BACK RIVER PROJECT
Tailings Management Plan

October 2017

BACK RIVER PROJECT
TAILINGS 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

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
MAD	Main Application Document
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

1. Introduction

The Tailings Management Plan (the Plan or TMP) 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), and the Environmental Impact Statement (EIS) Guidelines issued by the Nunavut Impact Review Board (NIRB) to Sabina Gold & Silver Corp. (Sabina) (NIRB 2013).

The Tailings Management System Preliminary Design Report (Main Application Document [MAD], Appendix F-4) was used as the basis for the development of the TMP, and 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;
- Tailings Storage Facility (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 Tailings Facilities (TF), including a tailings deposition plan for the TSF; and
- Closure and reclamation of the TSF and TFs.

This plan is a living document to be updated upon changes in related regulatory requirements, management reviews, 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 likely be based on detailed engineering design prior to the start of construction.

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

2. Scope and Objectives

The Plan is one of the documents that forms part of Sabina's overall Waste Management Program developed for the Back River Project (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 is divided into the following components:

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

The Plan applies to the Construction and Operations phases of the Project during which time tailings will be produced; and 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 also addressed in detail in the Interim Closure and Reclamation Plan (ICRP; Supporting Document [SD]-26).

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.

Progressive reclamation is considered as it presents an important opportunity to reduce environmental liabilities associated with mine closure while the mine is in operation.

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

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

- Environmental Management and Protection Plan (SD-20);
- Water Management Plan (SD-05);
- Mine Waste Rock Management Plan (SD-08);
- Interim Closure and Reclamation Plan (SD-26);
- Aquatic Effects Management Plan (SD-21);
- Tailings Management System Design Report (MAD Appendix F-4);

- Waste Rock Storage Area (WRSA) Design Report (MAD Appendix F-3);
- Geochemical Characterization Report (MAD Appendix E-3);
- Water and Load Balance Report (MAD Appendix E-2);
- Site Wide Water Management Report (MAD Appendix F-1);
- Air Quality Management Plan (FEIS Volume 10, Chapter 17);
- 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 (FEIS Addendum, Volume 4, Appendix V4-3D; and
- Peer Review of the Back River Project Waste Rock and Tailings Closure Strategy (FEIS Addendum, Volume 4, Appendix V4-3E.

3. Applicable Legislation and Guidelines

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

- *Fisheries Act* (1985), including the *Metal 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); *Nunavut Waters Regulations* (2013).

Water use and waste disposal in Nunavut is regulated by the Nunavut Water Board (NWB) through the water licensing process.

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 Operation, Maintenance, and Surveillance (OMS) Manual.

The following are TSM Guidance Documents that Sabina will refer to as the Project moves through the design and permitting phase and into Construction:

- Tailings Management Protocol (MAC 2011a);
- A Guide to the Management of Tailings Facilities (MAC 2011b);
- A Guide to Audit and Assessment of Tailings Facility Management (MAC 2011c);
- 2013 Canadian Dam Safety Guidelines (CDS 2013); and
- Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities (MAC 2011d).

It should be noted that the scope of this plan prescribed by the NWB overlaps with the scope and content of a future 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; this future OMS Manual will be provided 60 days prior to operation of any tailings management facility.

4. Planning and Implementation

4.1 TAILINGS PRODUCTION AND STORAGE

The Project will produce about 19.8 million tonnes (Mt) of tailings over the 10-year operational mine life. Tailings will be disposed in multiple facilities, and tailings storage management dictates how water is managed on the Project. The Operations Phase is described in stages according to the Tailings and Water Management plans as follows:

- Stage 1 – Tailings Storage Facility – For the first two years of Operations (Years 1 and 2), a purpose-built TSF will be utilized;
- Stage 2 – Umwelt Tailings Facility (Umwelt TF) – From Years 2 to 6, the mined-out Umwelt Pit will be used for the tailings deposition and storage; and
- Stage 3 – Goose Main Tailings Facility (Goose Main TF) – From Year 6 onward, tailings will be disposed of in the mined-out Goose Main 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 MAD Appendix A, base Figure 3. A plan view of the TSF Containment Area is shown in Figure A-01.

Tailings deposition will transition from the TSF to in-pit deposition in the mined-out Umwelt Pit for a period of about four years. Finally, tailings will be deposited in the mined-out Goose Main Pit during the remaining four years of the mine life. A summary of the Tailings Management System storage requirements is outlined in Table 4.1-1.

Table 4.1-1. Back River Property Tailings Management System Storage Requirements

Location	Period (Year and Quarter)	Tailings (tonnes)	Tailings (cubic metres)
TSF	Y-1 Q4 to Y2 Q3	3,777,749	3,148,124
Umwelt TF	Y2 Q4 to Y6 Q3	8,581,468	7,151,223
Goose Main TF	Y6 Q4 to Y10 Q2	7,446,079	6,205,066
Total Project	Y-1 Q4 to Y10 Q2	19,805,296	16,504,413

After tailings deposition transitions from the TSF to the Umwelt TF in Year 2, 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-09). Placement of waste rock over the tailings will provide protection of the tailings from the active layer and promote permafrost aggredation into the tailings.

Should contingency measures be implemented for the use of 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 with the following:

- waste disposal quantities;
- volumes;
- disposal timing;
- maximum pit capacity;
- effects to pit closure; and
- appropriate mitigation and monitoring plans.

4.1.1 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.

4.1.2 Tailings Geochemical Characteristics

Tailings geochemical characterization confirms that tailings will be PAG and metal leaching (ML) (MAD, 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, all effluent will meet relevant regulations or site specific water quality objectives. Further details on water treatment can be found in the Water Management Plan (SD-05).

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 Umwelt and Goose TFs 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.

4.2 TAILING STORAGE FACILITY

4.2.1 Tailings Storage Facility Design Basis

The design of the TSF has incorporated the following requirements:

- Applicable Legislation and Guidelines (Section 3);
- 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 4.2-1.

Table 4.2-1. Tailings Storage Facility Design Basis Summary

Component	Criteria
Dam Hazard Classification	High
Design Life Active use period as water retaining structure Use as temporary water retaining structure (seasonal pond) Total life until breach	 2 years 16 years 18 years
Dam staging	None
Tailings production rate	Ramp up period, with a maximum rate of 6,000 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	 3.8 Mt 3.2 Mm^3

(continued)

Table 4.2-1. Tailings Storage Facility Design Basis Summary (completed)

Component	Criteria
Ice entrainment allowance Percentage of tailings capacity By Volume	 20% 0.63 Mm^3
Contact water storage requirement	Average during Operations (Year 1 and 2) 1,000,000 m^3 Average at TSF closure (Year 3+) 260,000 m^3 95th percentile during Operations (Year 1 and 2) 1,555,000 m^3 95th percentile at TSF closure (Year 3+) 400,435 m^3
Total TSF storage requirement (tailings, ice entrainment and contact water)	Average during operations 4,830,000 Mm^3 95th percentile during operations 5,385,000 Mm^3
Tailings beach slope Subaerial tailings Subaqueous tailings	 1% 1%
Tailings deposition method	Single point spigot subaerial discharge (three locations over the life of mine)
Maximum design earthquake	1:2,475 year recurrence event; PGA of 0.036 g
Inflow design flood	probable maximum precipitation depth, approx. 221 mm (729,000 m^3)
Freeboard requirement: Wind Setup and Wave run-up allowance Probable maximum flood storage allowance Total freeboard (sum of above)	 1.3 m 0.5 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

4.2.2 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 document as developed by the Canadian Dam Safety Association (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 4.2-2. 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 4.2-2.

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 4.2-2. 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 0.5 m freeboard below the top of the liner to contain 100% of the probable maximum precipitation depth of 221 mm (729,000 m^3). The TSF Dam crest has also been designed to maintain freeboard that accounts for wind setup and wave run-up, which is an additional 1.3 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-07 shows the required freeboard for the TSF above the pond full supply level, including the probable maximum flood, wind set-up, and wave run-up.

Design Earthquake

Based on the dam hazard classification of High for the TSF, the Dam Safety Guidelines (CDA 2013, including a specific technical bulletin on the applications of mining dams [CDA 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 MAD.

4.2.3 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 (MAD, Appendix F-4). Seepage is expected to decrease when 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.

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.

4.2.4 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 (MAD, 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.

4.2.5 Climate Change

Climate change considerations were incorporated into the design of the Project, including the TSF and TFs (MAD Appendix F-3; and MAD 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 (FEIS Volume 4, Appendix V4-3B). For additional information refer to FEIS Addendum Volume 4, Appendix V4-3D and Appendix V4-3E.

Other climate change impacts such as increased precipitation, are not expected to meaningfully impact the TSF or the TFs in the Post-Closure Phase.

4.2.6 Tailings Storage Facility Embankment Construction

<u>Construction Schedule</u>

The TSF Dam will be constructed prior to the Goose Process Plant starting production. Construction of the TSF Containment Dam and TSF South Dyke will start at the end of Year -2. 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 (SD-03) for additional detail.

<u>Instrumentation</u>

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 (Figure A-08). 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.

4.2.7 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 6,000 tonnes per day. Water will be reclaimed from the TSF through the reclaim barge at an average rate of 4,905 m^3/d. The water balance is presented in the Water Management Plan (SD-05).

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, or it may be released to the receiving environment if water quality permits.

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 and the supernatant pond will be pumped to the Umwelt TF when deposition is transitioned from the TSF (Year 2). Therefore, the TSF is only expected to be near its design capacity for a very short period of time near the end of Year 2.

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

<u>TSF Tailings Deposition Plan</u>

The TSF tailings deposition plan proposes discharge from three points within the TSF, representing three periods in the deposition and tailings beach development. Deposition at the first and third discharge points are short in duration (2.5 months and 3 weeks, respectively), with the bulk of the tailings deposited in the second period (Figure A-01).

In the first period, tailings will be deposited from the crest of the South Dyke to fill in the southern end of the TSF, and create a sloped surface that will direct the tailings and the water towards the north end of the TSF. During the second period of the deposition, tailings will be discharged from an elevation of 310 masl, which is 3 m higher than the crest of the South Dyke; however, the first period tailings will limit the footprint of this cone. During the third period of deposition, tailings will be discharged from an elevation of 306 masl, which is the northern most discharge point and 1 m lower than the crest of the South Dyke.

4.2.8 Tailings Storage Facility Closure

Following completion of tailings deposition in the TSF (Year 2), the supernatant pond will be transferred to the Umwelt TF, waste rock placement will begin over the tailings, and the west side of the TSF will be used to temporarily store contact water from the TSF catchment area until the TSF Containment Dam is breached in Year 18.

PAG and NPAG waste rock from Goose Main Open Pit 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-09). This cover is expected to promote permafrost aggredation into the tailings, and to maintain frozen conditions in the tailings in the long term. Once covered, only a portion of the west limb of the TSF Dam will be visible. That portion of the TSF will continue to function as a normally empty seasonal run-off collection pond (TSF WRSA Pond) until the Post-Closure phase. Water from this pond will be pumped to Goose Main TF as required. Further details can be found in the ICRP (SD-26).

4.2.9 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).

4.3 TAILINGS FACILITIES IN OPEN PITS

As described in Section 4.1, the Umwelt and Goose Main open pits will be used for the storage of tailings after Year 2 when the TSF will cease operations and will be converted into a WRSA.

4.3.1 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 TFs 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 two TFs will be reclaimed and reused in the Process Plant.

Water from the Goose Main TF will be treated year-round during the Operations phase, and seasonally during the Active and Passive Closure stages. This treated water will be withdrawn from Goose Main TF and discharged back into Goose Main TF. There will be no discharge of effluent from the TFs during Operations and Active Closure.

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

Details on water storage capacity of TFs, and water treatment can be found in the Water Management Plan (SD-05).

4.3.2 Tailings Facility Closure

The Umwelt 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 not expected to be necessary at the Umwelt TF.

The closure plan for the Goose Main TF is similar to the Umwelt TF. Tailings deposition in Goose Main TF will provide a much greater water cover storage volume. Water from the Goose Main TF will continue to be treated in accordance with the Water Management Plan (SD-05) until the treated water meets discharge water quality objectives for the external receiving environment. The Goose Main TF may also be used to store non-hazardous waste from the final mine closure activities. Further details can be found in the ICRP (SD-26). Details on long-term pit lake stratification can be found in the Water Management Plan (SD-05).

5. 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 of the Plan;
- Operational aspects; and
- Internal reporting.

The Environmental Superintendent along with his/her direct reports is responsible for the implementation of this plan including:

- Monitoring;
- External reporting; and
- Ensuring 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 (see Section 3).

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 or it may be discharged to the environment, as appropriate. Additional details on ditches and berms can be found in the Water Management Plan (SD-05).

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 two TFs will be reclaimed and reused in the Process Plant. Discharges from the TSF and TFs 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 TFs 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 TFs are discussed in the Water Management Plan (SD-05) and the ICRP (SD-26).

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. During the two years 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. 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 Air Quality Management Plan (FEIS Volume 10, Chapter 17).

After the two-year operating life of the TSF, the supernatant pond will be pumped to the Umwelt TF and waste rock from the Goose Main Pit will be progressively placed over the tailings. 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 Year 6 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 TFs. These tailings facilities 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.;
- Seepage water quality monitoring in accordance with general site runoff regulated monitoring requirements provided in the Water Management Plan (SD-05);
- Monitoring geotechnical instrumentation installed in the TSF Dam embankment and foundation (ground temperature cables and survey prisms) over the life of the Project. 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); and
- An annual third-party geotechnical inspection of all earthworks including the TSF and TFs.

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

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 (SD-05).

Runoff water quality monitoring will be conducted as described in the Water Management Plan (SD-05) and will be prescribed in the Type A Water Licence. For details on TSF monitoring during Closure, please refer to the ICRP (SD-26).

8. Contingencies, Mitigation, and Adaptive Management

The mine design, including the TSF and TF 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 (SD-08).

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.

9. Environmental Reporting

Environmental reporting will be conducted as identified 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.

10. References

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NWB. 2010b. Miscellaneous Supplemental Information Guideline (SIG) for General Water Works (including crossings, flood control, diversions, and flow alterations) (M1). February 2010.

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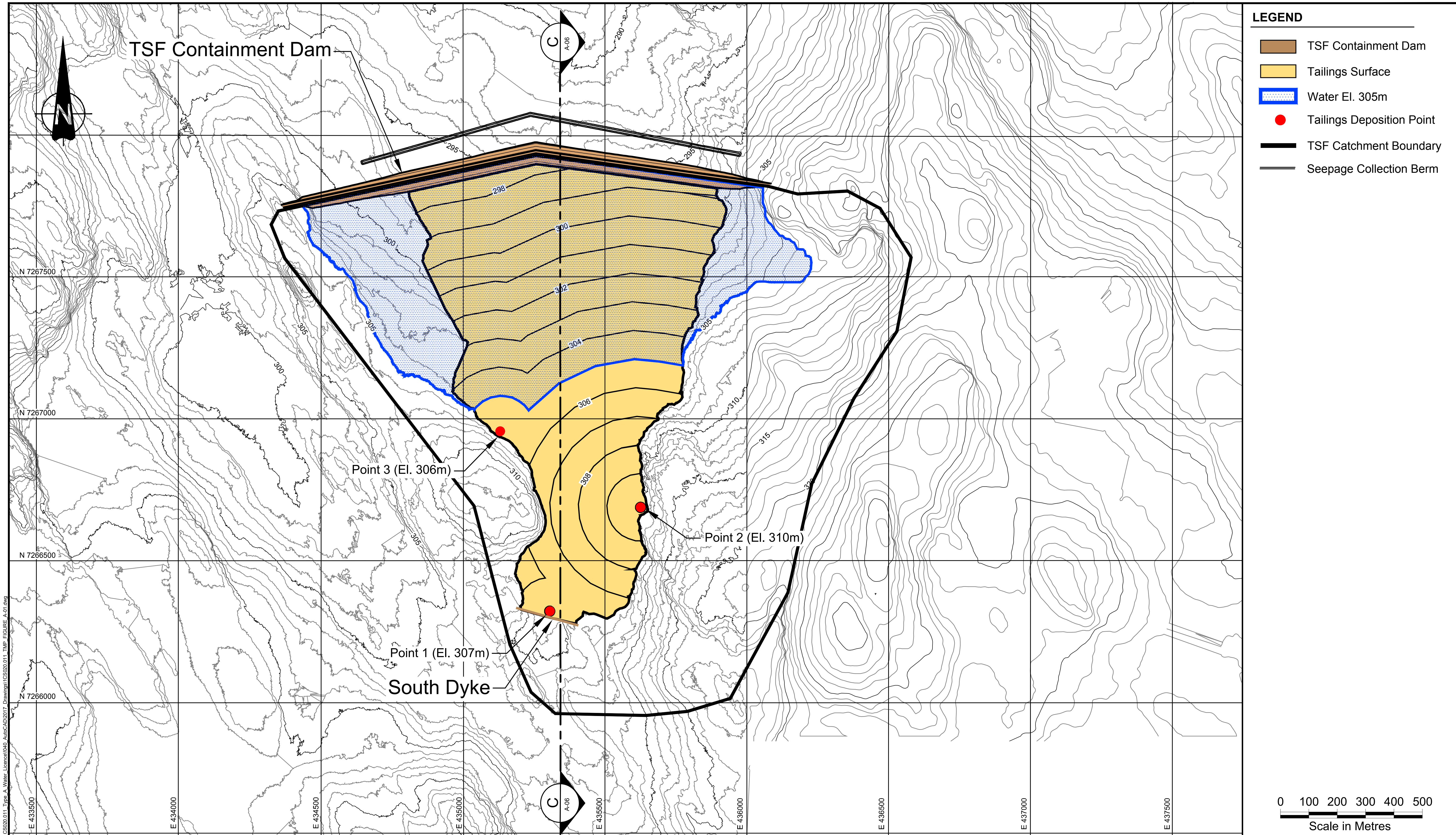
Appendix A. Figures



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Sabina GOLD & SILVER CORP.

BACK RIVER PROJECT

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

TAILINGS MANAGEMENT PLAN

TSF Containment Area
Plan View
Year 2

REVISION NO. B | SHEET 1 OF 9 | FIGURE NO. A-01

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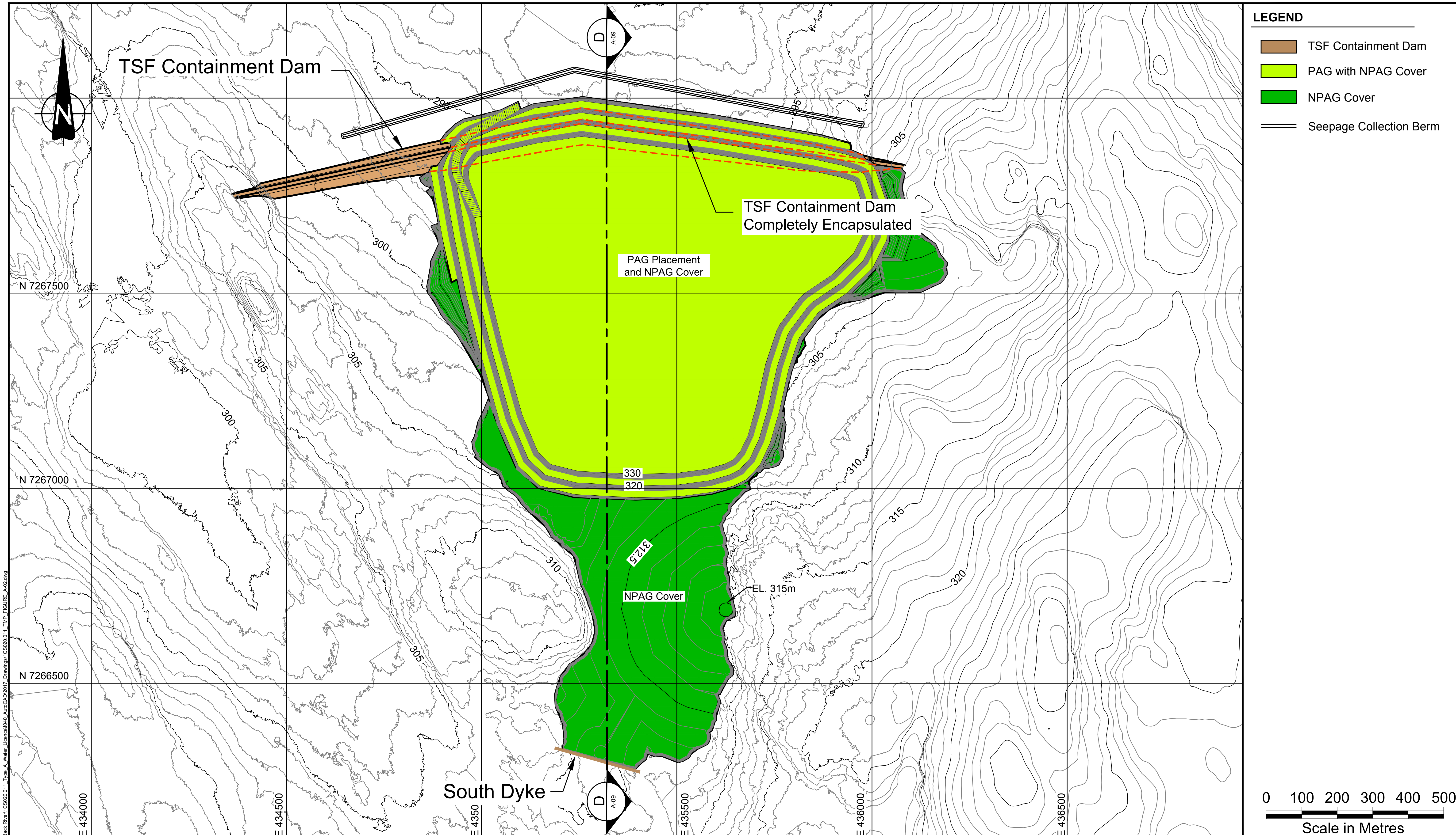

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BACK RIVER PROJECT

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TAILINGS MANAGEMENT PLAN

TSF Containment Area
Plan View
Year 6

REVISION NO. B | SHEET 2 OF 9 | FIGURE NO. A-02

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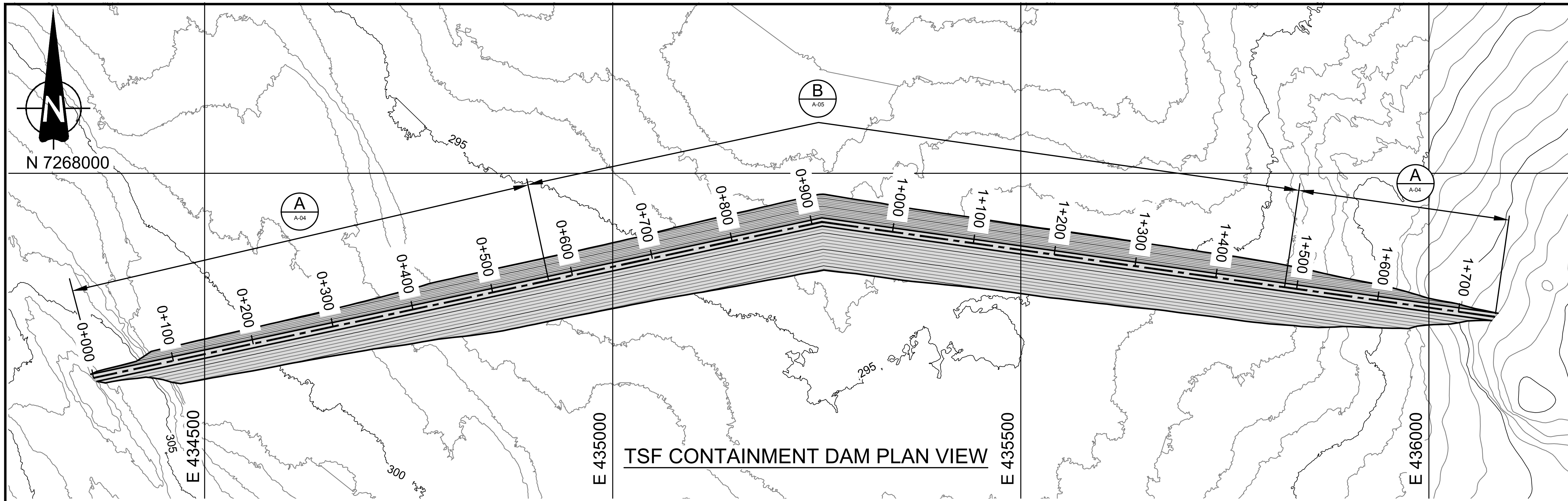
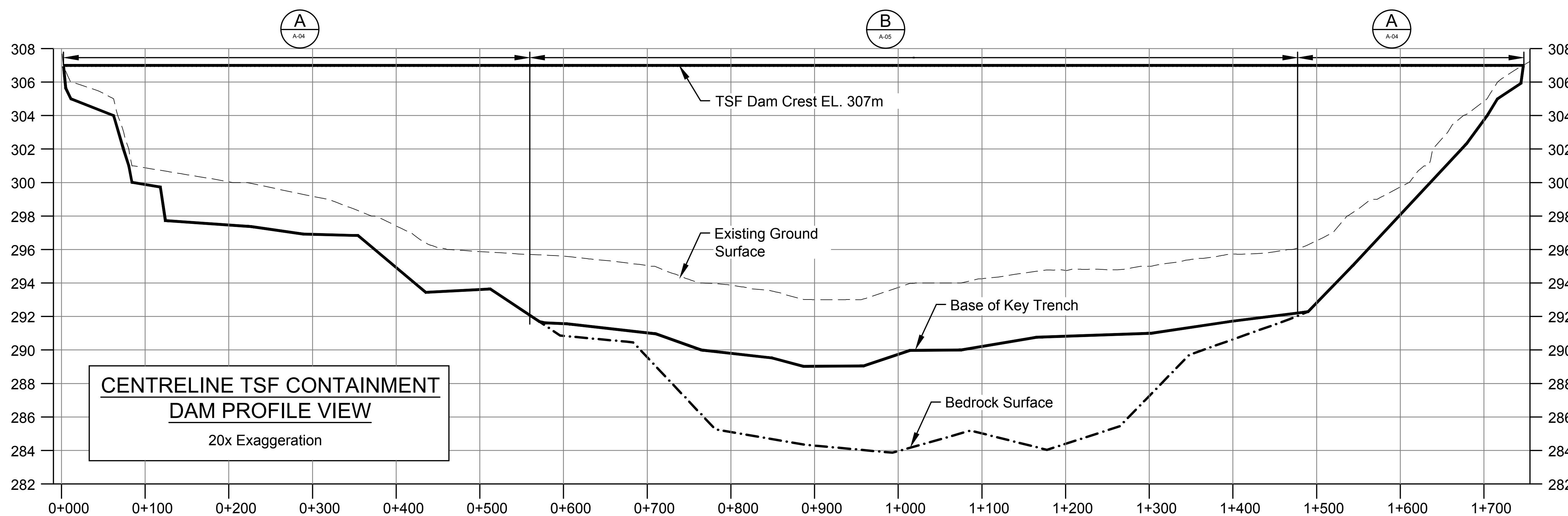


TSF CONTAINMENT DAM PLAN VIEW

LEGEND

- Existing Ground Surface
- Base of Key Trench
- Bedrock Surface



CENTRELINE TSF CONTAINMENT DAM PROFILE VIEW

20x Exaggeration

0 40 80 120 160 200
Scale in Metres
(Horizontal Scale)

0 2 4 6 8 10
Scale in Metres
(Vertical Scale)

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BACK RIVER PROJECT

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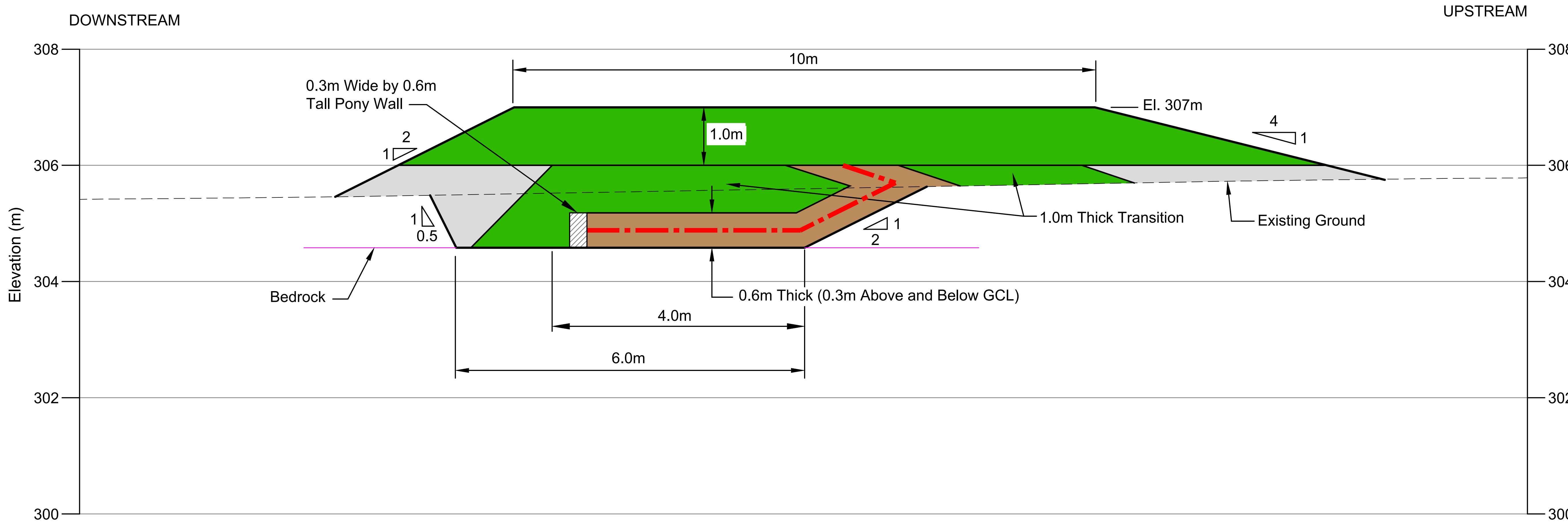
TAILINGS MANAGEMENT PLAN

TSF Containment Dam
Plan View and Profile View

REVISION NO. B | SHEET 3 OF 9 | FIGURE NO. A-03



A
A-03
TYPICAL CROSS-SECTION - SHALLOW BEDROCK

0 1 2 3 4 5

Scale in Metres

LEGEND

GCL LINER

Bulk Fill (ROM)

Transition Fill

Bedding Fill

Ground Surface

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BACK RIVER PROJECT

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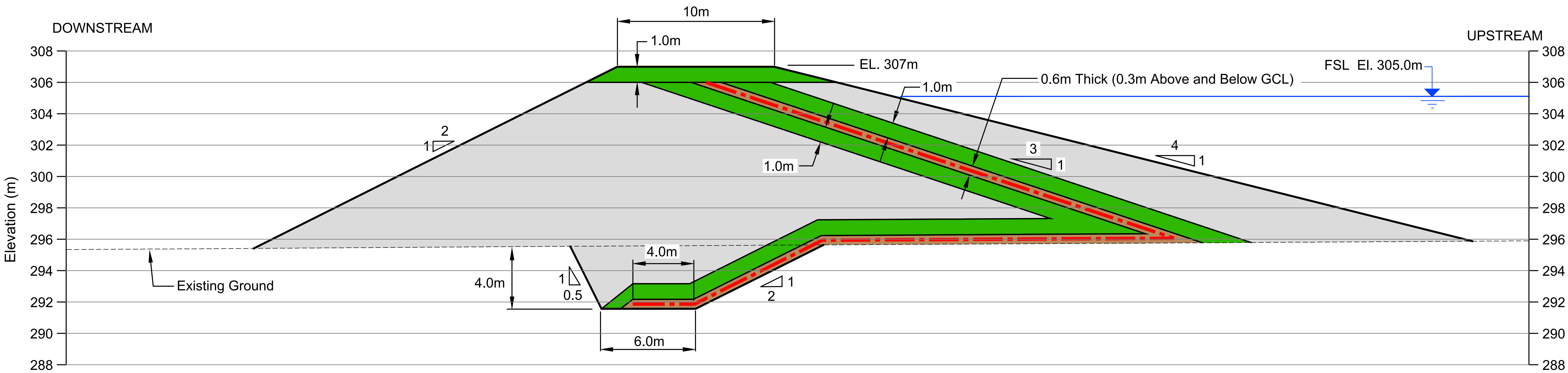
TAILINGS MANAGEMENT PLAN

TSF Containment Dam
Typical Cross Section A
(Shallow Bedrock)
Year 1

REVISION NO. B

SHEET 4 OF 9

FIGURE NO. A-04



B
A-03

TYPICAL CROSS-SECTION - DEEP OVERBURDEN

0 2 4 6 8 10

Scale in Metres

LEGEND

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

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Sabina GOLD & SILVER CORP

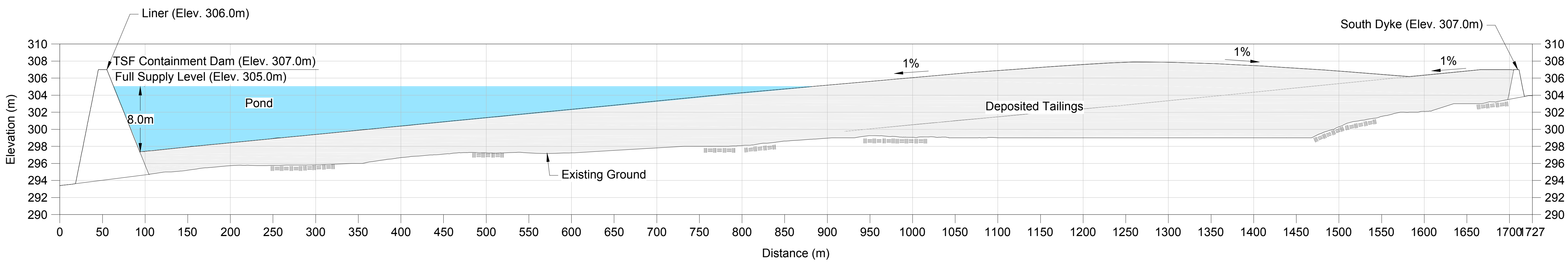
BACK RIVER PROJECT

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

TAILINGS MANAGEMENT PLAN

TSF Containment Dam
Typical Cross Section B
(Deep Overburden)
Year 1

REVISION NO. B | SHEET 5 OF 9 | FIGURE NO. A-05



CC A-01

CROSS-SECTION

10x Exaggeration

0 50 100 150 200

Scale in Metres

(Horizontal Scale)

0 5 10 15 20

Scale in Metres

(Vertical Scale)

NOTES

1. Maximum depth of pond is approximate 8.0m, which is located at the west abutment of the TSF Containment dam.
2. Available pond capacity at the end of operations is 2.9Mm³.

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BACK RIVER PROJECT

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TAILINGS MANAGEMENT PLAN

TSF
Typical Cross Section with
Full Supply Level
Year 2

REVISION NO. B | SHEET 6 OF 9 | FIGURE NO. A-06

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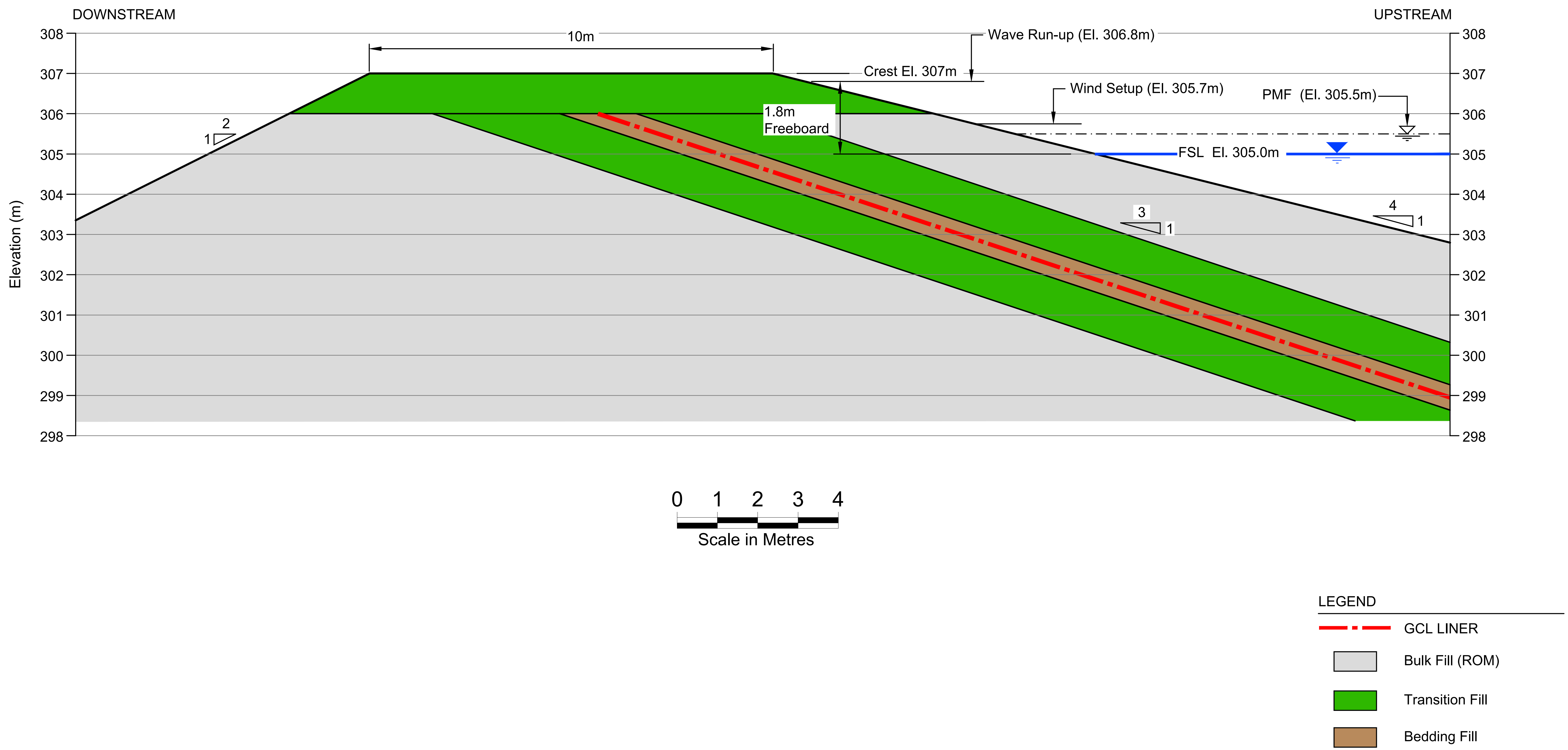

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BACK RIVER PROJECT

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

TAILINGS MANAGEMENT PLAN

TSF Containment Dam
Typical Freeboard Cross-Section
Year 2

REVISION NO. B | SHEET 7 OF 9 | FIGURE NO. A-07

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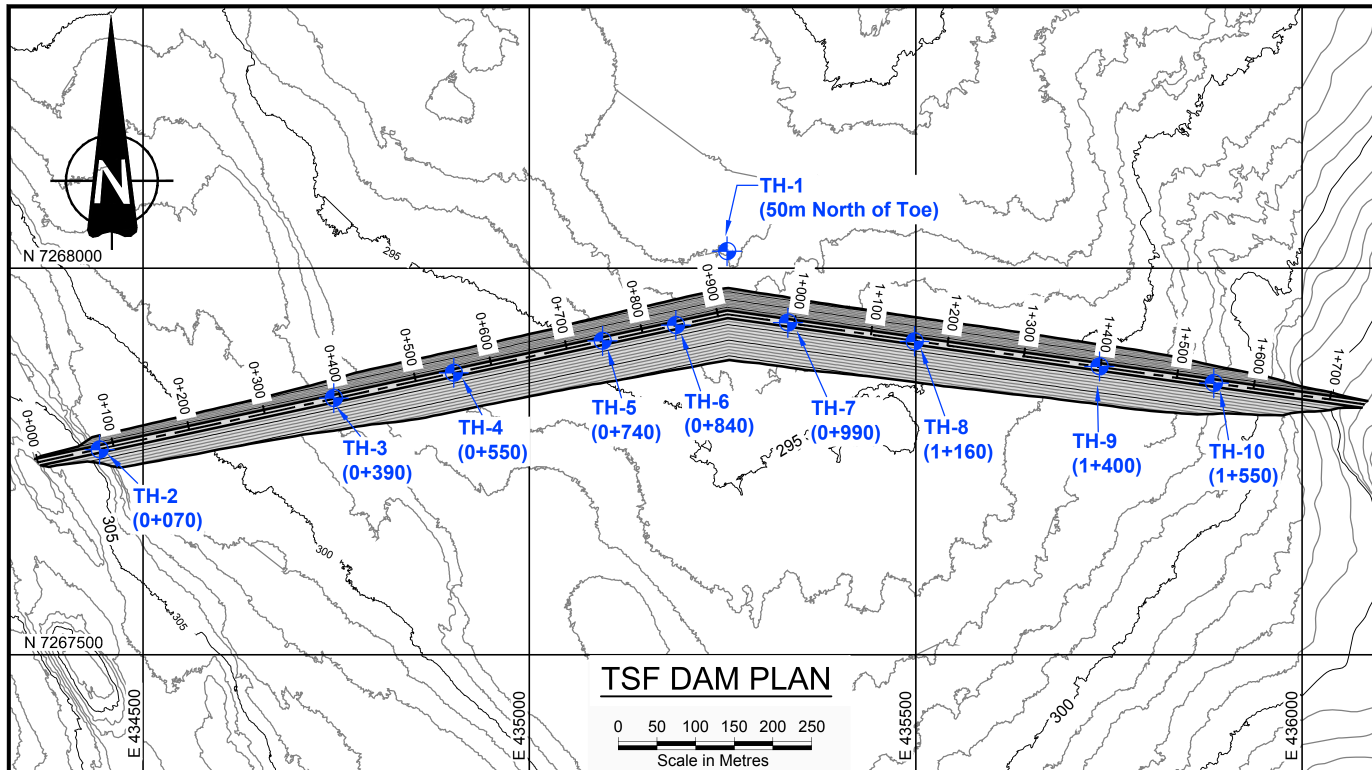
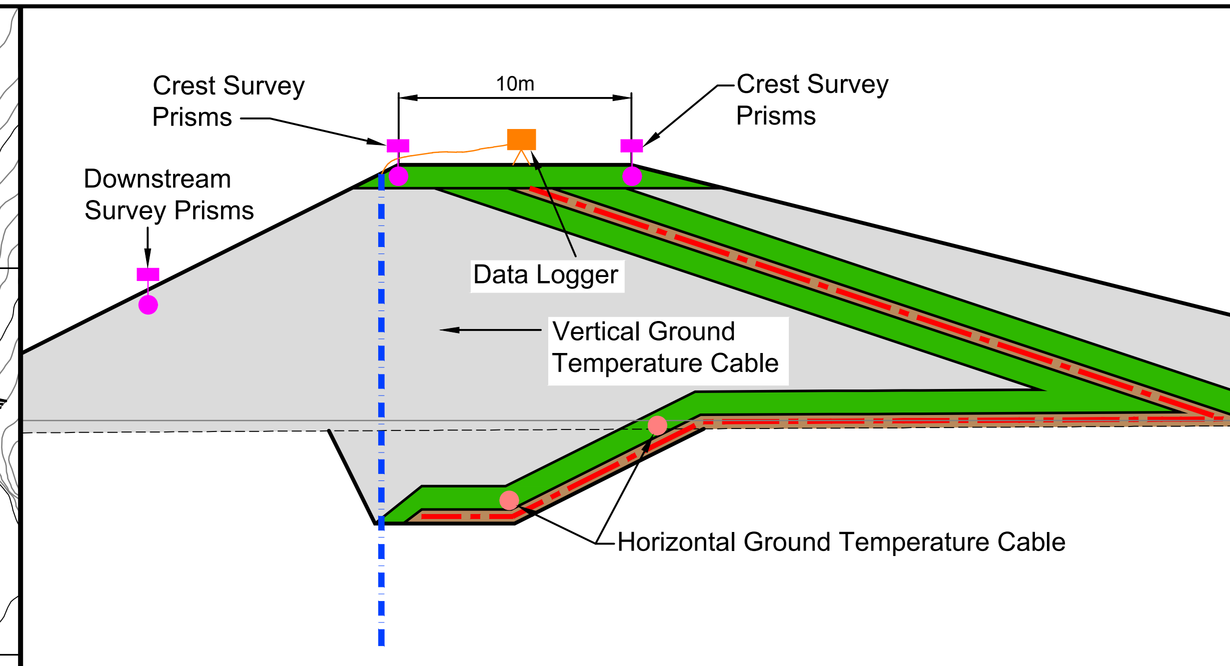


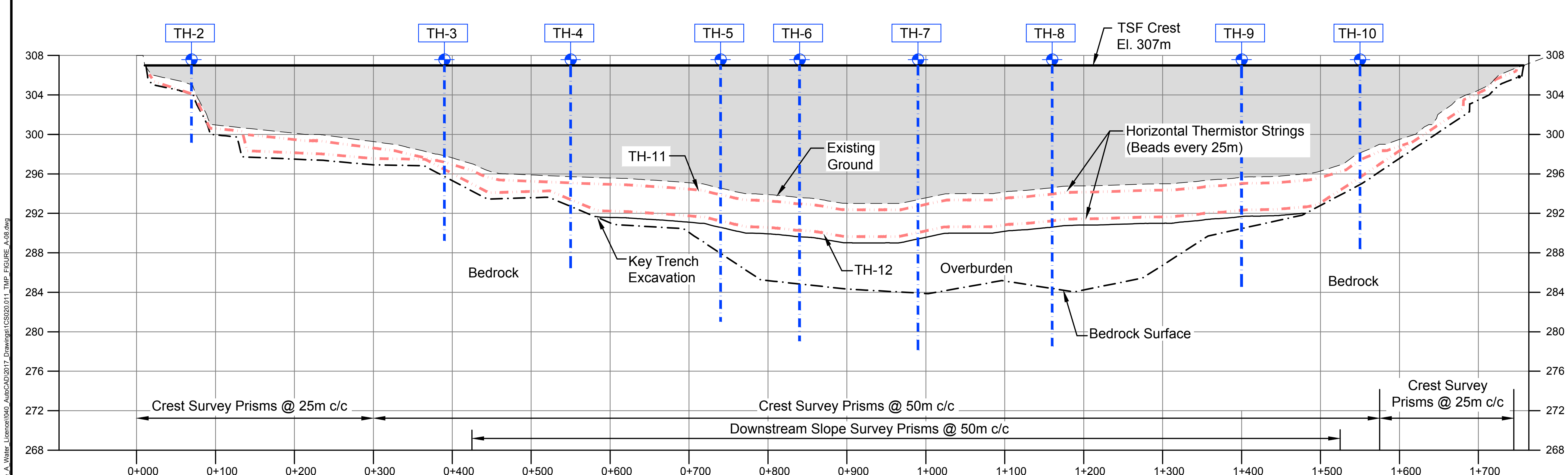


TYPICAL CROSS-SECTION SURVEY PRISM AND GROUND TEMPERATURE CABLE INSTALLATION LAYOUT

NTS

LEGEND

- Ground Temperature Cable Location
- Survey Prisms
- Data Loggers
- Vertical Ground Temperature Cable
- Horizontal Ground Temperature Cable
- TSF Dam Fill (ROM)



CENTRELINE TSF CONTAINMENT DAM PROFILE

10x Exaggeration

NO.	DESCRIPTION	CHK'D	APP'D	DATE
B	ISSUED FOR PERMIT	CP	EMR	17/08/30
A	ISSUED FOR PERMIT	CP	EMR	16/05/26

DRAWING NO. | DRAWING TITLE — REFERENCE DRAWINGS — REVISIONS

Original Drawings Stamped and Signed by Engineer

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PROFESSIONAL ENGINEERS STAMP

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DESIGN: CP | DRAWN: MZS | REVIEWED: EMR
CHECKED: EMR | APPROVED: EMR | DATE: 2017/08/30

FILE NAME: 1CS020.011_TMP_FIGURE_A-08.dwg

Sabina GOLD & SILVER CORP

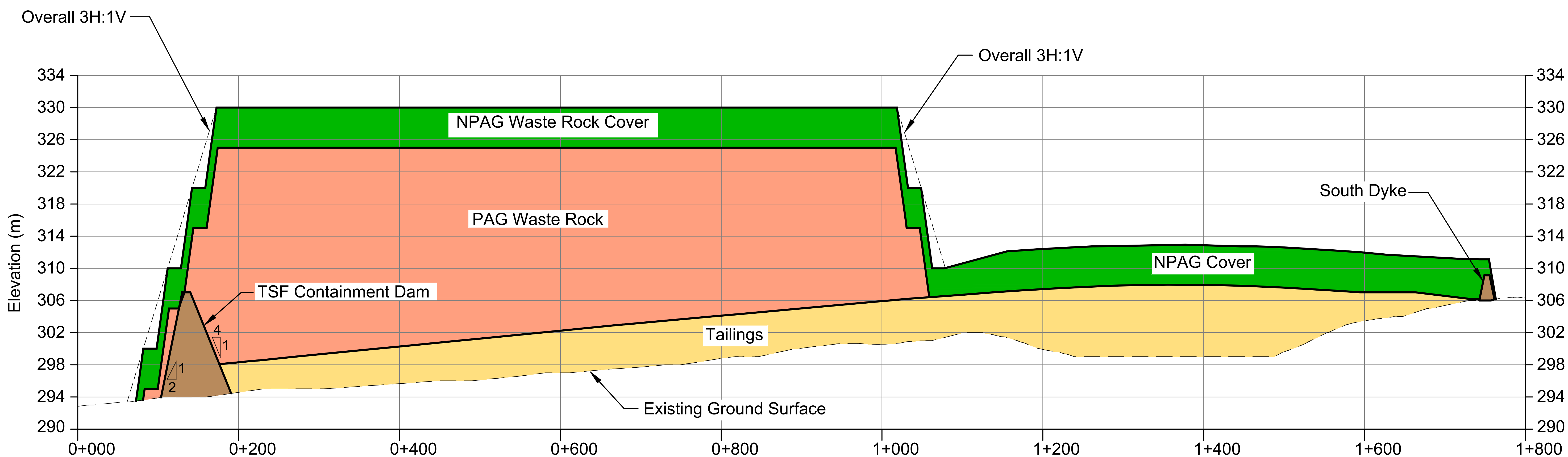
BACK RIVER PROJECT

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

TAILINGS MANAGEMENT PLAN

TSF Containment Dam Geotechnical Instrumentation Plan, Profile and Typical Cross-Section Year 1

REVISION NO. B | SHEET 8 OF 9 | FIGURE NO. A-08



DD TYPICAL TSF WRSA CROSS-SECTION

A-02

10x Exaggeration

0 40 80 120 160 200

Scale in Metres
(Horizontal)

0 4 8 12 16 20

Scale in Metres
(Vertical)

LEGEND

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

DRAWING NO.	DRAWING TITLE	NO.	DESCRIPTION	CHK'D	APP'D	DATE	NO.	DESCRIPTION	CHK'D	APP'D	DATE
–	–										
							B	ISSUED FOR PERMIT	CP	EMR	17/08/31
		–	–				A	ISSUED FOR PERMIT	CP	EMR	16/05/26
REFERENCE DRAWINGS		REVISIONS									

Original Drawings
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CHECKED: EMR	APPROVED: EMR	DATE: 2017/08/31

FILE NAME: 1CS020.011_TMP_FIGURE_A–09.dwg

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BACK RIVER PROJECT

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

TAILINGS MANAGEMENT PLAN

Typical TSF WRSA Cross-Section
Section DD
Year 6

REVISION NO.	SHEET	FIGURE NO.
B	9 OF 9	A-09