Sabina
GOLD & SILVER CORP.

BACK RIVER PROJECT
Mine Waste Rock Management Plan

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BACK RIVER PROJECT
MINE WASTE ROCK MANAGEMENT PLAN

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Revision Log

Version	Date	Section	Page	Revision
1	October 2017	All	All	Supporting Document for Type A Water Licence Application, submitted to Nunavut Water Board for review and approval

Acronyms

ABA	acid base accounting
ARD	acid rock drainage
ICRP	Interim Closure and Reclamation Plan
kt	kilotonne
MAD	Main Application Document
ML	metal leaching
MLA	Marine Laydown Area
Mt	million tonnes
NAG	Net Acid Generation test
NP	neutralizing potential
NPAG	non-potentially acid generating
NWB	Nunavut Water Board
OVB	overburden material
PAG	potentially acid generating
Project	Back River Project
ROM	run-of-mine
Sabina	Sabina Gold & Silver Corp.
TSF	Tailings Storage Facility
WRMP or Plan	Mine Waste Rock Management Plan
WRSA	Waste Rock Storage Area

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 with interconnecting winter ice roads (Main Application Document [MAD] Appendix A, base Figure 2): Goose Property (MAD Appendix A, base Figure 3) and the Marine Laydown Area (MLA) (MAD Appendix A, base Figure 4) situated along the western shore of southern Bathurst Inlet. The majority of annual resupply will be completed using the MLA, and an approximately 160 km long winter ice road will connect the MLA to the Goose Property. Refer to the MAD Appendix A, base Figures 1 to 5 for general site layout and locations. A detailed project description is provided in the MAD.

The Mine Waste Rock Management Plan (the Plan or WRMP) outlines the approach for managing waste rock produced at the Goose Property. While no waste rock will be generated at the MLA, quarry material will be used during construction; refer to Borrow and Quarry Management Plan (Supporting Document [SD]-03) for details.

This plan is based on the waste rock design report submitted as part of the Final EIS package (MAD Appendix F-3), which includes the following design details:

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

The WRMP and other management plans support the Type A Water Licence Application for the Project.

The Plan was prepared following the requirements of the Supplementary Information Guidelines (SIG) for Mining and Milling MM3 and Water Works M1, issued by Nunavut Water Board (NWB 2010 a, b); the Environmental Impact Statement Guidelines for the Project issued by the Nunavut Impact Review Board (NIRB 2013); and in accordance with best management practices and in conformance with current Federal and Territorial statutory requirements (refer to Applicable legislation and Guidelines Section 3).

This plan is a living document to be updated upon changes in related regulatory requirements, management reviews, incident investigations, changes to facility operation or maintenance, and environmental monitoring results, best practice updates or other Project specific protocols once construction starts through to Project closure activities. Any updates will be filed with the Annual Report submitted under the Type A Water Licence.

The information presented herein is current as of September 2017. An update will be initiated prior to the start of construction. The Plan will be reviewed as needed for changes in operation and technology, and as directed by the Nunavut Water Board (NWB) in the Type A Water Licence or other regulatory authorization where appropriate. Completion of the updated Plan will be documented through signatures of the personnel responsible for reviewing, updating, and approving the Plan.

Sabina will maintain a distribution list providing contact details for all parties who are to receive the Plan, including key personnel, contractors, organizations, and external agencies.

2. Scope and Objectives

The MWRMP is one of the documents that forms part of Sabina's overall Waste Management Program for the Project. This plan has been written to meet requirements of a Type A Water Licence and applies to all Sabina projects in the Kitikmeot region.

This plan is divided into the following components:

- Applicable Legislation and Guidelines (Section 3);
- Roles and Responsibilities (Section 4);
- Planning and Implementation (Section 5);
- Environmental Protection Measures (Section 6);
- Monitoring and Reporting Program (Section 7);
- Adaptive Management (Section 8); and
- Reclamation (Section 9).

This plan describes Sabina's approach to managing mine waste rock that will be produced in the Construction and Operations phases of the Project. The scope of the Plan covers operational procedures, the implementation of environmental protection measures, and monitoring and reporting of the effectiveness of mitigation.

The Plan applies to the Construction and Operations phases of the Project during which time waste rock will be produced, as well as the Closure and Post-Closure phases as waste rock will be permanently stored at the Property. 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 closure and reclamation of WRSAs is addressed in detail in the Interim Closure and Reclamation Plan (ICRP; SD-26). Progressive reclamation will be implemented where possible as it presents an important opportunity to reduce environmental liabilities associated with mine closure while the mine is in operation.

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 emissions from the WRSAs on the surrounding land and water.

The measures identified in this plan 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 RELATED DOCUMENTS

Documents within the Application for the Type A Water Licence supporting this plan include the following:

- Environmental Management and Protection Plan (SD-20);
- Water Management Plan (SD-05);
- Aquatic Effects Management Plan (SD-21);
- Road Management Plan (SD-02);
- Interim Closure and Reclamation Plan (SD-26);
- WRSA Design Report (MAD Appendix F-3);
- Geochemical Characterization Report (MAD Appendix E-3);
- Site-Wide Geotechnical Characterization Report (MAD Appendix F-2);
- Water and Load Balance Report (MAD Appendix E-2); and
- Site Wide Water Management Report (MAD Appendix F-1).

3. Applicable Legislation and Guidelines

The Plan has been prepared to comply with existing regulations and follow the available 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.

Sabina will also be bound by the terms and conditions of its land use permits to be issued by the Kitikmeot Inuit Association for Inuit Owned Land, and its Type A Water Licence to be issued by the NWB.

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 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)	

Other guidance documents considered in the development of the Plan include 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/AANDC 2013); and Guidelines for the Preparation of an Environmental Impact Statement for Sabina's Back River Project (NIRB 2013).

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.

The Environmental Superintendent, along with their direct reports, is responsible for the implementation of this plan including:

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

Future revisions to this plan will further define the site management structure, organizational chart, and a listing of designated personnel responsible for aspects of this plan as the organizational structure is developed. 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 64.3 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 = 24.7 Mt (~42 %).
- Potentially acid generating (PAG) waste rock = 34.3 Mt (~58 %).
- NPAG Overburden = 5.3 Mt.

The majority of waste rock and all overburden produced (about 59.3 Mt combined) will be stored in engineered WRSAs located close to each of the open pits (MAD Appendix A, base Figure 3). The remaining 4.9 Mt of waste rock will be used for other purposes, including 3.5 Mt for general site construction activities, and 1.5 Mt for construction of the Tailings Storage Facility (TSF) Containment Dam. Beyond this, a minor volume (0.5 Mt) will be used for backfill in the underground mines. The top organic layer from overburden stripping may be stockpiled separately for use during reclamation.

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

- Umwelt WRSA: Located to the East of the proposed Umwelt open pit and underground mines.
- Llama WRSA: Located to the East and South of the proposed Llama open pit and underground mines.
- 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. The majority of the waste rock placed in the TSF WRSA will come from the Goose Main open pit mine.
- Echo WRSA: Located to the East and North of the proposed Echo open pit and underground mines.

Figure A-01 shows the associated water management facilities and nearby receiving waterbodies. See the Water Management Plan (SD-05) for more details.

The WRSAs have been designed to encapsulate the PAG waste rock with a minimum 5-m thick NPAG waste rock cover on the top and sides of each pile. Depending on the physical characteristics of the overburden, the 5.3 Mt of overburden will either be incorporated within the piles, used for specific construction purposes, or used as cover material; overburden is geochemically suitable for use as cover or construction material. As noted above, the top organic layer from overburden stripping during development at site may be stockpiled for use during reclamation.

Over time, it is expected that permafrost will aggrade into the PAG rock, which will reduce oxidation rates and contact with seepage and runoff (MAD 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. Additional details on the water quality assessment can be found in the Water Management Plan (SD-05) and the Water and Load Balance Report (MAD Appendix E-2).

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 alternatives that were considered in the design.

5.2 WASTE ROCK PHYSICAL CHARACTERISTICS

Physical characterization of run-of-mine (ROM) 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 ROM waste rock for the Project; this table is sourced from the Site-Wide Geotechnical Characterization Report (MAD 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 OVERBURDEN AND WASTE ROCK 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; MAD 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.

A brief summary of the testing program and results for waste rock and overburden associated with the Goose Property is provided below, with further details provided in the Geochemical Characterization Report (MAD Appendix E-3).

The overburden testing program included 60 samples, which were submitted for acid base accounting (ABA), trace element analysis. A subset of these samples underwent shake flask extraction tests and net acid generation (NAG), and mineralogical analysis (Reitveld X-ray Diffraction). The waste rock testing program included ABA and trace element analyses on 676 representative samples within the vicinity of the mine workings, and mineralogical analyses, NAG tests, humidity cell tests, and field barrel tests on a representative subset of these samples. The testing program was completed in accordance with recommendations found in the Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials (MEND 2009). Static test results were used to define the general range of characteristics of overburden and waste rock that will be generated during mining. Kinetic test results were then used to determine the rate of reaction of key material types.

The Llama, Umwelt, Goose Main, and Echo 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.

The results of the geochemical characterization program indicate that overburden has a negligible potential for ML/ARD and is classified as NPAG. In contrast, an appreciable proportion of the waste rock is classified as PAG according to the results of ABA, NAG testing, and kinetic testing. 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.

The kinetic dataset presented in the Draft Environmental Impact Statement was reassessed and based on the results from that review, Sabina initiated two additional humidity cell tests on iron formation samples. These samples were selected to represent more typical iron formation material from all of the Goose deposit areas and are considered to be representative of the range of characteristics that will be found in iron formation waste 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. Therefore, 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.

The ML potential of NPAG rock was established using kinetic test results and seepage surveys in the vicinity of the existing Goose Property airstrip. The historic field barrel tests were not ideal for establishing reaction rates of NPAG rock, as the grain size of the material used to construct the field tests was not representative of the fine grained material that would contribute to waste rock reactivity in site specific conditions. Sabina completed a seep survey around the existing Goose Property airstrip to provide an indication of water quality from NPAG waste rock. Solubility controls were established based on the site-specific laboratory testing data and water quality data from geochemically similar mine sites, as well as the results from the seep survey, as described in Section 7 of the Geochemical Characterization Report (MAD Appendix E-3). The 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.

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, the Umwelt, Llama, and Echo deposits have the highest proportion of PAG samples, while the Goose Main deposit has the lowest proportion.

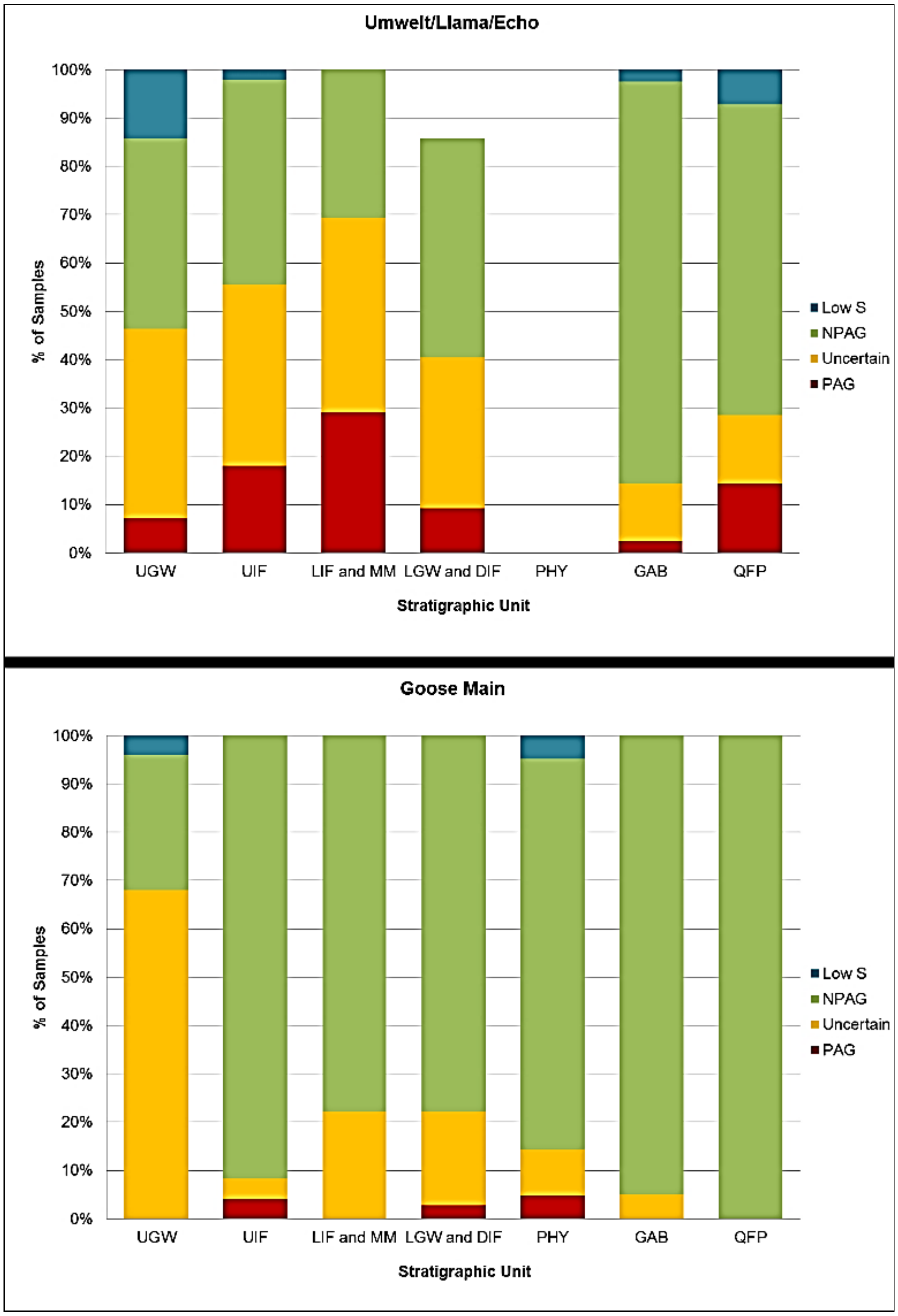

Figure 5.3-1: Distribution of PAG, Uncertain, NPAG, and Low Sulpher Waste Rock Samples According to Stratigraphic Unit and Deposit Groupings

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	9,490	9,163	1,289	51%	49%
	Llama	7,479	7,490	1,037	50%	50%
	Goose Main	3,663	20,693	2,755	15%	85%
	Echo	192	782	250	20%	80%
	Total	**20,823**	**38,127**	**5,331**	**35%**	**65%**
75% of NPAG recovered except 0% in Lower Iron Formation and 50% in Umwelt/Llama Upper Iron Formation	Umwelt	13,053	5,600	1,289	70%	30%
	Llama	10,548	4,421	1,037	70%	30%
	Goose Main	10,101	14,255	2,755	41%	59%
	Echo	584	389	250	60%	40%
	Total	**34,286**	**24,665**	**5,331**	**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 similar to the procedures that are used to identify and segregate ore in the mining operation. Details on the segregation program are provided in Section 6.1.

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 Main Application Document Section 7.1.8);
- 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;

- o when feasible, divert the upstream clean natural non-contact run-on water away from the WRSAs;
- o facilitate the collection and management of contact water from the WRSAs during Operations to avoid potential impacts on the surrounding environment;
- o maintain a minimum distance of 100 m between the toe of the WRSAs and the open pits;
- o 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
- o 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:

- o The WRSAs will be constructed in benches using a bottom-up technique.
- o 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.
- o 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.
- o 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 by Year 6.
- o 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 four 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 38 ha, have a height of approximately 34 m, and will be located East of the proposed Umwelt open pit. It is anticipated that, from Year -2 to Year 1, approximately 18.7 Mt of waste rock and 1.3 Mt of overburden will be sourced from the Umwelt open pit, with the majority of it stored in Umwelt WRSA. Waste rock from Umwelt Pit will 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 of the Umwelt WRSA and will be covered by the facility (MAD Appendix A, base 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 35 ha, have a height of approximately 30 m, and will be located East and South of the proposed Llama open pit. It is anticipated that, from Year 1 to Year 3, approximately 15.0 Mt of waste rock and 1.0 Mt of overburden will be sourced from the Llama open pit, all of which will be stored in Llama WRSA. There are no ponds or streams located within the footprint of the Llama WRSA (MAD Appendix A, base 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 56 ha. The height of waste rock will be approximately 24 m, with a total height above ground of approximately 36 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. It is anticipated that, from Year 2 to Year 5, approximately 24.4 Mt of waste rock and 2.7 Mt of overburden will be sourced from the Goose Main open pit, all of which will be stored in the TSF WRSA. Three small streams and four ponds are located within the footprint of the TSF WRSA, and will be covered by the facility (MAD Appendix A, base Figure 3). With the exception of 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.

5.4.1.4 Echo Waste Rock Storage Area

The proposed Echo WRSA will permanently occupy an area of approximately 6 ha, have a height of approximately 15 m, and will be located Northeast of the proposed Echo open pit. It is anticipated that, from Year 4 to Year 5, approximately 1.0 Mt of waste rock and 0.3 Mt of overburden will be sourced from the Echo open pit and stored in the Echo WRSA. There are no ponds or streams located within the footprint of the Echo WRSA (MAD Appendix A, base Figure 3). To manage slope stability, overburden will be placed within areas that will be surrounded by waste rock. The Echo WRSA is expected to reach its design capacity at the end of Year 5.

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 Echo 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 (MAD 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 (MAD 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 summarizes the waste rock production schedule for the Project by year. All waste rock is produced during the 2-year pre-production period (during the Construction Phase) and the first six years of Operations. Umwelt WRSA will be constructed first over a period of four years (although the fourth year has very limited waste rock placed). The Llama WRSA takes three years to construct and overlaps with Umwelt WRSA construction by one year. The TSF WRSA takes five years to construct (with the fifth year placement being negligible), overlapping with Llama WRSA construction for two years. Echo WRSA placement occurs in parallel with TSF WRSA construction, but is completed in two years.

Waste rock will be placed in accordance with its ARD classification (Table 5.3-1), 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 (SD-05).

Table 5.4-1. Waste Rock Disposal Schedule (ktonnes)

	Location	Mine	Waste Type	Total ('000s)	Year of Operation											
					-2	-1	1	2	3	4	5	6	7	8	9	10
GOOSE	Construction, TSF, & Umwelt WRSA	Umwelt Open Pit	OVB	1,289	1,289	0	0	0	0	0	0	0	0	0	0	0
			NPAG	5,601	1,292	3,458	831	21	0	0	0	0	0	0	0	0
			PAG	13,052	2,796	8,110	2,126	20	0	0	0	0	0	0	0	0
	Llama WRSA	Llama Open Pit	OVB	1,037	0	0	1,037	0	0	0	0	0	0	0	0	0
			NPAG	4,422	0	0	2,019	2,175	228	0	0	0	0	0	0	0
			PAG	10,546	0	0	4,532	5,519	496	0	0	0	0	0	0	0
	TSF WRSA & Echo WRSA	Goose Main Open Pit	OVB	2,754	0	0	0	2,362	392	0	0	0	0	0	0	0
			NPAG	14,255	0	0	0	685	6,683	5,575	1,309	3	0	0	0	0
			PAG	10,101	0	0	0	466	4,232	3,933	1,461	8	0	0	0	0
		Echo Open Pit	OVB	250	0	0	0	0	0	250	0	0	0	0	0	0
			NPAG	389	0	0	0	0	0	286	103	0	0	0	0	0
			PAG	584	0	0	0	0	0	412	172	0	0	0	0	0

NPAG = non-potentially acid generating; OVB = overburden material; PAG = potentially acid generating

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 MAD Appendix F-3.

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.

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 four WRSAs is provided in the WRSA Design Report (MAD 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 mine waste disposal (ECCC 2011) 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 four WRSAs as shown on MAD Appendix A, base 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 (MAD 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 (MAD 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 (MAD 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 IDENTIFICATION, SEGREGATION, AND PLACEMENT

Implementation of the selected waste rock management strategy will require a dedicated blast hole monitoring program to identify PAG and NPAG materials, and to direct each material to the appropriate location within each of the WRSAs. The procedures used to identify and segregate PAG and NPAG waste rock are similar to the procedures that are used to identify and segregate ore in the mining operation. Key aspects will include sampling and testing to identify and delineate zones of PAG and NPAG material in advance of blasting, and communications and tracking protocols. As a component of the Project Certificate, the results and interpretations of the blast hole cuttings sampling and testing program will be provided to the NWB for distribution to the relevant parties. Further sampling and testing will also be undertaken to determine the effectiveness of the segregation program, and confirm that the relative quantities of PAG/NPAG waste rock are within predicted ranges, as described in Section 7.

It is expected that additional work will be required in advance of mining to further develop the segregation plans and to ensure that the appropriate staff and equipment are in place when mining is initiated. This may include: geostatistical analysis of the existing data to determine the optimal density of sampling; and, development of sampling, testing, classification, data management, QA/QC, and segregation protocols. It is anticipated that this additional work could be completed over a period of a few months with sufficient time in advance of mining operations (pre-stripping). As with other types of grade control programs, Sabina anticipates that the results of the blast hole testing will be reviewed, and the program refined, on a regular basis throughout Operations as data is collected from different areas of the mine.

It is expected that the testing required to support segregation could include a combination of sulphur analyses (using a Leco furnace), total inorganic carbon (TIC) from which a carbonate mineral NP will be derived (or TICNP), and/or Modified Sobek NP or NAG tests. The proposed criteria for defining NPAG waste rock is provided in Table 5.3-1. In addition to on-site testing, a portion of the samples will be sent off-site for verification of the test results by an accredited commercial laboratory.

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. This is further detailed in the Water Management Plan (SD-05).

Prior to closure of the WRSAs, seepage and runoff is expected to contain elevated levels of some parameters (Section 5.3); 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. Seepage and runoff volumes were accounted for in the water and load balance; details on water treatment and runoff criteria can be found in the Water Management Plan (SD-05) in Sections 7.4 and 7.5, respectively.

The collection ponds constructed for the WRSAs will apply appropriate design criteria in terms of managing extreme flows.

The Umwelt (UWD1 and UWD2), Llama (LWD1 and LWD2), TSF (TWD1 and TWD2) WRSAs will straddle two catchment areas each, while the Echo WRSA will be confined within one catchment area (EWD). The catchment divides are shown on Figure A-01 of this plan, while the catchment areas labelled on Figure A-01 of the Water Management Plan (SD-05).

Seepage and runoff from the WRSAs during Construction and Operations phases will be managed using the water management system described below, and as shown on Figure A-01 and detailed on Figure A-01 of the Water Management Plan (SD-05):

- Seepage and runoff from the Umwelt WRSA within catchment UWD1 will be diverted by the Umwelt WRSA Diversion Berm to the Umwelt WRSA Pond and then pumped to the Primary Pond. Runoff from catchment UWD2 will flow directly to the Primary Pond. All contact water from the Primary Pond will then be pumped to the active tailings management facility.
- Seepage and runoff from the Llama WRSA within catchment LWD2 will be diverted by the Llama WRSA Diversion Berm to the Llama WRSA Pond and then pumped to the Primary Pond. Runoff from catchment LWD1 will flow directly to the Primary Pond. All contact water from the Primary Pond will then be pumped to the active tailings management facility.
- Seepage and runoff from the TSF WRSA within catchment TWD1 will be collected by the TSF WRSA Diversion Berm and pumped to the TSF WRSA Pond; this contact water will then be pumped to the active tailings management facility.
- Seepage and runoff from the Echo WRSA within catchment EWD will be diverted by the Echo WRSA Diversion Berm to the Echo WRSA Pond and then pumped to the Primary Pond; this contact water will then be pumped to the active tailings management facility.

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. Once runoff is demonstrated to meet applicable limits, the ponds will be decommissioned in accordance with the ICRP (SD-26).

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 (SD-05). 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.

6.4 AVOIDANCE OF NAVIGABLE WATERS

The siting of the WRSAs are not located in any navigable waters and therefore do not have the potential to affect navigation.

7. Monitoring and Reporting Program

This section presents a summary of the monitoring and reporting programs that will be carried out during Construction and Operations activities related to mine waste rock storage management. Refer to the ICRP (SD-26) for details on monitoring during the Closure Phase of the Project.

Table 7-1 summarizes the monitoring activities for each WRSA. Each monitoring activity will be further defined, including location and type of instrumentation, prior to construction of each WRSA, and will be completed according to the approved environmental protocols. Details on other water monitoring related to the WRSAs are included in the Environmental Monitoring and Protection Plan (SD-20).

Table 7-1 Waste Rock Storage Area Monitoring Activities

Proposed Monitoring	Monitoring Component	Monitoring Frequency	Reporting
Internal Monitoring	Routine visual inspections of WRSAs	Daily during active rock placement Monthly to semi-annually after placement in the pile is complete	Monitoring data will be used by Sabina internally.
	Elevation and geometry survey	Annually during WRSA operation	
Water Licence Monitoring	Quantities of PAG and NPAG waste rock and overburden placed into WRSAs	Daily records	Monitoring data will be reported to the Regulators in the Annual Water Licence Report
	Geochemical monitoring of waste rock to evaluate effectiveness of segregation program	A minimum of approximately one sample per 100,000 tonnes of mined waste material	
	Thermal and freeze-back monitoring	Daily data using automated data loggers after completion of the pile	
	Dust monitoring related to WRSAs	See Air Quality Monitoring and Management Plan	
	Geotechnical inspection by qualified Engineer	Annually	
	Containment of seepage and runoff	Monthly inspection of diversion and containment structures. Weekly during freshet.	
	Seepage water quality	Spring seep survey. Once per spring if seepage identified	
	Water quality in WRSA collection ponds	Twice annually: Once during freshet, once in late summer. Additional test as soon as practical after storm events.	

There are two types of monitoring related to mine waste management: 1) monitoring that is carried out for operational and management purposes by Sabina for day-to-day decision making, with no obligation to report; and 2) monitoring that is specified in the Type A Water Licence. The following monitoring data will be collected, compiled, and managed internally:

- During the active development of each WRSA, site staff will carry out daily visual inspections in relation to the performance and condition of each structure, and to ensure compliance with design, this management plan, permits, authorizations, and commitments. When placement activity ceases on an interim or seasonal basis, the inspection frequency will shift to monthly. Following the completion of a WRSA, inspections will continue on a semi-annual basis until Closure. The purpose of these inspections is to identify and document potential hazards or risks to the facility, such as deformations, unusual seepage, slumping, local failure, etc.
- During Operations, an annual elevation and geometry survey of the WRSAs will be performed to verify the overall volume placed, determine the reclamation progress, and provide input information to the operation plan.

The following monitoring data at the WRSAs will be reported to the NWB through the Water Licence Annual Report:

- The WRSAs were designed to store approximately 59 Mt of waste rock (including 24.7 Mt of NPAG and 34.3 Mt of PAG) and 5.3 Mt of overburden material during Operations. To confirm that there is sufficient NPAG for cover construction, quantities of the NPAG and PAG waste rock and overburden produced and placed in WRSAs will be recorded on a daily basis and a monthly summary will be provided in the annual report. Periodic surveys will also be completed, as required, to confirm the projected NPAG quantities were placed to provide the required WRSA cover thickness.
- Geochemical monitoring will be completed to evaluate the effectiveness of the segregation plan. In particular, to confirm that the geochemical characteristics of waste rock within the NPAG areas of the WRSAs are within expected ranges. Confirmatory samples will be taken at an approximate rate of one sample per 100,000 tonnes of mined material from NPAG areas within the WRSAs. The collected samples will be sent to an accredited commercial laboratory for ABA tests (with NP determination using the Modified Sobek method) and NAG tests.
- Ground temperature monitoring instrumentation (e.g., thermistors) will be installed in the WRSAs to monitor the progression of freezing in the PAG waste rock. Vertical ground temperature cables will be installed after completion of the WRSAs due to the high risk of damage associated with raising installations incrementally during WRSA development. Temperature readings will be taken monthly to track permafrost development within the WRSAs.
- Dust related to waste rock and overburden management is not expected to be an issue by employing the dust suppression measures presented in Section 6.3 through WRSA construction, operation, and closure. Air quality at the mine site will be monitored during Construction, Operations, and Closure using air quality monitoring stations. Results will be reported annually.
- Sabina will, have an independent third party geotechnical engineer inspect the facilities and review the associated monitoring data. The visual assessment, results of the third party inspection, and recommended actions related to the WRSAs will be summarized in the Annual Inspection Report.
- 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 (SD-05).

- 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 (SD-05).

Environmental reporting will be conducted as defined in future permits, approvals, and authorizations relevant to mine waste management. The Type A Water Licence is expected to be the primary regulatory instrument governing mine waste management for the Project.

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 operational and 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.

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. Some 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.

Sabina is committed to considering and incorporating Traditional Knowledge into the Plan. The incorporation of Traditional Knowledge will occur throughout all stages of the Plan, including identification of mitigation measures, monitoring study design, data collection, and follow-up programs to obtain feedback.

9. Reclamation

The majority of WRSA closure activities will occur as progressive reclamation. The WRSAs will be progressively capped using NPAG waste rock sourced from adjacent or nearby active open pit operations. All WRSAs will be fully developed by the end of Year 6, such that the final cover of NPAG waste rock over the piles can be completed during the Operations Phase. Eight years of Closure water quality monitoring and five years of Post-Closure water quality monitoring will be conducted in the area to confirm that runoff meets applicable receiving water quality objectives. Additional details pertaining to reclamation and closure are provided in the ICRP (SD-26).

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Appendix A. Drawings

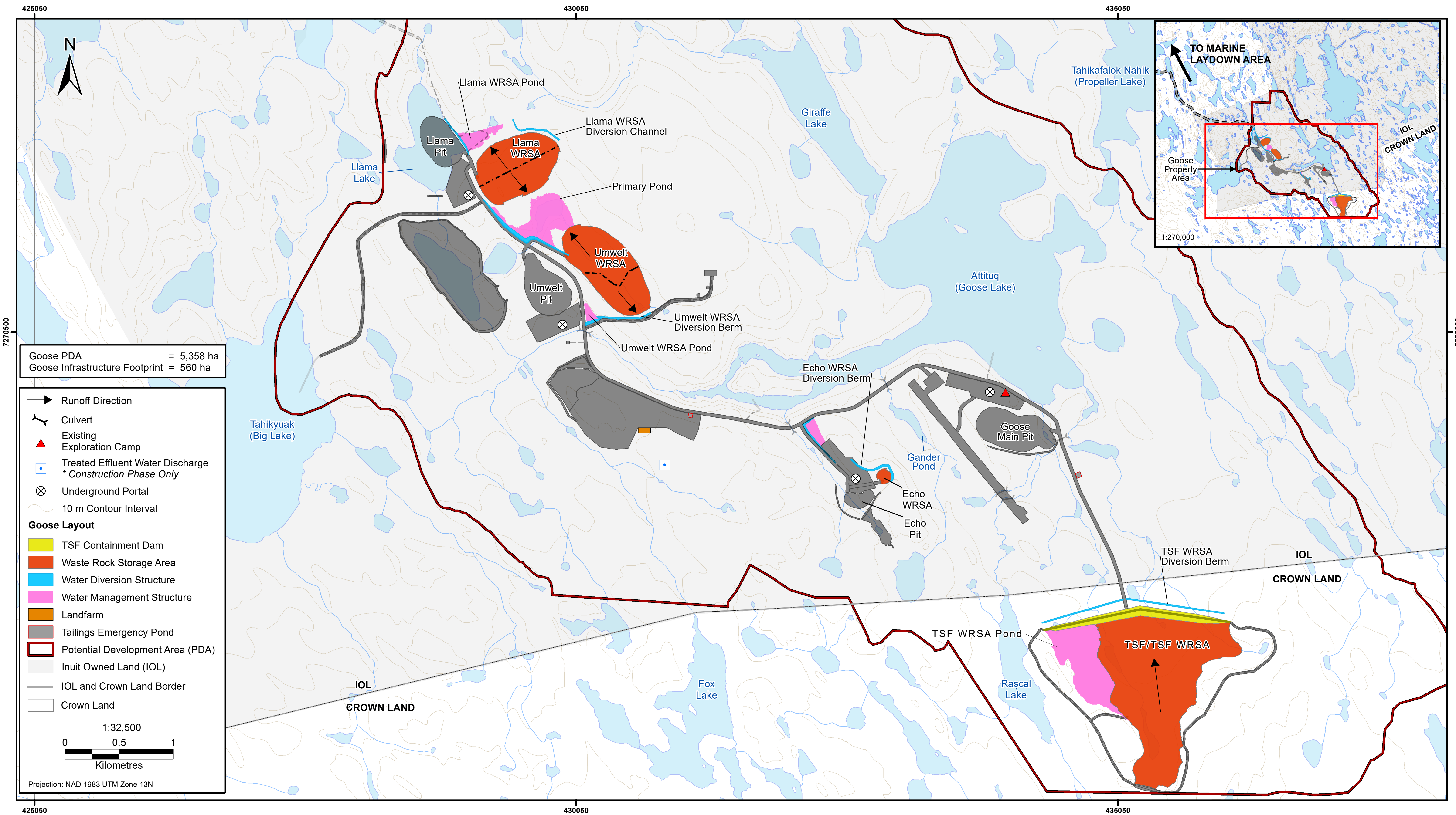

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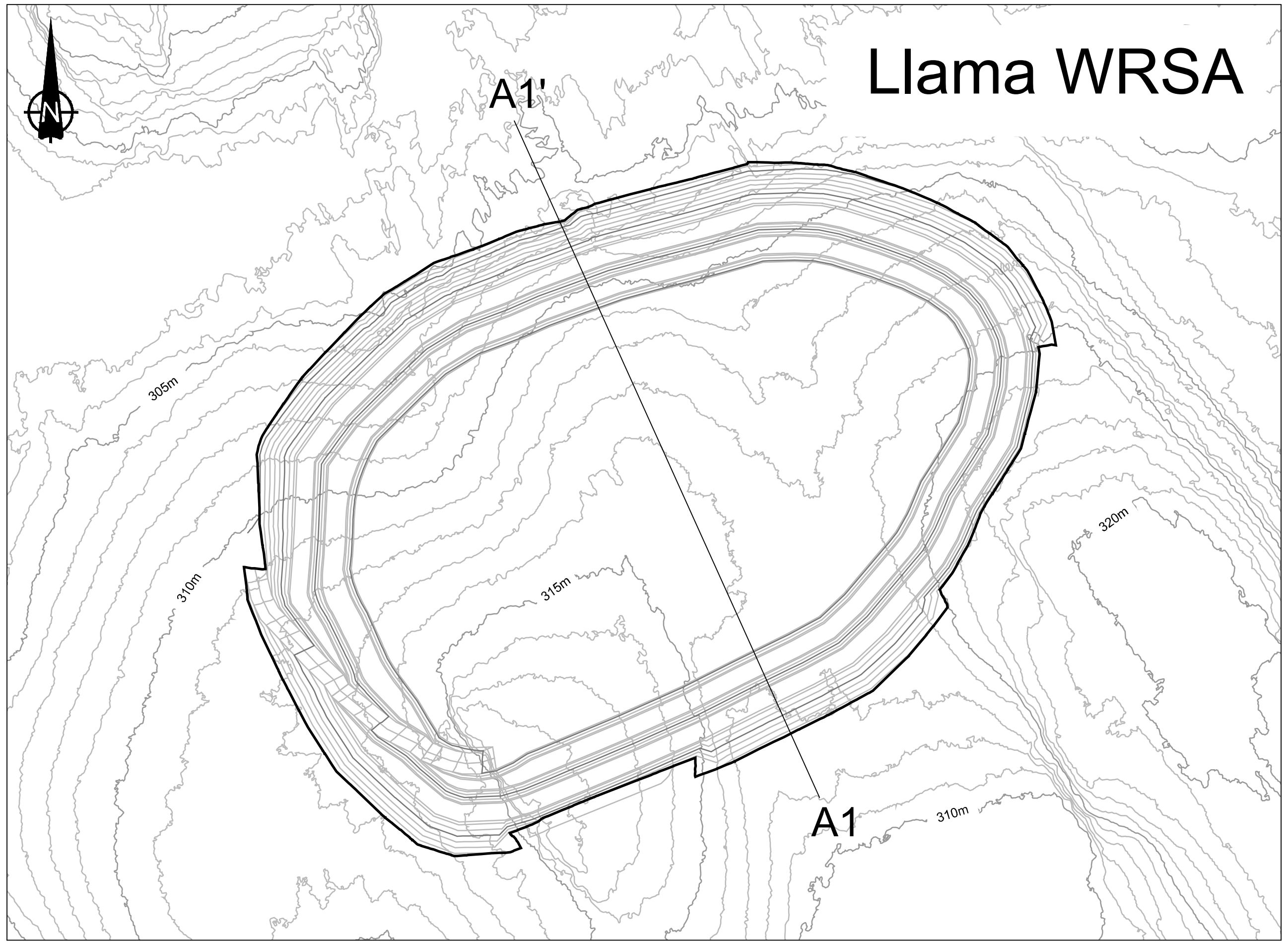
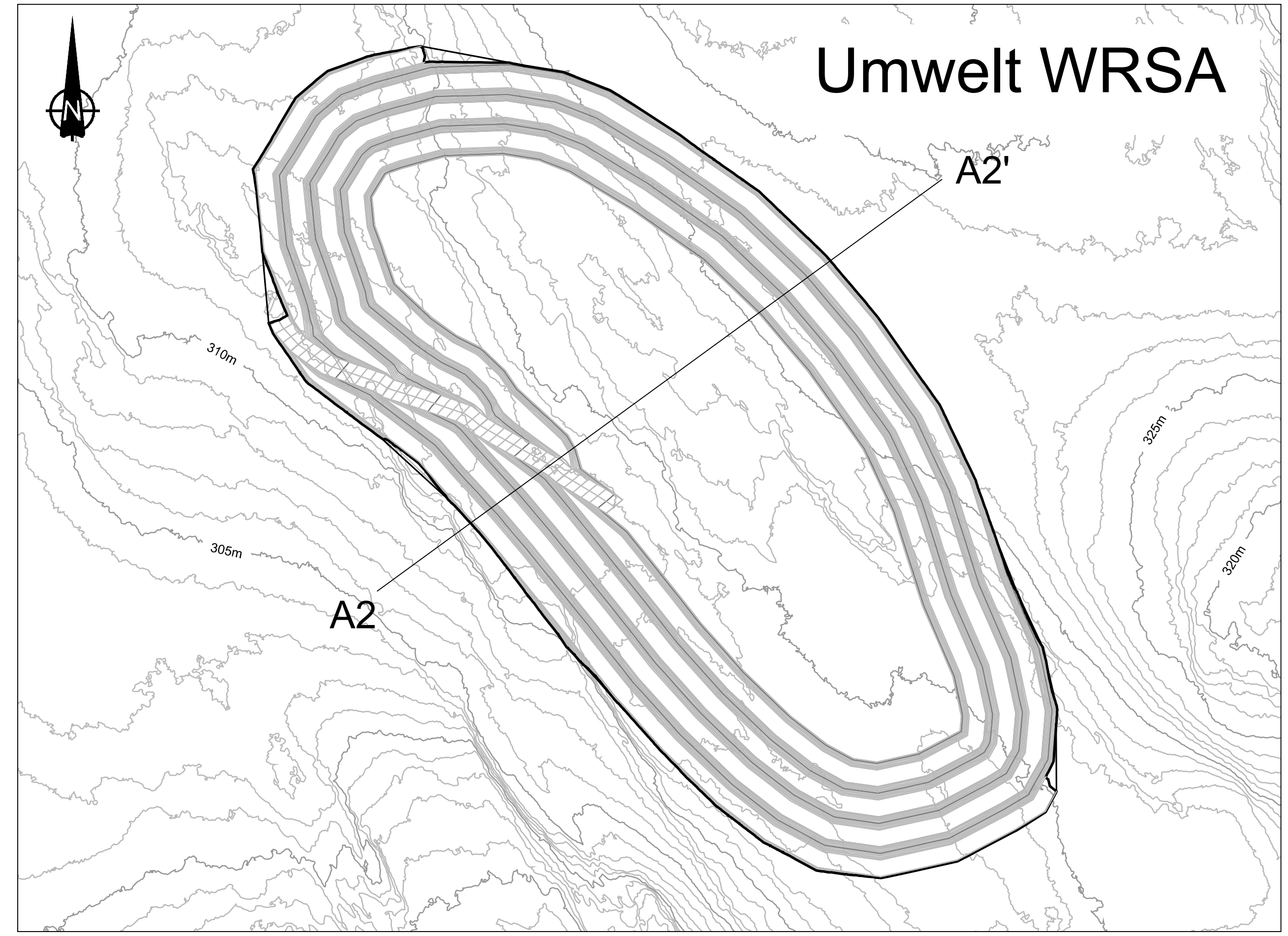
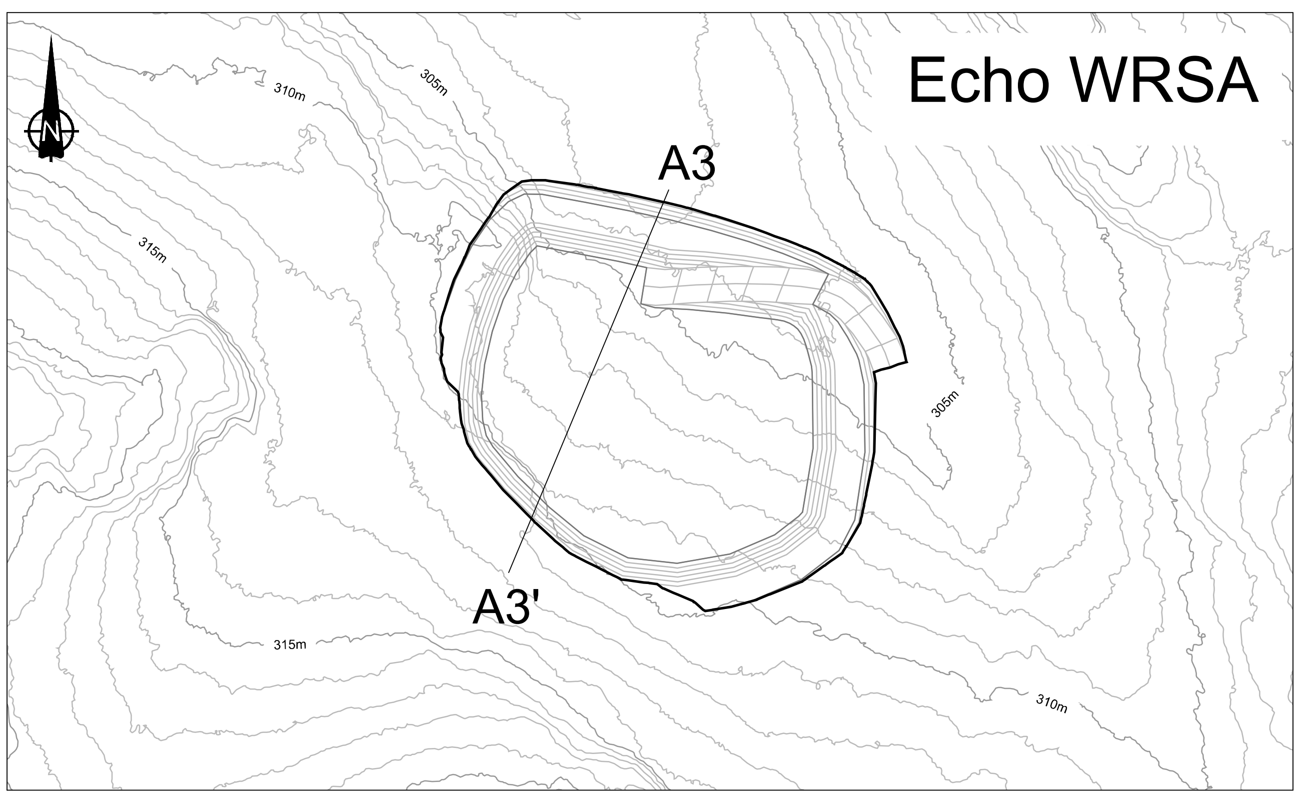
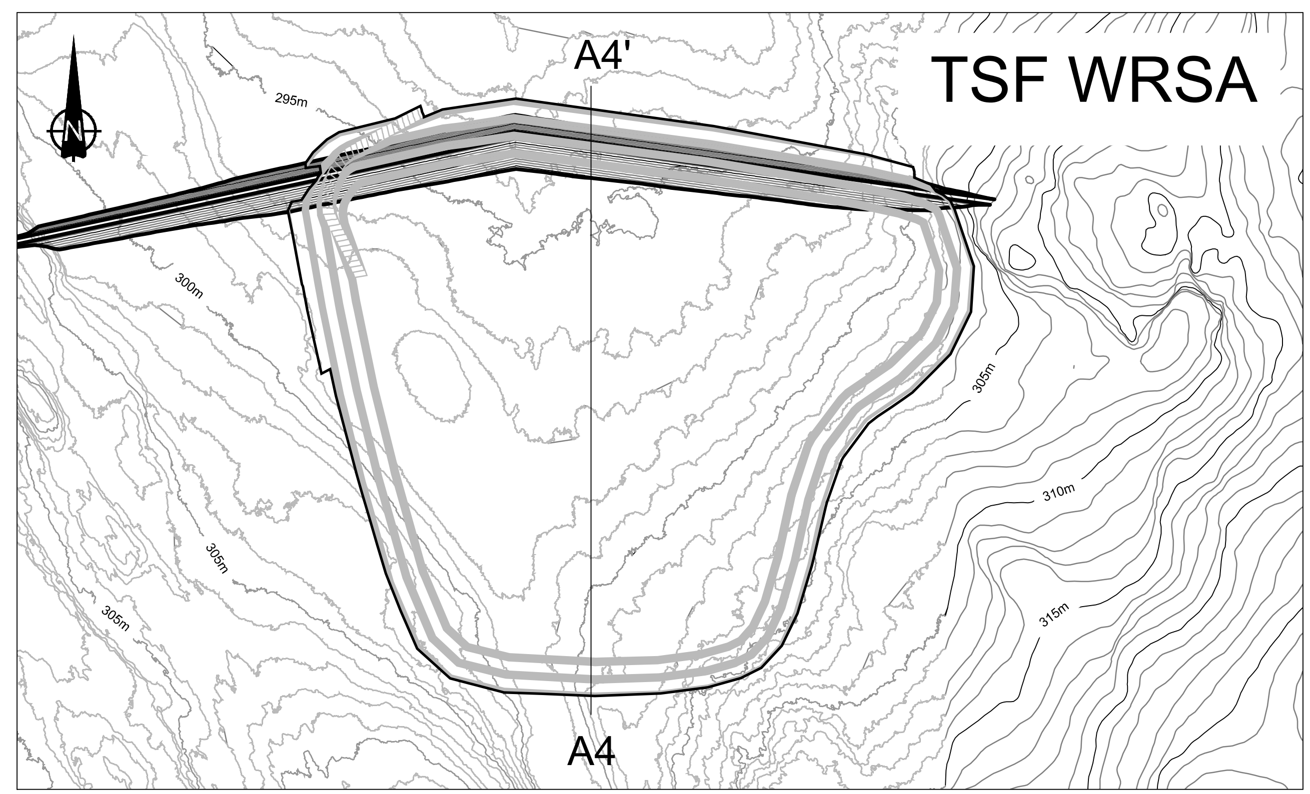
Figure A-01

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.

\\VAN-SVR0\Projects\01_SITES\Back River\1CS020.011_Type_A_Water_Licence\!040_AutoCAD\2017_Drawings\1CA020.011_MWRMP_FIGURE_A-02.dwg

REFERENCE DRAWINGS

DRAWING NO.	DRAWING TITLE
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REVISIONS

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

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CHECKED: EMR	APPROVED: EMR	DATE: 2017/08/30

FILE NAME: 1CA020.011_MWRMP_FIGURE_A-02.dwg

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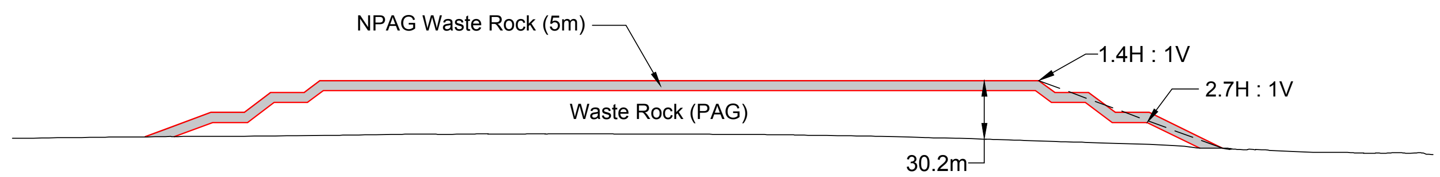
BACK RIVER PROJECT

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

MINE WASTE ROCK MANAGEMENT PLAN

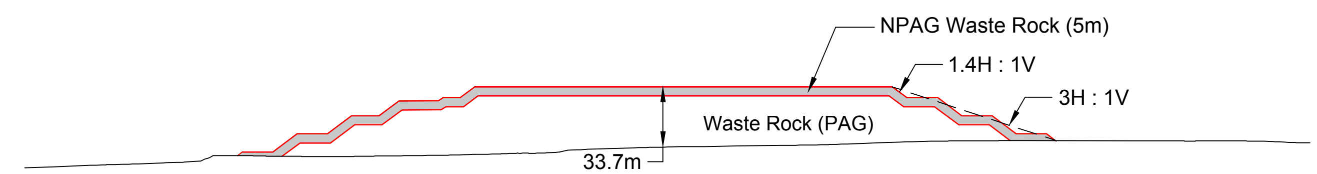
Goose Property Waste Rock Storage Areas at Closure - Plan View

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



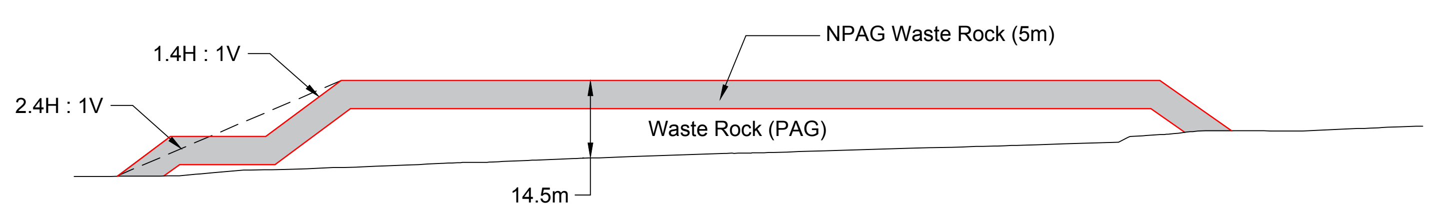
Profile A1-A1'

Llama WRSA Typical Cross-Section



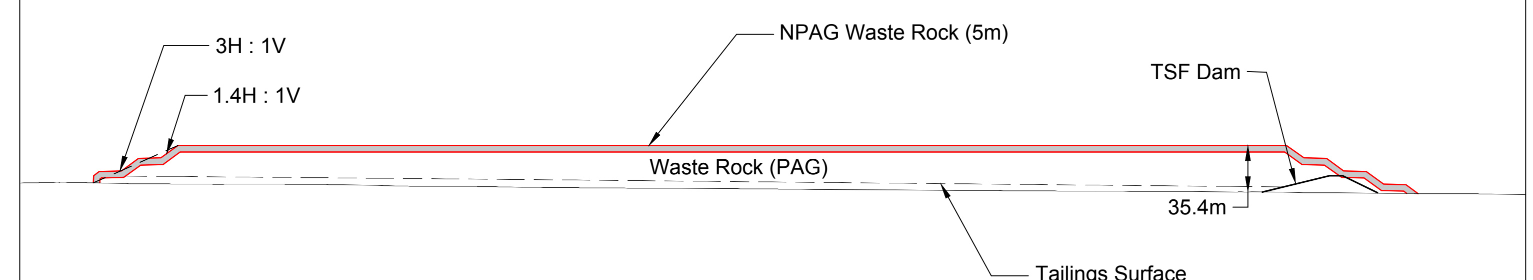
Profile A2-A2'

Umwelt WRSA Typical Cross-Section



Profile A3-A3'

Echo WRSA Typical Cross-Section



Profile A4-A4'

TSF WRSA Typical Cross-Section

DRAWING NO.	DRAWING TITLE
-	-

REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE
-	-			

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

REVISIONS

Original Drawings
Stamped and
Signed by Engineer

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FILE NAME: 1CA020.011_MWRMP_FIGURE_A-03.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.
B	3 OF 3	A-03

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