Waste Rock Storage Area and TSF = Tailings Storage Facility.

DRAWING NO.	DRAWING TITLE	NO.	DESCRIPTION	CHK'D	APP'D	DATE	NO.	DESCRIPTION	CHK'D	APP'D	DATE
-	-										
							C	ISSUED FOR PERMIT	CP	JBK	20/11/27
							B	ISSUED FOR PERMIT	CP	EMR	17/08/30
		-	-				A	ISSUED FOR PERMIT	CP	EMR	16/05/31

REFERENCE DRAWINGS | REVISIONS | PROFESSIONAL ENGINEERS STAMP

srk consulting

DESIGN: MM/CP | DRAWN: TAH | REVIEWED: JBK
CHECKED: CP | APPROVED: JBK | DATE: 2020/11/27
FILE NAME: 1CA020.011_MWRMP - PL.dwg

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BACK RIVER PROJECT

SRK JOB NO.: 1CS020.011, Task 500

MINE WASTE ROCK MANAGEMENT PLAN

Goose Property Waste Rock Storage Areas at Closure - Plan View

REVISION NO. C | SHEET 2 OF 3 | FIGURE NO. A-02

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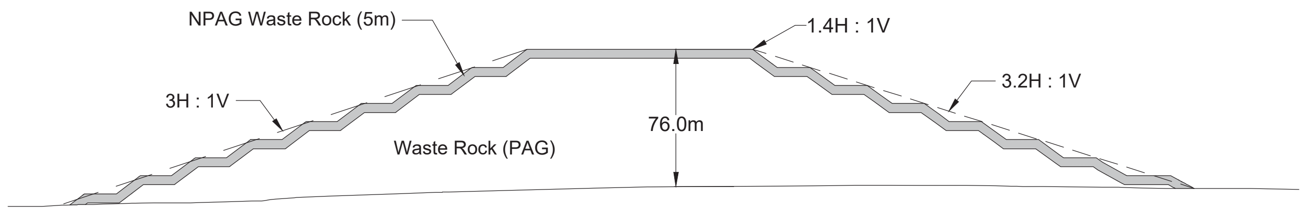
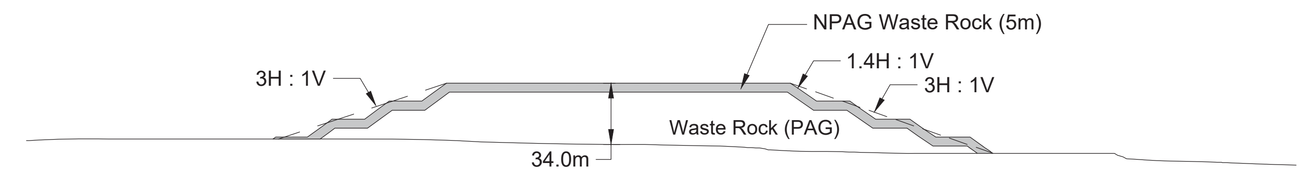


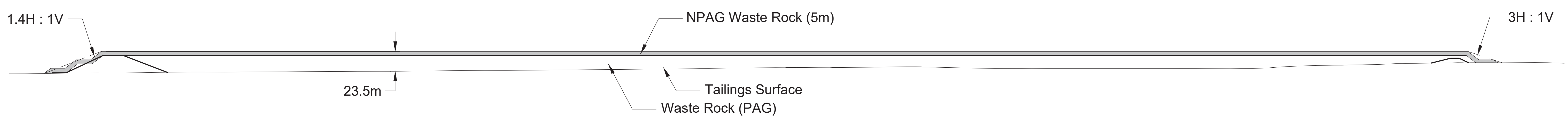
Profile A1-A1'

Llama WRSA Typical Cross-Section



Profile A2-A2'

Umwelt WRSA Typical Cross-Section



Profile A3-A3'

TSF WRSA Typical Cross-Section

NOTES

1. Waste rock layouts for permitting purposes. Not for construction.
2. Overall closure slopes will be at least 3H:1V.
3. Long term / closure slope, overall slopes, to have Factor of Safeties of 1.5 or greater.

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DRAWING NO.	DRAWING TITLE	NO.	DESCRIPTION	CHK'D	APP'D	DATE	NO.	DESCRIPTION	CHK'D	APP'D	DATE
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							B	ISSUED FOR PERMIT	CP	EMR	17/08/30
		-	-				A	ISSUED FOR PERMIT	CP	EMR	16/05/31

REFERENCE DRAWINGS | REVISIONS | PROFESSIONAL ENGINEERS STAMP

srk consulting

DESIGN: MM/CP	DRAWN: TAH	REVIEWED: JBK
CHECKED: CP	APPROVED: JBK	DATE: 2020/11/27

FILE NAME: 1CA020.011_MWRMP - XS.dwg

Sabina GOLD & SILVER CORP

BACK RIVER PROJECT

SRK JOB NO.: 1CS020.011, Task 500

MINE WASTE ROCK MANAGEMENT PLAN

Goose Property Waste Rock Storage Areas at Closure - Typical Cross Sections

REVISION NO.	SHEET	FIGURE NO.
C	3 OF 3	A-03

Attachment IR-F: Borrow Pits and Quarry Management Plan

Sabina
GOLD & SILVER CORP.

BACK RIVER PROJECT
Borrow Pits and Quarry Management Plan

November 2020

BACK RIVER PROJECT

BORROW PITS AND QUARRY MANAGEMENT PLAN

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Revision Log

Date	Section	Page	Revision
October 2017	All	All	Supporting Document for Type A Water Licence Application, submitted to Nunavut Water Board for review and approval
November 2020	All	All	Revision post-issuance of Project Certificate No. 007 and Water Licence 2AM-BRP1831 to address requirements of each and related commitments as well as to reflect the Project changes outlined in Sabina's 2020 Modification Package. Restructuring to provide quarry-specific information in annexes which can be added as quarries are sequentially developed.

Acronyms

ARD	acid rock drainage
DFO	Fisheries and Oceans Canada
ICRP	Interim Closure and Reclamation Plan
KIA	Kitikmeot Inuit Association
ML	metal leaching
MLA	Marine Laydown Area
Mt	million tonnes
NAG	non acid generating
NPAG	non potentially acid generating
NWB	Nunavut Water Board
PC	Project Certificate No. 007
PAG	potentially acid generating
Project	Back River Project
QMP or Plan	This Borrow Pits and Quarry Management Plan
ROQ	run-of-quarry
Sabina	Sabina Gold & Silver Corp.
SFE	Shake Flask Extraction
T&C	Terms and Conditions
WMP	Water Management Plan

QMP Executive Summary

This Borrow Pit and Quarry Management Plan (the Plan or QMP) describes the procedures and monitoring to be undertaken at the Back River Project relevant to the management of borrow pits and quarries. This Plan ensures that 1) the procedures for the management and monitoring of borrow pits and quarries are defined, 2) relevant laws and regulations are appropriately adhered to and that 3) potential impacts related to development and use of these borrow pits and quarries are minimized and monitored.

Tuaktaqvik Aulataunia Parnaut (QMP) Ataniqnut Nainaqhimayuq

Una Iluttuqnia Ilutuniq tamnalu Tuaktaqvik Aulataunia Parnaut (tamna Patrnaut uvaluniit Tuaktaqvik Aulataunia Parnaut (QMP) unniqtuqtai tapkuat pityuhit munariyaunilu havariyauyukhat talvani Hanningayuq Kuugaq Havaguhia turangayuq tapkununga aulatauni iluttaqhimayut ilutunit tuapaktaqvitlu. Una Parnaut atqupiaqtitai tapkuat 1) tapkuat pityuhit aulatauninut munaqtaunilu iluttuqhimayut ilutunit tuapaktaqvitlu unniqtuqhimayangi, 2) turangayut maligait maligauyutlu naamaktumik malikhaqni tapkuatlu 3) aktualaqnit turangayut pivaliatitninut atuqnilu tahapkuat iluttuqhimayut ilutunit tuapaktaqvitlu mikhigiaqni munariyaunilu.

QMP ᐃᓱᒪᑕᐅᓂᕐᓂᑦ ᓇᐃᓈᖅᓯᒪᔪᖅ

ᐊᑐᖅᑕᐅᔪᖅ ᓄᓇᒥᑦ ᐃᓗᑦᑐᖅᓯᒪᔪᒧᑦ ᐊᒻᒪᓗ ᓄᓇᐃᔭᐃᓂᕐᒧᑦ ᐊᐅᓚᑦᑎᓂᕐᒥᒃ ᐸᕐᓇᐅᑎ (ᐸᕐᓇᐅᑎ ᐅᑯᐅᓘᓐᓃᑦ QMP) ᐅᖃᐅᓯᖃᖅᑐᖅ ᐊᑐᖅᑕᐅᔭᕆᐊᖃᖅᑐᓂᒃ ᐊᒻᒪᓗ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᓴᓐᓂᖓᒍᔪᕐᒥᑦ ᐱᔾᔪᑎᖃᖅᑐᓂᒃ ᐊᐅᓚᑦᑎᓂᕐᒥᒃ ᐊᑐᖅᑕᐅᔪᓂᒃ ᓄᓇᒥᑦ ᐃᓗᑦᑐᖅᓯᒪᔪᓂᒃ ᐊᒻᒪᓗ ᓄᓇᐃᔭᐃᓂᕐᓄᑦ. ᐸᕐᓇᐅᑎ ᐃᒪᓐᓇᐃᑎᑦᑎᔪᖅ 1) ᐊᑐᖅᑕᐅᔭᕆᐊᓖᑦ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐊᒻᒪᓗ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᔪᓂᒃ ᓄᓇᒥᑦ ᐃᓗᑦᑐᖅᓯᒪᔪᓂᑦ ᐊᒻᒪᓗ ᓄᓇᐃᔭᐃᓂᕐᓂᒃ ᑐᑭᓕᐅᖅᑕᐅᓗᑎᒃ 2) ᐱᔾᔪᑎᖃᖅᑐᑦ ᒪᓕᒐᐃᑦ ᐊᒻᒪᓗ ᒪᓕᒋᐊᓖᑦ ᒪᓕᒃᑕᐅᕗᑎᐊᕐᓗᑎᒃ ᐊᒻᒪᓗ 3) ᐊᒃᑐᖅᓯᓂᐅᔪᓐᓇᖅᑐᑦ ᐱᕙᓪᓕᐊᓂᕐᓂᒃ ᐱᔪᓂᒃ ᐊᒻᒪᓗ ᐊᑐᖅᑕᐅᓂᖏᑦ ᓄᓇᒥᑦ ᐃᓗᑦᑐᖅᓯᒪᔪᑦ ᐊᒻᒪᓗ ᓄᓇᐃᔭᐃᓃᑦ ᒥᑭᓕᒃᑯᖅᑎᑕᐅᓯᒪᓗᑎᒃ ᐊᒻᒪᓗ ᖃᐅᔨᓴᖅᑕᐅᓗᑎᒃ.

1. Introduction

The Back River Project (the Project) is a proposed gold project owned by Sabina Gold & Silver Corp. (Sabina) within the West Kitikmeot region of southwestern Nunavut. It is situated approximately 400 kilometres (km) southwest of Cambridge Bay, 95 km southeast of the southern end of Bathurst Inlet, and 520 km northeast of Yellowknife, Northwest Territories. The Project is located predominantly within the Queen Maud Gulf Watershed (Nunavut Water Regulations, Schedule 4).

The Project is comprised of two main areas, Goose Property and the Marine Laydown Area (MLA) with interconnecting winter ice roads. The majority of annual resupply will be completed using the MLA situated along the western shore of southern Bathurst Inlet, which is connected seasonally to Goose via an approximately 160 km long Winter Ice Road. Both the Goose Property and the MLA make use of a local networks of all weather roads and pads.

This Borrow Pit and Quarry Management Plan (QMP or Plan) describes how Sabina intends to implement a range of environmental management, mitigation and monitoring measures related to the construction and operation of Back River Project borrow and rock quarries. Quarry-specific information, including any specific management or monitoring requirements, are provided in the quarry-specific plans attached as annexes to this main Plan. Annexes may be added over time as quarries are opened without requiring changes to the main body of this Plan.

Borrow pits and quarries are defined by the type of granular material extracted and the method of extraction. Quarries consist of rock material that is typically extracted by digging, cutting, or blasting and yields large stones that may then need to be crushed (INAC 2010). Borrows pits consist of fine grained fill materials, such as sand or clay, which are normally used at a nearby site (INAC 2010). However, for the purposes of this Plan, both borrow pits and quarries are occasionally jointly referred to as quarries.

This Plan is a requirement of both Project Certificate No. 007 and Water Licence 2AM-BRP1831 (the Licence) and has been developed to align with these regulatory instruments. This Plan will be reviewed and updated as needed to reflect changes in regulatory requirements, facility operation or maintenance, results of environmental monitoring, management reviews, incident investigations, best practice updates or other Project specific protocols.

Any updates to this Plan will be filed with the Nunavut Impact Review Board (NIRB) and the Nunavut Water Board (NWB) and the Kitikmeot Inuit Association (KIA) with the submission of the annual reports as per the requirements of the Project Certificate (PC) No. 007 and Water Licence 2AM-BRP1831. This includes the submission of quarry-specific annexes at least 30 days prior to initiation of quarry construction to both the NIRB and the KIA (Term & Condition [T&C] 16).

2. Scope and Objectives

The purpose of this Plan is to outline and address the requirements related to the development and operation of quarries and borrow pits at the Back River Project. This includes the identification of suitable material for construction use, management of overburden, as well as an overview of environmental and archaeological protection measures employed to minimize the impacts of a quarry. It is noted that quarry seepage and runoff management is addressed in Sabina's Water Management Plan (WMP), as required by Part D, Item 24 of the Licence.

The Plan applies to the Construction and Operations phases of the Project during which material will be quarried and the management actions. Quarries will be progressively closed and reclaimed as they become no longer needed. Closure and Post-Closure activities are addressed in Sabina's Interim Closure and Reclamation Plan (ICRP). This Plan does not address blasting-specific management and mitigation; this is addressed in the Explosives Management Plan.

The main environmental concerns related to quarry operations are the potential for metal leaching and acid rock drainage (ML/ARD), release of nutrients from explosives use, and/or total suspended solids on downstream water quality, deposition of dust emissions from the borrow / quarry sites, and protection of the permafrost. Quarry operations can also impact archeological sites, and this is mitigated both through the procedures outlined in this Plan as well as those outlined in the Cultural and Heritage Resources Protection Plan.

All volumes of quarry material presented in this plan are based on the current modified mine plan, accounting for permafrost and local thermal conditions.

2.1 RELATED PLANS AND STUDIES

This Plan is intended for use in conjunction with the following Plans:

- Cultural and Heritage Resources Protection Plan;
- Explosives Management Plan;
- Wildlife Mitigation and Monitoring Program Plan;
- Air Quality Monitoring and Mitigation Plan;
- Environmental Management and Protection Plan;
- Water Management Plan;
- Spill Contingency Plan; and
- Interim Closure and Reclamation Plan.

In addition, the following documents have also been used to inform the design and management decisions presented in this Plan:

- Geochemical Characterization Report (SRK 2016);
- Water and Load Balance Report (SRK 2020);
- Goose Plant Site Area – Technical Memorandum on Geochemical Testing (Golder 2017a); and

Goose Property – 2015 Overburden Geotechnical Investigation Program (Sabina 2016).

3. Applicable Legislation and Guidelines

Specific legislation, regulations, and guidelines related to borrow pits and quarry management in Canada, and specifically within Nunavut, are summarized in Table 3-1.

Table 3-1. Applicable Legislation to Quarry Management in Nunavut

Acts	Regulations	Guidelines
Federal		
Canadian Environmental Protection Act (CEPA 1999)		
Nunavut Agreement (1993)	Article 19	
Nunavut Waters and Nunavut Surface Rights Tribunal Act (2002)	Nunavut Water Regulations (2013)	
Fisheries Act (1985)		
Territorial Lands Act (1985)	Territorial Land Use Regulations (CRC, c.1524) Northwest Territories and Nunavut Mining Regulations (CRC, c.1516)	Implications of Global Warming and the Precautionary Principle in Northern Mine Design and Closure (BGC 2003) Northern Land Use Guidelines Pits and Quarries (INAC 2010)
Explosives Act (1985)	Explosives Regulations (SOR/2013-11)	
Transportation of Dangerous Goods Act (1992, C.34)	Transportation of Dangerous Goods Regulations (SOR/2001-286)	2016 Emergency Response Guidebook (Transport Canada and U.S. Department of Transportation, 2016)
Territorial – Nunavut		
Nunavut *Environmental Protection Act* (1988)	Spill Contingency Planning and Reporting Regulations (NWT Reg (Nu) 068-93) Used Oil and Waste Fuel Management Regulations (NWT Reg 064-2003)	

(continued)

Table 3-1. Applicable Legislation to Waste Management in Nunavut (completed)

Acts	Regulations	Guidelines
Wildlife Act (1988)	Wildlife General Regulations (NWT Reg (Nu) 026-92) Wildlife Licences And Permits Regulations (NWT Reg (Nu) 027-92) Wildlife Management Barren-Ground Caribou Areas Regulations (NWT Reg (Nu) 099-98) Wildlife Management Grizzly Bear Areas Regulations (NWT Reg (Nu) 155-96) Wildlife Management Zones Regulations (RRNWT (Nu) 1990 c W-17) Wildlife Regions Regulations (NWT Reg (Nu) 108-98) Critical Wildlife Areas Regulations, R.R.N.W.T. 1990 c. W-3 Polar Bear Defence Kill Regulations, N.W.T. Reg. 037-93 Wildlife Management Muskox Areas Regulations, R.R.N.W.T. 1990 c. W-11 Wildlife Management Polar Bear Areas Regulations, R.R.N.W.T. 1990 c. W-13 Wildlife Sanctuaries Regulations, R.R.N.W.T. 1990 c. W-20 Wildlife Preserves Regulations, R.R.N.W.T. 1990 c. W-18	
Mine Health and Safety Act (SNWT (Nu) 1994, c.25)	Mine Health and Safety Regulations (NWT Reg (Nu) 125-95)	

The discovery of any deposits of carving stone on Crown lands is be subject to Article 19 of the Nunavut Agreement.

Sabina is also be bound by the terms and conditions of its land use permits and leases held with Crown Indigenous Relations and Northern Affairs Canada (CIRNAC) for Crown Lands and the Kitikmeot Inuit Association (KIA) for Inuit Owned Land, and by Water Licence 2AM-BRP1831 (the Licence). Borrow pits and rock quarries within Inuit Owned Land require a land use licence or commercial lease.

Project Certificate No. 007 requires the maintenance of appropriate setbacks from fish bearing waters (T&C 23) and engagement with Fisheries and Oceans Canada's (DFO) to explore blasting related mitigations in consideration of the DFO *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters* (D.G. Wright and G.E. Hopky, 1998) (T&C 25). The Project certificate also requires that blasting activities also consider, in the Wildlife Mitigation and Monitoring Program Plan, increased potential for caribou presence between July 26 and August 31st (T&C 41), establishment of criteria and procedures for wildlife deterrence from blast zones (T&C 43), and develop mitigation measures tied to triggers for the protection of muskox (T&C 44).

It is noted that Sabina also holds exploration leases, permits, and licences under which quarrying activity may occur. At this time, these exploration activities are not addressed under this Plan, but rather under separate plans applicable to their respective licenses.

4. Planning and Implementation

4.1 EXISTING BORROW AND ROCK QUARRY FACILITIES

In support of exploration activities under a separate Licence, rock material was quarried from the Airstrip Quarry located approximately 750 m West of the existing Goose Exploration Camp. Estimates indicate that there is approximately 550,000 m^3 (1.5 million tonnes [Mt]) of available material remaining within this Airstrip Quarry.

4.2 PROPOSED BORROW AND ROCK QUARRY FACILITIES

At the Goose Property, an estimated 5 Mt of Run of Quarry rock (ROQ) will be required during pre-construction and construction. Of this 5 Mt, 1.5 Mt will be required to construct the Tailings Storage Facility Containment Dam and 3.5 Mt will be required for the other Goose Property infrastructure including all-weather airstrip and roads; mine infrastructure, buildings and laydown areas; and water management infrastructure.

Quarry operations at the Goose Property will begin with sourcing material from the existing quarry (Airstrip Quarry) for expansion of the Goose Airstrip and some all-weather roads. Once all-weather access to the Goose Plant Site area is established, material will be sourced by cutting bedrock material to create a suitable area for the Goose Plant Site and Goose Fuel Storage areas. This extracted material will be used to build roads, infrastructure pads, storage pads, and containment areas. Once all-weather access to the Umwelt open pit (Umwelt Pit) is established, the majority of construction material will be sourced from open pit operations. Initial development of the Umwelt Quarry (which will later become the Umwelt Pit) will commence early to provide material for the surrounding pads and roads.

At the MLA, an estimated 1.3 Mt of aggregate will be required for the development of service roads, laydown pads, infrastructure foundations, and fuel storage and other containment areas. All of this material will be sourced from the cut/fill balance during development of the Fuel Storage Area, which is referred to as the MLA Quarry.

Small localized quarries may also be developed along the Winter Ice Road to provide fill for improvements to sections of the road and for the development of laydown areas and small seasonal camps.

Quarry details will be provided as annexes to this Plan.

5. Quarry Management

5.1 PRE-DEVELOPMENT QUARRY IDENTIFICATION AND CHARACTERIZATION

Quarries are selected based on their material, geotechnical and geochemical characteristics, logistical requirements, and consideration of environmental and archaeological impacts. Pre-Development characterization programs are conducted on each quarry prior to use to identify and characterize these features. Only rock which is NPAG will be used for construction. If a quarry is deemed suitable for construction purposes quarry information and any quarry-specific management, mitigation or monitoring requirements will be appended to this QMP in the from of an Annex. These quarry-specific annexes may include:

- quarry maps indicating minimum setbacks and any relevant features
- estimates of the resources to be extracted;
- geochemical characterization information and additional sampling plans (where required);
- identification of any archaeological of fish habitat buffer zones;
- quarry-specific waste management facilities (where applicable); and
- quarry-specific water management facilities and any erosion control measures (if required).

5.2 QUARRY OPERATIONS

Quarries will be developed, operated, inspected, and maintained by Sabina or contractors charged with this responsibility under the direction of Sabina.

During quarry operations, quarries will be developed in a manner such that any contact water is retained within the quarry. This will allow testing of the water prior to release as per the WMP and Licence. Storm and snowmelt water will be diverted away from the quarry by a small berm on the upslope edges of the excavation.

Blasted rock will be loaded into haul trucks using either a loader or a hydraulic shovel/excavator. The ROQ material is then hauled to the construction area, dumped, and placed using a track dozer and/or motor grader. This sequence is called a “drill, blast, load, haul, dump” sequence.

Some of the ROQ will be moved to a crusher to produce aggregate of various sizes. The crusher will be offset from local waterways and may be shielded from the prevailing wind. When possible, the shielding will be managed by placing the crusher within the quarry behind a high wall to reduce the quantity of wind-blown dust and enabling dust to fall within the quarry boundaries.

Borrow pit operations may employ ripping methods using a track dozer. This loosens the material and allows it to be picked up using a loader or a hydraulic shovel/excavator. Standard drill and blast methods similar to quarry operations may be used in instances where ripping is not possible.

Topsoil and overburden will either be managed as run of mine waste (under the Mine Waste Rock Management Plan) or segregated and used where possible in reclamation activities as capping material.

Closure approach and objectives for quarries and borrow pits are outlined in the ICRP.

6. Roles and Responsibilities

The General Manager is ultimately responsible for the success of this plan and approves all relevant policies and documents, auditing, action planning, and the verification process.

The Mine Manager, along with their direct reports, is responsible for the specifics of this plan including overall management of the Plan and internal reporting.

The Geology Superintendent is responsible for ensuring that only NPAG quarry rock and overburden material is used for construction purposes.

7. Environmental Protection and Mitigation Measures

This standard mitigation and management measures to be applied under this QMP are detailed in the sections below. Should a specific quarry require the application of additional supplementary mitigation and management measures this information is provided in the quarry-specific plans attached as Annexes to this QMP. These Annexes may include descriptions of applicable buffer zones related to identified archaeological sites, waterbodies or areas of unsuitable rock identified during pre-development surveys (see Section 5.1).

7.1 IDENTIFICATION, SEGREGATION, AND PLACEMENT OF QUARRY ROCKS

Only NPAG quarry rock will be used for construction. This will be verified through the quarry pre-development surveys as well as through the operational monitoring discussed in Section 8.

Where possible, any areas within the quarries that are delineated as PAG will be avoided. However, if blasting of PAG material is required to access sufficient NPAG material, the PAG quarry rock will be hauled to one of the designated Waste Rock Storage Areas for disposal (per the Waste Rock Management Plan) or temporarily stockpiled until it can be incorporated into these areas. If intact PAG rock will be exposed in the backslopes or base of the quarries it will be addressed on closure and may be encapsulated with a minimum of a 2-m thick layer of NPAG overburden or rock.

In the unlikely event that PAG materials are found at the MLA or other sites far from the Goose Property, they would be consolidated and managed appropriately (e.g., consider covering with NPAG waste rock or other cover type or if small enough quantities, transported to the Goose Property).

7.2 SURFACE DRAINAGE AND WATER MANAGEMENT FROM QUARRIES AND BORROW PITS

Surface drainage and water management procedures will be implemented at all quarry/borrow locations. A setback of at least 31 m will be established from the quarry operations and associated workings to any local waterbody. These buffers are intended to minimize any ARD/ML from entering into the waterbodies and will be delineated prior to the commencement of work.

Borrow pit and quarry water runoff will be directed to sumps to allow for sampling of water prior to controlled discharge. Discharge suitable for release to the environment (per the WMP) will be discharged to the tundra via a portable pump to a location near the quarry/pit. The discharge location will be selected to allow free drainage of the discharged water (to prevent ponding) at least 31 m from water and discharge will occur in a manner that does not cause erosion, either by locating it in an erosion-resistant area (e.g., on a rocky outcrop), or otherwise mitigating the erosion potential if needed (e.g., through diffusion of flow or reducing discharge rates).

Water which does not meet discharge requirements may be treated in-situ or will be directed to other site water management facilities and managed as appropriate for that facility. Quarry and pit sumps will be low areas in these facilities to which all contact water drainage will be directed and will not be limited in capacity.

The quarry configuration will consist of a relatively flat surface graded such that water slopes to an area within, or adjacent to, the quarry boundaries during operation to allow testing and controlled release per the WMP. Since no extraction will occur below water level and the areas will be contoured to drain positively prior to closure to ensure there will be no residual ponds once the sites are closed. Storm and snow melts will be diverted away from the quarries by small berms on the upslope edges of any excavation where necessary. Measures will be taken to reduce the velocity of the water (e.g., silt curtains and small dikes) leaving the working areas and promote settlement of suspended sediments.

Additional management will include the grubbing of materials to expose rock surface for quarrying purposes. The principle concerns associated with grubbing and disposal of related debris are:

- Potential effects on water quality caused by erosion and sedimentation.
- Disturbance of the permafrost leading to ground failure (slumping and erosion).

All grubbing and disposal of debris near watercourses will comply with regulatory approvals. Measures that will be undertaken to minimize effects on aquatic habitat and resources are:

- Grubbing of the organic vegetation mat and/or the upper soil horizons will be minimized, and left in place where possible due to the sensitivity of Arctic soils.
- If needed, the organic vegetation mat and upper soil horizon material, which has been grubbed, will be spread in a manner that attempts to cover exposed areas. Any surplus of such material will be stored or stockpiled for site reclamation purposes elsewhere in the Project area at a minimum distance of 31 m from the ordinary high water mark of any water body. Topsoil will be stockpiled separately from the overburden. The location of the stockpiles will be recorded and accessible for future rehabilitation purposes.
- During grubbing, care will be taken to ensure that the material will not be pushed into sensitive areas which are to be left undisturbed.

Any evidence of erosion due to surface water flow from the quarries and borrow pits will be repaired by placing riprap or similar material over the affected area.

7.3 DUST MANAGEMENT

Crushers may be located near high obstacles to facilitate shielding from the prevailing winds and thereby reduce and restrict the quantity of dust to the quarry boundary. Drop heights will be minimized to reduce fugitive dust. Run of quarry will be transported from the quarries and borrow pits within speed restrictions to help reduce dust along the road corridors. Blasting best management practices will be used to minimize dust production and to minimize the quantity of explosives, to reduce dust and concentrations of nitrogenous compounds as residue. Dust management and monitoring activities are outlined in the Air Quality and Monitoring and Management Plan.

7.4 GROUND ICE AND PERMAFROST PROTECTION

Quarry sites are expected to be free of ground ice and will remain within the contiguous permafrost (which is up to 500 m deep). There will be some localized impacts to the surrounding active zone of the quarry locations and any water seeps originating in the quarries as a result of permafrost melting, or precipitation events, will be monitored as part of the surface water management (see the WMP).

Borrow pits are formed from glaciofluvial deposits and weathered bedrock. All borrows have positive topography rising about the local setting. These types of granular deposits are selected as they can be relatively free of ground ice. Minimal ground ice reduces the potential for thaw settlement, erosion caused by melt water, and external slumping. If ground ice is prevalent, the area will be monitored and may be stabilized by covering the affected land with granular material. This would allow the permafrost to aggrade into the covering material and restrict the remaining ground ice from melting.

7.5 ARCHAEOLOGICAL PROXIMITY

At the Goose Property, one archeology site was identified as requiring mitigation based on the proposed design. At the MLA, three archeology sites were identified as requiring mitigation based on the proposed design. In all cases, this is due to the required placement of the fuel storage tanks. All of these sites have since been mitigated. Other sites identified during pre-development surveys may also require mitigation in future. Information on exact location of archeology is not provided in this document as per guidance from the Government of Nunavut Department of Culture and Heritage. However, all information on-site locations has already been provided to Department of Culture and Heritage in the form of annual archeology reports. A summary of sites within 1,000 m of the Goose Property and MLA Potential Development Area can be found, along with proposed mitigation options, in the Cultural and Heritage Resources Protection Plan.

The quarries and borrow pits were selected to avoid archaeological resources. If any potential archaeological site is identified during the operation of any quarry/borrow pit, work will stop and the actions outlined in the Cultural and Heritage Resources Protection Plan will be followed.

All equipment will remain within the boundaries of the quarries/borrow pits to ensure any nearby archaeological site is not inadvertently damaged.

Before any new quarry/borrow pit is selected, it will be surveyed for archaeological resources by a professional archaeologist registered in Nunavut as part of the pre-development survey. Sites with archaeological resources present will not be selected if there is a similar site devoid of archaeological resources nearby. Any required archaeological mitigation measures including the implementation of buffers will be documented in the quarry-specific Annex.

7.6 NATURAL ENVIRONMENT

The Wildlife Mitigation and Monitoring Plan (WMMP) details mitigation measures to be employed at site based on various activities, including quarrying and blasting. Measures address noise impacts, pre-blast wildlife screening, wildlife deterrence measures, wildlife monitoring during operation, housekeeping, and footprint minimization. These measures have been developed based on best practices and input from relevant regulators and stakeholders and may be refined further in future revisions to the WMMP. As a result, the details of those mitigation measures have not been replicated here but instead readers and quarry operators are referred to the WMMP for the current practices to be employed for the protection of wildlife. Wildlife deterrence may only be undertaken in alignment with criteria, thresholds and procedures developed in consultation with the Government of Nunavut and other relevant parties. These mitigation measures must be adhered to.

Impacts to fish and fish habitat are also managed and mitigated through:

- minimization, management and monitoring of quarry runoff (under the WMP);
- maintaining setbacks of quarries from permanent and fish-bearing waterbodies to prevent their contamination; and
- consideration of blasting mitigation measures near fish bearing waters (such as appropriate setback distances and confirmatory blast vibration monitoring where needed) to protect fish.

8. Monitoring

This section describes the routine inspections, monitoring and quarry rock confirmatory testing that will take place under this Plan during quarrying activities.

Additional monitoring related to quarrying activities is undertaken and reported under separate Project monitoring and management plans. To avoid plan overlap and the resulting potential for conflicting information, these monitoring details are not repeated in the QMP. Instead, relevant monitoring has been identified below and the appropriate management plan(s) referenced.

The additional quarry-related monitoring that supplements the monitoring described in this Plan includes:

- dust monitoring (see the Air Quality Management and Monitoring Plan);
- wildlife monitoring (see the WMMP);
- water monitoring at quarries and related to quarried rock (see the WMP and the Aquatic Effects Monitoring Plan);
- noise monitoring (see the Noise Abatement Plan);
- geotechnical monitoring (see the Thermal and Geotechnical Monitoring Plan);
- monitoring of archaeological sites (see the Cultural and Heritage Resources Protection Plan);
- monitoring related to quarry Closure monitoring (see the Interim Closure and Reclamation Plan).

The standard monitoring to be conducted under this QMP is detailed in the sections below. Should a specific quarry require additional supplementary monitoring for any reason, this information is provided in the quarry-specific plans attached as Annexes to this QMP.

8.1 OPERATIONAL MONITORING

8.1.1 Daily workplace inspections

During the active development of the quarries, personnel will carry out daily visual inspections in relation to the performance and condition of each structure. The purpose of these inspections is to identify and document any potential hazards or risks to the facility, safety, or the environment, such as deformations, unusual seepage, slumping, local failure, pooling water etc. Some of these conditions relate to the success of maintaining permafrost and ground ice within the borrow and rock quarries.

These daily workplace inspections will be recorded and any issues addressed.

8.1.2 Monthly Quarry Inspections

During the active development of a quarry, monthly inspections will be conducted by a geologist to verify rock quality and structural stability of the pit wall (for rock quarries) within active rock quarry areas. Specific consideration will be given to documenting any visible impacts to permafrost and ground ice conditions, particularly in borrow pits.

This monitoring supplements the geochemical sampling undertaken as described in Section 8.3 and the annual geotechnical evaluation conducted under the Thermal and Geotechnical Monitoring Program. The results of these inspections will be recorded and any issues addressed adaptively.

8.1.3 Annual Quarry Inspections

All quarries which have been active in a given year will also be subject to an annual elevation and geometry survey to verify the overall volume excavated. Any accumulated piles of aggregate may also be surveyed to quantify their volume, surface area and aggregate size for the purposes of National Pollutant Release Index reporting conducted under the Air Quality Management and Monitoring Plan. These annual surveys may be conducted in concert with the Annual Geotechnical Inspection undertaken as part of the Thermal and Geotechnical Monitoring Plan.

Inactive quarries will also be visually inspected on an annual basis to confirm geotechnical stability under the Thermal and Geotechnical Monitoring Plan.

The results of these inspections will be recorded and any issues addressed adaptively.

8.2 PRE AND POST-BLAST MONITORING

Quarry rock development plans will be created for on-site use prior to excavation of each new batch of material. These plans will include geological maps showing the available geochemical data, quarry footprint, and the anticipated blast hole locations. The predetermined pattern of drillholes will be drilled to a depth not exceeding the overall depth of the quarry to ensure positive drainage can be attained at closure. Similarly, for borrow pits, areas demarked for removal will ensure pooling of water will not occur at closure.

Geology personnel will review the quarry rock development plans and the geologic conditions of the quarry to ensure there are no concerns in relation to previously identified PAG and to select potential blast holes or areas for sample collection. After each blast or removal campaign, geology will inspect and map the active quarry face to visually confirm the rock type and characteristics of the rock in the muck pile, and to note geological structures and where sulphide minerals are observed.

Wildlife monitoring required in relation to blasting activities is outlined in the WMMP.

8.3 QUARRY ROCK CONFIRMATORY TESTING AND SEGREGATION

An overview of the standard sampling and analytical testing to be conducted and result-based management response is shown in Figure 8.3-1. This sampling will be conducted at all quarries unless otherwise prescribed in the quarry specific plans to be included as Annexes to this QMP. Samples will be collected in advance of, or concurrent with, quarry development to characterize these materials.

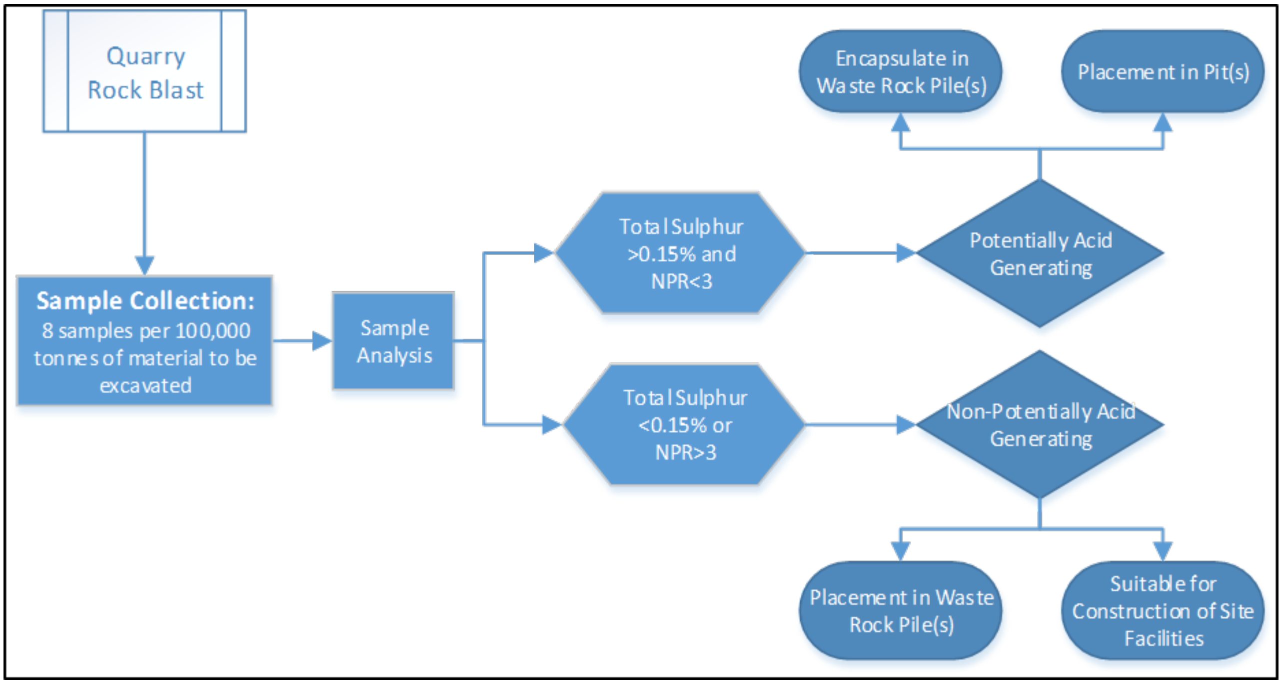

Figure 8.3-1. Proposed Bedrock Monitoring and Testing Plan

At a minimum, 8 samples will be collected for every 100,000 tonnes of material to be excavated (MEND 2009). For borrow pits, operational monitoring samples will be collected from the excavated material or active pit face. For rock quarries, samples will be collected from blast holes drilled in the rock quarries prior to quarry excavation. For either quarry type, samples will be as follows:

- Each sample should weigh no less than 1 kg.
- Each sample should be labeled with a unique sample identification number.
- Each sample should be documented in terms of sample depth and location within the quarry, and the blast hole number in the case of rock quarries.
- Composite samples (more than one lithology) should be avoided where possible.

All samples will be submitted for total sulphur and total inorganic carbon analysis at an off-site, accredited laboratory, using LECO furnace analyser or a similar appropriate technique. Analytical methods must achieve a suitable detection limit for classification. Total sulphur will be used to calculate acid potential (AP) and TIC will be used to calculate neutralization potential (NP).

Additional laboratory testing on a subset of the samples collected will include acid base accounting and net acid generation (NAG) testing to confirm geochemical the ARD classification. Short term leach testing following the shake flask extraction (SFE) method will also be conducted on a subset of samples to confirm the metal leaching (ML) potential of NPAG material; this testing is not required for PAG samples, as PAG waste rock will not be used for construction.

Classification of Material

Sample results will be evaluated against the following criteria:

- o Materials classified as NPAG (NP/AP greater than 3) or low sulphur (total sulphur content less than 0.15%) are suitable for use in construction.
- o Materials classified as uncertain (NP/AP between 1 and 3) or PAG (NP/AP less than 1) are not suitable for use in construction

The testing programs described in the Geochemical Characterization Report (SRK 2016) show that these criteria provide an appropriate level of conservatism for waste rock classification.

NPAG samples analyzed for SFE will be compared against 10x CCME guidelines for aquatic life to confirm metal leaching potential. Material with a high metal leaching potential should not be used for construction in the vicinity of sensitive receptors.

If a single sample or a cluster of samples are classified as PAG or to be metal leaching, the area from which the sample(s) were collected will be considered unusable for construction purposes. If this material must be, or has already been blasted, it will be handled as described in the Waste Rock Management Plan for PAG rock or as otherwise indicated in the quarry-specific Annex attached this this QMP (e.g., for the MLA quarry).

Following the ARD/ML classification of the confirmatory samples, the delineation of NPAG material may be incorporated in the blasting plan outlined in the quarry rock development plan. After blasting, dig limits are to be flagged and documented to ensure that only NPAG material is utilized for construction purposes.

In future, Sabina may install an on site LECO furnace for sample analysis. This would provide a faster turnaround time for results and minimizes double handling of quarry rock. As a quality assurance and quality control measure, 10% of samples will be split and sent to an external laboratory for verification testing to confirm site-generated results.

Some quarries may have areas or rock types that need to be monitored more intensively than described here. Where this is the case, it will be identified in the quarry-specific management plans attached as Annexes to this Plan.

9. Adaptive Management

This plan represents an adaptive approach to understanding the effects of the Project on the landscape and the species that live there. In this context, the Plan is part of a continually evolving process that relies not only on the efficacy of data collection and analytical results, but is also dependent on feedback from the communities, government, Aboriginal groups, and the public. Having an adaptive and flexible program allows for appropriate and necessary changes to the design of monitoring studies, and the mitigation and monitoring plans.

Checking and corrective action will occur through regular inspections and the evaluation of monitoring data. Corrective action will be undertaken if inspections identify inconsistencies with this plan or with applicable legislation. Work will be stopped if necessary to implement corrective action.

Should confirmatory sampling of potential quarry rock change the anticipated delineation of NPAG material or the classification of specific rock types, modification to the approach to ARD/ML sampling and analysis will be reviewed. In most cases it is anticipated that any necessary modifications would be quarry-specific and would be addressed through an update to the respective Annex attached to this Plan.

Further changes may come about through the observation of unanticipated effects or inadequacies in the sampling methods to detect measurable effects. Other changes may result from ecological knowledge acquired through working with Aboriginal community members and discussions with Elders, both in the field and through workshops or community engagement sessions.

Adaptive management based on monitoring undertaken under other management and monitoring plans is described in those plans and is not repeated here.

10. Reporting

A summary of quarrying activities will be reported to the NWB, NIRB and the KIA as part of the annual reports in accordance with requirements of the Project Certificate, Licence, and Commercial Leases. Reporting will include a summary of results of the geochemical inventory and monitoring programs outlined in Section 8, including the amount of rock used from each quarry.

Any revisions to blasting thresholds, mitigation measures, or monitoring related to blasting near fish bearing waters, and developed in collaboration with DFO, will be reported in the Project Certificate annual report (T&C 25). Any wildlife mitigation or deterrence measures related to quarrying and blasting activities will also be recorded and reported in the annual Project Certificate report (T&C 43 and 44), this includes any consideration given to the increased potential for caribou presence between July 26th and August 31st (T&C 41).

11. Reclamation

Final closure of the borrow pits and quarry sites will be undertaken once they are no longer needed, or when the mine closes as part of mine closure activities. Final closure of the borrow pits and quarries will consider the removal of all mobile and stationary equipment, regrade the sites so they blend with the existing topography and drain positively, and water quality monitoring. Additional details pertaining to Closure activities are provided in the ICRP.

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