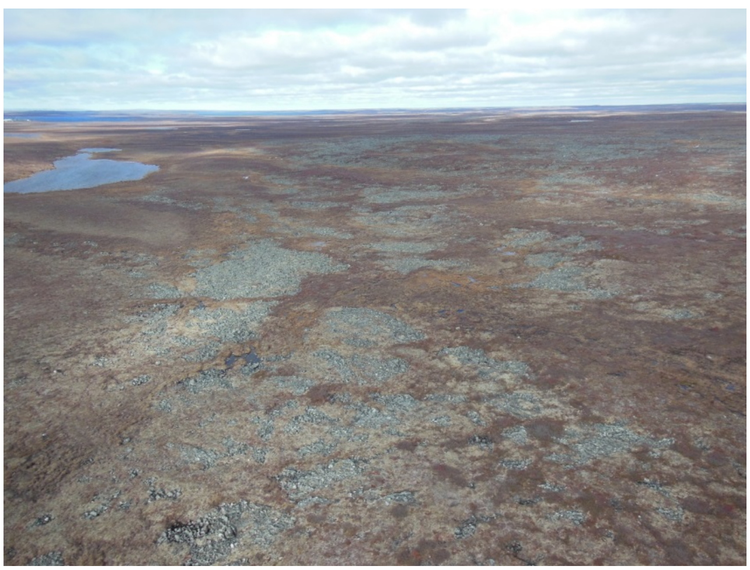
Tailings Management System Preliminary Design Report

Back River Property, Nunavut, Canada

Prepared for

Sabina Gold & Silver Corp



Prepared by

SRK Consulting (Canada) Inc.
1CS020.008
October 2015

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Sabina Gold & Silver Corp.
202-930 West 1st Street
North Vancouver, BC V7P 3N4
Canada

Tel: +1 604 998 4175+1 604 998 4175
Web: www.sabinagoldsilver.com

Prepared by

SRK Consulting (Canada) Inc.
2200–1066 West Hastings Street
Vancouver, BC V6E 3X2
Canada

Tel: +1 604 681 4196
Web: www.srk.com

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1 Introduction

1.1 General

As part of a larger team preparing the Final Environmental Impact Statement (FEIS) for the Back River Project (the Project), SRK Consulting (Canada) Inc. (SRK) was retained by Sabina Gold & Silver Corp. (Sabina) to carry out a Tailings Management System (TMS) preliminary design, following on the recently completed Feasibility Study (FS) for the Project (SRK 2015a).

The Back River Property (the Property) is located in the territory of Nunavut roughly 525 km northeast of Yellowknife, and about 160 km south of Bathurst Inlet, as illustrated in Figure 1. The Project is comprised of two primary areas: Goose Property, and the Marine Laydown Area (MLA). Mining will be completed using both open pit and underground methods at the Goose Property only.

Currently no road access is available to the Property, with plans for a winter ice road to link the Goose Property to the dedicated MLA to be built on southern Bathurst Inlet. Primary transportation to and from the Property is currently reliant on the existing airstrip located near the future Goose Main open pit. The Property is located in the continuous permafrost zone, about 100 km south of the Arctic Circle.

The TMS at Goose Property will entail deposition of 19.8 million tonnes (Mt) of tailings at three separate locations. The initial two years of production will be deposited in a purpose-built Tailings Storage Facility (TSF) located about 2 km south of the Goose Main open pit as shown in Figure 2. Tailings deposition will then transition to in-pit deposition in the mined out Umwelt open pit for a period of about four years. Finally, tailings deposition moves to the mined out Goose Main open pit, for deposition during the remaining four years of the mine life. Note that once the Umwelt and Goose Main open pits receive tailings, the names transition to tailings facility (TF); namely, Umwelt TF and Goose Main TF, respectively.

1.2 Scope of Work

The scope of work entails the following:

- Develop a comprehensive TMS design criteria by taking into consideration Sabina's environmental design criteria, and the most current operational and technical considerations.

- Conduct the necessary TSF geometric design, complete with appropriate hydrotechnical and geotechnical design analysis to support preliminary engineering. Numerical analysis in support of this design is included, but is limited to limit-equilibrium slope stability, tailings consolidation, seepage, and thermal assessment.

- Complete a tailings water balance, sufficiently detailed to be seamlessly integrated into the site wide water and load balance.

- Prepare a tailings deposition plan to facilitate design of associated tailings pumps and pipelines (including reclaim water) by others.

The TMS consists of the TSF (complete with containment dam), and two in-pit tailings facilities.

This report specifically excludes any discussion regarding selection of tailings options. The designs as presented are based on the preferred tailings management strategy as presented in SRK (2015b).

1.3 Report Structure

A concise description of the important site characteristics associated with the footprint occupied by the preferred TMS is presented in Section 2, while the TMS concept including storage requirements are described in Section 3. TMS containment dam design criteria are presented in Section 4, and summary details of the TMS design analysis are provided in Section 5. Section 6 lists the TMS construction details, including construction material take-off quantities. The TMS operational plan which includes the deposition plan is described in Section 7, while TMS closure is described in Section 8.

A comprehensive list of appendices is included which provides details pertaining to the seismic hazard assessment, tailings deposition plan, tailings physical characterization, hydrotechnical design and engineering analysis (seepage, stability, thermal; and consolidation), as well as TSF containment dam instrumentation requirements.

2 Site Description

2.1 Site Topography

The Tailings Storage Facility (TSF) will be located at the headwater of a wide and shallow natural valley trending approximately south-north, with the high point at the south end, as illustrated in Figure 3. The eastern flank limit of the area rises to an elevation greater than 320 metres above sea level (masl) while the effective basin elevations on the western flank are limited to about 307 masl. The water divide at the southern-most point of this valley has an elevation of approximately 306 masl.

2.2 Regional Geomorphology

The Project is situated in the central-eastern portion of the Slave structural province of Nunavut Territory (Tetra Tech 2013). Much of the area is underlain by members of a folded meta-sedimentary turbidite sequence belonging to the Beechey Lake Group. Banded iron formations occur in greywacke and mudstone country rock. The stratigraphic sequence, from oldest to youngest, includes the greywacke, the lower iron formation, the middle mudstone, and the upper iron formation (Rescan 2014a). Brittle fault structures associated with folding have been identified at the Goose Property striking north and northwest (SRK 2012b).

During the last Quaternary period, the region was subjected to multiple glaciations. This has resulted in the striated landscape with post-glacial overburden deposits, such as glacial till and glaciofluvial soils, which exist at the Project today (Rescan 2014a). Overburden thickness varies from 1 m associated with outcropping weathered bedrock in the highlands, to greater than 37 m in topographic lows. Slope processes, frost action, and permafrost have further contributed to the current landscape of the Property.

2.3 Site Geology

2.3.1 Bedrock

The majority of the Project is underlain by clastic meta-sedimentary rock types consisting of turbidites (greywacke and mudstone) of the Slave Province. The Goose Property is underlain by the folded meta-sedimentary turbidite sequence belonging to the Beechey Lake Group which consists of banded iron formations hosted in greywacke and mudstone country rock. The stratigraphic sequence includes the greywacke, lower iron formation, middle mudstone, upper iron formation, and interbedded sediments.

Regional folding trends to the northwest with associated steeply dipping faults. These formations were then intruded by felsic dykes of the Regan Intrusive Suite and younger gabbro dykes (Rescan 2014a, Knight Piésold 2013). The gold mineralization in the Project is the result of this widespread quartz and carbonate veining and sulphidization related to the brittle faulting and subsequent folding (SRK 2012a).

The rock mass characterization for each major lithological unit has been summarized by Knight Piésold (2013) and is provided in Table 2:1 below:

Table 2.1: Summary of Rock Mass Characterization

Lithological Unit	Rock Quality Designation (NGI-Q)	Rock Mass Rating (RMR_{89})	UCS (MPa)
Greywacke	Good	60 to 75	120 (mean)
Lower Iron Formation	Good to Very Good	65 to 85	260 (mean)
Middle Mudstone	Poor to Good	35 to 70	60 (Mean)
Upper Iron Formation	Fair to Good	55 to 80	190 (mean)
Interbedded Sediments	Fair to Good	55 to 75	110 (mean)
Felsic Dykes	Good	60 to 75	130 (mean)
Gabbro Dykes	Fair to Good	55 to 75	120 (mean)

2.3.2 Overburden

Overburden soils on the Property generally consist of silty sands with some clay and gravel (SM, ML, and SW) according to the United Soil Classification System (USCS), which are likely the result of the reworked marine and glacial sediments. Pockets of sandy, silty gravel till (GM) underlie these sediments at the Goose Property (SRK 2011; Knight Piésold 2013).

In general, ice content within these overburden soils is low (around 15%); however, visible ice and small zones of higher ice content were observed in some locations at the Goose Property (SRK 2011; Knight Piésold 2013).

Exploration, geotechnical, and overburden drilling at the Goose Property shows overburden thickness ranges from 0 to 25 m. Thicker sequences of overburden occur in the Goose Main open pit, Llama open pit, and Goose airstrip areas, while overburden thickness is generally less in the area east of the Umwelt WRSA (Knight Piésold 2013; SRK 2015b).

Laboratory testing of near-surface soil samples indicated that there are some scattered occurrences of high salinity pore water throughout the Property. Due to a relatively limited set of samples, the high salinity values cannot be attributed to a particular soil terrain unit (SRK 2011; Knight Piésold 2013; SRK 2015b). High salinity values have the effect of depressing the freezing point, as well as contributing to high unfrozen water content. These salinity values have been attributed to the relatively long seasonal freezing time of the active layer in some areas of the Property (Rescan 2014a).

2.3.3 Permafrost

Surficial geotechnical investigations at the Property confirm that the Project is within the region of continuous permafrost. Permafrost temperatures below the point of zero amplitude range between -6 and -8˚C (Rescan 2104). A geothermal gradient of 0.013 to 0.014˚C/m exists between -50 and -400 masl. This results in basal permafrost depths ranging from 490 to

570 metres below ground surface (mbgs). The active layer depth ranges from approximately 1.3 to 4.2 mbgs, with the greatest active layer depths occurring in areas with thin soil veneers (Rescan 2014a).

2.4 Climate

The Property is situated in the vicinity of the Arctic Circle climate region in Northern Canada. Review of the Back River Draft Environmental Impact Statement (DEIS) (Rescan, 2013) confirms the site specific climate data collected from baseline studies reflect the regional climate trends from the two closest Environment Canada meteorological stations, Lupin A and Kugluktuk A (EC 2014). Climate norms from 1981 to 2010 for the two identified stations are used to describe the average climatic conditions of the Property.

The climate at the Property follows Arctic regional trends; with mean temperatures of -29.9°C and lows of -33.4°C in January, and mean temperatures of 11.5°C and highs of 16.3°C in July. The annual mean temperature is -10.9°C. The winter sub-zero conditions typically last from October to May.

Detailed analysis of the regional precipitation data was completed concluding that an undercatch correction factor is required to accurately reflect the typical site precipitation (SRK 2015c). Total average precipitation is 412 mm and rainfall periods occur between May and October with the most rainfall experienced in August at 61.1 mm. Snowfall occurs throughout the year, but the heaviest snowfall occurs from September through May while the lightest occurs from June through August.

Monthly evaporation was estimated using local site and regional data. Annual lake surface evaporation was determined to be 324 mm/year, while annual evapotranspiration is 248 mm/year.

2.5 Surface Hydrology

The Property is located within the Ellice River, Back River, and Western River watersheds. The Ellice River and Back River flow north to discharge into the Queen Maud Gulf, and the Western River discharges north into Bathurst Inlet.

Baseline hydrometric programs have been initiated for the Project spanning a period from 2004 to 2014 (Rescan 2014b). The baseline hydrometric program for the Project includes a total of 12 stations to represent baseline hydrological conditions for Goose Property, and the George Exploration Camp located 60 km north of Goose Property. SRK 2015c provides a detailed account of the Property hydrology.

The mean annual runoff (MAR) for the Property was determined to be 149 mm/year where the highest flows tended to coincide with freshet in June and continuously recede thereafter. Over the winter period, precipitation is stored as snow causing flows to decrease since no surface runoff is released and only base flow contributes to stream flow.

Regional water balance inputs were used to calibrate the monthly undercatch factors, which in turn were used to evaluate the mean annual precipitation (MAP) for the Property. This analysis determined that the MAP was 412 mm/year, and resulted in an undisturbed runoff coefficient of 0.36 (SRK 2015c).

2.6 Hydrogeology

It is generally understood that groundwater flow does not occur in permafrost, unless there are taliks present, where groundwater is unfrozen and flow can occur. There are no lakes present in the TSF area, and as a result no groundwater interaction is expected.

The analyses of baseline ground temperatures, mapping of potential open taliks and thermal modeling suggest frozen conditions exist for most of the pits, with an exception of where the Llama open pit mine intercepts Llama Lake (SRK 2015d). The thermal modeling, supported by baseline ground temperature data, confirms that the Umwelt, Goose Main, and Echo open pits do not intercept taliks. The Llama open pit overlaps the footprint of Llama Lake, which is expected to have an open (through) talik.

The Umwelt, Llama, and Goose Main underground mines will intercept unfrozen bedrock at depth, but the Echo underground mine is completely within permafrost.

2.7 Seismicity

The Property is located in a low seismicity zone. Seismic parameters were calculated using the National Building Code of Canada website (Appendix A) which provides ground accelerations and probability of occurrence. The seismic hazard is described by spectral acceleration (Sa) values at 0.2, 0.5, 1.0, and 2.0 seconds. Spectral acceleration and peak ground acceleration (PGA) values are presented in Table 2:2.

Table 2.2: Project Seismic Hazard Values

Spectral Acceleration	Ground Motion (g)
$Sa_{(0.2)}$	0.095
$Sa_{(0.5)}$	0.057
$Sa_{(1.0)}$	0.026
$Sa_{(2.0)}$	0.008
PGA	0.036

3 Tailings Management System Concept

3.1 Tailings Storage Requirement

The life-of-mine ore production is about 19.8 Mt. This is approximately equal to the amount of tailings that will be produced. The TMS is based on the principle of maximizing the use of open pits for tailings storage. To that end, the mine production schedule shows that the first pit to become available for tailings deposition is Umwelt Pit late in Year 2 of the mine plan.

Therefore, a TSF is required for the first two years of tailings production, following which tailings will be deposited in Umwelt open pit (aka Umwelt TF). Once the tailings have reached an elevation of 5 m below the discharge elevation of Umwelt open pit, tailings deposition will switch to Goose Main open pit (aka Goose Main TF). Table 3.1 summarizes this tailings management concept.

Table 3.1: 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 Q3 to Y10 Q2	7,446,079	6,205,066
Total Project	Y-1 Q4 to Y10 Q2	19,805,296	16,504,413

3.2 Tailings Physical Properties

Appendix B contains a comprehensive summary of all tailings physical testing completed. This includes testing on both 100 micron samples representative of the PFS process design (SRK 2015e), and 50 micron samples representative of the FS process design (Sabina 2014). Table 3.2 summarizes the key tailings physical properties used for the TMS design presented in this report.

Table 3.2: Summary of Tailings Physical Properties

Property	Value
Solids Content	49% solids (by weight)
Tailings Solids Specific Gravity	2.88
Settled Density	1.2 t/m^3
Plasticity	Non-plastic
Grind Size	50 µm (P_{80})

3.3 Tailings Geochemical Properties

Tailings geochemical characterization (SRK 2015e) confirms that the tailings are potentially acid generating (PAG), albeit with very slow reaction rates, with a potential for metal leaching. The exception to this was observed in some samples from the Goose Main deposit. Therefore tailings will need to be managed to prevent acid rock drainage and manage metal leaching. Once tailings deposition is complete in the TSF, the stored process water will be pumped to Goose Main TF. The contact water from the TSF WRSA will also be conveyed to Goose Main TF. Treatment of the Goose Main TF water will be necessary to reduce copper loading (SRK 2015f).

Exposed tailings beaches are likely to be an ongoing source of sulphate and arsenic leaching, and if they are left exposed for an extended period (estimated to be decades) of time, pH changes may result in increased concentrations of other trace elements. 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.

4 TSF Containment Dam Design Criteria

4.1 Dam Hazard Classification

The design, construction, operation, and monitoring of dams, including tailings dams, have to be completed in accordance with appropriate Provincial and Federal regulations and industry Best Management practices. The primary guidance document in this regard is the 2013 Canadian Dam Safety Guidelines (CDA 2013) published by the Canadian Dam Safety Association (CDA), and the dam safety guidelines specific to mining dams (CDA 2014).

A key component of the guidelines is classifying the dam(s) in question into hazard categories (Dam Class) which establishes appropriate geotechnical and hydrotechnical design criteria. Table 4.1, is a reproduction of the recommended Dam Classifications as presented in the CDA Guidelines. This classification is based on Incremental Consequence of a dam failure (as opposed to Total Consequences). The Incremental Consequences of failure are defined as the total damage from an event with dam failure, less the damage that would have resulted from the same event (e.g. a large earthquake, or a large flood event), had the dam not failed.

Determining the appropriate hazard rating is subjective, dependent on site specific circumstances, and may require an agreement between the proponent, regulator, and stakeholders. During the dam classification process, each of the four hazard rating components in Table 4.1 (i.e. population at risk, loss of life, environmental and cultural values, and infrastructure and economics) is considered individually, and the overall dam hazard rating is defined by the component with the highest (i.e. most severe) rating. It is important to note that the hazard rating refers to the downstream consequences in the inundation zone of a dam breach.

Table 4.1: Dam Hazard Classification

Dam Class	**Population at Risk**[1]	**Incremental losses**		
		Loss of Life[2]	**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 possible but impractical.	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances).

Dam Class	Population at Risk[1]	Incremental losses		
		Loss of Life[2]	Environmental and Cultural Values	Infrastructure and Economics
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).

(Reproduced from Table 2-1 in CDA(20013))

[1] Definitions for population at risk:

None - There are 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 through 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, 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).

[2] 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.

No general population resides within the Property area or nearby; therefore, the “Population at Risk” category receives a qualifier of “None”. By definition of Table 4.1, “Loss of Life” is judged to be “Unspecified”. This is based on the presumption that once the TSF dam construction is complete and tailings deposition is started, all activities downstream of the facility will be related to the tailings and water management. Ongoing repair and maintenance work is anticipated to be carried out by relatively small crews, and will be short duration activities. Loss and/or deterioration of fish habitat is a real risk, although the diluted supernatant will not likely have an acutely toxic effect on fish in the local watershed. Furthermore, restoration and compensation is possible for the system, based on the fact that any tailings spill would impact the southeast portion of Goose Lake and not likely spill over into Propeller Lake. For these reasons, the most appropriate classification with respect to Environmental and Cultural Values is “High”.

Economic activity undertaken directly downstream of the TSF while the facility is actively operating will be very short in duration. Development of the Goose Main open pit, 2 km downstream of the TSF, is currently scheduled to overlap for only three months with active deposition in the TSF. The current closure concept for the TSF is complete encapsulation within the waste rock originating from the Goose Main open pit. The water managed in the TSF will be drained to allow completion of the waste rock cap, which will further reduce the risk of catastrophic failure. Therefore, with respect to the Infrastructure and Economics, the most appropriate classification is “Low”.

Therefore, the highest hazard rating is defined by the Environmental and Cultural values category, which means the designated dam hazard rating for the Project TSF containment dam is High.

4.2 Design Life

In accordance with the mine plan, active tailings deposition in the TSF is expected during the initial two years of ore production. In addition to tailings, the TSF will be used as a contact water storage facility starting one year prior to tailings deposition. Following completion of tailings deposition, the pond will be drained, and a portion of the TSF containment dam (the western flank, aka TSF WRSA Pond) will be used to seasonally store contact water up to the end of the active water treatment stage which is six years after ore production ceases.

The TSF containment dam will therefore have an active design life of two years as a full water retaining structure. The design life of the TSF for the purpose of this study was determined to be eighteen years, which includes the two years of operations and sixteen additional years until the Containment Dam can be breached and gravity flow to Goose Main TF established.

4.3 Storage Requirement

The TSF is required to provide storage for approximately 3.15 Mm^3 of tailings (at final density of 1.2 t/m^3), representing the mill production for the first two years of operations. Due to continuous subaerial tailings deposition (including the winter months), ice entrainment of supernatant water may occur. Although Best Management practice operational procedures will be employed to minimize ice entrainment, the TSF design includes an allowance for up to 20% ice entrainment (i.e. about 0.63 Mm^3). The total tailings and ice storage requirement for the TSF is therefore approximately 3.8 Mm^3.

In addition to the tailings volume, the TSF will provide contact water storage containment. Based on the site wide water balance (SRK 2015f); the required contact water storage containment volume is approximately 3.5 Mm^3.

4.4 Tailings Beach Slope

Beach slope studies to determine the most suitable beach slope angles for the deposition of TSF tailings have not been carried out. Considering the tailings tests that have been conducted (Appendix B), and using engineering judgement, the beach angle has conservatively been assumed to be 1%. Although it is common practice for beach angles to steepen up significantly where tailings enter the TSF pool, the beach angle was maintained constant for the subaerial (beach) and subaqueous sections of the TSF.

4.5 Stability Criteria

In accordance with CDA (2013), temporary (i.e. under construction) and final dams are considered safe against slope and foundation failure if static stability analyses, including seepage forces, lead to a factor of safety (FOS) of 1.3 and 1.5, respectively. Under seismic loads, using the pseudo-static method of analysis, dams are considered safe for a FOS of 1.0. These FOS are the minimum design requirements for the TSF.

4.6 Inflow Design Flood

Based on the dam hazard classification of High, the guidelines (CDA 2013) recommend the use of an inflow design flood (IDF) of 1/3 between the 1:1,000 return period, 24-hour duration precipitation event and the probable maximum precipitation (PMP) for this region.

Notwithstanding this criterion, the TSF has been designed to contain 100% of the probable maximum flood (PMF) of 221 mm, resulting in a freeboard requirement of 0.55 m to accommodate this extreme precipitation. This freeboard allowance has been considered to avoid the requirement of a constructed permanent spillway for a facility with such a short lifespan. Details are provided in Appendix D.

4.7 Wave Run-up

Wave run-up calculations have been completed based on the assumption water will be stagnant against the TSF dam at the full supply level (FSL) elevation. Regional wind data and TSF geometry were considered in the calculations. Further details are provided in Appendix D.

4.8 Design Freeboard

Based on the CDA (2013) recommendations, the freeboard was calculated for two scenarios:

- Sunny day – it assumes high wind (1:1,000 year) with pond level at FSL; and
- Rainy day – it assumes normal wind (1:2 year) with pond level elevated by the PMF to 305.55 masl.

A freeboard of approximately 1.3 m was calculated for both scenarios applied to the TSF design. Figure 10 illustrates graphically the various components of the freeboard, while detailed calculations are provided in Appendix D.

4.9 Design Earthquake

Based on the dam hazard classification of High, the Dam Safety Guidelines (CDA 2013) recommend the seismic stability analysis be completed assuming the PGA for 1:2,475 year event. For the Property, this event results in a PGA of 0.036 g.

4.10 Summary of TSF Design Criteria

The complete TSF containment dam design criteria are listed in Table 4.2, and are consistent with Best Management practices, including the Canadian Dam Association (CDA 2013) guidelines.

Table 4.2: Summary of TSF Containment Dam Design Criteria

Component	Criteria
Dam Hazard Classification	High
Design Life • Active use period as water retaining structure • Use as temporary water retaining structure • 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
Ice entrainment allowance • Percentage of tailings capacity • By Volume	 20% 0.63 Mm^3
Contact water storage requirement	Average during operations 2,802,000 m^3 Average at TSF closure 335,160 m^3 95th percentile during operations 3,641,000 m^3 95th percentile at TSF closure 723,435 m^3
Total TSF storage requirement (tailings, ice entrainment & contact water)	Average during operations 5,950,000 Mm^3 95th percentile during operations 6,789,000 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 flood, approx. 221 mm
Freeboard requirement: • Wind Setup and Wave run-up allowance • Probable maximum flood storage allowance • Total freeboard (sum of above)	 1.2 m 0.6 m 1.8 m
Stability Factors of Safety (Static)	1.3 during construction 1.5 during operation and closure
Stability Factors of Safety (Pseudo-Static)	1.0 following earthquake

5 TSF Containment Dam Design

5.1 Foundation Conditions

The foundation conditions at the TSF containment dam were first characterized using a walkover visual survey, followed by a low altitude aerial reconnaissance using a helicopter. This work was complemented with analysis of digital photography (LiDAR, aerial streophotos, low altitude and ground level) calibrated using Property wide geotechnical data (SRK 2010, 2011, 2015a). During the winter of 2015, a detailed geotechnical site investigation was carried out along the proposed centerline of the TSF dam.

The field investigation included 19 boreholes with drill methods that allowed for preservation of permafrost and collection of undisturbed soil samples. Routine indicator and specialized strength and consolidation testing was carried out on collected samples (SRK 2015b).

The inferred subsurface stratigraphic profile below the proposed TSF dam centerline is presented in Figure 4. The data suggests that overburden is in the order of 10 m thick toward the center of the valley, thinning out towards east and west abutments as the topography rises. Approximately half the length of the proposed dam alignment appears to have bedrock at less than 4 m below ground.

All overburden soils, which are primarily characterized as sand, are confirmed to be cold permafrost (10 ground temperature cables to monitor the thermal regime was installed). The shallow overburden areas along both abutments are free from excess ice, while the deeper overburden area at the center of the valley have increased ice content (between 10% to 30% excess ice) and sporadic massive ice lenses (maximum thickness of 0.7 m). A profile of bedrock and ice content is presented in Figure 5.

Bedrock is generally competent, with only three of the 19 borehole logs indicating a highly fractured (RQD < 60%) bedrock contact zone, with a thickness of 2 to 3 m. All three instances of fractured rock were found to underlay the dam near the west abutment (from 0+000 to 0+500).

Based on the geotechnical field investigation, the TSF dam foundation has been classified into three primary zones as described in Table 5.1. The table also contains a summary of the key properties of each foundation zone complete with the proposed foundation treatment associated with the TSF dam key trench.

Table 5.1: Foundation Zones and Material Properties

Zone Descriptor	Properties	Key Trench Treatment
Shallow bedrock	Bedrock is near surface, covered with less than 4 m of overburden.	Excavate all overburden and highly fractured bedrock No other treatment required.
Deep ice-poor overburden	Deep overburden (greater than 4 m). Massive ice not present and low (less than 10%) interstitial ice content.	Excavate overburden to design extents of key trench.
Deep ice-rich overburden	Deep overburden (greater than 4 m). Massive ice and high (more than 10%) interstitial ice content.	Excavate overburden and massive ice zones contiguous with the key trench excavation.

5.2 Containment Dam Concept

Consideration was given to a number of different dam types as listed below:

- Frozen core dam with a secondary geosynthetic liner;
- Frozen foundation rockfill dam with a geosynthetic liner; and
- Frozen foundation rockfill dam with a conventional low permeability core.

Given the most prevalent inferred foundation conditions, the most suitable dam design would be a frozen core dam with a secondary geosynthetic liner. This type of dam is expensive to construct, and given the relative short design life, a more cost effective solution was sought.

A frozen foundation dam would allow construction of a conventional dam on the deep permafrost foundation, while making use of the permafrost conditions to seal the water retaining feature of the dam within the foundation. There are no known deposits of low permeability soils on the Property and arctic conditions pose significant challenges for the construction of low permeability cores. The decision was therefore made to construct the TSF containment dam as a frozen foundation rockfill dam with a geosynthetic liner. For this concept to function, the liner will be frozen into the key trench permafrost, and over the life of the structure, the foundation should not thaw deep enough to compromise this seal.

5.3 Choice of Geomembrane Liner

The TSF containment dam will have to act as a water retaining facility for a period of at least three years. During this time, leakage from the facility must be minimized. Selection of the most suitable geomembrane considered the following:

- Flexibility - the dam is likely to undergo small deformations through its design life and the geomembrane must be able to accommodate such deformations.
- Chemical suitability - the TSF will contain contact water, saline groundwater and mine processing fluids. The chemicals in these liquids must not react with the geomembrane.

- Constructability - ability to install the liner in harsh winter conditions is an important consideration, requiring the geomembrane to remain flexible in extreme cold conditions. Also, consideration should be given to the method of seaming adjacent panels and joints.
- Transportation - cost of transportation to the property could be significant due to the remote location, so lighter geomembranes are preferable.

Table 5.2 provides a summary of the typical geomembranes commercially available and their performance ratings for various parameters.

Table 5.2: Geomembrane Comparison Table

	HDPE	LLDPE	PP	PVC	BGM	GCL
Chemical Resistance	Very Good	Good to Very Good	Very Good	Moderate	Good	Moderate
Longevity	Very Good	Good to Very Good	Very Good	Moderate	Very Good	Moderate
Strength	Medium	Medium	Weak	Weak	Strong	Medium
Flexibility	Good	Very Good	Very Good	Very Good	Moderate	Moderate
Product Variation	Diverse	Diverse	Good	Good	Moderate	Minimal
UV Resistance	Very Good	Very Good	Good	Moderate	Very Good	Moderate
Typical Installed Unit Cost (per m^2)	$11	$11	$14	$10	$21	$7
Installation	Specialist	Specialist	Specialist	Specialist/ General Labor	General Labor	General Labor

Glossary: HDPE – High Density Polyethylene; LLDPE – Low Linear Density Polyethylene; PP – Polypropylene; PVC – Polyvinylchloride; BGM – Bituminous Geomembrane; GCL – Geosynthetic Clay Liner

Considering all the above factors, it was concluded that linear low-density polyethylene (LLDPE) would be the best alternative for the TSF. However, the analysis of the seepage through the liner found that a risk of significant seepage volumes exists with the LLDPE liner, and in fact with any of the thin membrane liners. Therefore it was determined that the geomembrane of choice will be the Geosynthetic Clay Liner (GCL) (Appendix E).

5.4 Containment Dam Geometry

The TSF containment dam will be constructed as a relatively low and long structure, with a maximum height of about 14 m in the central section, as shown in Figure 7. The 1,744 m long dam centerline consists of two limbs articulated at an angle of 160°, with the apex to the north. The two straight portions are similar in length, with the west side at 912 m and the east side at 832 m.

The crest of the dam was designed at 10 m width. This width was selected to allow for ease of construction using the mining fleet of 64 t haul trucks. The upstream slope has a grade of 4H:1V while the downstream slope is 2.5H:1V. Figures 8 and 9 provide details of typical dam cross sections at various sections of the dam.

The key trench will be aligned with the centerline of the dam, such that the upstream toe of the key trench coincides with the dam centerline.

The key design parameters of the TSF containment dam are summarized in Table 5.3.

Table 5.3: Summary of TSF Containment Dam Design Parameters

Parameter	Value
Dam type	Frozen foundation rock fill dam with geomembrane
Geomembrane type	GCL (Geosynthetic Clay Liner)
Geomembrane deployment slope	3H:1V
Dam crest centerline length	1,744 m
Dam maximum height	14 m
Dam crest elevation	307 masl
Full supply level (FSL)	305 masl
Total freeboard	1.3 m
Spillway	None
Dam crest width	10 m
Upstream dam slope	4H:1V
Downstream dam slope	2.5H:1V
Key trench depth	Variable; 4 m maximum
Key trench upstream slope	2H:1V
Key trench downstream slope	0.5H:1V

5.5 TSF Containment Dam Components

5.5.1 Key Trench

In accordance with the foundation zones inferred (see Table 5.1), the key trench will be excavated in the frozen overburden underlying the dam to a depth up to 4 m (see Figure 7). The upstream slope of the key trench will be excavated to 2H:1V to accommodate the deployment of the geomembrane. The key trench downstream slope will be excavated to a grade of 0.5H:1V to minimize the excavation.

Excavation of the key trench must be completed in the winter when the ground is completely frozen. This is necessary to ensure that the ground is as cold as possible before backfilling starts, to facilitate the bond between the foundation and the GCL. 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 will be required. The excavated material will be hauled away and disposed of in a waste rock storage area (WRSA).

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

5.5.2 Pony Wall

In the shallow bedrock foundation zones, a reinforced concrete pony wall will be cast to attach the GCL to. The pony wall will be doweled to bedrock to ensure a good bond. The pony wall will measure approximately 0.6 m high, by 0.3 m wide, and will span the length of the foundation zone.

5.5.3 Geosynthetic Clay Liner (GCL)

The GCL will be the water retaining element of the dam and will be frozen into the key trench to provide the necessary seal. The GCL will be deployed in a chevron shape, starting at the base of the key trench (or attached to the pony wall), along the upstream 2H:1V key trench slope, and then sweeping back on a 3H:1V to an elevation of 306 masl, which is 1 m below the dam crest (see Figures 8 and 9). The top edge of the GCL will be terminated in an appropriately sized anchor trench. The GCL will be deployed in vertical strips (the width of the GCL rolls). Overlaps will be at least 0.5 m wide, and all overlaps will have a bead of granular bentonite spread between them.

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 0.3 m thick compacted layers of crushed gravel (pea gravel size).

5.5.4 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 with a good mix of fines, and size will be limited to a maximum size of 600 mm. This material must be placed in lifts no greater than 1 m and must be compacted with a 15 tonne vibratory compactor or using wheel traffic from loaded haul trucks, or an alternate site specific method.

5.5.5 Transition Zone

The GCL is protected using a fine crushed gravel (pea gravel) produced from ROM waste rock. To minimize losses of this bedding material, a transition zone of 150 mm minus crushed ROM waste rock will be placed between the bedding and dam bulk fill zones. The material must be well graded with sufficient fines. This transition layer will be about 1 m thick, will be placed in two 0.5 m lifts, and compacted using the same means as the dam bulk fill.

5.5.6 Bedding Zone

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.

5.5.7 Dam Shell

No special dam armouring is required, and no special upstream riprap is required. The dam shell will be constructed using the same ROM waste rock as the dam bulk fill. Consideration should however be given to using more gap graded material on the outer shell with less fines; this will stand up better over the long term avoiding fines washout, especially on the upstream slope.

5.5.8 Monitoring Instrumentation

A series of ground temperature cables and survey prisms will be installed at the TSF dam to monitor the thermal regime of the foundation and deformation performance. Details are provided in Appendix I and instrument locations are shown on Figure 13.

The vertical ground temperature cables will be installed in boreholes drilled through the dam fill after the completion of the dam. The portion of the boreholes within the rockfill may require temporary casing. The horizontal ground temperature cables will be placed within the bedding zone along the upstream side of the key trench (Figure 13).

The survey prisms will be permanently installed in large boulders within the dam shell.

5.5.9 South Dyke

To ensure that the tailings within the TSF are constrained to the Potential Development Area (PDA), a small retaining dyke is required along the southern end. This structure will be a saddle dyke built of ROM waste rock with a length of approximately 200 m and crest elevation of 307 masl, resulting in a maximum height of just over 3 m. The crest width will be 6 m, with side slopes of 2.5H:1V on both upstream and downstream sides. No key trench is planned for this structure and no impermeable liner is required because the tailings deposited against the dyke will push the water away from the structure and direct it downstream towards the north end of the facility.

5.6 Stability Analysis

A comprehensive stability analysis was carried out to confirm whether the TSF dam meets the appropriate design requirements as stipulated in Section 4.5.

Complete details of the analysis are presented in Appendix F and the results are summarized in Table 5.4. The stability assessment took into consideration the location and layout of the GCL as the potential weakest element of the dam. 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. Both static and pseudo-static scenarios were assessed for each model. The results confirm that in all cases the design FOS complies with the minimum required FOS.

Table 5.4: Minimum Factors of Safety

Model	Slope Assessed	Analysis Type	Factor of Safety
Model A	Upstream	Static	1.5
Model B	Upstream	Static	1.5
Model B	Upstream	Pseudo-static	1.2
Model B	Downstream	Static	1.6
Model B	Downstream	Pseudo-static	1.4
Model B	Upstream	Static Drawdown	1.4

5.7 Settlement Analysis

Settlement of the TSF containment dam could occur as a result of one of two reasons; dam fill consolidation, or foundation consolidation. Since the bulk of dam fill is compacted ROM waste rock, and the total dam height is limited, there is no expectation of any appreciable fill settlement.

Foundation settlement, in the context of the TSF containment dam, could occur as a result of thaw consolidation. Normal thaw consolidation can also be exacerbated by thaw of massive ice which may be present in the foundation soils. Through thermal analysis (see Section 5.9) it has been demonstrated that the foundation will remain frozen for the design life of the structure, and as a result thaw consolidation is not expected to be of concern during the period when this facility is in active operation.

5.8 Deformation (Creep) Analysis

Another form of deformation that the TSF containment dam may be subject to is creep. Creep is a slow acting phenomenon and is unlikely to pose any risk to the structure given its short operational life. The TSF containment dam has been overbuilt by 0.7 m, which provides an allowance for deformation, whether creep or settlement. This is considered to be a very conservative approach, considering that the TSF will be operated as a normally empty event pond after completing the first two years of active tailings deposition.

5.9 Thermal Analysis

Rigorous thermal modeling was completed to determine whether the design as proposed would function. Complete details of this thermal assessment are provided in Appendix G. The modeling confirms that, using conservative assumptions, the GCL would remain frozen into the underlying foundation for a period of at least ten years. The design freezing point depression used in the analysis was -1.4^{o}C, to compensate for the pore water salinity in the overburden soils. The thermal modeling for active tailings deposition did not take into consideration climate change, since the design life of the structure is short. A thermal model of the normally empty pond (TSF WRSA Pond) was however run taking into consideration potential global warming effects, since this section of the dam will remain in place for a longer period of time (16 years).

5.10 Tailings Consolidation Analysis

Tailings consolidation would result in a change of storage capacity over the life of the facility. Since the TSF operates for such a short period of time, consolidation, even if significant, is not a large concern. A rigorous assessment of the consolidation characteristics of the Property tailings was however undertaken (Appendix H) for tailings storage in the Umwelt TF and Goose Main TF.

The consolidation assessment completed for the TFs confirmed that consolidation would be negligible for tailings deposits of about 10 m thick, as planned for the TSF. The closure strategy of capping the entire TSF with waste rock is therefore not at risk of failure due to tailings settlement over time.

5.11 Dam Break Analysis

In accordance with the Canadian Dam Safety Guidelines (CDA 2013), a dam break analysis may be required when a dam has a hazard rating of High or greater. The purpose of a dam break analysis is to determine the inundation zone downstream of the dam in question should a catastrophic breach occur.

In determining the dam hazard classification, consideration was given to tailings supernatant water and tailings solids reaching Goose Lake during a potential breach; this lake is located approximately 2 km downstream of the TSF. Although some dilute supernatant water may flow on towards Propeller Lake (a lake downstream and to the north of Goose Lake), no tailings solids are expected to pass beyond Goose Lake. Without completing a full dam breach analysis, it can be inferred conservatively that the inundation zone would extend along a zone between the TSF and Goose Lake with little to no opportunity to prevent supernatant water from entering Goose Lake. It may be possible to prevent tailings solids from entering the lake by constructing deflector berms.

Given the short operational life of the structure, the dam geometry, and the expected consequences of failure, which has arguably been overstated, it was concluded that a dam breach analysis would not lead to any new conclusion being reached, and consequently it was not conducted. During detailed design, further analysis could confirm the necessity for potential deflector berms; however, given the life of the TSF, inclusion of these design elements was considered unnecessary at this time.

5.12 TSF Water Balance

A site-wide water and balance, including the TSF, has been developed for the Property (SRK 2015f). The TSF is designed to contain site-wide contact water, saline groundwater, and mill process water. Reclaim water will be drawn from the TSF for reuse in the Goose Process Plant. Once storage capacity is available in the mined out open pits, any water stored in the TSF will be pumped to those facilities, allowing the TSF to operate as a normally empty contact water event pond for the TSF and Goose WRSA only (aka TSF WRSA Pond).

There are no non-contact surface water diversions upstream of the TSF. The TSF is located at the headwater of the catchment and thus ruled unnecessary. The benefits of any diversions are outweighed by the relative cost and complexity of constructing them.

5.13 Seepage Analysis

The water retention capability of the dam is relying on the GCL being keyed into the permafrost foundation or competent bedrock. Thermal modeling (see Section 5.9) has confirmed the viability of this, thus the seepage through the foundation is negligible.

In the case of the GCL, the swelling of the bentonite in the liner ensures that once hydrated, a properly installed liner becomes virtually defect-free. A comprehensive calculation of the seepage through the GCL was completed (Appendix E), which concluded that if the TSF was at its FSL, seepage of up to 1,210 m^3/year could occur.

It is acknowledged that a 2 to 3 m thick fractured bedrock contact zone was found in some of the drill holes near the west abutment of the dam, which may become a pathway for seepage through the foundation of the dam. However, the amount of dam bulk fill present in this specific portion of the dam will be a minimum of 6 m, which far exceeds the minimum thermal cover requirement of 1.9 m to maintain the underlying materials frozen; therefore seepage is unlikely to occur.

The maximum head of water expected to be present in this area is in the order of 5 to 9 m during active tailings deposition. During the later stages of operation as an event pond, the head of water will normally be zero, with sporadic and temporary head as high as 5 m The thermal protection provided by the dam fill will maintain the key trench frozen, thus seepage is not a concerns.

5.14 Seepage Collection

The inferred foundation conditions at the TSF containment dam are not conducive towards constructing seepage collection ditches or drains. Seepage collection will therefore be completed by constructing a berm downstream of the dam. The berm will incorporate an impermeable liner keyed into the permafrost. Depending on the quality of the water, seepage may be directed to sumps, from where it will be pumped back into the TSF, or discharged to the environment, as appropriate.

5.15 Spillway

The TSF has been designed to contain the PMF when the facility is operating at FSL. Therefore no spillway is required. Subsequent to completion of active operations, the western portion of the TSF will be used as a normally empty event pond, and will not reach the design FSL (305 masl) at any time. When decommissioned, the dam will be breached along a section of the dam where no tailings have been deposited.

6 TSF Containment Dam and South Dyke Construction

6.1 Construction Equipment

Typical construction equipment will be used at the TSF dam. The mining fleet will be used for hauling the excavated overburden and the dam fill, with smaller articulated trucks used in the narrower areas near the top of the dam. Bulldozers and smooth drum vibratory compactors will be used to complete the fill placement. Hydraulic excavators may be used for special tasks as required. Drilling and blasting will be done using conventional tracked blast hole drills.

6.2 Construction Schedule

The dam must be completed before the Goose Processing Plant starts production. Construction of the TSF dam and South Dyke will start in Q4 of Year -2. The key trench excavation and backfill must be completed in the winter (i.e. end of Q1 of Year -1) to eliminate potential issues caused by thawing of the soft overburden, soils as well as to ensure that a thermal blanket is completed to protect the permafrost in the foundation.

6.3 Material Quantities

Material quantities for the construction of the TSF containment dam and the South Dyke are summarized in Table 6.1. All fill and excavation volumes represent neat volumes, i.e. “in place”, with no allowance for swelling and compaction. The liner quantities are neat quantities, with no allowance for seams and waste.

Table 6.1: Summary of Material Quantities

Material	Quantity
Main Dam	
Liner Bedding (m^3)	61,400
GCL (m^2)	102,400
Run-of-mine waste rock (m^3)	604,500
Transition Fill (m^3)	106,400
Key-trench excavation (m^3)	56,400
South Dyke	
Run-of-mine waste rock (m^3)	5,700

6.4 Construction Material Geochemistry

Given the geochemistry of the waste rock for the Project (SRK 2015e) and the design intent of the TSF containment dam, the eastern limb of the dam can be constructed with any waste rock, while the western limb must be constructed with non-acid generating waste rock.

7 TMS Operations

7.1 TSF Tailings Deposition Plan

Two tailings deposition plans were modeled (SRK 2015g, Appendix C). The preferred 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 from a discharge point at elevation 310 masl as shown in Figure 6.

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. Beach development will be controlled in the beginning of the second period, and local ponding will be prevented by trenching along the west embankment.

The stage-capacity curve for the TSF after tailings deposition is presented in Figure 11, while the storage capacity of the TSF WRSA Pond is shown in Figure 12. Detailed analysis of the tailings deposition is attached as Appendix C.

7.2 TF Tailings Deposition Plan

Tailings will be deposited in the mined out open pits by using a single spigot discharge point. This discharge location will be changed over the life of deposition to ensure that a near struck tailings surface is created when the 5 m threshold below the overflow elevation is reached.

7.3 Tailings Discharge and Reclaim Water Pipelines

The design, including routing of tailings and reclaim pumps and pipelines, is being completed by others and are not addressed in this report. Reclaim will however be done via a reclaim barge from the TSF as well as the two TFs.

8 TMS Closure and Reclamation

8.1 TSF Closure

Following completion of tailings deposition in the TSF, the facility will continue to be used as temporary contact water storage. During this period, Goose Main open pit will be in development and waste rock from this source will be used to cover the tailings surface. The entire tailings surface will be covered, including a 25 m wide zone downstream of the TSF containment dam, as shown in Figures 14 and 15. This entire covered surface, whether waste rock or tailings, will receive a final non-acid generating waste rock cover at least 5 m thick. This cover will ensure that the tailings surface will freeze back. Once covered, only a portion of the west limb of the dam will be visible. That portion of the TSF will continue to function as a normally empty event pond (TSF WRSA Pond) until the Post-Closure phase. Water from this pond will be pumped to Goose Main TF as required.

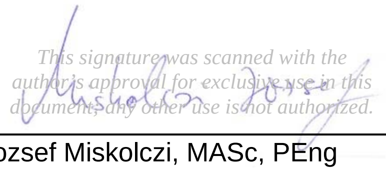
In Year 18, the west limb of the TSF containment dam (i.e. the TSF WRSA Pond) will be breached to allow any surface runoff to flow unimpeded towards Goose Lake.

8.2 TF Closure

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 prevent resuspension of tailings solids due to wave action, surge following storm events, and ice scour. Water from the Umwelt TF will continue to be treated in accordance with the Project’s water management plan (SRK, 2015f) until such time as the discharge meets water quality objectives for the external receiving environment.

The closure plan for the Goose Main TF is similar to Umwelt TF; however, once tailings deposition is complete, there will be a much greater water cover. The Goose Main TF may also be used to store non-hazardous waste from the final mine closure activities.

This report, Tailings Management System Preliminary Design Report Back River Property, Nunavut, Canada", was prepared by SRK Consulting (Canada) Inc.



Iozsef Miskolczi, MASc, PEng
Senior Consultant

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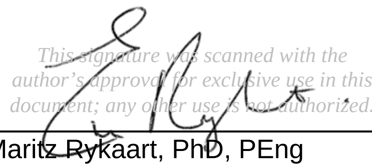

Maritz Rykaart, PhD, PEng
Principal Consultant

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Figures

srk consulting	Sabina GOLD & SILVER CORP.	Tailings Management System Design
		Site Location Plan
SRK JOB NO.: 1CS020.008	BACK RIVER PROJECT	DATE: SEPT. 2015
FILE NAME: BR–TMSD FIGURE 1_2.dwg		APPROVED: IM
		FIGURE: 1

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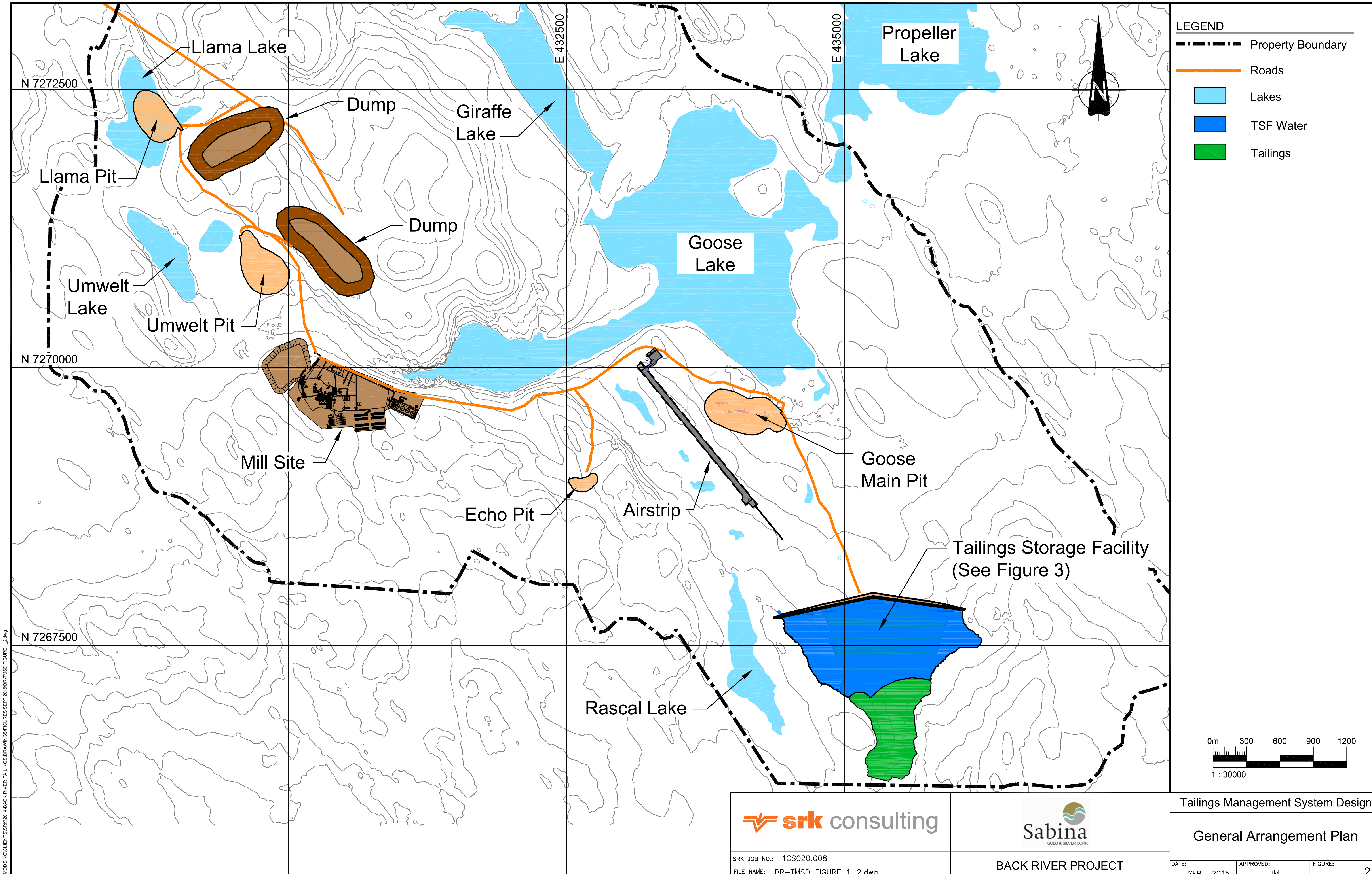

Llama Lake
Dump
Giraffe Lake
Propeller Lake
Llama Pit
Dump
Goose Lake
Umwelt Lake
Umwelt Pit
Mill Site
Echo Pit
Airstrip
Goose Main Pit
Tailings Storage Facility (See Figure 3)
Rascal Lake
N 7272500
N 7270000
N 7267500
E 432500
E 435000
N
LEGEND
Property Boundary
Roads
Lakes
TSF Water
Tailings
0m 300 600 900 1200
1 : 30000
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FILE NAME: BR-TMSD FIGURE 1_2.dwg
BACK RIVER PROJECT
Tailings Management System Design
General Arrangement Plan
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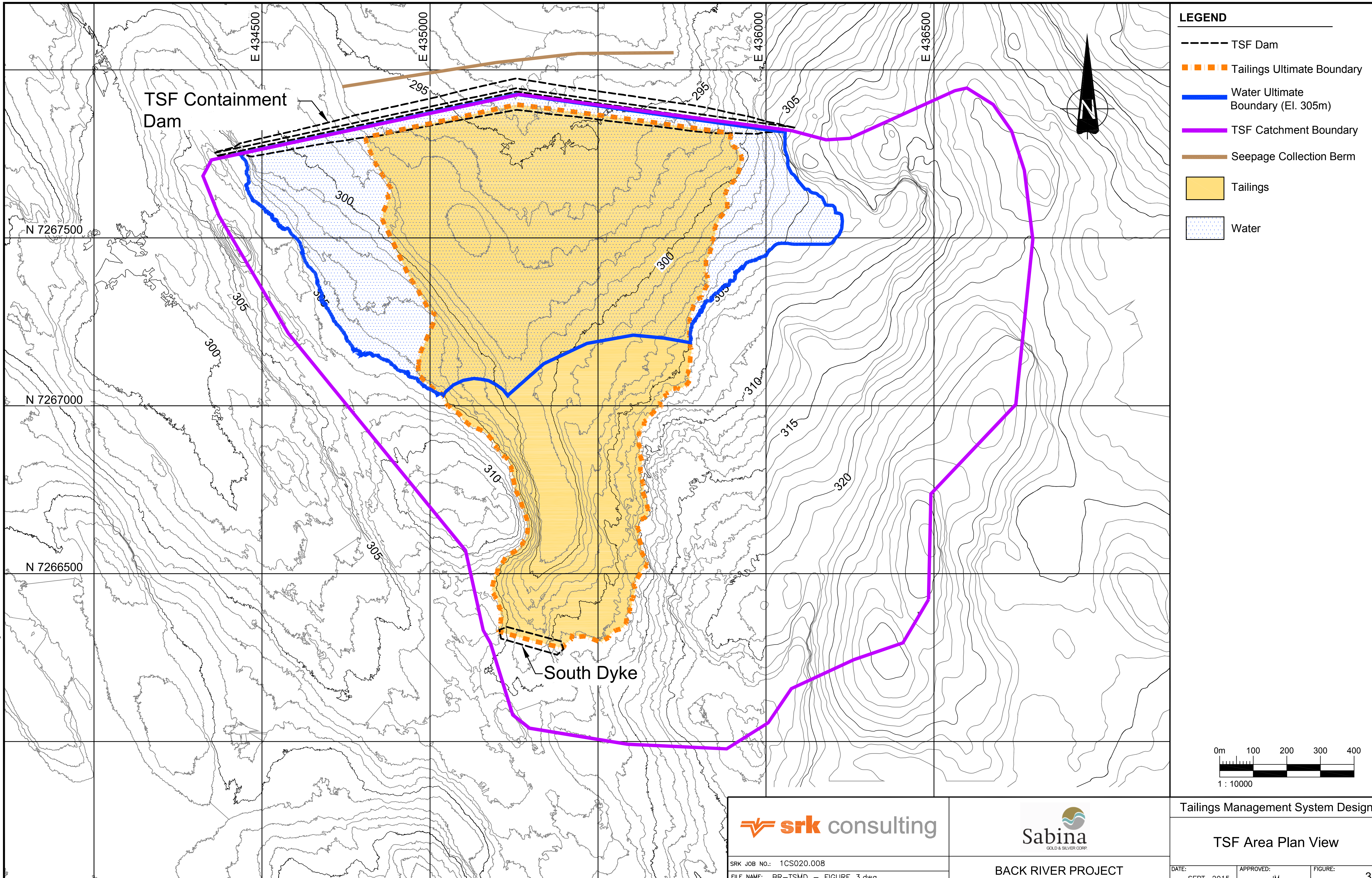
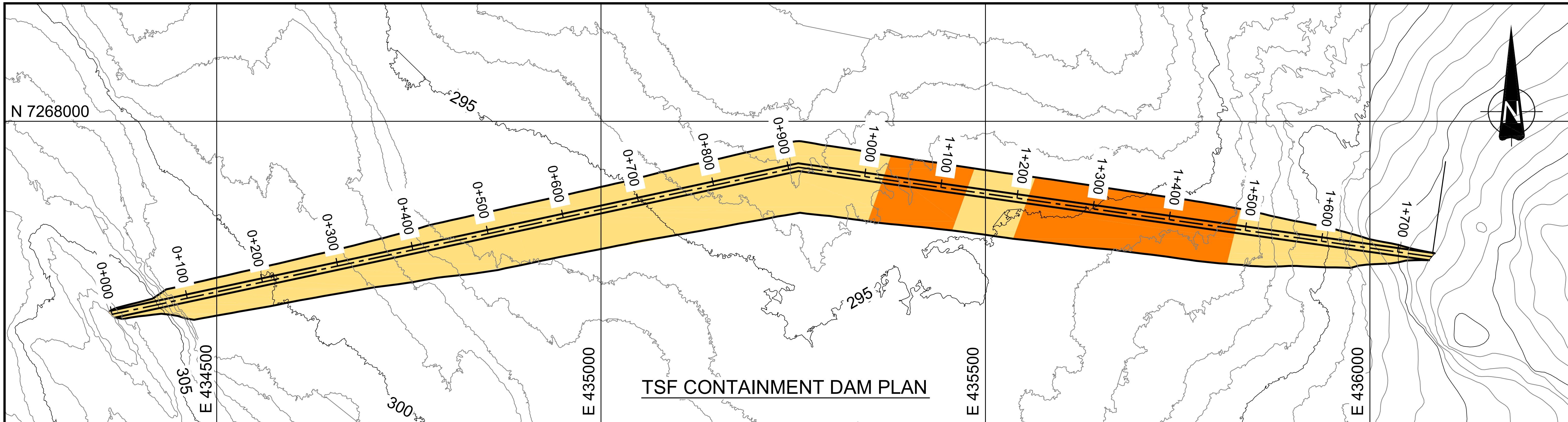
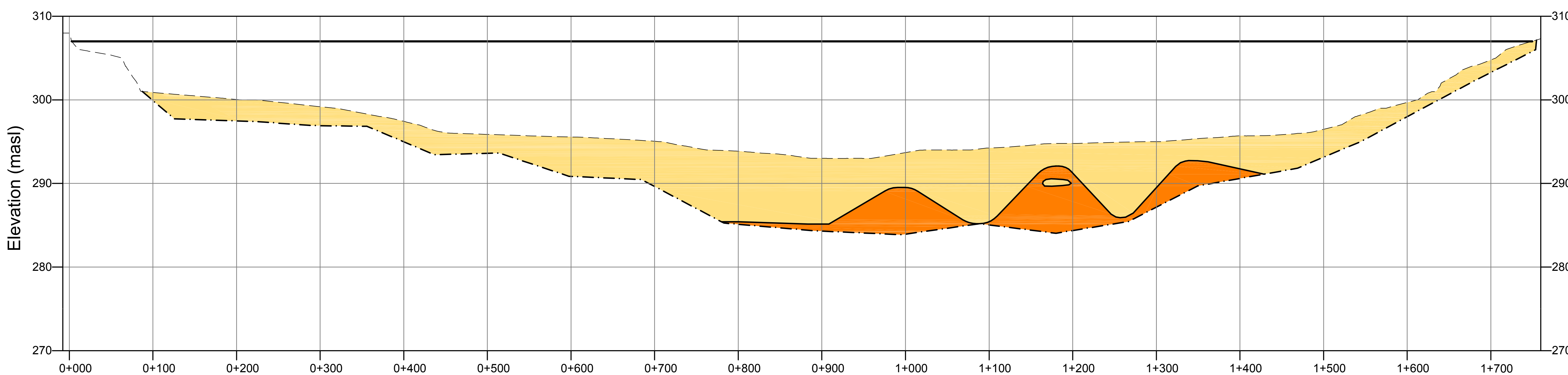


LEGEND
TSF Dam
Tailings Ultimate Boundary
Water Ultimate Boundary (El. 305m)
TSF Catchment Boundary
Seepage Collection Berm
Tailings
Water
TSF Containment Dam
South Dyke
E 434500
E 435000
E 436000
E 436500
N 7267500
N 7267000
N 7266500
295
300
305
310
315
320
N
0m
100
200
300
400
1 : 10000
srk consulting
Sabina
GOLD & SILVER CORP.
SRK JOB NO.: 1CS020.008
FILE NAME: BR-TSMD – FIGURE 3.dwg
BACK RIVER PROJECT
Tailings Management System Design
TSF Area Plan View
DATE: SEPT. 2015
APPROVED: IM
FIGURE: 3



TSF CONTAINMENT DAM PLAN



CENTRELINE TSF DAM PROFILE

10x Exaggeration

LEGEND

- Ground Surface
- Bedrock Surface
- Silt
- Sand

0m 50 100 150 200

1 : 5000 (Horizontal Scale)

srk consulting

SRK JOB NO.: 1CS020.008

FILE NAME: BR-TMSD FIGURE 4.dwg

Sabina GOLD & SILVER CORP.

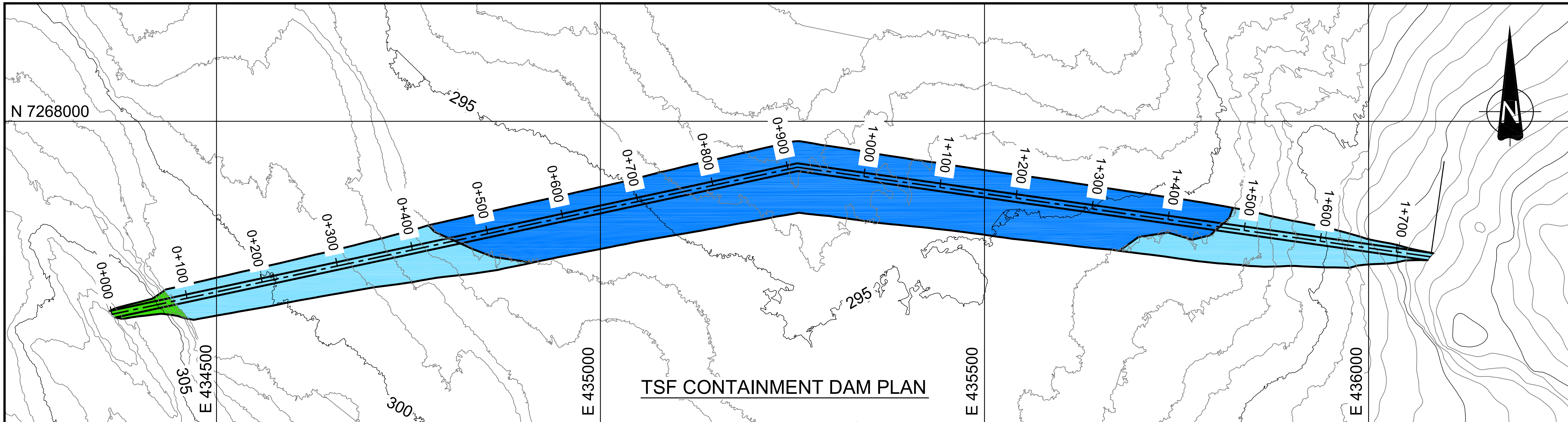
BACK RIVER PROJECT

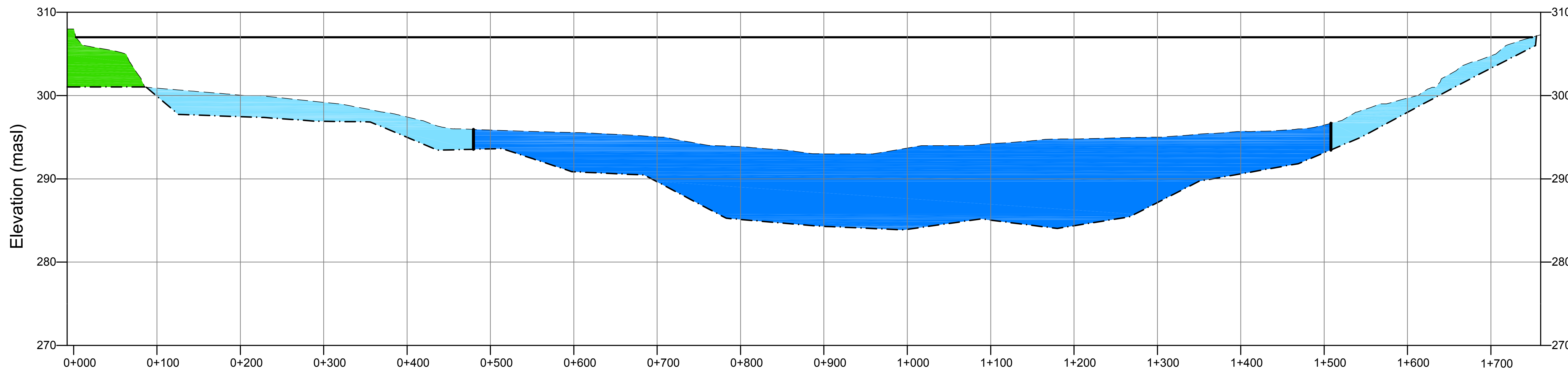
Tailings Management System Design

TSF Containment Dam Overburden Plan and Profile

DATE: SEPT. 2015 | APPROVED: IM | FIGURE: 4

C:\MDDSINC\CLIENTS\SRK\2014\BACK RIVER TAILINGS\DRAWINGS\FIGURES SEPT 2015\BR-TMSD FIGURE 4.dwg





CENTRELINE TSF DAM PROFILE

10x Exaggeration

LEGEND

- Ground Surface
- Bedrock Surface
- 10% - 30% Excess Ice Content and Massive Ice
- 0% - 5% Excess Ice Content
- Bedrock Outcrop

0m 50 100 150 200

1 : 5000 (Horizontal Scale)

srk consulting

SRK JOB NO.: 1CS020.008

FILE NAME: BR-TMSD FIGURE 5.dwg

Sabina GOLD & SILVER CORP.

BACK RIVER PROJECT

Tailings Management System Design

TSF Containment Dam Ice Plan and Profile

DATE:	APPROVED:	FIGURE:
SEPT. 2015	IM	5

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