Appendix B. Water Management Plan

BACK RIVER PROJECT
Water Management Plan

June 2020

BACK RIVER PROJECT
WATER 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
2	June 2020	All	All	Updated to reflect the 2020 Modification Package changes, and as a Supporting Document for the Type A Water Licence Application; submitted to the Nunavut Water Board for review and approval.

Acronyms

AEMP	Aquatic Effects Management Plan
AN	Ammonium nitrate
ANFO	Ammonium Nitrate Fuel Oil
ARD	Acid Rock Drainage
BMP	Best Management Practices
CCME	Canadian Council of Ministers of the Environment
DFO	Department of Fisheries and Oceans Canada
ECCC	Environment and Climate Change Canada
FEIS	Final Environmental Impact Statement
GCL	Geosynthetic Clay Liner
LOM	Life of Mine
MAD	Main Application Document, submitted October 2017 (2AM-BRP1831)
masl	metres above sea level
mbgs	metres below ground surface
mg/L	milligrams per litre
ML	Metal Leaching
MLA	Marine Laydown Area
MDMER	Metal and Diamond Mining Effluent Regulations
MWRMP	Mine Waste Rock Management Plan
NH_3	ammonia
NIRB	Nunavut Impact Review Board
NPAG	Non-Potentially Acid Generating
NWB	Nunavut Water Board
PAG	Potentially Acid Generating
Project	Back River Project
Sabina	Sabina Gold & Silver Corp.
SOP	Standard Operating Procedure
STP	Sewage Treatment Plant
SSWQO	Site-specific Water Quality Objectives
SWMP	Saline Water Management Plan
TF	Tailings Facility

TSF	Tailings Storage Facility
TSS	Total Suspended Solids
WIR	Winter Ice Road
WL	Type A Water Licence
WMP or Plan	Water Management Plan
WRSA	Waste Rock Storage A rea
WTP	Water Treatment Plant

1. Introduction

The Back River Project (the Project) is a proposed gold project owned by Sabina Gold & Silver Corp. (Sabina) within the West Kitikmeot region of southwestern Nunavut. It is situated approximately 400 kilometres (km) southwest of Cambridge Bay, 95 km southeast of the southern end of Bathurst Inlet, and 520 km northeast of Yellowknife, Northwest Territories. The Project is located predominantly within the Queen Maud Gulf Watershed (Nunavut Water Regulations, Schedule 4) (Modification Package Appendix A, Figure 1).

The Project is comprised of two main areas with interconnecting winter ice roads (WIR) (Modification Package Appendix A, Figure 2): Goose Property (Modification Package Appendix A, Figure 3) and the Marine Laydown Area (MLA) (Modification Package Appendix A, Figure 4) situated along the western shore of southern Bathurst Inlet. The majority of annual resupply will be completed using the MLA, and an approximately 160 km long WIR will connect the MLA to the Goose Property. Refer to Modification Package Appendix A, Figures 1 to 5 for general site layout and locations. A high-level summary of the Project waste and water management can be found in Section 3 of the Modification Package.

The Water Management Plan (WMP or Plan) outlines the procedures necessary to manage the quality and quantity of water interacting with Project components throughout the Construction, Operations, Closure and Post-Closure phases of the mine. It includes management practices that reduce the potential for adverse impacts to receiving waters, to aquatic ecosystems, and to fish and fish habitat.

The Plan was prepared: following the requirements of the Supplementary Information Guidelines (SIG) for Mining and Milling MM3 and Water Works M1 issued by Nunavut Water Board (NWB 2010 b, c), and the Environmental Impact Statement (EIS) Guidelines issued by the Nunavut Impact Review Board (NIRB) (NIRB 2013); in accordance with best management practices (BMPs); and in conformance with current Federal and Territorial statutory requirements (See Applicable Legislation and Guidelines Section 4.0).

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

The information presented herein is current as of May 2020. An update will be initiated prior to the start of construction and will incorporate issue-for-construction engineering drawings of associated water management infrastructure. Final design plans will include the quality assurance/quality control measures that will be applied during the Construction Phase. A detailed schedule for construction of water works is outlined in Section 5 and 8 of the WMP. The Plan will be reviewed as needed for changes in operation and technology, and as directed by the NWB in the Type A Water Licence or other regulatory authorizations where appropriate. Completion of the updated Plan will be documented through signatures of the personnel responsible for reviewing, updating, and approving the Plan.

A record will document all significant changes that have been incorporated in the Plan subsequent to the latest review. The record will include the names of the persons who made and approved the change, as well as the date of the approval.

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 WMP is the key document that forms part of Sabina's overall Water Management Program for the Project. The Plan has been written to meet requirements of a Type A Water Licence.

This plan is divided into the following components:

- Applicable Legislation and Guidelines (Section 3);
- Roles and Responsibilities (Section 4);
- Planning and Implementation (Section 5);
- Water Modelling and Design Criteria (Section 6);
- Water Management (Section 7);
- Water Management Phases (Section 8);
- Environmental Protection Measures (Section 9);
- Monitoring Program (Section 10);
- Environmental Reporting (Section 11); and
- Adaptive Management (Section 12).

This plan describes the procedures necessary to manage the quality and quantity of water interacting with Project components throughout the Construction, Operations, Closure, and Post-Closure phases of the mine. It includes management practices that reduce the potential for adverse impacts to receiving waters, to aquatic ecosystems, and to fish and fish habitat. The Plan includes:

- A brief summary of the physical setting at the mine site;
- A description of mine development;
- A summary of water treatment and water supply locations and requirements throughout the life of mine (LOM), including sewage disposal facilities;
- Water quantity thresholds and water quality objectives and discharge criteria;
- A summary of water management infrastructure design;
- A description of the water management at the mine site during Construction, Operations, and Closure;
- A presentation of the Water and Load Balance model and a summary of its results;
- A summary of environmental protection measures;
- A description of the mine site water quality monitoring program; and
- An overview of mitigation and adaptive management.

The Plan is structured to help ensure that: the Project is built as proposed; predicted adverse environmental effects are promptly mitigated; the applied mitigation measures are successful; and relevant laws and regulations are met. It outlines procedures for the reassessment, improvement, or reorientation of the Plan if determined at any point in the Project's development that it no longer meets the initial purpose or objective.

Results of monitoring identified in this plan will be publicly reported and may feed into other ongoing regional initiatives or programs with relevant government organizations, or regional authorities.

2.1 RELATED PLANS OR STUDIES

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

- Road Management Plan (WL Supporting Document [SD]-02);
- Borrow Pit and Quarry Management Plan (WL SD-03);
- Ore Storage Management Plan (WL SD-07);
- Waste Rock Management Plan (WL SD-08);
- Tailings Management Plan (WL SD-09);
- Landfill and Waste Management Plan (WL SD-10);
- Landfarm Management Plan (WL SD-12);
- Environmental Management and Protection Plan (WL SD-20);
- Aquatic Effects Management Plan (WL SD-21);
- Marine Monitoring Plan (Sabina 2018);
- Interim Closure and Reclamation Plan (WL SD-26);
- Mine Plan (Sabina 2017);
- Water and Load Balance Report (Appendix E of WMP);
- Geochemical Characterization Report (Sabina 2017, Appendix E-3);
- Tailings Management System Design Report (Sabina 2017, Appendix F-4);
- Hydrogeological Characterization and Modelling (Sabina 2017, Appendix F-5);
- Cultural and Heritage Resources Protection Plan (Sabina 2015, Volume 10, Chapter 27);
- Explosives Management Plan (Sabina 2015, Volume 10, Chapter 13);
- Geotechnical Design Parameters Report (Sabina 2017, Appendix F-2);
- Hydrology Report (Sabina 2015, Volume 2, Appendix V2-7B); and
- Saline Water Management Plan (Appendix C of WMP).

3. Applicable Legislation and Guidelines

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

Sabina will also be bound by the terms and conditions of its land use permits issued by the Kitikmeot Inuit Association for Inuit Owned Land, and its Type A Water Licence 2AM-BRP1831 issued by the NWB.

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

Acts	Regulations	Guidelines
Federal		
Canadian Environmental Protection Act (CEPA; 1999)		
Nunavut Waters and Nunavut Surface Rights Tribunal Act (2002)	Nunavut Water Regulations (2013)	
Territorial Lands Act (1985)	Territorial Land Use Regulations (CRC, c.1524) Northwest Territories and Nunavut Mining Regulations (CRC, c.1516)	Implications of Global Warming and the Precautionary Principle in Northern Mine Design and Closure (BGC 2003)
Fisheries Act (1985)	Metal Mining Effluent Regulations (SOR/2002-220)	Fisheries Protection Policy Statement (2013) Fisheries Productivity Investment Policy: A Proponent Guide to Offsetting (2013 Protocol for Winter Water Withdrawal from Ice-Covered Waterbodies in the Northwest Territories and Nunavut (DFO 2010) Freshwater Intake End-of-Pipe Fish Screen Guideline (DFO 1995)
Territorial - Nunavut		
Nunavut *Environmental Protection Act* (1988)	Spill Contingency Planning and Reporting Regulations (NWT Reg (Nu) 068-93)	Government of Nunavut (GN) Environmental Guidelines for the Management of:
Public Health Act (1998)	Public Water Supply Regulations (RRNWT. 1999, c.P-23) Public Sewerage Systems Regulations (RRNWT. 1999, c.P-22)	
Mine Health and Safety Act (SNWT (Nu) 1994, c.25)	Mine Health and Safety Regulations (NWT Reg (Nu) 125-95)	

4. Roles and Responsibilities

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

The Environmental Superintendent and his/her direct reports are responsible for the implementation of this plan including:

- Overall management of the Plan;
- Monitoring;
- Operational aspects;
- Internal reporting;
- External reporting; and
- Ensuring compliance and adaptive management.

5. Planning and Implementation

Water is an essential component of any mine. Understanding the existing physical setting and the overall mine development plan are essential components for development of an effective WMP for the Project.

5.1 PHYSICAL SETTING

5.1.1 Topography

The topography of the region is dominated by undulating landscapes of low relief that present in a sequence of smooth, non-linear rises and hollows, and elongated rises and valleys that repeat in a wave-like pattern. Slopes are generally uniform and range between 0 and 5%. Terrain elevation ranges between 300 and 700 metres above sea level (masl) in the region.

Uplands are typically covered by veneers of morainal materials deposited on Precambrian, sedimentary, metamorphic or intrusive rocks. The thickness of overburden, defined as unconsolidated organic or mineral material, is generally small; it is greatest in areas of plains or gentle slopes where it can range from 1 to 37 m (average of 10.8 m). A number of distinct landforms also exist throughout the region including small and medium sized kettle lakes, eskers, moraines, and boulder fields.

5.1.2 Seismicity

The Back River Property is located in an area of low seismic risk. The peak ground acceleration for the area was estimated using seismic hazard calculator from the National Building Code of Canada’s website (NRCC 2014a). The peak ground acceleration value of 0.036 (corresponding to the 1:2,475 year event) was accounted for in the design.

5.1.3 Permafrost and Groundwater

The Back River Property is located in the continuous permafrost region of the Canadian Arctic. Although permafrost may extend in excess of 400 metres below the ground surface (mbgs), it is expected that some of the underground development will extend below this depth into unfrozen rock and soil. In addition, both open pit and underground developments will occur underneath or in close proximity to lakes associated with taliks. Therefore, while the permafrost is essentially impermeable, groundwater inflows are expected during open pit and underground mining.

As part of the Project, a groundwater prediction model was completed to estimate potential groundwater inflows during mining at the Goose Property. Groundwater will also flow through the active layer (the top 1 to 3 m of overburden) during unfrozen months; however, the volume of flow is likely insignificant.

At the Goose Property, groundwater modelling and analysis determined that inflows are expected from Llama Open Pit, and Umwelt Underground (Table 5.1-1). Llama open pit mining will be developed below Llama Lake within a through talik that is connected to the groundwater system. It is also expected that Umwelt Underground stopes will intercept the groundwater system below the permafrost layer. These inflows were included as input in the Water and Load Balance model.

The remaining developments (Umwelt Open Pit, and Goose Main Open Pit) are not expected to have notable groundwater inflows.

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

Table 5.1-1. Goose Property Groundwater Inflows

Mine Year	Umwelt Underground Inflow		Llama Open Pit Inflow	
	Volume (m3)	Rate (m3/day)	Volume (m3)	Rate (m3/day)
Y1Q1	11,000	100	0	0
Y1Q2	27,000	300	0	0
Y1Q3	38,200	400	82,200	900
Y1Q4	60,500	700	48,300	500
Y2Q1	71,200	800	21,500	200
Y2Q2	74,400	800	20,100	200
Y2Q3	74,400	800	49,100	500
Y2Q4	74,400	800	28,800	300
Y3Q1	74,400	800	38,400	400
Y3Q2	74,400	800	35,700	400
Y3Q3	62,000	700	46,800	500
Y3Q4	51,900	600	44,600	500
Y4Q1	45,700	500	32,900	400
Y4Q2	45,700	500	37,700	400
Y4Q3	63,500	700	35,300	400
Y4Q4	74,400	800	44,400	500
Y5Q1	72,900	800	48,800	500
Y5Q2	60,500	700	Interpolated	
Y5Q3	54,500	600	Interpolated	
Y5Q4	51,100	600	Interpolated	
Y6Q1	48,100	500	Interpolated	
Y6Q2	44,700	500	Interpolated	
Y6Q3	43,300	500	Interpolated	
Y6Q4	42,200	500	Interpolated	
Y7Q1	40,700	400	Interpolated	
Y7Q2	38,700	400	Interpolated	
Y7Q3	38,000	400	Interpolated	
Y7Q4	37,400	400	Interpolated	
Y8Q1	36,500	400	Interpolated	
Y8Q2	35,000	400	Interpolated	
Y8Q3	34,600	400	Interpolated	
Y8Q4	34,300	400	Interpolated	
Y9Q1	33,700	400	Interpolated	

Note: Umwelt Underground completed in Year 9.

A more detailed description of the groundwater prediction model and results through all mine phases can be found in the Hydrogeological Characterization and Modelling Report for the Project (Sabina 2017, Appendix F-5).

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

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

Sabina is aware of the uncertainty related to fault zones and will safely and appropriately manage groundwater inflows. Actions may include use of surface and underground exploration information to identify enhanced permeability that may be intercepted, advancing cover and probe drilling (i.e., exploration drainage holes), and interpretation of groundwater pressure and inflow data when high permeability formations are encountered.

5.1.4 Climate and Hydrometric Characteristics

Baseline meteorological and hydrometric programs have been initiated for the Back River Property spanning the period from 2004 to 2014. Detailed climate and hydrometric characteristics are presented in the Hydrology Report (Sabina 2015, Appendix V2-7B), and the Meteorological Baseline Report (Sabina 2015, Appendix V4-3A). Additional meteorological site data was collected from 2015 to 2019. This data was reviewed and used to validate the Water and Load Balance model data set. For the Modification Package, the climatology was updated and was developed from a regional analysis to develop more robust climate change predictions.

Meteorological parameter estimates utilize the Goose Lake meteorological station located at elevation 277 masl. The data collected at this station were combined with historical data from the Meteorological Services of Canada branch of Environment and Climate Change Canada (ECCC) and were used in conjunction with research conducted by Waterloo University and ECCC to develop long-term meteorological estimates for the Project.

Available site data was correlated to the corresponding monthly temperature data at the Lupin Meteorological Services of Canada station using a linear regression analysis. The resulting synthetic temperature record has an average annual temperature of -10°C. The minimum and maximum average monthly temperatures of -28°C and 14°C occur in January and July, respectively. Channel freeze-up generally occurs in late October or early November, and ice break-up generally occurs in May or early June.

Regional wind speed data are not available near the Project area, so mean monthly values were derived from the measured Goose Property record. The mean annual wind speed on site is approximately 4.4 m/s, with the wind direction exhibiting strong seasonality. The maximum recorded wind gust during the monitoring period was measured at 30.7 m/s (111 km/h).

The mean annual precipitation at the Property is estimated to be 413 mm, with approximately 55% falling as rain and 45% falling as snow. This estimate takes into consideration potential undercatch at the Goose Property station and is calibrated to the long-term mean annual runoff derived for the Project area. Monthly average total precipitation is presented in Table 5.1-2.

The annual long-term lake evaporation (including sublimation) in the region is about 324 mm; the strongest control on evaporation is net radiation. Annual actual evapotranspiration from the tundra is estimated to be approximately 199 mm.

Hydrometric data are currently being collected at 25 stations in the immediate Project area. Of these stations, the Propeller Lake inflow (PL-H2) and outflow (PL-H1) stations were deemed to be the most complete and representative for the Property. The 2011 monitoring year had the longest continuous record, including spring freshet and late summer flows, and was therefore used in the development of long-term synthetic flow series for the Project area.

Due to the incompleteness of the records, a regional analysis was conducted using 11 hydrometric stations from the Water Survey of Canada to determine regional hydrologic trends. The Baillie River near the Mouth Water Survey of Canada station (10RA002) was found to be the most comparable regional station to the 2011 local hydrometric station records (i.e., PL-H1 and PL-H2). The 25 years of flow data from Baillie River were corrected to the site, generating a continuous flow record for the Project. The resultant long-term mean annual runoff for the Project area is 149 mm.

Table 5.1-2 presents the runoff, total precipitation, evaporation and air temperature characteristics of the Back River Property. Table 5.1-3 presents the estimated extreme values of annual precipitation and runoff for various return periods at the mine site based on frequency analyses.

Table 5.1-2: Summary of Mean Hydrologic Inputs

Month	Runoff		Total Precipitation (mm)	Evaporation		Air Temperature (°C)
	Distribution (%)	Mean (mm)		Distribution (%)	Mean (mm)	
January	0.0%	0.0	26.9	0.0%	0	-29.1
February	0.0%	0.0	22.5	0.0%	0	-28.7
March	0.0%	0.0	29.2	0.0%	0.1	-26.1
April	0.0%	0.0	27.8	1.8%	5.9	-16.4
May	1.9%	2.9	28.9	8.0%	25.8	-5.3
June	66.3%	98.6	39.5	29.8%	96.4	6.1
July	10.1%	15.0	41.7	33.0%	106.7	12.5
August	14.8%	22.1	61.1	20.3%	65.8	10.0
September	6.8%	10.2	40.3	6.9%	22.4	2.6
October	0.0%	0.0	39.3	0.1%	0.4	-6.7
November	0.0%	0.0	29.7	0.0%	0	-19.9
December	0.0%	0.0	25.1	0.0%	0	-25.7
Annual	100.0%	149	413	100.0%	324	-10.5

Source: "Z:\01_SITES\Back River\1CS020.017_2019 Water Mgmt & Earthworks Design\1100_Water_Load_Balance\Inputs\BackRiver_Runoff_Distribution_mgs.xlsx

Table 5.1-3: Summary of Frequency Analysis for Annual Runoff and Precipitation

Hydrological Condition	Return Period	Annual Runoff (mm)	Annual Precipitation (mm)
Wet	200	269	658
	100	258	632
	50	245	603
	20	227	562
	10	210	527
	5	190	487
Average	-	151	413
Dry	5	112	344
	10	92	311
	20	75	284
	50	56	256
	100	44	238
	200	32	221

Source:\\srk.ad\DFS\na\van\Projects\01_SITES\Back River\1CS020.017_2019 Water Mgmt & Earthworks Design\1100_Water_Load_Balance\Inputs\Hydrology\Time series for WB.xlsx

5.1.4.1 Climate Change

Climate change projections over the Project life were developed in SRK (2015d). While most surface water management infrastructure will have a short lifespan and be breached as soon as their effective use has been fulfilled, Waste Rock Storage Areas and pits will remain in perpetuity. Climate change has now been incorporated into the Water and Load Balance model and the water management plan.

The long-term air temperature and precipitation trends are compared to a baseline set from 1979 – 2005 and provided in Table 5.1-4. These values were input into the Water and Load Balance model and interpolated linearly centred on 2025, 2055, and 2085 for the 2020s, 2050s, and 2080s periods, respectively.

Table 5.1-4: Long-Term Air Temperature and Precipitation Projections

Period	Change over Baseline (1979 – 2005)	
	Mean Annual Air Temperature	Total Annual Precipitation
2020s (2011 – 2040)	+2.0°C	+6%
2050s (2041 – 2070)	+3.7°C	+11%
2080s (2071 – 2100)	+5.3°C	+16%

Source: 01_SITES\Back River\1CS020.017_2019 Water Mgmt & Earthworks Design\1100_Water_Load_Balance\Inputs\BackRiver_Runoff_Distribution_mgs.xlsx

5.1.4.2 Hydrology

5.1.4.2.1 Waterbody Description

The Property is predominantly located within the Queen Maud Gulf Watershed with a small portion in the Back River Watershed (Nunavut Water Regulations, Schedule 4). This is shown in Modification Package Appendix A, Figure 1. The Project is composed of two main areas, the Goose Property area and the MLA. The majority of proposed infrastructure at the Goose Property area is within the Queen Maud Gulf Watershed, which flows northwest and enters the ocean on the west side of Bathurst Inlet. The Back River Watershed is located south of the Goose Property and flows east eventually entering the Arctic Ocean south of Gjoa Haven. The MLA is a narrow strip of land that drains directly to the west side Bathurst Inlet. A list of all waterbodies within the Potential Development Area can be found in FEIS Volume 6, Chapter 3 (Sabina 2015).

The Goose Property is divided by several smaller drainage areas each contributing to the larger, previously described watersheds. These drainage areas are shown on Figure A-19. This figure also indicates flow direction and the lakes in which bathymetry has been completed.

5.1.4.2.2 Hydrological Processes

The Project lies within the continuous permafrost zone of the continental Canadian Arctic. The physiography of the region is dominated by vegetated tundra hillslopes with lakes and scattered wetlands. The presence of permafrost is hydrologically influential, as it has very low hydraulic conductivity, and thus acts as a barrier to deep groundwater recharge. The physical restriction tends to increase surface water runoff and decrease infiltration.

Compared to unfrozen regions, permafrost watersheds tend to have higher peak flows and lower baseflows (Kane 1997). Streamflow in the continuous permafrost zone is governed by the Arctic nival regime, where runoff is dominated by high, snowmelt-driven flows in spring (the freshet). Following freshet, streamflow declines throughout the summer and early fall, with the exception of rare and episodic rainfall-generated runoff (Church 1974).

Channel freeze-up typically occurs between late October and early November. In smaller drainage basins, stream channels typically freeze to their bottom, with zero flow occurring in winter. In very large catchments and larger lake outlets, depth, flow energy, and water turbulence may be sufficient to maintain streamflow and prevent downstream reaches from freezing completely.

Ice begins to form in October and is generally present on lakes until July. Ice depths are typically 1.5 to 2 m and reach their maximum depth in February (Fish Offsetting Plan; Sabina 2019a). Shallow water bodies, including most streams in the Project area, generally freeze to bottom over winter.

The maximum daily snowmelt rate was determined to be 28 mm/day (Sabina 2015, Appendix V2-7B). Snowmelt occurs in the month of May and June. The open water season typically starts in July and ends in September; however, there are variations in the length of the open water season year to year (Rescan 2014).

Return period unit peak flows were calculated using the index flood method, and a precipitation-based hydrology model with Soil Conservation Service unit hydrographs and curve numbers. Curve numbers were calibrated for each return period using two smaller regional gauging stations from the Ekati Diamond Mine (Sabina 2015, Appendix V2-7B).

5.2 MINE DEVELOPMENT PLAN

The total mine life of the Project from Construction to the end of Closure is estimated to be approximately 28 years. The mine life was divided into four phases and two stages in both Operations and Closure to describe key periods as detailed in Table 5.2-1.

Table 5.2-1: Mine Phase and Stage

Phase	Stage	Description	Start	End	Comment
1	-	Construction	Y-3, Q1	Y-1, Q4	*Build Process Plant and TSF; start Umwelt open pit mining*
2	1	Operations - TSF	Y1, Q1	Y5, Q1	*Begin milling and tailings deposition in TSF*
	2	Operations - Llama TF	Y5, Q2	Y12, Q4	*Continue milling and tailings deposition in Llama TF*
3	1	Closure – Active Closure	Y12, Q4	Y14, Q4	*Active site closure, remove site infrastructure, and passive pit flooding and continued water treatment (seasonal), if required*
	2	Closure – Passive Closure	Y15, Q1	Y19, Q4	*Passive pit flooding and continued water treatment (seasonal), if required*
4	-	Post-Closure	Y20, Q1	+	*Site closed; performance monitoring*

The Construction Phase will occur over approximately three years, and involve dewatering, pit excavation, and the construction of tailings management and water management structures as well as pads and roads. Major mine development infrastructure will be constructed at both the Goose Property and the MLA. The design of water management conveyance structures is described in detail in Section 8.

The major infrastructure at the Goose Property will include the following:

- Goose Plant Site (Goose Camp Accommodations and Process Plant);
- Ore Stockpile;
- Tailings management facilities (i.e., Tailings Storage Facility [TSF], Llama Pit as Llama Tailings Facility [TF]);
- Waste Rock Storage Areas (WRSAs) (Umwelt WRSA, Llama WRSA, and TSF WRSA);
- Goose Property All-weather Airstrip;
- Saline Water Pond (Umwelt Lake, once dewatered);
- Umwelt Reservoir (Umwelt Pit as meromictic lake);
- Event Ponds (i.e., Llama WRSA Pond, Primary Pond, Plant Site Pond);
- Haul and service roads; and
- Open pits and underground mine workings (Umwelt, Llama, and Goose Main open pits; Umwelt Underground).

The infrastructure at the MLA will include the following:

- Industrial area including camp and storage areas;
- Hazardous waste management area and landfarm;
- Desalination plant and associated water management infrastructure;

- Construction laydown area; and
- Fuel storage and offloading pad.

The Operations Phase will extend for 12 years and will consist of both open pit and underground mining at the Goose Property. Two tailings management facilities will be operated sequentially through Operations; a purpose-built TSF and a mined-out open pit (Llama TF). Deposition in each tailings management facility is presented as a separate stage within the Operations Phase.

Three deposits; namely Umwelt, Llama, and Goose Main, will be mined by open pit and Umwelt will also include an underground mine. The mining schedule for each deposit is described in Table 5.2-2. Ore will be produced over approximately ten years; the mill will continue to operate from ore stockpiles for the remaining approximately two years of Operations. A total of 12.4 Mt of ore will be processed from open pit and underground developments, at a milling rate of 3,000 tpd.

Table 5.2-2: Summary of Mine Schedule

Mine Operation	Start	End
Open Pit Development		
Umwelt Open Pit	Y-1, Q2	Y2, Q3
Llama Open Pit	Y1, Q3	Y5, Q1
Goose Main Open Pit	Y3, Q4	Y8, Q3
Underground Development		
Umwelt Underground Mine [1]	Y-3, Q1	Y9, Q1

1) *From Year -3 to Year -1, the underground development is for portal and ramp development only. Underground production begins in Year 1, Q1.*

In recognition that the refined mine plan (see 2020 Modification Package, Section 3.1.3 for details) is a subset of the previously approved permitted mine plan, Sabina acknowledges that, with the continued advancement in Detailed Engineering and market consideration, the previously approved deposits may be reintegrated into this updated mine plan; namely: Llama Underground, Goose Main Underground, Echo Open Pit, and Echo Underground. Should Sabina choose to include these mining areas in the future mine plan, all applicable management plans, including the WMP, will be updated to reflect these changes, and Sabina will adhere to all appropriate requirements of the Back River Project Certificate (PC No. 007) and the Type A Water Licence (2AM-BRP1831).

The Closure Phase will occur over approximately eight years. The majority of the mine workings, tailings structures, and water management structures will be decommissioned throughout Closure. The Project will subsequently enter Post-Closure, which will consist of monitoring and adaptive management.

The development sequence for mining and water management activities is summarized in Table 5.2-3 and is shown in Figures A-03 through A-08 in Appendix A. For detailed activity descriptions of the phases and stages of Water Management refer to Section 8.

Table 5.2-3: Mine Development Sequence

Mine Year	Mine Development Sequence and Key Activities
-3	**Phase 1 – Construction** • Main Construction activities begin, including construction of the Goose Plant Site and Camp area. • Water intake infrastructure is constructed at Goose Lake and Big Lake to meet the freshwater demands for domestic, construction, operation, and associated uses, including mining and milling activities. • One culvert crossing location in the Goose Airstrip is constructed. • Umwelt Underground exploration decline begins.
-2	**Phase 1 – Construction** • Water discharge infrastructure is constructed at Umwelt and Llama Lake to prepare for lake dewatering activities and fish-out activities. • The Primary Pond is constructed. • The TSF Main Containment Dam and TSF South Dyke are constructed; the downstream collection berm (called the TSF WRSA Diversion Berm) is also constructed. • Four culvert crossing locations in the all-weather roads are constructed. • The Plant Site Pond is constructed. • Umwelt Underground decline continues. • Refer to Figure A-04 and Section 8.1 for additional clarification.
-1	**Phase 1 – Construction** • Llama Lake is dewatered to Goose Lake via Umwelt Lake; assumes 50% of water requires treatment for TSS. • Umwelt Lake is fully dewatered to Goose Lake to allow for construction of the Saline Water Pond assumes 50% of water requires treatment for TSS. • The Saline Water Pond is constructed. • Umwelt Open Pit development begins. • Reclaim water is pumped from the Primary Pond to the Process Plant during Year -1 and Year 1. • Refer to Figure A-04 and Section 8.1 for additional clarification.
1	**Phase 2 – Operations: Stage 1** • Milling operations begin (* this could occur as early as Y-1, Q4) • Tailings deposition begins in the TSF (* this could occur as early as Y-1, Q4); TSF WRSA Diversion Berm will collect any seepage from the TSF which will be pumped back into the TSF, or discharged to the environment, as appropriate. • Withdrawal of ore from the Ore Stockpile begins. • The Llama WRSA Pond containment dams are constructed. • Llama Open Pit mining operations begin; saline pit inflows are pumped to the Saline Water Pond, which continues through open pit operations. • Waste rock deposition in the Llama WRSA begins. • Contact water from the Llama WRSA Pond and the Plant Site Pond will be pumped to the Primary Pond. • Reclaim water is pumped from the Primary Pond to the Process Plant during Year -1 and Year 1. • Umwelt Underground mining begins. • Umwelt Underground groundwater is pumped to the Saline Water Pond, which continues throughout underground operations. • Refer to Figure A-05 and Section 8.2 for additional clarification.
2	**Phase 2 – Operations: Stage 1** • Umwelt Open Pit mining operations are completed. • Deposition of waste rock in the Umwelt WRSA is complete. • Reclaim water source becomes the TSF during Year 2 until it's dewatered in Year 12. • A non-contact water diversion berm, called the Goose Pit Diversion Berm, is constructed south of Goose Main Open Pit to divert water away from the pit and into Goose Lake via the Goose Culvert. • Refer to Figure A-05 and Section 8.2 for additional clarification.
3	**Phase 2 – Operations: Stage 1** • Saline Water Pond is dewatered to the bottom of Umwelt Reservoir during the open water season. • Primary Pond is dewatered via reclaim to Process Plant, and breached to Umwelt Reservoir, forming a freshwater cap above saline water. • The mined-out Umwelt Open Pit permanently becomes Umwelt Reservoir and stores excess contact water. • Goose Main Open Pit development and mining begins; contact water in Goose Main Open Pit is pumped to the TSF. • Waste rock deposition on the TSF (TSF WRSA) begins; waste rock sourced from Goose Main Open Pit. Refer to Figure A-05 (Stage 1) and Section 8.2 for additional clarification.

Mine Year	Mine Development Sequence and Key Activities
4	**Phase 2 – Operations: Stage 1** • No changes from previous year. • Saline Water Pond is dewatered to the bottom of Umwelt Reservoir Year 3 and Year 4. • Saline Water Pond breached, and the area is remediated. • Refer to Figure A-05 and Section 8.2 for additional clarification.
5	**Phase 2 – Operations: Stage 1** • Llama Open Pit mining is complete at the beginning of Year 5, and tailings deposition is transitioned from the TSF into Llama Tailings Facility (Llama TF). **Phase 2 – Operations: Stage 2 begins** • Contact water in Goose Main Open Pit is pumped to the TSF. • Contact water in Plant Site Pond is pumped to Llama TF. • Llama WRSA Pond containment structures are breached to Llama TF. • Water Treatment Plant becomes operational year-round from Year 5 to Year 11 from Llama TF with water recirculated back into Llama TF. • Reclaim water for the Process Plant continues from the TSF until dewatered in Year 12, Q2. • All groundwater inflows from Umwelt Underground continue to be pumped to lower saline layer of Umwelt Reservoir. • Refer to Figure A-05 (Stage 1), Figure A-06 (Stage 2) and Section 8.2 for additional clarification.
6	**Phase 2 – Operations: Stage 2** • No changes from previous year. • Refer to Figure A-06 (Stage 2) and Section 8.2 for additional clarification.
7	**Phase 2 – Operations: Stage 2** • No changes from previous year. • Refer to Figure A-06 (Stage 2) and Section 8.2 for additional clarification.
8	**Phase 2 – Operations: Stage 2** • Goose Main Open Pit mining is complete, and the facility becomes Goose Main Reservoir. • Goose Main Pit Diversion Berm is breached, allowing the open pit to passively flood. • Waste rock deposition in the TSF WRSA is completed. • Refer to Figure A-06 (Stage 2) and Section 8.2 for additional clarification.
9	**Phase 2 – Operations: Stage 2** • No changes from previous year. • Refer to Figure A-06 (Stage 2) and Section 8.2 for additional clarification.
10	**Phase 2 – Operations: Stage 2** • No changes from previous year. • Portion of saline water from Umwelt Reservoir pumped into mined-out Umwelt Underground. • Refer to Figure A-06 (Stage 2) and Section 8.2 for additional clarification.
11	**Phase 2 – Operations: Stage 2** • Water treatment at Llama TF is completed. • Refer to Figure A-06 (Stage 2) and Section 8.2 for additional clarification.
12	**Phase 2 – Operations: Stage 2** • Reclaim water source transitions from the TSF (now dewatered) to Llama TF For Year 12, Q3&4. • Milling at Process Plant completed. • Refer to Figure A-06 (Stage 2) and Section 8.2 for additional clarification.
13 – 20	**Phase 3 – Closure** • Active closure phase begins with decommissioning of remaining infrastructure. • Open pits passively flood and overtop and restore natural drainage. • Monitoring to ensure compliance with regulatory requirements. • Decommission Water Treatment Plant. • Refer to Figure A-07 (Closure) and Section 8.3 for additional information related to closure.
21+	**Phase 4 – Post-Closure** • Monitoring to ensure compliance with regulatory requirements. • Refer to Figure A-08 (Post-Closure) and Section 8.4 for additional information related to post-closure. • Refer to the Interim Closure and Reclamation Plan for additional information.

5.2.1 Mine Waste Management Summary

This subsection provides a summary of the mine waste management plans. Detailed plans regarding the management of tailings, overburden, and waste rock are presented in the Tailings Management Plan (WL SD-09) and the Mine Waste Rock Management Plan (MWRMP; WL SD-08).

Table 5.2-4 presents a summary of the estimated tonnages of waste materials that will be produced by the Project. The table also indicates the quantities of waste materials that will be deposited in each waste storage facility, or if the material will be used for another purpose. There are three WRSAs: Umwelt WRSA, Llama WRSA, and TSF WRSA. Where two storage facilities are presented in the table as the destination for a quantity of materials, the exact quantity distribution between the facilities will be determined based on on-site conditions and requirements.

Table 5.2-4: Mine Waste Summary

Waste Type	Estimated Quantities (Mt)		Source Area and Destination
Overburden	6.5	1.2	Removed from the Umwelt Open Pit and stored in Umwelt WRSA.
		1.3	Removed from the Llama Open Pit and stored in the Llama WRSA.
		4.0	Removed from the Goose Main Open Pit and stored in the TSF WRSA.
Waste Rock	86.6	14.2	Removed from the Umwelt Open Pit and stored in the Umwelt WRSA, as well as used for general site construction and TSF Dam construction.
		29.1	Removed from the Llama Open Pit and stored in the Llama WRSA.
		43.3	Removed from the Goose Main Open Pit and stored in the TSF WRSA.
Tailings	12.4	4.4	Stored in the TSF.
		8.0	Stored in the Llama TF.

Should Sabina identify additional opportunities for the use of other open pits as TFs or WRSAs, or the expansion of current waste management facilities, 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.

5.2.2 Overburden Management

Overburden will be removed from the surface footprint of the three open pits (quantities as shown in Table 5.2-4). A majority of the overburden materials will be co-disposed of with waste rock in the WRSAs. Depending on the physical characteristics of the overburden material, a portion may be used for the construction of site infrastructure, kept for future revegetation studies/efforts, or used for WRSA cover material. Refer to the MWRMP (WL SD-08) for more details on overburden.

5.2.3 Waste Rock Management

A summary of the location and surface areas of each WRSA is included in Table 5.2-5. Details regarding approximate final waste rock material quantities and source locations are shown in Table 5.2-4. Only waste rock from the open pit mining operations will be deposited in the WRSAs. Waste rock from underground workings will be redeposited underground. Refer to the MWRMP (WL SD-08) for more details on waste rock.

Table 5.2-5: Waste Rock Storage Area Summary Information

Facility	Approximate Location	Surface Area (ha)
Llama WRSA	200 m southeast of the Llama Open Pit	42.9
Umwelt WRSA	200 m east of the Umwelt Open Pit	28.2
TSF WRSA	1,800 m south of the Goose Main Open Pit	172.6

5.2.4 Tailings Management

Approximately 12.4 Mt of tailings will be produced over the 12-year LOM. All tailings will be deposited as slurry. Initially, tailings will be deposited in the TSF, which is the only purpose-built tailings management facility on-site. Tailings deposition will transition Llama Open Pit once mining operations have ceased in that location (called Llama TF). The Operations Phase is described in stages according to the tailings storage and water management plans, as follows:

- Stage 1 – Tailings Storage Facility – For the first four years of Operations (Years 1 to 4), a purpose-built TSF will be utilized;
- Stage 2 – Llama Tailings Facility (Llama TF) – From Year 5 onward, tailings will be disposed of in the mined-out Llama Open Pit.

The TSF will be covered with waste rock and overburden material once tailings deposition is complete. Water covers with a minimum water depth of 5 m will be used for closure of the Llama TF.

Refer to the Tailings Management Plan (WL SD-09) for further tailings management details and design drawings associated with TSF retaining structures.

Should Sabina identify additional opportunities for the use of other open pits as TFs or WRSAs, or the expansion of current waste management facilities, 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.

5.2.5 Ore Management

There will be one main Ore Stockpile at the Goose Property located southeast of the Process Plant, and temporary stockpiles at the underground laydowns area (Modification Package Appendix A, Figure 3). The Ore Stockpile will contain three sub-stockpiles: low-grade, mid-grade, and high-grade ore. Ore will be processed during the Operations Phase only, and runoff from the ore stockpile areas will be collected and managed as site contact water. Refer to the Ore Storage Management Plan (WL SD-07) for more details.

6. Water Modelling and Design Criteria

The focus of water management is to control the inventory of mine water stored on site, and to maximize the separation of saline, contact, and non-contact water. Water management at the Property entails multiple, codependent components which include storage facilities and conveyance facilities. Water is stored using ponds (short-term storage) and reservoirs (long-term storage). Ponds are structures with a finite operational life and will be fully decommissioned at Closure. The ponds on site are a combination of event ponds and short term (few years) non-event water ponds. Event ponds are sized with retention capacity for specific design storms and are normally empty or will hold only a nominal amount of water. The non-event pond on site consist of the Saline Water Pond for saline water, and the contact water Primary Pond. These ponds have defined storage capacity. The Saline Water Pond will remain operational as a storage facility until the transfer of saline water to Umwelt Reservoir. The Primary Pond will remain in use to assist with lake dewatering (and associated TSS treatment), to help with the Process Plant start up as a water source, and to capture contact water until the Umwelt Open Pit mining is complete, at which point the Primary Pond can be breached to the Umwelt Reservoir.

Long-term (i.e., permanent) water storage facilities are denoted as reservoirs, and include the three pit lakes (Llama, Umwelt, and Goose Main). Note the Llama Pit is also called Llama TF as it will permanently hold tailings as well as act as long-term water storage.

Sumps in each of the open pits will be used to collect water during acting mining, which may later be conveyed to an alternative reservoir via pipeline in accordance with the WMP.

Diversions are engineered structures that maintain separation between contact and non-contact water. These structures are constructed for the Operations Phase of the Project and are completely decommissioned during Closure.

6.1 WATER AND LOAD BALANCE

The Water and Load Balance model (the model) was used as a tool to analyze water management options during the life of the Project. For additional information refer to the Water and Load Balance Report (Appendix E). Where necessary, treatment and discharges of mine water were assessed to manage excess site-wide contact water and meet water quality guidelines downstream of discharge points from the Goose Property.

The Water and Load Balance model for the Project was developed using the GoldSim© software package (version 12.1.3) (GoldSim Technology Group 2019). The model was run on a daily time step and runs from Year -2 to Year 47. This run length was chosen as it allows the model to run until steady-state conditions are reached in pits and downstream receptors.

The Water and Load Balance Report (Appendix E) includes a detailed description of the model assumptions, framework, inputs and results, and an overview of the model limitations and sensitivity analysis. The report also provides details on the main mine components relevant to the water quality predictions, including the mine plan, open pits, underground facilities, WRSAs, Ore Stockpile, and water reservoirs. Flowsheets for each phase of the Project, including Construction, Operations, and Closure, are presented in Appendix D. The flowsheets depict the water management strategy that was implemented for the Project, cumulative volumes, and change in storage over the period of a specified Project phase.

The Water and Load Balance Model shall be reviewed periodically, to reflect changes in operations and/or technology and submit results for review with the Annual Report in accordance with the Type A Water Licence (2AM-BRP1831, Part B, Item 2) as appendix to the approved Water Management Plan.

6.1.1 Water Balance Overview

The monthly operational water balance model is based on mass balance principles, available hydrology inputs, mining and production schedules, developed water management plans, and best available water chemistry and source load inputs. The water balance tracks all inputs, outflows, and available storage at the site. The water balance can be represented in a simplistic form as follows:

$$\text{Water Storage} = \text{Water Input} - \text{Water Output} \qquad \text{(eq. 6a)}$$

The total water inputs to the site are groundwater from taliks, as described in Section 5.1, and precipitation (direct precipitation on ponds/lakes, and runoff). The primary sources of storage available at the Goose Property are the open pits, TSF, and tailings pores. Water outputs from the Goose Property are discharges such as treated effluent, pit overflows to downstream receptors, evaporation, and seepage.

In general terms, runoff and direct precipitation on ponded areas can be represented as follows:

$$Surface\ Runoff = Area \times Precipitation \times Runoff\ Coefficient \qquad \text{(eq. 6b)}$$

$$Direct\ Precipitation\ Rate = Pond\ Area \times \mathrm{P}recipitation\ Release\ Rate \qquad \text{(eq. 6c)}$$

The runoff coefficient accounts for losses such as evaporation and infiltration.

The modelling of the WRSAs was simplified in the water balance. A runoff coefficient was applied to estimate the net total runoff at the toe of a WRSA. This runoff coefficient accounts for all losses such as evaporation, seepage to the groundwater table, and loss of storage in the waste rock voids. As such, runoff from a waste rock surface area was evaluated using equation 6b.

Additional details on the Water and Load Balance model, including model inputs and hydrology assumptions, are presented in Water and Load Balance Report (Appendix E).

6.1.2 Water Quality Overview

The load balance for the Project was developed to evaluate the potential effects of water quality parameter loadings from mine components on water quality in downstream receptors, such as Goose Lake and Propeller Lake. The load balance and water quality predictions were also used as a tool to optimize the water management and treatment requirements during Operations and Closure.

The load balance is based on conservation of mass. Loadings and concentrations were calculated for each mine component, and loading rates were generated for each corresponding inflow of the water balance. There are two types of loading rates included in the load balance model:

- Direct loadings based on a defined input source term; and
- Linked loading from reservoirs (i.e., open pits or lakes).

The majority of the loading rates are calculated based on the concentrations of source terms (eq. 6d) but can also be based on loading per unit volumes (eq. 6e).

$$Inflow\ Loading\ Rate = Inflow \times Source\ Term\ Concentration \qquad \text{(eq. 6d)}$$

$$Inflow\ Loading\ Rate = Load\ per\ Unit\ Volume \times Rock\ Volume\ Flooded \times Flush\ Factor \qquad \text{(eq. 6e)}$$

Linked inflow loading rates (eq. 6f) from another facility are calculated based on the calculated concentration (eq. 6g) for the facility and associated inflow volume from the water balance.

$$Inflow\ Loading\ Rate = Inflow \times Calculated\ Concentration \qquad \text{(eq. 6f)}$$

$$Concentration = \frac{Load\ (L)}{Volume\ (V)} \qquad \text{(eq. 6g)}$$

Detailed source term concentrations and loading rates are presented in Appendix C of the Water and Load Balance Report (Appendix E).

6.1.3 Prediction Nodes

The objective of the Water and Load Balance model is to predict water quality at the Goose Property, as well as the effect to downstream receptors, if any.

Predictions were evaluated in pits and ponds at the Goose Property, as well as at downstream control points. A total of 10 prediction nodes were included in the model. The prediction nodes were strategically chosen to assess the flow and water quality effects from Project infrastructure and to optimize the required water treatment to meet water quality objectives. Details regarding the catchment areas and mine infrastructure contributing runoff to each node are shown in Figure A-01 and presented in Table 3-5 of the Water and Load Balance Report (Appendix E). The water diversions upstream of Goose Lake were accounted for in the Water and Load Balance model.

6.1.4 Water Balance Predictions

Water balance predictions were generated by running the model as a Monte Carlo simulation. Predictions are presented for the 5th, 50th, and 95th percentiles, where the 50th percentile represents the median of all outcomes. The median values represent the results that are most likely to occur (i.e., which have the highest probability of occurrence). Additional details on the stochastic water balance model are presented in the updated Water and Load Balance Report (Appendix E).

6.1.4.1 Open Pit and Reservoir Surface Water

The open pits will be passively filled by breaching various water management structures, thereby allowing both contact and non-contact water to fill the pits. Once flooding is complete, open pit reservoirs will discharge into nearby watercourses, where they will meet applicable discharge criteria and eventually discharge into Goose Lake. The year and quarter that each pit is expected to fill under the 5th, 50th, and 95th percentile is presented in Table 6.1-1.

Table 6.1-1: Goose Property Pit and Reservoir Fill Time

Facility	Result	5th Percentile	50th Percentile	95th Percentile
Llama TF	Fill Date	Y11, Q2	Y11, Q2	Y11, Q1
Umwelt Reservoir	Fill Date	Y12, Q2	Y11, Q2	Y11, Q2
Goose Main Reservoir	Fill Date	Y14, Q2	Y13, Q3	Y13, Q2

6.1.4.2 Open Pit and Underground Workings Groundwater

Umwelt Underground and Llama Open Pit both capture groundwater inflows (Table 5.1-1). These inflow quantities were included in the Water and Load Balance model (Appendix E).

6.1.4.3 Prediction Node Flow Results

To assess the effect of the Project to baseline hydrology, the change in monthly flows at each prediction node and water levels for Goose Lake and Propeller Lake for the 5th, 50th, and 95th percentile water balance predictions were modelled. Detailed monthly summary of the results for each prediction node can be found in Appendix G of the Water and Load Balance Report (Appendix E). The supporting figures in the Water and Load Balance Report (Appendix E) provide a summary of annual flows for the downstream prediction nodes, and Figure 6-16 of the same report provides a summary of the average annual change in water levels for Goose Lake and Propeller Lake.

The prediction node, PN01 (Figure A-03), has negligible effects from the Project as it includes a large catchment area compared to the Project infrastructure. PN02 and PN03 are located at the outlet of Propeller Lake and Goose Lake, respectively. These prediction nodes illustrate that during Operations and Closure, downstream flows are reduced as water is kept on site for water reclaim and pit filling. During Post-Closure, flows are greater than baseline as runoff coefficients from the Property infrastructure (i.e., frozen WRSAs) are greater than natural conditions.

PN04 illustrate flows downstream of Llama and Umwelt open pits. As expected, flows during Operations are lower than baseline as water from Project infrastructure is captured and used for Operations. Maximum change over baseline occurs in Year 11 when Llama TF overflows.

PN07 flows are directed towards PN05 during Construction, Operations, Closure and Post-Closure. This is due to the Goose Main Open Pit being located immediately upstream of PN07 cutting off flows to this prediction node. PN05 represents discharge from Goose Main Open Pit. As expected, flows during Operations are lower than baseline as water from Project infrastructure is captured and used for Operations. PN05 catchment spills to PN08 once the Goose Diversion is built and flows to Goose Main Pit once mining is complete.

PN06 is located at the outlet of Giraffe Lake and receives undisturbed and road runoff. PN06 catchment flows spill over PN04. PN08 is located at the Gander outlet. PN08 Project flows are greater than baseline due to the spill flow from PN05 after Goose Main Diversion Berm is built.

PN09 is located at the Echo culvert crossing location (C4) and PN10 is located at the Mam Lake outflow. Both nodes receive undisturbed and road runoff and change over baseline remains relatively constant throughout Operations. PN10 flows spill over PN04 during high flows.

6.1.5 Water Quality Predictions

The predicted water quality concentrations are based on a deterministic modelling approach, assuming average hydrological conditions. This approach is consistent with the derivation of source terms, which were developed based on average hydrology. Water quality results at each prediction node are presented in the Water and Load Balance Report (Appendix E) and are compared with Metal and Diamond Mining Effluent Regulations (MDMER; Canada Gazette 2020) and Site-specific Water Quality Objectives (SSWQOs). This section of the WMP provides a summary of receiving water quality during the Closure and Post-Closure phases. There will be no discharge of effluent to the receiving environment during Operations, until Llama TF and Umwelt Reservoir overtop in Year 11 under average hydrologic conditions.

It should also be noted that Llama TF, Umwelt Reservoir, and Goose Main Reservoir will at no time be fish bearing waterbodies.

Monthly average water quality predictions for dissolved metal concentrations were assessed for three prediction nodes located upstream and downstream of Goose Lake. Water quality results were compared to MDMER limits, coupled with SSWQOs, in order to evaluate water treatment requirements. Parameters highlighted in the Water and Load Balance Report (Appendix E) include ammonia, chloride, sulphate, arsenic, and copper.

PN04, which is located downstream of Llama TF and Umwelt Reservoir, will meet MDMER limits for ammonia, arsenic, and copper. To meet this requirement, treatment for ammonia is proposed to begin during Operations in Year 5, soon after tailings deposition begins in Llama TF. This ammonia treatment may last for approximately 6 years at a rate of approximately 8,500 m^3/day. Final treatment rates will be based on the detailed design of the water treatment plants.

Goose Main Reservoir is the facility upstream of the PN05 node, which is at the Goose Lake inlet. Goose Main Reservoir also must meet MDMER limits for ammonia, arsenic, and copper when it overflows in the second quarter of Year 13 under average hydrologic conditions. The predictions for these parameters are presented as a time series in Appendix E and indicate that these are below MDMER limits.

PN03 node is located at the outflow of Goose Lake towards Propeller Lake. The SSWQO limits were applied at this node, specifically adjusted limits for arsenic and copper. Average monthly concentrations at PN03 for ammonia, chloride, sulphate, arsenic, and copper are presented in Appendix E and show that arsenic meets the site-specific limit at PN03. In addition, Sabina anticipates that water treatment for copper will also be required in Llama TF for approximately one year at a rate of approximately 8,500 m^3/day (see Table 7.4-1) to meet the SSWQO for copper at PN03.

Table 6.1-2 summarizes the average monthly water quality concentrations at the time of flooding and the average open water long-term steady state conditions at the downstream prediction nodes of the flooded open pits. The results in Table 6.1-2 include water treatment of Llama TF to reduce TSS, arsenic, copper, and ammonia concentrations. Long-term steady state conditions are expected to meet MDMER limits during Operations and Closure at PN04 (Goose Neck), and will meet SSWQOs at PN03 (outlet of Goose Lake). Water treatment will continue from Operations into the Closure Phase as required to meet MDMER Schedule 4 limits and SSWQOs.

As per Part E, Item 2b of the Type A Water Licence (2AM-BRP-1831), Sabina has updated the WMP to include further details respecting potential management and treatment options related to water quality in the effluent discharged from flooded pits and the downstream receiving environment. Sabina notes that, as per Part E, Item 15b of the Type A Water Licence (2AM-BRP-1831), Sabina is required to provide an updated Hydrodynamic model. Sabina intends to submit this updated Hydrodynamic model as part of the NWB process associated with the 2020 Modification Package. This updated Hydrodynamic model will be utilized to verify the Water and Load Balance model, determine treatment options required to meet CCME guidelines, and to establish potential associated regulated mixing zones within the receiving environment.

Sabina will also update and validate the model predictions, and results will be provided through an updated Water and Load Balance Report, as per Part E, Item 16 of the Type A Water Licence (2AM-BRP1831).

Table 6.1-2: Water Quality Results for the Goose Property (with Operations Phase Water Treatment)

Parameter	MDMER[1]	SWQO[2]	PN04 (Goose Neck)		PN03 (Goose Outflow)		PN05 (East of Goose Main Pit)	
			At Flooding[3]	Long-term[4]	At Flooding[3]	Long-term[4]	At Flooding[3]	Long-term[4]
Total CN as N	0.5	0.005	0.00592	0.000495	0.001694	0.000498	0.003091	0.00081
Chloride	-	-	80.96	1.715354	17.9	1.415023	2.992	0.833019
Ammonia as N[5]	0.5[5]	-	0.5	0.0003	0.06	0.0001	0.009	0.00001
Arsenic	0.1	0.01	0.03996	0.002235	0.009199	0.0022	0.009775	0.003109
Copper	0.1	0.0042	0.0153	0.000719	0.004648	0.000833	0.002454	0.000781
Lead	0.08	-	0.0007735	6.26E-05	0.000215	3.60E-05	5.69E-05	1.83E-05
Nickel	0.25	-	0.009163	0.002464	0.007535	0.003019	0.01009	0.003173
Zinc	0.4	-	0.00351	0.000698	0.002104	0.000841	0.002805	0.000885

Note: Units are mg/L unless otherwise noted; - = no guideline; values in bold are above Site-specific Water Quality Objectives.
1) Proposed Metal and Diamond Mining Effluent Regulations; Maximum Monthly Mean Concentrations
2) SSWQO – Site Specific Water Quality Objectives
3) Monthly Average
4) Annual Open Water Average
5) pH (8.1) and temperature (15ºC) were used in the predictions to convert total ammonia to unionized ammonia

6.2 HYDROTECHNICAL DESIGN CRITERIA

The hydrotechnical design criteria for the Project include a combination of BMPs and specified criteria based on engineering and operational judgement and/or constructability considerations. Four classes of design criteria were considered: Table 6.2-1 presents the hydrologic design criteria used to formulate peak flows; Table 6.2-2 presents the design criteria used for sizing of pond infrastructure; Table 6.2-3 presents containment dam and diversion berm design criteria, and Table 6.2-4 presents culvert design criteria.

Table 6.2-1: Hydrologic Design Criteria for Formulating Peak Flows

Item	Value	Unit	Source
SCS Curve Number (Waste Rock)	84	-	George (2008)
SCS Curve Number (Natural Ground)	72-89	-	SRK (2015a)
SCS Curve Number (Pit Walls)	92	-	George (2008)
Critical Snowmelt Month	June	-	SRK (2015a)
June Average Snowmelt Rate	28	mm/day	SRK (2015a)
Rainfall Distribution	Type I	-	USDA (1986)
Minimum Time of Concentration	10	minutes	Engineering Judgement

SCS = Soil Conservation Service

Table 6.2-2: Pond (Event and Saline Water) Design Criteria

Item		Value	Unit	Source/Comments
Event Ponds	Event Return Period	10-100	Years	BMP. See Table 6.4-1
	Minimum Dewatering Requirement	2	days	Operational consideration
	Storage Requirement	24-hour total rainfall volume + snowmelt	m^3	BMP
	Minimum Freeboard	0.5	m	Engineering Judgement
Saline Water Pond	Storage Volume	1.1	Mm^3	95th percentile volume from SRK Water Balance (SRK 2015a)
	Minimum Freeboard	1.0 – 1.3	m	Saline Water Pond Freeboard Memo (Sabina 2017, Appendix A of Appendix F-1)

Table 6.2-3: Containment Dams (Event and Saline Water Ponds) and Diversion Berm Design Criteria

	Item	Value	Unit	Source/Comments
Diversion Berm Design	Event Return Period	10-100	Yrs	BMP
	Conveyance Capacity	24-hour total rainfall volume + Snowmelt	m³	BMP
	Manning's Roughness	0.035	-	For minor natural steam with stones and weeds (Chow 1994)
	Minimum Slope	0.005	m/m	BMP
	Upstream Side Slopes	2:1	(H:V)	Constructability consideration
	Downstream Side Slopes	1.5:1	(H:V)	Engineering judgement
	Berm Top Width - minimum	4	m	Constructability consideration
	Minimum Berm Height	2	m	Constructability consideration and for foundation permafrost preservation.
	Minimum Berm Freeboard	0.5	m	Engineering judgement and to allow for adequate time for maintenance if / as required
Event Pond Containment Dam Design	Minimum Dam Height	2	m	Constructability consideration
	Bedding Material Thickness around GCL	0.5	m	Engineering judgement
	Liner Tie-Back Length (without liner anchor trench)	3	m	Engineering judgement
	Liner Tie-Back Length (with anchor trench)	1	m	Engineering judgement and based on pull out calculations.
	Upstream Side Slope (Ponded Water Level > 4m) - minimum	3:1	(H:V)	Constructability consideration
	Upstream Side Slope (Ponded Water Level < 4m)	2:1	(H:V)	Constructability consideration
	Downstream Side Slopes	2:1	(H:V)	Stability and permafrost requirement
Saline Water Pond Containment Dam Design	Bedding Material Thickness around GCL	0.5	m	Engineering judgement
	Dam Top Width	8	m	Constructability consideration
	Minimum Dam Height	2	m	Constructability consideration
	Upstream Side Slope	3:1	(H:V)	Constructability consideration
	Downstream Side Slope - minimum	2:1	(H:V)	Engineering Judgement
	Liner Tie-Back Length (without liner anchor trench)	3	m	Engineering judgement
	Liner Tie-Back Length (with anchor trench)	1	m	Engineering judgement and based on pull out calculations.
	Key Trench Tie-in Depth - minimum	2.2	m	May be adjusted / deepened to 3m in areas where massive ice encountered in the foundation (Sabina 2017, Appendix C of Appendix F-1).

Table 6.2-4: Culvert Design Criteria

Item	Value	Unit	Source
Event Return Period	50 to 100 *	Years	BMP; SRK (2014)
Conveyance Capacity	24-hour total rainfall volume	m^3	BMP; SRK (2014)
Maximum Velocity during Average June flow for Fish Passage	1.5	m/s	SRK (2014)
Manning's Roughness for culverts with cobble stone base	0.040	-	Chow (1994)
Manning's Roughness for culverts without cobble stone base	0.024	-	Chow (1994)

** Event return period for culverts will be based on a location specific risk assessment. Wherever practical, a 100-year design event will be adopted (and will be required for high risk culvert locations) and a minimum 50-year design event will be use for all culverts.*

6.3 HYDROLOGIC MODEL

Hydrologic modelling was completed to appropriately design and size the water management infrastructure including ponds and pumps, and to verify the diversion structures were not likely to overtop during specified design storm events.

6.3.1 Catchment Delineation

The Goose Property was delineated into catchments associated with the TSF, and each pit (or TF), WRSA, underground pad, event pond, and diversion. Areas were also incorporated into the Water and Load Balance model to form predictive flow and water quality estimates.

Catchments were delineated in AutoCAD (AutoDesk) and Global Mapper™ (Blue Marble Geographics) using available LiDAR topography. Once delineated, the catchment characteristics, including average slope, total area and head differential, were calculated in Global Mapper. Catchments are presented in Figure A-01, and in Table 6.3-2.

6.3.2 Approach

Instantaneous peak flows and volumes for design storm events were generated in HEC-HMS software (US Army Corps of Engineers) using the design criteria summarized in Table 6.2-1 along with catchment areas presented in Table 6.3-2. Peak flows derived for a rain-on-snow event were used to size the water management infrastructure, and required storage volumes were determined based on the total snowmelt and rainfall accumulation over a 24-hour period. Resultant rainfall depths are summarized in Table 6.3-1.

6.3.2.1 Return Period Selection

The return period was selected for each structure based on the qualitative level of risk associated with overtopping or breaching of the structure, whether it was an event pond, open pit, or diversion. Three levels of risk were selected for the Project, with an associated return period (Table 6.3-1). The risk was determined using engineering judgement, taking into consideration the human health and safety, environmental, reputational, and economic consequences of the specified failure events.

Table 6.3-1: Return Period Selection Criteria

Level of Risk	Type of Facility	Return Period	Rainfall Depth[1] (mm)
Low	Non-contact water diversions Pit sumps	10	44.4
Medium	Contact water diversions Contact water event ponds with additional water infrastructure downstream Culverts on all-weather road away from primary infrastructure or not connected to other water management infrastructure systems	50	64.2
High	Contact water event ponds without downstream water infrastructure Culverts connected to water management infrastructure or near ponds, diversions or puts.	100	73.4

1) From SRK Hydrology Report (SRK 2015a) and increased based on the regional climate change work.

Infrastructure which has the potential to overtop/breach and discharge to the downstream environment was assigned a "High Risk". At the Goose Property, this includes the Llama WRSA Pond, Plant Site Pond, and TSF WRSA Diversion Berm. The Goose Property infrastructure and corresponding risk level are listed in Table 6.3-2, as well as their associated catchment areas. The culverts are assigned a risk rating (typically at medium risk and above) based on their connection to other water management elements.

For any structure that is classified as a 'dam' then the Canadian Dam Association (CDA 2013, 2014) standards must be applied and therefore override the return period selection criteria outlined in Table 6.3-1. Structures that classify as a dam includes the TSF Main Containment Dam, Saline Water Pond Containment Dam, and the Primary Pond Containment Dam.

Table 6.3-2: Level of Risk for Each Item of Goose Infrastructure and Contributing Catchment Areas

Infrastructure	Catchment ID	Catchment Area (km²)	Level of Risk	Type of Water	Pumped Inflow	Pumped Outflows	Embankment	Downstream Water Infrastructure
Umwelt Pit Sump	UP UU	0.23 0.10	Low	Contact Water	None	P1 Construction: to Primary Pond Operations: Plant / Llama TF as needed	No	N/A
Primary Pond Containment Dam (Primary Pond)	PPUWD2 LWD1 UWD1	0.35 0.17 0.24 0.16	Medium	Contact Water	Construction: P9, P4, P2 Operations Stage 1: P2	P7 Operations Stage 1: Process Plant	Yes	Saline Water Pond and Umwelt Pit
Llama Open Pit West Berm	LL	0.37	Medium	Non-Contact Water	None	None	No	Llama Lake Reservoir/Llama Pit
Llama Open Pit North Berm	LD2	0.30	High	Non-Contact Water	None	None	No	Llama Lake Reservoir/Llama Pit
Llama Reservoir Diversion Berm	LD1	0.52	Medium	Non-Contact Water Mixes with Contact Water in Llama WRSA Pond during Operations	None	None	No	Llama Lake Reservoir/Llama Pit Llama WRSA Pond
Llama WRSA Containment Dam and Llama Pit East Berm (Llama WRSA Pond)	LCP LWD2	0.08 0.18	High	Contact Water	None	P8	Yes	Llama Lake Reservoir/Llama Pit
Llama Pit Sump	LP	0.23	Low	Saline Water	None	P9	No	Saline Water Pond
Plant Site Pond	OD MA	0.14 0.46	High	Contact Water	None	P3 To pit reservoirs during Operations as needed	Yes	None
Saline Water Pond	SWP	1.55	High	Saline Water	P9, Umwelt Underground	Construction: to Primary Pond Operations Stage 2: to Umwelt UG and Umwelt Reservoir	Yes	None

Infrastructure	Catchment ID	Catchment Area (km^2)	Level of Risk	Type of Water	Pumped Inflow	Pumped Outflows	Embankment	Downstream Water Infrastructure
Goose Main Pit Sump	GP	0.31	Low	Contact Water	None	P10 Operations: TSF	No	None
Goose Main Diversion Berm	GD1	34.77	Medium	Non-contact Water	None	None	No	Goose Main Pit
TSF WRSA Diversion Berm	TWD2	0.14	High	Contact Water	None	P11 Operations: TSF	No (TSF Main Dam is an Embankment)	None Could be directed to Goose Main Pit as needed

6.3.2.2 Interpretation of Results

The resultant peak instantaneous flows and 24-hour storage volumes were used to size water management infrastructure. Peak flows were used to size culverts and diversion structures, and total storm volumes were used to size water management event ponds and pumping rates.

Since all diversions are constructed as berms as opposed to excavating into existing ground, the minimum berm height defines the conveyance configuration. In all cases, the 2 m minimum berm height (Table 6.2-3) was greater than the design flow depth and freeboard, and therefore governed the design requirements.

6.4 POND AND PUMP SIZING

Table 6.4-1 summarizes the pond capacities and associated pumping rate requirements for the Goose Property. The location of each of the ponds is illustrated on Figure A-02 based on the Pond ID number listed in Table 6.4-1. Sabina is committed to providing detailed design details 60 days prior to construction.

Table 6.4-1: Goose Property Pond Capacity and Pumping Rate Summary

Pond ID	Description	Design Return Period	Required Capacity (m^3)	Available Capacity (m^3)	% Full	Dewatering Duration (days)	Pumping Rate (m^3/s)
P1[1]	Umwelt Open Pit Sump	10	18,000	N/A	N/A	2	0.10
P2[2]	Umwelt WRSA Sump	N/A	N/A	N/A	N/A	N/A	0.03
P3	Plant Site Pond	100	10,000	49,800	20%	2	0.06
P4[3]	Saline Water Pond	N/A	1,473,000	1,79,000	91%	N/A	0.15
P5[4]	Water Treatment Plant	N/A	N/A	N/A	N/A	N/A	0.15
P6	TSF Supernatant Pond (Reclaim)	N/A	N/A	N/A	N/A	N/A	0.03
P7	Primary Pond	50	109,500	316,650	35%	23	0.06
P8	Llama WRSA Pond	100	20,000	26,00f0	77%	2	0.11
P9[1]	Llama Open Pit Sump	10	12,000	N/A	N/A	2	0.07
P10[1]	Goose Main Open Pit Sump	10	20,000	N/A	N/A	2	0.11
P11[2]	TSF WRSA Diversion Sump	N/A	N/A	N/A	N/A	N/A	0.03
P12[2]	Llama Pit Berm / Diversion Sump	N/A	N/A	N/A	N/A	N/A	0.03

1. *Pit sump actual capacities are defined by the open pit design, and as a result are always larger than the required capacity.*
2. *Sumps including the Umwelt WRSA Sump, TSF WRSA Diversion Sump and Llama Diversion Sump are not engineered ponds and will collect seepage and marginal runoff volumes. A pump and pipeline will be located in a topographic low point to re-route any seepage to the nearest event pond (Umwelt WRSA sump pumps to the Primary Pond, Llama Diversion sump pumps to the Llama WRSA Pond and TSF WRSA Diversion Sump pumps to the TSF).*
3. *Pond size and dewatering rate from Saline Water Pond are based on water balance results. Pond size is based on the 95th percentile maximum ponded water volume and dewatering is assumed to occur over two open water seasons. (Appendix E)*
4. *Operational water treatment plant rate based on Water and Load Balance Model (Appendix E).*

The pumping rate for each pond was set to allow dewatering the pond in 2 days (Table 6.2-2), to allow for quick re-establishment of storage capacity after large storm event. The dewatering duration was increased beyond the 2 days only for the ponds that have an available capacity significantly larger than the minimum required capacity. This additional available capacity will allow for managing storm events that may occur during the longer dewatering period. From a practical operational perspective, the maximum design pumping rate was set at 0.15 m^3/s.

As described in the design criteria outlined in Table 6.2-2, all collection ponds will be sized with sufficient freeboard contingency to provide both operational flexibility and accommodate large flows. Further refinements to the design will be completed during detailed engineering and will be captured in an updated version of this plan prior to construction.

6.5 CULVERT SIZING

There are five proposed culvert crossing locations at the Goose Property: one crossing through the airstrip and four crossings through the all-weather roads. Two types of culverts are considered for the all-weather roads and airstrip:

- Non fish-bearing crossings; and
- Fish-bearing crossings.

The non-fish-bearing crossings will consist of corrugated steel pipe and are currently designed with a diameter of either 1.2 m or 2.5 m, depending on the associated design flow. The fish-bearing crossings will be sized to keep maximum water velocities below 1.5 m/s for the average June flow such that they do not present a velocity barrier to migrating Arctic Grayling. In addition, all culverts, will meet the 0.3 m criteria for maximum water depth above the top of culvert. The fish-bearing culverts will be embedded at depth and a thin layer of streambed material will be placed to promote fish passage and habitat suitability. The design criteria for the culverts are presented in Table 6.5-1; Figure A-02 shows the culvert locations in plan view, and typical crossing sections are shown in Figure A-17. Sabina will provide the detailed engineering drawings and report 60 days in advance of construction, pursuant to the requirements of the Type A Water Licence. Sabina notes that fish bearing crossings are subject to appropriate DFO processes.

Table 6.5-1: Goose Property Culvert Characteristics – Design Storm

Culvert Description		Goose Culvert	Gander Pond Culvert	Goose Airstrip Culvert	Echo Culvert	Goose Neck Culvert
Culvert ID		C1	C2	C3	C4	C5
Characteristics	Slope (%)	1.0	3.6	1.0	1.5	3.5
	Diameter (m)	2.5	2.5	2.5	1.2	2.5
	Culvert Shape	Circ.	Circ.	Circ.	Circ.	Circ.
	Number of Barrels	2	2	2	1	1
	Culvert Material	CSP	CSP	CSP	CSP	CSP
	Embedment Depth (m)	0	0.4	0	0	0
100 Year Event	Total Discharge (m^3/s)	19.27	9.64	18.82	1.99	10.47
	Culvert Inlet Elevation (m)	100	100	100	100	100
	Headwater Elevation (m)	102.27	101.89	102.23	101.46	102.39
	Water Depth above Culvert (m)	0	0	0	0.26	0
	Invert Control Depth (m)	2.27	1.49	2.23	1.32	2.39
	Outlet Control Depth (m)	1.31	0	0.23	1.46	1.01
	Normal Depth (m)	1.18	0.98	1.17	1.20	1.06
	Critical Depth (m)	1.41	1.21	1.4	0.77	1.10
	Outlet Depth (m)	1.20	0.99	1.18	0.77	1.47
	Tail Water Depth (m)	0.82	0.54	0.83	0.06	0.12
	Outlet Velocity (m/s)	4.14	4.21	4.12	2.58	5.03
	Tail Water Velocity (m/s)	2.34	1/.8	2.27	0.64	0.49

Note – the final design criteria for the culverts will be determined at the detailed design stage based on the level of associated risk. Drawings with additional design details and layouts will be submitted for regulatory approval before construction, as per the Type A Water Licence (2AM-BRP1831).

Refer to Section 9.4 for additional information on environmental protection measures related to culvert installations and stream crossing or diversions.

6.6 DIVERSION BERMS AND CONTAINMENT DAMS

Three types of berms will be constructed to support water management across the Project area:

- Unlined non-contact water diversion berms;
- Lined contact water containment dams and berms; and
- Unlined contact water diversion berms.

All diversion berms will be constructed directly onto the tundra surface with non-potentially acid generating (NPAG) run of mine or run of quarry material that contains sufficient fines to contain and convey water. All containment dams and berms will be constructed with run of mine or run of quarry material; in addition, all lined structures and will contain a geosynthetic clay liner (GCL) that will be tied into the active permafrost layer if the operational head is less than 4 m, and into permafrost if the operational head is greater than 4 m. Additional design criteria are summarized in Table 6.2-3. Table 6.6-1 summarizes the conveyance structures, in terms of their purpose and whether or not they require a liner.

Table 6.6-1: Diversion and Containment Structure Summary

Structure	Lining Details	Notes
Llama Pit North Berm, Llama Pit West Berm	Unlined	Divert upstream non-contact runoff. Minimize non-contact water volumes entering Llama Pit and assists with general water management at the pit.
Primary Pond Containment Dam	Lined	Contains contact water in the Primary Pond to the east, alignment along haul road. Will be designed to Canadian Dam Association (CDA 2013, 2014) standards.
Llama WRSA Diversion Berm	Unlined	Diverts seepage and runoff from the Llama WRSA towards the Llama WRSA Pond
Llama WRSA Containment Dam and Llama East Pit Berm	Lined	Contains runoff from Llama WRSA into Llama WRSA Pond.
Plant Site Pond Containment Dam	Lined	Contains contact water from Ore Stockpile and runoff from the Plant Pond, along norther edge of the Plant Pad area (along the Goose AWR). Ore Stockpile placed in sub catchment area that naturally directed (via topography) towards Plant Site Pond. Base pad of ore stockpile also will assist to promote surface water drainage towards the Plant Site Pond.
Saline Water Pond Containment Dams (South)	Lined	South section of dam containing saline water, around former Umwelt Lake footprint / outlet of former Umwelt Lake. Will be designed to Canadian Dam Association (CDA 2013, 2014) standards.
Goose Main Diversion Berm	Unlined	Diverts non-contact runoff around Goose Main Pit
TSF WRSA Diversion Berm	Partially Lined	Collects seepage and runoff from the TSF WRSA. Will only be lined with non-woven geotextile to promote a higher hydraulic conductivity contract along the upstream to better promote seepage capture. TSF Main Containment Dam not included in list (as for tailings) but this dam will also be designed to Canadian Dam Association (CDA 2013, 2014) standards.

As described in the Geotechnical Design Parameters Report (Sabina 2017, Appendix F-2), permafrost soils are sensitive to damage if they are altered in any way. Therefore, excavation into these soils will be avoided as much as practical. The diversions and containment structure designs are presented in the WMP Figures (Appendix A). If diversion structures result in water flowing and/or ponding over previously dry areas, it is possible that permafrost degradation may result due to the additional heat source imparted from the water. If the underlying soils are ice rich, the subsequent differential settlement resulting from ice melting may be notable. This may result in increased localized ponding that might affect the natural drainage. These potential occurrences will be monitored, and if degradation is observed, then clean overburden soil or NPAG material will be imported to manage and stabilize the settlement.

7. Water Management

Many water management considerations and design criteria apply throughout the LOM. Sections 5 and 6 outline those considerations; this section provides details on the specific plans that occur during different phases of the mine life.

7.1 WATER CLASSIFICATION

Site water at Goose Property is categorized into three types:

- Contact water: surface water that is impacted by/contacts mine workings (runoff over waste rock, ore stockpiles, open pits, tailings, etc.);
- Non-contact water: surface water that is not impacted by/does not contact mine workings; and
- Saline water: groundwater that flows into Llama Open Pit and Umwelt Underground workings.

Each type of water is managed separately throughout each Project phase, to the extent practicable. Contact water is contained within event ponds and tailings management facilities and is conveyed on site via diversions and pumped pipelines. Non-contact water is diverted off site through berms, and culverts.

Saline water is pumped out of the underground workings, as well as Llama Open Pit, and stored in the Saline Water Pond (previously Umwelt Lake). During Operations, saline water is pumped back into the bottom of the mined-out Umwelt Open Pit (then called Umwelt Reservoir) and into the mined-out Umwelt Underground. Sabina commits to continue looking for alternative strategies/locations for temporary storage of saline water, before pumping it to the Umwelt Reservoir.

The MLA does not require any pond or diversion infrastructure for water management purposes and remains in the same condition for both the Construction and Operations phase. A desalination plant will produce domestic and industrial water, and greywater will be discharged to the tundra.

7.2 WATER MANAGEMENT OBJECTIVES

The key water management objectives for the Project include:

- Minimizing the impact of mining activities on the aquatic environment surrounding the mining area to the greatest reasonable extent;
- Using BMPs, recognizing the unique constraints of each project element;
- Providing a reliable freshwater supply to the Process Plant;
- Managing contact, non-contact, and saline water separately in order to minimize freshwater withdrawal from Goose Lake and Big Lake;
- Facilitating mining operations by managing inflows that occur as a result of groundwater or direct precipitation; and
- Collecting and treating contact water as required to meet SSWQOs in the receiving environment.

7.3 WATER SUPPLY

Water intake structures will be constructed in Goose Lake and Big Lake to supply domestic, industrial, and process make-up water. The selected locations for these intakes are deep and close to shore. The structures will consist of PVC pipe installed on a rockfill base within the lake to keep the pipe above the lake bottom and the intakes will be screened. See Figure A-18 for a typical plan and section of the freshwater intake pipeline. Rock armouring will protect the pipeline from ice scour. Water intakes will be equipped with screens to prevent the entrainment or impingement of fish in accordance with current DFO requirements.

High-density polyethylene pipelines will convey freshwater from the intakes at Goose and Big lakes to dedicated pumphouses for the Process Plant, Goose Camp, and other operational uses. A potable Water Treatment Plant (WTP) will be constructed at the end of the domestic supply pipeline.

The water intake structures are temporary as they will only be used throughout the LOM. Both intake structures at Goose and Big lakes will be constructed in Year -3.

Construction of these intakes will involve in-water works. To limit disruption to aquatic resources, the following practices will be implemented:

- Only NPAG armour rock that is free of sediment will be placed in the water during construction to minimize acid generation and turbidity;
- Work will be isolated using silt curtains;
- Work will be carried out during calm water periods to minimize any turbidity effects due to the re-suspension of sediment; and
- Total suspended solids (TSS) and turbidity levels will be monitored throughout construction and work will be delayed if TSS levels and turbidity become too high.

In-water blasting is not planned for the construction of the water intakes.

At Closure, all pumphouses will be drained, decommissioned, and landfilled. All pipelines will be cut at the shoreline, decommissioned, and landfilled. The pipelines extending into the water, along with the surrounding rock armour and rock bases, will be left in place and capped at the substrate so not as to disturb the in-water environment. Additional design details will be provided in future updates to this plan. For additional information, refer to the Fish Offsetting Plan (Sabina 2019a) Section 4.0 and 5.2.1.1.

The proposed freshwater intake structure locations are presented in Figure A-03, and a typical intake design is shown on Figure A-18. The intake locations and consumption rates during the various Project phases are summarized in Table 7.3-1.

Table 7.3-1: Water Supply Locations and Volumes

Water Source	Total Water Use as per Modification Package Type A Water Licence Amendment [m^3/yr]
Total Water Use: Goose Lake	608,700[a]
Total Water Use: Big Lake	273,750[b]
Total Water Use: MLA	110,000[c]
Total Water Use: Dewatering	1,400,000[d]
Total Water Use: Winter Ice Road	2025 m^3/km[e]

a Proposed change to 2AM-BRP1831, Part E, Item 3a.
b Proposed change to 2AM-BRP1831, Part E, Item 3b.
c Proposed change to 2AM-BRP1831, Part E, Item 3c.
d Proposed change to 2AM-BRP1831, Part E, Item 4.
e Proposed change to 2AM-BRP1831, Part E, Item 5.

During the life of the Project, water consumption requirements from Goose Lake include 1,500 m^3/day of freshwater year-round and 400 m^3/day during the open water season (Table 7.3-1). For Big Lake, water consumption requirements include 750 m^3/day of freshwater year-round for the life of the Project. Water from both of these sources will be utilized for domestic, construction, operation, and associated uses, including mining and milling (2AM-BRP1831, Part E Item 3). No water use is required for hydrostatic testing of Goose Property and MLA fuel tanks at the respective fuel storage areas. Tanks will be commissioned using non-destructive examination techniques (e.g., tank x-ray, vacuum testing of tank floors, and air testing of fittings); this testing will be completed in accordance with API650 (API 2013).

Llama Lake will be dewatered to Goose Lake in the open water season of Year -1 in advance of open pit mining. Llama Lake has a natural capacity of 0.95 Mm^3. It is assumed that 50% of the current lake volume can be discharged directly to Umwelt Lake and ultimately into Goose Lake without treatment. The remaining 50% is anticipated to TSS concentrations in excess of allowable discharge limits. A modular Water Treatment Plant for suspended solids removal will be operational in Year -1 to treat this portion of lake volume (Table 7.4-1). Effluent from the treatment plant will be discharged into Umwelt Lake where it will continue to flow into Goose Lake.

Umwelt Lake, which has a natural capacity of 0.24 Mm^3, will also be dewatered to Goose Lake in Year -1. Similar to Llama Lake, only 50% of the total lake volume is estimated to be acceptable for direct discharge into Goose Lake. The remaining 50% is anticipated to TSS concentrations in excess of allowable discharge limits. A modular Water Treatment Plant for suspended solids removal will be operational in Year -1 to treat this portion of lake volume (Table 7.4-1). Effluent from the treatment plant will be discharged into Goose Lake.

Depending on process water start up requirements (Table 7.3-2), water from Llama and Umwelt lakes may be stored and directed to the Process Plant for use during Operations.

Table 7.3-2: Milling Rates and Parameters

Parameter	Value
Average Production Rate	3,000 tpd
Specific Gravity of Tailings	2.88
Tailings Dry Density	1.20
Void Ratio[1]	1.40
Slurry Percent Solids	47%
Ore Moisture Content	3%
Average Reclaim Rate	2,100 m^3/day
Process Freshwater Demand	900 m^3/day
Water Loss to Voids	1,458 m^3/day

1) The void rate was calculated based on material properties.

Used Process Plant water will be directed towards the active tailings management facility and eventually used as reclaim at a rate of 2,100 m^3/day (Table 7.3-2). Based on the tailings properties, the tailings slurry will result in 3,400 m^3/day of water and 1,040 m^3/day of solids. The volume of water entrained in tailings voids is a function of the void ratio and tailings density.

All water will be withdrawn, distributed, and directed via pumped pipelines.

7.4 WATER TREATMENT

Water treatment is required throughout the mine life for various water uses and constituent reductions. The following sections describe the various types of water treatment.

7.4.1 Marine Laydown Area Desalination Plant

Freshwater requirements at the MLA are met using a desalination plant, drawing ocean water from Bathurst Inlet. The plant will operate using reverse osmosis or similar process and will discharge brine to Bathurst Inlet as a product of the desalination process.

Discharge of brine water from the desalination plant will meet the CCME salinity guideline for the protection of marine life and will not cause the salinity of the receiving environment to fluctuate by more than 10% of the natural expected salinity (CCME 2015). The desalination plant is designed with a maximum intake flow rate of 33 m^3/h and a maximum discharge rate of 30 m^3/h; therefore, only a small portion of intake water will be desalinated. Assuming the freshwater plant product has a salinity of zero, the discharge from the plant is predicted to be no more than 10% more saline, and therefore within the CCME salinity guideline at the point of ocean discharge. The discharged effluent is expected to mix in the receiving environment and is not expected to be detectable beyond the outfall. The locations of the water intake and effluent discharge are identified in Figure A-09. Consumption rates at the MLA during the various Project phases are summarized in Table 7.3-1.

7.4.2 Goose Property Water Treatment Plant

A WTP will be required at Goose Property during the initial dewatering of Llama Lake, as well as to treat site contact water in the Llama TF.

Flows from dewatering efforts in Llama Lake will be treated for TSS, and clean water will be discharged into Umwelt Lake.

The transition of the mined-out Llama Open Pit to Llama TF begins in Year 5; year-round treatment of the Llama TF supernatant will begin in the first quarter of Year 5, shortly after tailings deposition begins. Primary constituents to be removed in treatment include arsenic, copper, and ammonia, as well as suspended solids. Treatment will continue until Llama TF spills (Year 12 under average hydrologic conditions). The treatment is proposed to be year-round at a flow rate of approximately 8,500 m^3/day to achieve MDMER limits at PN04 when pit flooding occurs. In addition, Sabina anticipates that water treatment for copper will also be required in Llama TF for approximately one year at a rate of approximately 8,500 m^3/day to meet the SSWQO for copper at PN03(see Table 7.4-1). Treated effluent will be recirculated back into Llama TF to aid in pit flooding.

In the years when no treatment occurs, all mine effluent will be stored in the active tailings management facility and used as reclaim water for the Process Plant.

The same WTPs will be used during Construction and Operations and will be available for Closure if required. During the Construction Phase, the WTP will be focused on TSS associated with Llama and Umwelt lake dewatering. During Operations, additional water treatment is planned for ammonia, arsenic, copper, and TSS, if required. The WTPs will be modular, can be relocated, and combined as necessary to achieve the appropriate water treatment at different phases of the Project. Table 7.4-1 summarizes the water treatment activities at Goose Property throughout the LOM. Sabina notes that there are two separate circuits associated with Llama TF water treatment.

Table 7.4-1: Water Treatment Goose Property during Construction and Operations

Source	Discharge Location	Period Start	Period End	Flow Rate (m^3/d)	Parameter	Comment	Approximate Treated Volume (m^3)
Llama Lake	Goose Lake (via Umwelt Lake)	Yr-1, Q3	Yr-1, Q3	13,000	TSS	50% lake volume, open water season	480,000
Umwelt Lake	Goose Lake	Yr-1, Q3	Yr-1, Q3	13,000	TSS	50% lake volume, open water season	120,000
Llama TF	Llama TF	Y5, Q1	Yr11, Q2	8,500	Ammonia	Recirculation of treated water back into Llama TF, year-round	20,030,000
Llama TF	Llama TF	Y10, Q1	Yr11, Q2	8,500	Copper	Recirculation of treated water back into Llama TF, year-round	4,220,000

Note: Flow rates for water treatment plant to be further refined at detailed design stage.

7.4.3 Sewage Treatment and Disposal

7.4.3.1 Goose Property Sewage Treatment and Disposal

Sewage at the Goose Property will be treated using a package Sewage Treatment Plant (STP), such as a Membrane Bioreactor or similar. The STP will be located in the Goose Plant Site area (Modification Package Appendix A, Figure 3), and during the Construction Phase (i.e., before the TSF is available) and Closure Phase (i.e., when all tailings management facilities are no longer available), treated sewage effluent will be discharged to the tundra west of the Goose Plant Site (Figure A-20). It will be land discharged to maximize attenuation distance prior to entering an outflow watercourse from Fox Lake and ultimately entering Goose Lake. Off-specification treated sewage during upset conditions will be discharged to the closest collection pond. Any discharges of sewage effluent from the collection pond will need to meet the applicable discharge criteria. In-pond treatment by coagulation can be applied if required as a contingency. Refer to the Landfill and Waste Management Plan (WL SD-10) for details on STP treated effluent volumes.

In Operations, effluent will be discharged to the active tailings management facility. During Post-Closure, the Goose Camp will convert to Pacto or incinerating toilets and effluent discharge will not be necessary. If STP effluent meets discharge requirements during Operations, Sabina may choose to discharge on land consistent with Construction Phase STP effluent management. See the Landfill and Waste Management Plan (WL SD-10) for information on sludge disposal.

7.4.3.2 Marine Laydown Area Sewage Management

There will be no direct discharge of treated sewage effluent or camp greywater to the marine environment. The MLA camp will employ Pacto or incinerating toilets for all Project phases to avoid the need for a STP.

Greywater from domestic use will be pumped through an oil and grease separator prior to discharge to the tundra. It will be discharged through a designated pipeline to a relatively flat, non-channelized area on the tundra north of the Laydown Area (Figure A-09) and will ultimately flow into Bathurst Inlet. Water management at the MLA will consist of the following:

- Greywater will be discharged in an area of low slope to minimize velocities, encourage sheet flow, and minimize channelization.
- The discharge will be directed towards gravel beds or rock to reduce water velocities as appropriate.
- To maximize attenuation, the expected flow path to the nearest receiving environment (Bathurst Inlet) will be greater than 700 m. This is due to the gently sloping topography extending to the west and north of the discharge location.

Greywater will meet the ocean disposal criteria identified in Table 7.5-4.

7.4.4 Potable Water Treatment

Public water supply of potable water is regulated under the *Public Health Act* and Public Water Supply Regulations administer by the Government of Nunavut. Sabina plans to develop SOP that will include the use of chlorination to ensure potability of water. Regular test work of water quality will be conducted to ensure potable water meets Canadian drinking water standards. Sabina will meet all regulatory requirements around the management of potable water.

7.5 EFFLUENT CRITERIA

If the monitored changes in water quality result in levels above the regulated effluent discharge criteria define in the Type A Water Licence, Sabina will implement further appropriate mitigation measures.

7.5.1 Runoff Criteria

Site runoff from the Goose Plant Site area and pads is expected to contain suspended solids, or oils and grease from heavy equipment. General site runoff will meet the discharge criteria presented in Table 7.5-1.

Table 7.5-1: Site Runoff Discharge Criteria

Parameter	Maximum Average Concentration (mg/L)	Grab Sample Maximum Concentration (mg/L)
TSS	50	100
Oil and Grease	No Visible Sheen[1]	No Visible Sheen[1]
pH	Between 6.0 and 9.5[1]	Between 6.0 and 9.5[1]

1) Source: Standard NWB Licence requirement

These proposed discharge criteria are the same discharge criteria that have been considered protective of the receiving environment by the NWB for multiple mining Projects in Nunavut to date, including the Mary River Project, Doris North Project, and Meadowbank Project.

Due to similar site conditions, these Arctic projects are considered applicable to, and analogous of, the Project. Hydrological and meteorological conditions for the above projects are typical of conditions in the Project area, namely; hydrological conditions are snowmelt dominated, with peak flow events occurring from early May to mid-June, and meteorological conditions consist of occasional rainfall driven high flow events occurring between June and September.

Note that the minimum 31 m buffer distance from waterbodies reported in the FEIS (Sabina 2015), intended to minimize surface flow impacts on water quality, has been adopted in the above water licences provided by the NWB. This 31 m buffer was identified based on guidance documents and commonly established riparian zone buffer widths used in many regions, including the Arctic.

Sediment and erosion control are an important component of the environmental protection plan for the Project. Mitigation and management measures for sediment and erosion control measures are presented in the Aquatic Effects Management Plan (WL SD-21) and in the mitigation and adaptive management section in the freshwater water quality assessment chapter (Sabina 2015, Volume 6, Chapter 5, Section 5.8).

7.5.2 Dewatering Discharge Criteria

In advance of dewatering, a fish-out program will be completed. For additional information related to conservation, and mitigation measures to be implemented refer to Section 9.3. Dewatering discharge criteria are presented in Table 7.5-2.

Table 7.5-2: Dewatering Discharge Criteria

Parameter	Maximum Average Concentration (mg/L)	Grab Sample Maximum Concentration (mg/L)
TSS[1]	15	30
pH	Between 6.0 and 9.5	Between 6.0 and 9.5
Aluminum	1.5	3.0
Turbidity (NTU)	15	30

1) As per Type A Water Licence (2AM-BRP1831) Part D, Item 26

7.5.3 For Discharges to Land

At both the Goose Property and MLA, hydrocarbon contaminated soil resulting from accidental release of fuel, will be placed in a lined containment area (landfarm). Water pooling within the landfarm will be monitored for quality and will be sent to the active tailings management facility or released to designated locations on land, at a minimum setback of 31 m from waterbodies provided that the water meets the criteria specified in Table 7.5-3. Otherwise, treatment will be provided. Additional details regarding the Goose Property and MLA landfarms are included in the Landfarm Management Plan (WL SD-12).

Oily (hydrocarbon contaminated) water, ice, and snow may be generated from the following activities:

- Snow clearing operations;
- Precipitation accumulating in the landfarms;
- Heavy equipment and truck washing;
- Precipitation accumulating in lined bulk fuel storage facilities; and
- Accidental releases of fuel or other substances.

Rock quarries, and potentially sand/gravel borrow areas, will be developed at each of the Project sites to facilitate construction. The Borrow Pits and Quarry Management Plan (WL SD-03) outlines operating quarry procedures that include environmental protection measures and monitoring plans. Runoff from quarries and borrow area excavations will be managed in accordance with the environmental protection measures outlined in Section 9.6.

Runoff from quarries and borrow pits can be elevated in suspended solids as well as possibly hydrocarbons from minor spills during refueling of equipment, and residual concentrations of ammonia from the use of ammonia nitrate fuel oil (ANFO) explosives. Runoff will be collected within the work area and will only be discharged to land if meeting the water quality criteria in Table 7.5-3. If any water source from quarry or borrow areas does not meet the discharge criteria, this water will be pumped to the active tailings management facility and managed with other site contact water.

Table 7.5-3: Discharge to Land Criteria

Parameter	Maximum Average Concentration (mg/L)	Grab Sample Maximum Concentration (mg/L)
TSS[1]	50	100
pH	Between 6.0 and 9.5	Between 6.0 and 9.5
Oil and Grease	No Visible Sheen	No Visible Sheen

1) As per Type A Water Licence (2AM-BRP1831) Part D, Item 21

Landfills will be constructed and operated at the Goose Property. The landfills will be used for the disposal of non-combustible inert waste, and as such, are expected to generate minimal leachate. The Goose Property landfills will be located within the Umwelt and TSF WRSAs that are shown in Figures A-11 and A-12. Any potential seepage from the Goose landfills will be collected along with mine contact water via the water management system of collection ponds and berms and will therefore be subject to meeting the same mine contact water quality requirements. Inert non-combustible waste from the MLA will be temporarily stored at the site until the waste can either be transferred to the Goose Property or backhauled by sealift for final disposal. Additional details and figures on landfills can be found the Landfill and Waste Management Plan (WL SD-10).

7.5.4 Sewage Effluent Discharge Criteria

Treated sewage effluent discharged by the Project will meet the discharge limits in Table 7.5-4. Distinct criteria are presented for land discharges (ultimately reporting to freshwater), discharges to the active tailings management facility, and discharges to the tundra prior to entering the ocean based on an average flow rate of 170 m^3/day.

Table 7.5-4: Treated Sewage Effluent Criteria

Parameter	Land Discharges – Freshwater Environment MAC[1] (mg/L)	Discharges to Tailings Facilities MAC[1] (mg/L)	Land Discharges – Marine Environment MAC[1] (mg/L)
BOD_5	30	100	100
Total Suspended Solids (TSS)	35	120	120
Fecal Coliform (CFU/100 mL)	1,000	10,000	10,000
Ammonia (NH_3-N)	4[1], 8[2]	Not applicable[3]	--
Phosphorus	4[1], 8[2]	--	--
Oil and Grease	No Visible Sheen	--	No Visible Sheen
pH	between 6.0 - 9.5	--	between 6.0 – 9.5

1) MAC – Maximum Average Concentration
2) Maximum Grab Concentration
3) As per Type A Water Licence (2AM-BRP1831) Part F, Item 4

Treated effluent water discharge locations are shown on Figure A-04 and A-09 for the Goose Property and MLA, respectively.

7.6 WINTER ICE ROAD

Overland winter access to the Project is possible between December through May each season. Annually, in early December, preparation for the WIR linking the MLA to the Goose Property will be undertaken. Once the WIR is ready for traffic, the equipment, materials, fuel, and supplies staged at the MLA will be transported by trucks over the WIR to the Goose Property. It is expected that the transfers will occur annually between January and April.

7.6.1 Winter Ice Road Construction and Use

Winter ice road construction will adhere to the following guidelines based on DFO Operational Statements:

- Use existing trails or WIRs wherever possible as access routes to limit unnecessary clearing of additional vegetation and prevent soil compaction;
- Construct approaches and crossings perpendicular to the watercourse wherever possible;
- Construct ice bridge and snow fill approaches using clean, compacted snow and ice to a sufficient depth to protect the banks of the lake, river or stream;
- Install sediment and erosion control measures before starting work to prevent the entry of sediment into the watercourse. Inspect the installed control measures regularly during the course of construction and decommissioning activities and make all necessary repairs if damage occurs;
- Operate machinery on land or on ice, and in a manner that minimizes disturbance to the banks of the lake, river or stream;
- Ensure that the intakes are sized and adequately screened to prevent debris blockage and fish mortality;
- Crossings do not impede water flow at any time of the year;
- When the crossing season is over and where it is safe to do so, create a v-notch in the centre of the ice bridge to allow it to melt from the centre, and to also prevent blocking fish passage,

channel erosion and flooding. Compacted snow should be removed from snow fills prior to the spring freshet;

- Stabilize any waste materials removed from the work site to prevent them from entering the lake, river, or stream. This could include covering spoil piles with biodegradable mats or tarps; and
- The site should be stabilized using effective sediment and erosion control measures. In areas with permafrost, care should be exercised to ensure these measures do not cause thawing or frost heave.

Water withdrawal for the construction of WIRs will also adhere to the following DFO guidelines taken from the *Protocol for Winter Water Withdrawal from Ice-Covered Waterbodies in the Northwest Territories and Nunavut* (DFO 2010):

- In one ice-covered season, total water withdrawal from a single waterbody is not to exceed 10% of the available water volume;
- In cases where there are multiple users withdrawing water from a single waterbody, the total combined withdrawal volume is not to exceed 10% of the available water volume; and
- Only waterbodies with a minimum unfrozen water thickness of 1.5 m under ice should be considered for water withdrawal.

Water for the WIRs will be drawn from various sources along the WIR alignment. The supply locations and consumption rates will be provided at least 60 days prior to water withdrawal. Consistent with the Project terms and conditions (NIRB 2017), Sabina will provide bathymetry, depth, and location of proposed water withdrawal sites, volumes to be extracted, anticipated water level decreases, and fish habitat features within each waterbody proposed to be used for winter water withdrawal in support of the annual construction of the WIRs. If additional waterbodies are required, Sabina will provide all required information on the additional proposed lakes prior to the use of the waterbodies.

In addition, Sabina will implement all applicable DFO BMPs to avoid and mitigate serious harm to fish as a result of the construction, operation, and decommissioning of WIRs, and from under ice water withdrawals. This includes adequately screening the water intakes pipes to prevent impingement and entrainment of fish.

8. Water Management Phases

Water management throughout the mine life is described in a series of phases:

- o Phase 1: Construction (Year -3 to Year -1)
- o Phase 2: Operations (Year -1 to Year 12)
- o Phase 3: Closure (Year 13 to Year 20)
- o Phase 4: Post-Closure (Year 21 +)

These phases are illustrated in Figures A-04 through A-12. The Operations Phase (Phase 2) is subdivided into two stages; each stage represents the duration of tailings deposition in a single tailings management facility. The two stages are:

- o Phase 2, Stage 1: Tailings Storage Facility (Year 1 to Year 5)
- o Phase 2, Stage 2: Llama Pit (Llama TF) (Year 5 to Year 12)

The following subsections describe the water management details of each phase and stage.

8.1 PHASE 1: CONSTRUCTION

A summary of the key water management activities during Phase 1 are included in Table 8.1-1. Further details on the water management activities are included in the subsections that follow. General water management activities in this phase are also depicted in Figure A-03.

Table 8.1-1: Summary of Water Management Activities during Phase 1

Mine Year	Figure	Water Management Activities
-3	A-04	• Main Construction activities begin, including construction of the Goose Plant Site and Camp area. • Water intake infrastructure is constructed at Goose Lake and Big Lake in Year -3 to meet the freshwater demands for domestic, construction, operation, and associated uses, including mining and milling activities. • One culvert crossing in the Goose Airstrip is constructed. • Umwelt Underground exploration decline begins.
-2		• Water discharge infrastructure is constructed at Llama and Umwelt lakes to prepare for fish-out and dewatering activities. • The Primary Pond is constructed in advance of waste rock placement from Umwelt Open Pit and to assist with TSS treatment if required. • The Plant Site Pond is constructed around the Goose Plant Site. • Pumping of contact water that is collected around site to the Primary Pond begins. • The TSF Containment Dam begins, and TSF South Dyke construction is completed in Year -2. • The TSF WRSA Diversion Berm is constructed. • Four culvert crossing locations in the all-weather roads are constructed. • Umwelt Underground decline continues.
-1		• The Saline Water Pond is constructed at the south end/outlet of the former Umwelt Lake. • Umwelt Open Pit development begins in Year -1. Waste rock material will be sourced from Umwelt Open Pit for construction in Year -1. Inflows to Umwelt Open Pit are pumped to Primary Pond. • Llama Lake is dewatered fully in Year -1 during the open water season, with approximately 50% of the volume dewatered directly to Umwelt Lake, ultimately flowing to Goose Lake. The remaining 50% volume is expected to have high TSS and will be treated prior to discharge into Umwelt Lake. • Umwelt Lake is dewatered fully in Year -1 during the open water season, with approximately 50% of the volume dewatered to Goose Lake. The remaining 50% volume is expected to have high TSS and will be treated prior to discharge into Goose Lake. • Waste rock from Umwelt Open Pit is placed in the Umwelt WRSA, and ore is placed in the Ore Stockpile. Contact water runoff from the Ore Stockpile is collected in newly constructed Plant Site Pond and pumped to the Primary Pond. Contact water runoff from the Umwelt WRSA flows by gravity to the Primary Pond. • The TSF Containment Dam is completed. • Umwelt Underground decline continues.

8.1.1 Lake Dewatering

Llama Lake will be dewatered to Goose Lake in the open water season of Year -1 in advance of open pit mining. It is assumed that 50% of the lake water volume will be suitable for direct discharge to Goose Lake via Umwelt Lake. The remaining 50% is assumed to have TSS concentrations in excess of the discharge limit and will be treated in a modular Water Treatment Plant (WTP). Effluent will be discharged to Umwelt Lake and ultimately flow into Goose Lake.

Umwelt Lake, which has a natural capacity of 0.24 Mm^3, will be dewatered in Year -1. Similar to Llama Lake, it is assumed that only 50% of the lake water volume will be suitable for direct discharge. The remaining 50% is assumed to have TSS concentrations in excess of the discharge limit and will be treated in a modular Water Treatment Plant (WTP). Effluent will be discharged to Goose Lake; this will allow for the Saline Water Pond to be constructed around the existing extents of Umwelt Lake.

In advance of dewatering, a fish-out program will be completed. For additional information related to conservation and mitigation measures to be implemented, refer to Section 9.3.

8.1.2 Water Treatment

A Water Treatment Plant (WTP) will be operational in the open water season at the Goose Property in the Construction Phase to initially dewater Llama Lake, in advance of open pit mining, and to dewater Umwelt lake, in advance of the Saline Water Pond construction. The purpose of water treatment in Construction is the removal of TSS.

It is assumed that 50% of the water in both Umwelt and Llama lakes can be dewatered directly to Goose Lake using the natural channels, while the other 50% of the water in both lakes will require treatment for TSS prior to discharge to Goose Lake. If TSS is higher than expected, a greater percentage of water will be treated. Any treatment sludge generated will be disposed of in Umwelt WRSA.

Once Llama Lake dewatering is complete, lake bottom sediments within the Llama Pit boundaries will be excavated and placed in the Umwelt WRSA footprint.

8.1.3 Open Pits

The development of Umwelt Open Pit will commence during the Construction Phase. Water will be collected in the Umwelt Open Pit using sumps and will be pumped to the Primary Pond. Refer to Section 5.1.3 for more information on groundwater inflows.

8.1.4 Tailings Storage Facility

Milling may commence towards the end of the Construction Phase. Any tailings generated during the Construction Phase will be deposited in the purposed-built TSF, located 2 km south of Goose Main Open Pit (Modification Package Appendix A, Figure 3).

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). The TSF will be constructed prior to the Process Plant starting production. Construction of the TSF Containment Dam will start at the end of Year -2; the smaller TSF South Dyke is completed in Year -2. Refer to the Tailings Management Plan (WL SD-09) for further details on the TSF.

The GCL is the preferred liner option for the TSF Containment Dam in consideration of freeze thaw effects, hydraulic conductivity, and installation. Laboratory and field testing have shown that impacts of freeze-thaw cycles on the hydraulic performance GCLs is minimal (Kraus et al. 1997). The GCL hydraulic conductivity, which specifically accounts for predicted porewater chemistry, is estimated to be between 10^{-9} and 10^{-8} cm/s, which is within manufacturer's product specifications. From an installation perspective, GCL liners are significantly more robust than other thinner geomembranes (e.g., LLDPE).

Tailings will generally be deposited off the TSF Containment Dam and the TSF South Dyke to develop a tailings beach and allow the supernatant water pond to develop at least 100 m from the crest of both structures during facility operation. This beach development will also reduce the dedicated design reliance on the GCL liner element.

8.1.5 Waste Rock Storage Areas

Runoff and seepage from the Umwelt WRSA will be directed towards the Primary Pond. The Umwelt WRSA footprint has taken the natural topography and catchments into consideration to best use the topography to direct surface water towards the Primary Pond while using the WRSA toes and access roads to help direct non-contact surface water away from the WRSA, which will minimize the amount of contact water that needs to be managed. A sump and pumping system have been included at the southeast corner of the Umwelt WRSA to manage seepage from the toe should any ponding occur, as shown in A-02.

8.1.6 Ore Stockpile

The ore stockpile will be used for ore deposition in Year -1 from mining of Umwelt Open Pit as well as through early development of Umwelt Underground mine; this will occur prior to the Process Plant becoming operational. Runoff and seepage from the Ore Stockpile will be directed towards the Plant Site Pond, which will be lined, keyed into permafrost, and adjacent to the haul road adjacent to the Plant Site. Water from the Plant Site Pond is pumped to the Primary Pond, which is ultimately treated, stored for use in the Mill, or pumped to the Llama Reservoir (once Llama Lake is dewatered) during the Construction Phase (Year -3 and beyond).

8.1.7 Saline Water Pond

Umwelt Lake will be fully dewatered to construct the Saline Water Pond (SWP). The SWP South Containment Dam will be constructed in Year -1. As the lake will be fully dewatered, there is some capacity available where saline water underground decline advancement could be stored, if encountered. The Saline Water Pond Dam will be completed before receiving any notable saline water inflows pumped from the Umwelt underground development, which will first occur in Year 1.

To manage saline groundwater and minimize potential associated impacts; a Saline Water Management Plan is provided in Appendix C of the WMP.

8.1.8 Stream Diversions

The majority of Project infrastructure has been located to avoid fish-bearing water and, wherever possible, to avoid encroaching on freshwater fish habitat. Additional mitigation to avoid adverse effects on fish is required for streams that may experience reduced discharge resulting in the potential for increased fish and egg stranding. In these cases, all potential fish use (migration, spawning, rearing, and egg incubation) will be prevented by creating permanent fish barriers at migratory pathways into channels prior to ice melt. These barriers will be constructed at the following locations:

- Umwelt Outflow: at the limit of the southern flowing downstream end where the stream connects to eastern flows toward Goose Lake;
- Goose Inflow East: at the downstream limit where the stream enters Goose Lake; and
- Rascal Stream East: upstream of the airstrip culverts.

Blocking fish access to these locations will involve creating a permanent impassable fall or cascade barrier to prevent fish access to upstream water management areas.

The Goose Airstrip is extended in Year -3, crossing the Rascal Stream East. A culvert crossing denoted as the Goose Airstrip Culvert, or C3 in Figure A-02, will facilitate drainage through the Goose Airstrip. A second crossing just south of Goose Main Open Pit, denoted as C1, will be installed on the Rascal Stream East in the haul road in Year -2, downstream of the airstrip and upstream of the Rascal Stream East discharge into Goose Lake. Three additional culvert crossings along the haul road are constructed in

Year -2, including the Goose Neck Culvert (C5) south of Llama Pit, the Echo Culvert (C4), and the Gander Pond Culvert (C2), northwest of the Goose Airstrip. Further culvert details can be found in Section 6.5.

8.1.9 Roads

All-weather roads at Goose Property include haul roads, which will connect the ore bodies to the WRSAs and the Plant Site; and service roads, which connect other on-site infrastructure. Where possible, the roadways servicing the mining areas will be constructed so that drainage will be directed towards the proposed contact water management infrastructure. Five culvert crossings will be installed within the Goose Property, four of which cross all-weather roads; culvert details are included in Section 6.5.

8.1.10 Marine Laydown Area

Water management strategies at the MLA will remain the same during the Construction Phase (Year -3 to Year -1) and the Operations Phase (Year 1 to Year 12) (Figure A-09). The MLA will not require ponds or other diversion infrastructure for water management purposes and will discharge towards Bathurst Inlet along the same flow paths as the predevelopment topography.

MLA infrastructure will be designed such that footprints are minimized to limit changes to local drainage patterns. Roads and pads, which will be constructed using geochemically suitable material, will be designed to have runoff as dispersed sheet flow to minimize channelized flow.

Non-contact water will be diverted around MLA infrastructure as much as practicable and directed to natural downstream drainage networks to maintain local drainage patterns. Clean water and snow will be managed to restrict contribution to potentially poor-quality water and will be diverted to maintain natural drainage networks as much as possible.

8.2 PHASE TWO: OPERATIONS

A summary of the key water management activities during Operations (Phase 2) are included in Table 8.2-1 to Table 8.2-2. The tables break Phase 2 into its two stages, based on the active tailings management facility at the time. Further details of the water management activities are included in the subsections following the tables.

Table 8.2-1: Summary of Water Management Activities during Phase 2, Stage 1 (Year 1 to 5)

Mine Year	Figure	Mine Development Sequence and Key Activities
1	A-05	• Milling operations begin (* this could occur as early as Y-1, Q4). • Tailings deposition begins in the TSF (* this could occur as early as Y-1, Q4). • The TSF downstream berm (called the TSF WRSA Diversion Berm) will collect any seepage from the TSF; this seepage will be pumped back into the TSF. • The Llama WRSA Containment Dam and Llama Pit East Berm are built, which create the Llama WRSA Pond. Mining of Llama Open Pit begins in the third quarter of Year 1. Waste rock is placed in the Llama WRSA; contact water runoff from the Llama WRSA is collected in the Llama WRSA Pond and pumped to the Primary Pond, as required. • Saline groundwater inflows to Llama Open Pit are pumped to the Saline Water Pond (former Umwelt Lake), along with saline water from the Umwelt Underground, if present. • The Primary Pond collects contact water across the Goose Property, including flows collected in the Llama WRSA Pond, runoff from the Umwelt WRSA, and pumped inflows from the Plant Site Pond and Umwelt Open Pit. The collected contact water in the Primary Pond is used as reclaim in the Goose Process Plant. • Underground production starts at Umwelt in Year 1. The Umwelt Underground portal is built on a pad graded towards Plant Site to allow runoff to flow directly into the Plant Site Pond. • Withdrawal of ore from the Ore Stockpile begins.
2	A-05	• A non-contact water diversion berm, the Goose Main Pit Diversion Berm, is constructed south of Goose Main Open Pit to divert water away from the facility, towards Goose Culvert, and into Goose Lake. • Umwelt Open Pit mining is completed in Year 2. • The Primary Pond is dewatered to the Process Plant as reclaim, then breached via culverts beneath the haul road, allowing contact water to drain by gravity to Umwelt Reservoir. The Umwelt WRSA is covered and closed. • Reclaim to the Process Plant begins from the TSF. Reclaim water to the Process Plant transitions from the Primary Pond to the TSF supernatant pond from Year 2 through Year 12, Q2.
3	A-05	• The mined-out Umwelt Open Pit permanently becomes Umwelt Reservoir and stores excess contact water. • The Saline Water Pond is dewatered to the bottom of Umwelt Reservoir during the open water seasons of Year 3 and Year 4, creating a meromictic lake of saline water at the base, overlain by contact water. • Goose Main Pit mining begins in the fourth quarter of Year 3. Surface water inflows to Goose Main Open Pit are also pumped to the TSF supernatant pond, which is used in the Process Plant. • As part of progressing reclamation, waste rock from Goose Main Open Pit is stored in the TSF, which progressively becomes the TSF WRSA.
4	A-05	• The Saline Water Pond dam is breached, and the area is remediated.

Table 8.2-2: Summary of Water Management Activities during Phase 2, Stage 2 (Year 5 to 12)

Mine Year	Figure	Mine Development Sequence and Key Activities
5	A-06	• Year-round water treatment starts at Llama TF in approximately Year 5, Q1. Water treatment, which recirculates treated effluent back into Llama TF, will continue until end of Operations.
6	A-06	• Water management strategies beginning in Year 5 continue.
7	A-06	• Water management strategies beginning in Year 5 and 6 continue.
8	A-06	• Water management strategies beginning in Year 5 to 7 continue. • Reclaim water continues to be sourced from the TSF until the facility is dewatered in Year 12, Q2 under average hydrologic conditions. Reclaim water is then sourced from the Llama TF for the remainder of Operations. • Goose Main Open Pit mining is completed in the third quarter of Year 8. Goose Main Pit Diversion Berms is breached, allowing the pit to flood, forming the Goose Main Reservoir. • The TSF WRSA is covered and closed after completion of mining at Goose Main Pit.
9	A-06	• Water management strategies beginning in Year 5 to 8 continue.
10	A-06	• Portion of saline water from Umwelt Reservoir pumped into mined-out Umwelt Underground • Water management strategies from Year 9 continue.
11	A-06	• Water management strategies from Year 9 continue. • Water treatment at Llama TF is expected to be completed in Year 11, Q2.
12	A-06	• Milling is completed at the end of Year 12. • Reclaim water source is transitioned from the TSF to Llama TF. • The TSF Containment Dam is breached, allowing WRSA runoff to flow by gravity into Goose Main Reservoir.

8.2.1 Open Pits and other Contact Water

During Operations, precipitation will accumulate in open pits, which will be collected using in-pit sumps. Sumps will pump water across the site, eventually discharging to the active tailings facility. Llama Open Pit is the exception, which is expected to have saline water inflows from the associated Llama Lake through talik; this saline groundwater and meteoric inflows will be pumped to the Saline Water Pond.

Other contact water across the Goose Property will be directed and collected in the Primary Pond or into a temporary holding pond (e.g., Llama WRSA Pond, or Plant Site Pond). In Stage 1, the final destination for contact water is the Primary Pond, which then may be used as water for milling process. In Stage 2 of Operations, the final destination for contact water is the Umwelt Reservoir or the Llama TF.

Upon completion of mining in Umwelt Open Pit, the Primary Pond is breached via installation of a culvert crossing through the haul road, allowing contact water to flow by gravity into the former Umwelt Open Pit (now Umwelt Reservoir). The Saline Water Pond will be dewatered to the lower portion of the Umwelt Reservoir, forming a meromictic (stratified) lake. The meromictic lake will have a freshwater cover of contact and non-contact water runoff and saline water is not expected to mix with the surface layer.

8.2.2 Water Treatment

Treatment is inactive after Year -1 begins again year-round in Year 5 in the Llama Tailings Facility (Llama TF) to reduce metals, ammonia, and suspended solids loading in the facility. From Year 5 to Year 11, the Llama TF water is treated year-round and is circulated back into the Llama TF for use as reclaim water for the

Process Plant. The duration of water treatment, based on a treatment rate of 8,500 m^3/day, will be completed by the end of Operations. Should water quality in the Llama TF not be suitable for discharge by the end of Operations, Sabina will continue treatment until discharge criteria to the receiving environment are met.

8.2.3 Underground Facilities

Average groundwater inflows into the underground workings during the Operations Phase have been estimated for Umwelt Underground to be around 380 m^3/day, with inflows estimated to be as high as 600 m^3/day.

Groundwater accumulating in the underground workings will be pumped to the Saline Water Pond during the operational LOM. During Operations, and in support of closure objectives, water from the Saline Water Pond will be pumped back into the Umwelt Underground mine, and to the bottom of Umwelt Reservoir to create a meromictic lake.

8.2.4 Waste Rock Storage Areas

During the Operations Phase (Phase 2), water accumulating from the WRSAs at the Goose Property will be monitored and pumped to Primary Pond or Llama TF, ultimately providing water for reclaim at the Process Plant (Figures A-05 and A-06). Shallow groundwater around the WRSAs prior to freeze back will ultimately report to the event ponds (sometimes via sumps) which are situated at the local topographic low points. The containment dams around each pond will be lined with geosynthetic materials (liners) which will be keyed into bedrock where possible. If bedrock is not practical, the liners will be keyed into the permafrost foundation.

At Stage 1 of Operations, the TSF is the active tailings management facility and mining occurs at Umwelt, Llama, Goose Main open pits, and Umwelt Underground. As such, all WRSAs (Llama WRSA, Umwelt WRSA, and TSF WRSA) are active waste rock facilities during this stage. Contact water from both the Llama and Umwelt WRSAs is diverted into Primary Pond, and contact water collection at the TSF in the TSF WRSA Diversion Berm is pumped back into the TSF as part of the supernatant water pumped to the Process Plant.

During Stage 2 of Operations, tailings deposition transitions to Llama TF as mining continues at Goose Main Open Pit and in the Umwelt Underground. All WRSAs (Llama, Umwelt, and TSF) will be progressively closed during this stage, and permafrost aggradation will occur in parallel. Water from all three WRSAs will continue to be collected during this stage and ultimately pumped to Llama TF.

8.2.5 Ore Stockpile

During Operations, runoff water from the Ore Stockpile will be collected in the Plant Site Pond, which will be pumped to the active tailings management facility.

8.2.6 Tailings Management Facilities

The tailings management strategy is based on the principle of maximizing the use of open pits for tailings storage. To that end, tailings will be stored in the mined-out Llama Open Pit as soon as the pits are available for tailings deposition (Table 8.2-4).

Table 8.2-4: Back River Property Tailings Management System Storage Requirements

Location	Operations Stage	Period (Year and Quarter)	Tailings Solids (Mm^3)
TSF	1	Y-1 Q4 to Y5 Q1	3.5
Llama TF	2	Y5 Q1 to Y12 Q4	6.8
Total Project		**Y-1 Q4 to Y12 Q4**	**10.3**

The TSF will store both tailings solids and supernatant water for the first five years of Operations. As development continues, the mined-out Llama Open Pit will be used to store tailings and supernatant water. Over this period (until approximately Year 12, Q2), supernatant water will continue to be reclaimed from the TSF until the pond depth reaches an approximate depth of 1.0 m. At this time, it is assumed that further reclaim will no longer be viable in the TSF, and the reclaim line will be relocated to Llama TF for the last two quarters of Year 12. The TSF will then be breached, allowing WRSA runoff to flow by gravity to the Goose Main Reservoir (formerly Goose Main Open Pit).

A seepage analysis of the TSF Containment Dam liner predicts that minor seepage through the TSF Containment Dam at an anticipated rate of around 1,200 m^3/year while it is an active tailings management facility.

The TSF WRSA Diversion Berm, constructed downstream of the TSF, will collect surface runoff and sub-surface seepage through the active layer, which in turn will be pumped back into the TSF. Once the TSF is closed, the TSF WRSA Diversion Berm will also be breached and cover with waste rock. All runoff from the covered TSF WRSA will report to Goose Main Reservoir.

Seepage analysis for the TSF South Dyke was also completed during the FEIS process and flow is anticipated to be around 90 m^3/year; this minimal seepage will be easily managed by intermittent pumping, as well as early development of the tailings beach off this structure, which will promote tailings freeze back.

The bulk of tailings that will be stored in the TSF will have a moderate to high acid rock drainage (ARD)/metal leaching (ML) potential. During Operations, if tailings material that forms the TSF beaches is not buried under fresh material before a lag time on the order of 10 to 20 years is exceeded, then ARD could develop. This understanding of lag times has informed the tailings deposition plan in the TSF in order to prevent the development of ARD. The Water and Load Balance model has taken the tailings deposition schedule into account in the prediction of the TSF runoff quality.

8.2.7 Saline Water Pond

Saline water from the Umwelt Underground and the Llama Open Pit will be collected and pumped to the Saline Water Pond. In Year 4, saline water from the Saline Water Pond is pumped at a rate of 13,000 m^3/day to the bottom of the partially flooded Umwelt Reservoir, creating a meromictic (stratified) lake. In total, just over 1.3 Mm^3 of saline water will be pumped into the Umwelt Reservoir over the remaining LOM. Saline water will also be pumped into the mined-out Umwelt Underground (around Year 10).

8.2.8 Explosives Manufacture and Storage

Pre-packaged explosives delivered by air or Winter Ice Road will be used early in construction until an ammonium nitrate (AN) facility is constructed at the Goose Property. Ammonium nitrate for ammonium nitrate fuel oil (ANFO) production will be delivered to the mine site in shipping containers. The storage of pre-packaged explosives and AN is expected to represent a low potential to impact water resources.

An explosives truck wash facility will be constructed and operated at the AN Facility. Wash water from this facility may be high in ammonia, suspended solids, and/or metals. This wash water will be treated at the AN Facility in an evaporator. Alternatively, the truck wash water will be transported to a water management pond for treatment or discharge as appropriate.

8.2.9 Marine Laydown Area

Water management strategies at the MLA will remain the same during the Construction Phase (Year -4 to Year -1) and the Operations Phase (Year 1 to Year 10) (Figure A-09). Refer to Section 8.1.11 for further details.

8.3 PHASE THREE: CLOSURE

Milling ends and closure begins in Year 13 of the Project life. The total duration of the closure period is 13 years, with a Closure Phase of 8 years and a Post-Closure Phase of 5 years. Water management during the Closure Phase relates to ongoing camp operation, passive filling of open pits, runoff control from WRSAs, and recirculation treatment within the Llama TF, if required. These activities will continue to be implemented until the contact water in the flooded open pits, meets site-specific discharge limits and receiving water quality objectives. At that point, passive discharge to the environment will be possible. Water management activities during the Closure Phase at the Goose Property are presented in Table 8.3-1 and are depicted in Figure A-07.

Further details regarding the closure and reclamation activities outlined in 8.3.1 to 8.3.9 are presented in the Interim Closure and Reclamation Plan (WL SD-026).

Table 8.3-1: Diversion and Containment Berm Breach Schedule during Closure and Post-Closure Period

Phase	Figure	Water Management Structure	Closure Timeline	Closure Strategy
Phase 3 - Closure 13-20	A-07			
		Saline Water Pond Containment Dam	Operations	Decommissioned after dewatering of Saline Water Pond and Umwelt Reservoir is complete.
		Primary Pond Containment Dam	Operations	All Primary Pond flows conveyed to Umwelt Reservoir. Umwelt WRSA capped and freeze back promoted.
		Plant Site Pond Containment Dam	Closure	Pond is dewatered after removal of the Ore Stockpile and Plant Pad is decommissioned. Runoff from the area will report to Goose Lake.
		Llama WRSA and Pit diversion berms	Operations	Drains Llama WRSA Pond into Llama TF when open pit mining is complete. Allow Llama TF to flood.
		Goose Main Pit Diversion Berm	Operations	Breached upon completion of open pit mining, allowing Goose Main Reservoir (formerly Goose Man Open Pit) to flood.
		Main TSF Containment Dam and TSF WRSA Diversion Berm	Closure	Both will be breached towards Goose Main Reservoir and onwards to Goose Lake
Phase 4 - Post Closure 21+	A-08	All water management structures are decommissioned during Closure (Phase 3)		

8.3.1 Culvert Closure

Culverts will be removed from all-weather roads and the natural drainage restored. Roads will otherwise remain intact to ensure preservation of permafrost and facilitate long-term site access for monitoring and inspection.

8.3.2 Berm Closure

During the closure period, the diversion and containment structures will be breached to restore natural drainage and allow runoff to naturally fill the open pits. A general water management infrastructure breaching schedule for the diversion and containment structures at the Goose Property can be seen in Figure A-07 to A-08.

Berm closure is not expected to significantly impact the water quality of site runoff water. All runoff is expected to meet the site runoff quality standards as indicated in Table 7.5-1. Water quality monitoring will occur at strategic locations throughout Closure to identify whether water quality criteria are being met.

Breached diversion structures will remain in place during and beyond the Post-Closure Phase. Collection ponds will have been breached, liners removed and landfilled, and the breaches re-contoured and armoured (if necessary) to allow for passive runoff.

8.3.3 Open Pit Closure

The open pits will be passively filled by breaching various water management structures, thereby allowing both contact and non-contact water to fill the pits. Pit water will be monitored to ensure it meets applicable discharge criteria and then be allowed to overtop into nearby watercourses.

Table 6.1-2 provides a summary of the average monthly water quality concentrations at the time of flooding and the average open water long-term steady state conditions at the downstream prediction notes of the flooded open pits. The results in Table 6.1-2 include the effects of water treatment required in Llama TF to reduce TSS, arsenic, copper, and ammonia concentrations. Long-term steady state conditions are expected to meet MDMER conditions shortly into closure at PN04 (Goose Neck) and will meet SSWQOs at PN03 (outlet of Goose Lake). Water treatment will continue from the Operations into the Closure Phase if required to ensure water quality guidelines are met.

Llama Open Pit, which was already partially flooded by the operation of Llama TF, will be further flooded as all Llama diversion berms will be breached. Runoff from the Llama WRSA will also be routed to Llama TF. The Llama TF will overtop under average hydrologic conditions in Year 11 and discharge into Goose Lake via Umwelt Lake. Recirculation treatment in Llama TF will continue year-round until Year 11 or until water quality objectives are met.

Umwelt Open Pit, which was already partially flooded by the operation of Umwelt Reservoir, will be allowed to continue to fill with catchment water, as well as water from the breached Primary Pond. Umwelt Reservoir will be breached at the north end and will overtop in Year 11 under average hydrologic conditions.

Goose Main Open Pit, which was already partially flooded with contact water as Goose Main Reservoir will be allowed to continue to fill with catchment water. Goose Main Reservoir will be breached at the east side and overtop into Goose Lake once water quality objectives have been met, which is expected to occur in Year 13 under average hydrologic conditions.

Pit lake water quality monitoring will be conducted to ensure water meets discharge criteria prior to pit overtopping and passive discharge. In the unlikely event that the water in any of the pit lakes is not suitable for discharge, the pit lake water will be batch-treated to address remaining water quality impairments. Sabina intends to implement five years of post-closure water quality monitoring for each open pit to ensure that water quality objectives are met. If closure objectives have not been met in this five-year monitoring period, Sabina will extend monitoring beyond the stated 5-year Post-Closure monitoring period. Additional details of the above proposed monitoring are included in the ICRP (WL SD26).

8.3.4 Underground Facility Closure

During mine operations, saline groundwater entering the underground workings will be pumped to the Saline Water Pond (and subsequently the Umwelt Reservoir) at surface. During Operations, as a part of closure activities, a portion of the saline water in Umwelt Reservoir will be pumped into the mined-out Umwelt Underground. Vent raises and the underground portal will be capped with concrete and waste rock, respectively.

8.3.5 Waste Rock Storage Area Closure

During Operations, potentially acid generating (PAG) material in WRSAs will be progressively covered with NPAG material starting in the first year of development for each facility (e.g., approximately in Year 1 for the Umwelt WRSA and Year 2 for the Llama WRSA). Progressive reclamation will consist of a 5-m cap of NPAG waste rock to promote the aggradation of permafrost into the WRSAs so that the PAG rock remains frozen. Final sloping and minor NPAG covering activities will occur during the Closure Phase. Permafrost aggradation into the WRSAs will be monitored during placement and once the WRSAs are closed.

Once the WRSA runoff consistently meets the site-specific contact water discharge criteria following completion of WRSA operations, the WRSA ponds and diversion structures will be breached and removed, and the final post-closure discharge will be established. Five years of post-closure water quality monitoring from the WRSAs will take place to confirm water quality objectives are being met.

8.3.6 Ore Stockpile Facility Closure

Milling of all remaining stockpiled material will be completed in Year 12. The Plant Site Pond will be breached at the beginning of the Closure Phase so the pond flows towards Goose Lake. No remaining seepage or runoff from the area is expected. Five years of post-closure water quality monitoring will be conducted in the area to confirm runoff meets water quality objectives.

8.3.7 Tailings Management Facility Closure

No tailings deposition or milling will occur during the Closure period.

The TSF Main Containment Dam and TSF WRSA Diversion Berm will be breached in Year 13 so any runoff flow would be directed towards Goose Main Reservoir and onwards to Goose Lake. Therefore, water quality objectives associated with TSF runoff will be assessed in the Goose Main Reservoir before discharging to the environment. The entire facility will be covered with NPAG waste rock material.

Once recirculation treatment within the Llama TF meets water quality objectives and overtops (Year 11 under average hydrologic conditions), any remaining diversions around Llama TF will be breached and the facility will discharge to former Umwelt Lake. Five years of post-closure water quality monitoring will be conducted at the former tailings facilities to confirm water quality objectives are being met.

8.3.8 Saline Water Pond Closure

The Saline Water Pond will be dewatered into Umwelt Open Pit (then called Umwelt Reservoir) and into the Umwelt Underground, if required. Once the Saline Water Pond is dewatered in Year 4, the top one to two-meter layer of sediments around the original footprint of Umwelt Lake is planned to be excavated and placed into Llama TF. The excavation and storage of this sediment has been included into the Water and Load Balance model. The remaining chloride in the porewater of the sediments underlying the original footprint Umwelt Lake is assumed to diffuse upwards into Umwelt Lake within the first year of it being re-established.

The proposed depth of sediment excavation was determined by a chloride diffusion model that calculated the concentration of chloride in the porewater of the sediment underlying the Saline Water Pond over time, based on the predicted chloride concentration in the Saline Water Pond water itself (Sabina 2015, Appendix V2-7H). Should the chloride concentration at the 2-m depth be higher than the long-term CCME guideline, more sediment around the original footprint of Umwelt Lake will be excavated and placed in the Llama TF.

Following excavation of the lake-bed sediment, the Saline Water Pond Containment Dam will be breached allowing Umwelt Lake to re-establish. No further water management activities at the Saline Water Pond will take place during Closure. Water quality monitoring will happen during the closure and five-year post-closure periods to confirm water quality objectives are being met.

8.3.9 Water Treatment Closure

As mentioned above, 8,500 m^3/day year-round recirculation water treatment in Llama TF for TSS, arsenic, copper, and ammonia will occur from Year 5 to Year 11 of Operations. This treatment will continue until water quality objectives are met, which is expected in Year 11 in advance of the facility overtopping in Year 12. Should additional treatment be required to meet water quality objectives, Sabina would continue the water treatment into the Closure Phase during the open water season in Llama TF. Once objectives have been confirmed by water quality sampling, all pumping and piping infrastructure, as well as the WTP itself, will be dismantled and landfilled. Any sludge produced from water treatment during the Closure period will also be landfilled.

8.3.10 Marine Laydown Area Closure

Water management strategies at the MLA will remain the same during the Closure Phase (Year 13 to Year 20) and the Post-Closure Phase (Year 21 to Year 25).

The MLA will require minimal closure with the respect to water management as the site does not require ponds or other diversion infrastructure for water management purposes (Figure A-10). Decommissioned roads and pads, which will be constructed using geochemically suitable material, will be designed to have runoff as dispersed sheet flow to minimize channelized flow.

Refer to the Interim Closure and Reclamation Plan for discussion on other closure aspects of the MLA.

8.4 PHASE FOUR: POST-CLOSURE

Water management activities during the Post-Closure Phase at the Goose Property are presented in Table 8.3-1 and are depicted in Figure A-08. The Goose Airstrip Culvert crossing will be removed, and the Goose Airstrip will be breached.

Water management strategies at the MLA will remain the same during the Closure Phase (Year 13 to Year 20) and the Post-Closure Phase (Year 21 to Year 25) (Figure A-10).

Post-Closure monitoring will be completed at both sites during this phase.

8.5 WATER MANAGEMENT – CARE AND MAINTENANCE

Temporary closure (also termed Care and Maintenance) is defined as the cessation of mining and processing operations for a finite period of time with the intention of resuming operations upon resolution of the cause of cessation (MVLWB/AANDC 2013). Care and Maintenance activities will depend on the phase at which cessation of operations takes place. For more details, refer to the Interim Mine Closure and Reclamation Plan.

Monitoring will take place and continue as outlined in Section 10 at whatever phase cessation occurs. Key surface water infrastructure will be maintained through Care and Maintenance to ensure proper operation. Depending on the stage at which temporary closure occurs, the water level in the active tailings management facility at the time may need to be monitored as there will be a net buildup of water due to precipitation inflows and no water reclaim for processing. Should temporary closure occur for an extended period of time (i.e., two or more years), it may be necessary to begin pumping from the active tailings management facility and treating the excess water for discharge.

9. Environmental Protection Measures

9.1 GENERAL OBJECTIVES

The purpose of environmental protection measures for site water management is to eliminate or reduce Project effects on water quality.

The main objectives of Sabina's water management strategies are to:

- Minimize the amount of water that contacts mine ore and wastes, which ultimately reduces the volume of water requiring management;
- Appropriately manage all contact water and discharges to protect local aquatic resources; and
- Implement water conservation and recycling to maximize water reuse and minimize the use of natural waters.

Protection measures may include the planning and design of engineered structures, the application of control technologies, the implementation of BMPs, and specific requirements from regulatory authorizations. Monitoring of the protection measures and adaptive management are also an integral part of effective environmental protection measures.

Pending further direction from the NWB, Sabina is committed to maintain a Water Management Plan designed to the above main objectives. The plan includes monitoring that demonstrates that contact water (runoff and shallow groundwater) from the ore storage and WRSAs is adequately captured and managed consistent with the MWRMP (WL SD-08).

9.2 WATER USAGE

The following protection measures will be applied to water usage:

- Freshwater intake and discharge pipelines will be designed to limit erosion and sedimentation, protect against freezing, and accommodate peak flows;
- Controlled construction of the engineered intake and discharge pipelines will ensure minimal changes in turbidity and resuspension of sediment;
- All material used in construction will be clean, free of sediment, and geochemically stable; and
- All intake and discharge pipelines will be screened in accordance with the *Freshwater Intake End-of-Pipe Fish Screen Guideline* (DFO 1995). The water withdrawal rate will be controlled such that fish do not become impinged on screens.

Water will be recycled to the maximum extent possible. The most significant water recycling activities will be within the tailings management facilities. The TSF and the Llama TF will store both tailings solids and supernatant water. The supernatant water will include contact water from the open pits and WRSAs. Water will be recycled and form the main source of water for the Process Plant.

9.3 CONSERVATION MEASURES

Long-term water usage has been closely evaluated; the focus has been on identifying maximum water use, while protecting fish and fish habitat. Short-term use will be required for various Project activities (i.e., WIR construction, dust suppression, etc.). Potential short-term water sources will be evaluated in advance to determine if they will be adequate for the activity in accordance with the DFO (2010) winter water withdrawal guidelines, including:

- Total water withdrawal from a single waterbody will not exceed 10% of the available water volume; and
- Only waterbodies with a minimum unfrozen water thickness of 1.5 m under ice will be considered for water withdrawal.

Sabina is committed to minimize and mitigate impacts to fisheries. For fish bearing crossings, Sabina will implement all applicable DFO BMPs to avoid and mitigate serious harm to fish as the result of water crossing construction, operation, and decommissioning for all fish-bearing water crossings. These measures will include, but are not limited to, appropriate design of water crossings to facilitate fish passage at both high and low flows; timing windows that incorporate spawning, incubation, and hatch times for all species using watercourses; sediment and erosion control; protection of riparian vegetation; and other forms of bank stabilization.

Sabina will ensure that all project infrastructure in watercourses are designed and constructed in such a manner that they do not unduly prevent and limit the movement of water in fish bearing streams and rivers, unless otherwise authorized by DFO. In addition, unless otherwise directed by DFO, Sabina's monitoring program for culverts on fish bearing watercourses during Construction, Operations, and Closure phases will include measures to ensure that barriers to fish passage do not form over time as a result of crossing damage due to ice blockage, flooding, or movement of debris; all of which may occur at freshet. Detailed design drawings and an updated monitoring program for culverts on fish bearing watercourses will be produced prior to construction.

Sabina will continue to engage DFO, the Kitikmeot Inuit Association, and other interested parties during the regulatory phase on the design, construction, and operation of adequate fish passage to permit migration of Arctic Grayling from Goose Lake to natural spawning and rearing habitat located in upper Rascal Stream East, south of the planned airstrip. Any additional information required to ensure the design of the fish passage will be completed prior to significant construction activities at the Goose Property. Specifically, Sabina will provide annual monitoring updates regarding the Rascal Stream Fish Passage that enables parties to determine its effectiveness.

Inline with dewatering, a fish-out program will be completed. The fish-out program will follow the DFO's *General Fish-Out Protocol for Lakes and Impoundments in the Northwest Territories and Nunavut* (Tyson et al. 2011). Lake dewatering will commence once the catch-per-unit-effort (CPUE)/recapture phase of the fish-out program has been completed (typically between August and September).

The fish-out program will aim to be completed outside of periods where there is high migratory bird use of the lake (i.e., nesting, brood rearing, and migration periods) to avoid the incidental take of migratory birds through entanglement in gill nets. Mitigation measures for minimizing mortalities of diving birds may include increasing the visibility of gill nets, use of visual or auditory deterrents to prevent birds from landing on the lake during active gill-netting, monitoring migratory bird usage of the lake, determining high use feeding areas prior to setting gill nets and avoiding these areas, and reporting of by-catch to adjust mitigation measures.

9.4 GENERAL SITE RUNOFF

Collected water or runoff that meets the criteria specified in Table 7.5-1 will be discharged to land, and where possible at a minimum setback of 31 m from a waterbody. To protect the freshwater environment during construction and decommissioning activities, the Project will minimize runoff and the transport of material into freshwater by the following planning and design measures:

- WRSAs will be confined to the local watersheds where the deposits are located to limit potential effects on water quality in local drainage areas;
- Infrastructure will be located, whenever feasible, on competent bedrock or appropriate base material that will limit permeability and the transport of potentially lower quality water into the active layer and ultimately to the freshwater environment;
- Footprint areas of Project components will be minimized to the extent practicable, such as locating infrastructure nearer to the central location of Project sites around the deposits; and
- The landscape will be reclaimed as soon as feasible to minimize erosion potential.

At select water crossings, pumping or siphoning may be employed to facilitate the transfer of water from one side of the structure to the other side. Pumping can also serve as a temporary solution during freshet or prior to a culvert installation.

9.4.1 Sediment and Erosion Control Measures

Surface water will be managed within the Project footprint such that sediment-laden runoff is minimized, intercepted, and/or treated prior to entering downstream receiving waters or mine process facilities. Effective sediment control depends on the isolation of easily-eroded, disturbed ground surfaces.

Measures will be implemented to reduce the quantity of runoff where the mobilization of sediments cannot be eliminated. Sediment-laden water will be captured and routed to sediment basins.

Sediment and erosion management and control during initial and ongoing construction may involve establishing contact water collection ditches/berms, constructing sediment ponds, limiting land disturbance to a practical minimum, reducing water velocities across the ground through surface texturing and re-contouring, and progressively rehabilitating and stabilizing disturbed land surfaces to minimize erosion.

Exposed landscape surfaces will be protected by the installation of covering material such as riprap, aggregate, or rolled erosion control products. Runoff flow may be controlled by a combination of measures, including:

- Texturing/grading of slopes to slow runoff and reduce effective slope length;
- Synthetic permeable barriers and/or fibre rolls to reduce runoff velocities and retain sediments; and
- Check dams, gabions, and energy dissipation structures to reduce flow velocities in channels.

Sediment levels in runoff will be minimized by intercepting sediment before it reaches the freshwater environment. In addition to measures aimed at controlling runoff flow, the quantity of transported material in runoff may be controlled by measures including:

- Preserving riparian zones which trap sediment and reduce flow velocities;
- Installing synthetic permeable barriers, fibre rolls, and/or silt fences as required;
- Installing check dams, gabions, and sediment basins to reduce flow velocities and encourage sediment deposition;
- Maintaining and repairing any machinery prior to use that has the potential to result in a fluid release or leak; and
- Locating fuel transfer and maintenance activities greater than 31 m from a watercourse or waterbody, except for approved activities near water.

Sabina will implement the following mitigation and management measures for erosion and sediment controls, as well as the following bank stabilization measures:

Mitigation by Erosion and Sediment Control

- The area of landscape disturbance will be minimized, and restoration will occur as soon as possible to minimize erosion potential.
- Silt fences will be used in areas of cuts and excavations, downslope from exposed or erodible areas to prevent sedimentation of waterbodies.
- Effective erosion and sediment control measures will be installed before starting work to prevent sediment from entering the waterbody.
- Site isolation measures (e.g., silt boom or silt curtain) will be used to contain suspended sediment where in-water work is required.
- Regular inspection and maintenance of erosion and sediment control measures and structures will be conducted during the course of construction.
- Regular inspection and maintenance of erosion and sediment control measures and structures will be conducted during the course of construction.

Mitigation by Shoreline/bank re-vegetation and stabilization

- Clearing of riparian vegetation will be kept to a minimum to avoid disturbance to the riparian vegetation and prevent soil compaction.
- If replacement rock reinforcement/armouring is required to stabilize eroding or exposed areas, appropriately-sized, clean rock will be installed at a similar slope to maintain a uniform bank/shoreline and natural stream/shoreline alignment.
- Exposed landscape surfaces will be protected, where possible, by the installation of covering material like riprap, aggregate, or rolled erosion control products.
- Decommissioning of the roads will involve restoring natural drainages and stabilizing any slopes where there is potential for erosion; stabilization measures may require pulling back of side-cast fills on locally steep slopes or buttressing and/or re-contouring of steepened slopes using non-potentially acid generating material.

A total suspended solids (TSS)-turbidity relationship will be developed, where needed, either from historical site data (if sufficient TSS-turbidity data are available to create a statistically supported relationship), experimentally, or during activities (in which case, the use of Turbidity in place of TSS would only be possible once a relationship had been established; until that time compliance would only be verifiable through TSS concentrations). Which methodology to be used will depend on the site, the amount of historical data available, and the planned work. In all situations, regression analysis will be used to identify site-specific statically significant relationships (equations) relating turbidity to TSS in a manner to allow the derivation of TSS from in-field measurements of turbidity. TSS will be monitored during in-water construction against criteria presented in Section 7.5. Should monitoring indicate that TSS has surpassed 80% of these criteria additional mitigation measures will be implemented (such as a temporary reduction in, or cessation of, activity or use of additional mitigation).

9.4.2 Saline Water Management

The Saline Water Management Plan (SWMP) is included an Appendix C to the WMP, and provides details related to the management of saline groundwater in compliance with the Type A Water Licence 2AM-BRP1831.

The SWMP provides a description of the saline water management, outlines the procedures required to manage the quantity and quality of saline groundwater interacting with Project components throughout the mine life, and characterization of saline water inflows into the underground mine workings. The SWMP also includes monitoring of thermal conditions, monitoring of saline water at the Goose Property, mitigation measures designed to address the potential for higher-than-predicted volumes of saline water inflows into the open pits and the underground mine, and potential water treatment and disposal methods.

In summary, the saline water management strategy consists of collecting saline water from Llama Open Pit and the underground mine workings, and temporarily storing this groundwater in a dedicated storage facility, the Saline Water Pond, until it can be dewatered into Umwelt Reservoir, and pumped back into underground workings. Additional details can be found in WMP Appendix C.

9.4.3 Mine Water Runoff Management

Environmental protection measures will be implemented to manage mine water runoff, including:

- Collection of all mine water runoff through use of diversions, collection ditches/berms and pipelines;
- Recycling of mine contact water to the extent possible at the Goose Property;
- Treatment of mine contact water prior to discharge to the environment during Construction, Operations, and Closure;
- Land discharge of mine contact water where possible, rather than direct discharge to surface waters; and
- Passive discharge of mine contact water during the Post-Closure Phase, provided discharge criteria are met.

At the Goose Property, these measures will be achieved by collecting all mine contact water from open pits, ore stockpiles, WRSAs, and the TSF. Water will be recycled from the TSF and TF for use in the milling process. At Closure, water from the Llama TF will be circulated through the WTP until water quality has improved to discharge criteria. As previously mentioned, passive discharge of untreated mine contact water will occur only if discharge criteria and receiving water quality objectives are met. In the unlikely event that mine water runoff from pit lakes and WRSAs do not meet discharge criteria, water treatment will be provided by directing runoff from these areas to a central location and treating from there.

Diversion structures will be required around Llama, and Goose Main open pits to divert non-contact water away from mining areas. This strategy will reduce the total amount of contact water generated by the Project. Mine water runoff management has been optimized based on the plans as outlined in Section 6 of Sabina (2017). The management strategies will continue to evolve and will be finalized during detailed design.

9.5 ACID ROCK DRAINAGE / METAL LEACHING

This plan will be periodically updated as new geochemical information becomes available. The MWRMP (WL SD-08) will be updated during the water licencing process to incorporate criteria and procedures for the segregation of PAG and NPAG waste rock.

Goose Property Waste Rock

Goose Property mine workings and waste rock represent a moderate ARD/ML potential. Low to moderate bulk Neutralizing Potential (NP) contents could result in acidic drainage after a lag time of 14 to 20 years. Interaction with the deposit material and air/water could result in runoff/drainage exhibiting concentrations of arsenic and copper greater than MDMER limits. This plan has been designed to minimize exposure time of the mine workings and waste rock to air/water and, wherever possible, to ensure the exposure time is less than the expected lag time.

Tailings Geochemistry

The bulk of tailings that will be stored in the TSF will have a moderate to high ARD/ML potential. During Operations, if tailings material that forms the TSF beaches is not buried under fresh material before the lag time (on the order of 10 to 20 years) is exceeded, then ARD could develop. This understanding of lag times has informed the tailings deposition plan to prevent the development of ARD. The Water and Load Balance model has taken the tailings deposition schedule into account in the water quality prediction of the TSF runoff.

9.6 BORROW PIT AND QUARRY DEVELOPMENT

Plans to develop aggregate sources, as well as the identified environmental protection measures and monitoring plans, are described in the Borrow Pits and Quarry Management Plan (WL SD-03). The following summarizes the environmental protection measures identified to minimize impacts to water during borrow area and quarry planning and development:

- Maintain a setback distance of 31 m from creeks and streams;
- Preserve vegetative buffers to limit impacts on water quality;
- Use berms and ditches to direct runoff away from the excavation;
- Slope rock quarry floors so that water is diverted to a sump within the quarry or adjacent to the quarry boundaries where it can be monitored prior to release;
- Sample accumulated water within water collection areas for TSS, oil and grease, and ammonia-nitrogen;
- Apply sediment and erosion control measures such as those described in Section 9.4.1;
- Use dust skirts on conveyors and apply dust suppression measures as identified in the Air Quality Monitoring and Management Plan (Sabina 2019b);
- Monitor for ground ice during excavation of borrow areas;

- Monitor and address any subsequent settlement to maintain positive drainage and avoid the ponding of water (which can further exacerbate thawing of ground ice); and
- Routinely inspect the effectiveness of water management structures.

Sabina will maintain an appropriate setback distance between Project quarries and fish-bearing or permanent waterbodies, or implement appropriate mitigation measures, as required to prevent acid rock drainage or metal leaching into such waterbodies.

These environmental protection measures are described further in the Borrow Pits and Quarry Management Plan (WL SD-03). Individual quarry development plans and SOPs will be prepared by the contractor before extraction activities commence.

9.7 DUST MANAGEMENT

Dust from ore stockpiles and WRSAs is not expected to be substantial; however, dust will be monitored and managed to the extent reasonable. Crushing and screening operations will be conducted with equipment designed to mitigate dust dispersion. In the unlikely event that an unacceptable amount of dust is generated from end-dumping or front-loading during stockpiling and transferring operations, additional dust mitigation measures will be applied as identified in the MWRMP (WL SD-08). A nominal amount of water has been requested for dust suppression if needed (Table 7.3-1).

9.8 AMMONIA MANAGEMENT PLAN

Ammonium nitrate will be used in large quantities by the Project. ANFO is the main explosive mixture to be used for mining at the Project. Ammonium nitrate will be delivered by sealift in solid form in tote bags within seacans. They will be protected from the elements to prevent contact with water during transport and storage. The seacans will be placed on a laydown pad at the Goose AN Facility. Diversion berms will direct any runoff water to a sump at the AN Facility pad. Collected runoff from the AN Facility area will be treated as contact water as described in Section 8.2.8. Water from the AN Facility truck wash will be transported to a water management pond for treatment or discharge as appropriate, or will be collected and treated in an evaporator.

Ammonia concentration predictions for all sources were incorporated in the Water and Load Balance model; these sources include blasting residues associated with rock, Process Plant/tailings contributions, and camp wastewater. Ammonia, nitrate, and nitrite concentrations as a result of blast residue were derived from methods described by Ferguson and Leask (1998). These methods calculate the annual release of total AN as nitrogen based on the powder factor, fraction of ammonium nitrate in ANFO, the fraction of nitrogen content in AN, and the residual nitrogen remaining. Additional details on the assumptions are presented in the Water and Load Balance Report (Appendix E).

With adherence to BMPs for AN storage and handling there is minimal risk of AN spillage; however, ammonium nitrate and/or ANFO may be spilled during handling or during use in the open pit or underground. Spill locations would be generally limited to single storage bags within the AN Facility or seacans in the storage pad areas. These areas will be inspected regularly according to operating procedures. Spill prevention and response actions will include the following:

- establish and use SOPs for handling and working around storage areas;
- ensure proper containers are used for the storage and transport of explosives and AN;
- restrict access to authorized and trained personnel;

- o conduct regular inspections of storage areas, containers, and transport vehicles with frequency driven by activity levels;
- o clean up dry AN according to established SOPs, to minimize likelihood of nitrates entering watercourses;
- o manage and limit contact with snow and water, with particular anticipation of spring thaw/freshet period; and
- o properly dispose of spill material and any impacted rock pad material, which could include placing within a blast pattern prior to initiation.

More detailed spill response procedures for AN and explosives will be provided with the explosive's supplier Emergency Response Assistance Plan. An Emergency Response Assistance Plan will be prepared by the explosive's supplier for the transportation of explosives to all storage sites for the Project as required by the Transportation of Dangerous Goods regulations. For detailed information related to spill response for potential explosives refer to the Spill Contingency Plan (WL SD-17).

For specific water quality monitoring related to ammonia management refer to Section 10.

10. Monitoring Program

The three levels of monitoring proposed for mine development are:

- Environmental Monitoring; which further refines three forms of general monitoring into:
  - regulated discharge monitoring (i.e., set by legislation or authorization requiring specific discharge/effluent criteria to be met for compliance);
  - verification monitoring (i.e., internal operation management monitoring); and
  - general monitoring (i.e., NWB general monitoring requirements set in Type A Water Licence);
- Performance Measurement Monitoring; which tracks performance of mitigation measures implemented, identifies environmental changes in the receiving environment, and validates environmental effects predictions; and
- Design Support Monitoring; which is site-specific field monitoring required to support detailed engineering designs and confirm modelling assumptions.

All three types of monitoring will be used at the Project. The sum of all three types of monitoring will provide sufficiently robust data to support decisions in mine and water management.

The proposed general water monitoring program is outlined in Appendix B of this plan. Environmental monitoring station locations are shown on Appendix B, Figure B-01 and Figure B-02 for the Goose Property and MLA, respectively. In addition, Table B-01 and Table B-02 summarizes proposed water quality and flow monitoring of the Project during the Construction, Operations, and Closure phases, and includes monitoring station location, monitoring type, description, purpose, mine phase, parameters grouping, and sample frequency for each location. The list of constituents in each parameter group is provided in Table B-03.

Additional information supporting the general water monitoring plan can be found in the General and Aquatic Effects Monitoring Program documents. The Program includes the following documents:

- Environmental Management and Protection Plan (WL SD-20);
- Aquatic Effects Management Plan (WL SD-21);
- Fish Offsetting Plan (Sabina 2019a);
- Marine Monitoring Plan (Sabina 2018); and
- Quality Assurance/Quality Control Plan (WL SD-24).

The Aquatic Effects Management Plan (AEMP; SD-21) is a comprehensive monitoring program that considers Project related effects on the aquatic environment and is harmonized to meet MDMER and Environmental Effects Monitoring requirements. Monitoring established in the Type A Water Licence has to be at least as stringent as the requirements set by any Regulation under the *Fisheries Act* (refer to the Fish Offsetting Plan for additional information). Further, Sabina's proposed monitoring program for culverts on fish bearing watercourses during the Operations and Closure phases will include measures to ensure that barriers to fish passage do not form over time as a result of crossing damage due to ice blockage, flooding, or movement of debris.

Where appropriate all monitoring will be undertaken using established methods and defined Quality Assurance/Quality Control measures. Refer to the QA/QC Plan (WL SD-24) for additional detail. Sabina will also have in place an internal inspection plan to monitor activities and mine components that could adversely affect the use of water or the deposit of waste into water. Sabina's internal due diligence plan for inspections, Table 8.4-1, is provided in the Environmental Management and Protection Plan (WL SD-20), and be completed for each mine component or activity, including all earthworks or facilities constructed for the use, storage, treatment, and/or disposal of water and/or waste into water.

In addition, Sabina has completed the commitment to collect additional baseline water quality data to characterize the lakes and streams within the freshwater aquatic environment prior to Construction, and Sabina has used this data to update the Water and Load Balance model to account for potential seasonal variation (2AM-BRP1831, Part E Item 15).

11. Environmental Reporting

Internal reporting structures will provide the framework so monitoring results can be reviewed, instances of non-compliance with this plan can be identified, and subsequent corrective action can be undertaken in a timely manner. Items of non-compliance with applicable permits, licenses, and authorizations will be reported to the respective agency as outlined in those authorizations.

External reporting of Sabina's monitoring results and performance against this management plan will be in accordance with the following permits, licenses, approvals, and authorizations (Table 11-1).

Table 11-1: Reporting Requirements

Regulatory Instrument	Responsible Agency	Information to be Reported	Frequency	Compliance Inspections
Project Certificate	NIRB	Terms and conditions relevant to water management	Annually	A NIRB Monitoring Officer will inspect the site against the Project Certificate annually
Type A Water Licence	NWB	Water licence reporting requirements, including those identified in this plan	Monthly (General Monitoring requirements); Summary results in Annual Report	A waters inspector will inspect the site
Authorization for HADD of fish habitat under the Fisheries Act	DFO	Specified in the authorization – focused on protection of fish habitat	Annually	A fisheries officer may inspect the site periodically to determine compliance
MDMER	ECCC	Effluent quality and toxicology; sediment, benthics, fish population data	Monthly reporting of effluent quality and receiving water quality; annual reporting	
AEMP	NWB	To be determined – possibly inclusive of water and sediment quality and freshwater biota	As prescribed in the AEMP; Summary results in Annual Report	The AEMP will be submitted to the NWB and reviewed by other relevant agencies including DFO and ECCC

12. Adaptive Management

The mine design, including the water management design, has been carefully prepared taking into consideration the vast database of site characterization data gathered for the Project, coupled with rigorous engineering analysis. Where data was limited, conservative assumptions were consistently applied. Notwithstanding, a key element of monitoring as outlined in Section 10 is to verify that mitigation measures in relation to water management activities are being implemented and are achieving their intended outcomes. Adaptive management will be employed where mitigation is not achieving the intended result. Alternative mitigation measures may be identified at a later time and will be reflected in updates to this plan and related management plans.

Possible water management scenarios and the potential contingency strategies are outlined Table 12-1.

Table 12-1: Water Management Contingency Strategies

Possible Scenario	Contingency Strategy
While dewatering Llama and Umwelt lakes to Goose Lake, the concentration of TSS may be higher than the expected 50% volume requiring treatment before discharge.	Treat a greater percentage of the water from Llama and Umwelt lakes. Additional contingencies described below.
The volume of seepage from the TSF Containment Dam is greater than expected.	Larger return pumps may be required.
Seepage from any of the contact berms or other dams on site occurs.	Repairs to the berms/dams may be required. Alternatively, seepage collection berms may need to be constructed and return pumps may be required.
Saline inflows into the mine workings are greater than expected.	Additional storage locations will need to be identified, blending of saline water with other contact water may be investigated, or treatment to desalinate the water may be required. See SWMP Section 7 for additional details.
Waste rock leaches a greater concentration of metals or other constituents than expected.	Additional settlement time or water treatment may be required.
Underground mining operations cease prior to the underground deposition of the required volume of saline water from the Saline Water Pond.	Additional storage locations will need to be identified, or treatment to desalinate the water may be required.
The results of Water quality monitoring (WMP, Appendix B) or the Aquatic Effects Monitoring Program (AEMP) shows non-compliance.	Identify the issue (i.e. contact water not collected by contact berms, seepage through contact berms, ineffective treatment, etc.) and develop a strategy to improve treatment or reduce the release of mine water.

Checking and corrective action will occur during dewatering through the evaluation of continuous flow data and daily TSS and turbidity data. Results of the monitoring program will be reviewed by the Environmental Team, and water quantity and quality trends will be updated on a time scale relevant to the dewatering activity. If the dewatering activity will take two weeks or less, then data will be updated daily. If dewatering will take longer, then a more appropriate time scale may be used (e.g., every 3 days or weekly). This program will allow early detection of changes in water quality and implementation of corrective actions, if required. If trigger levels or thresholds are approached or exceeded, dewatering activities will be suspended.

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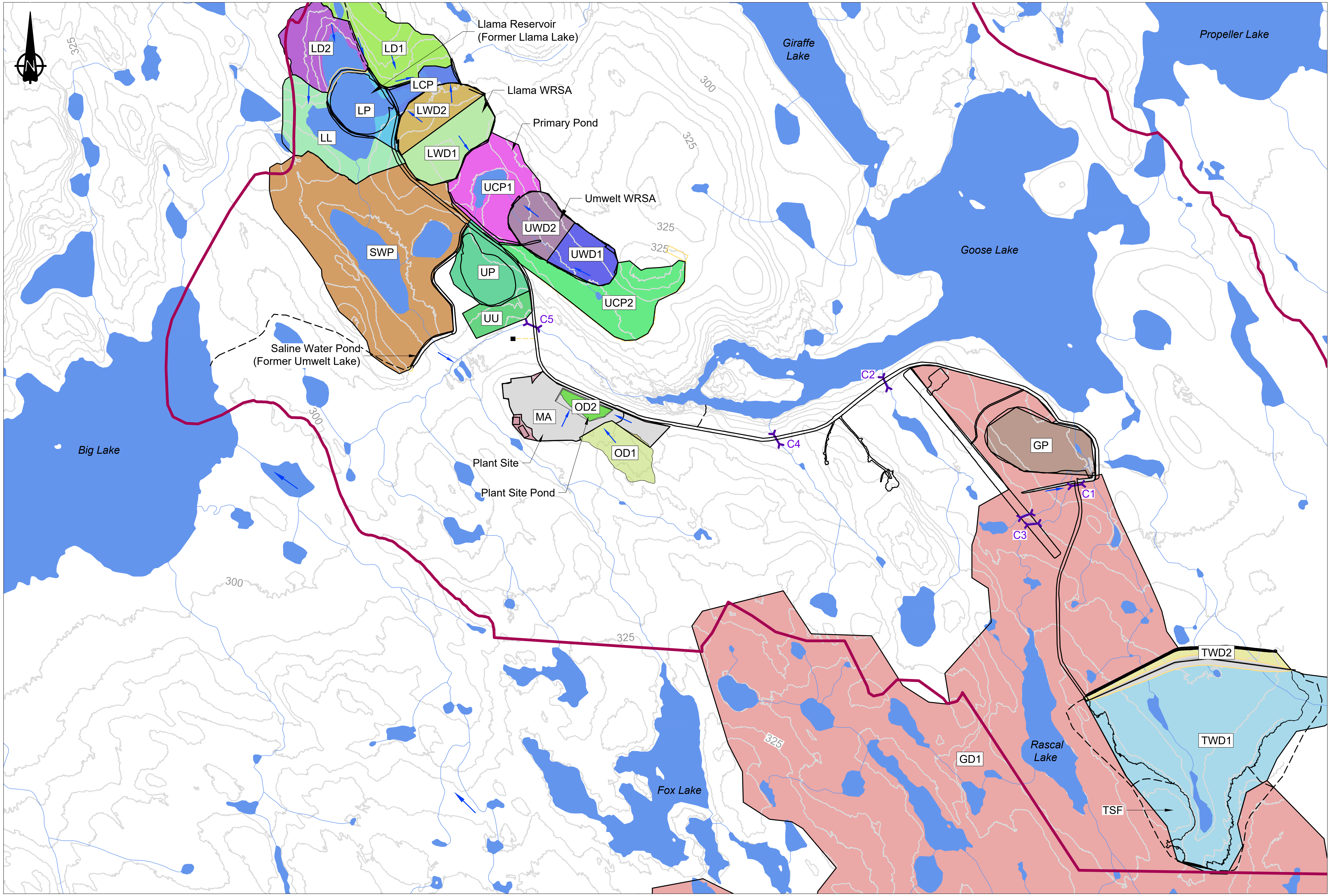
Appendix A. Figures



LEGEND

- Culvert
- Flow Direction
- Site Infrastructure
- Watercourse
- Waterbody

CATCHMENT LEGEND

- GD1 - Goose Main Pit Diverted
- GP - Goose Main Pit
- LCP - Llama WRSA Pond
- LD1 - East Llama Lake Diverted
- LD2 - West llama Lake Diverted
- LL - Llama Lake around Llama Pit Diverted
- LP - Llama Pit
- LWD1 - South Llama WRSA
- LWD2 - North Llama WRSA
- MA - Goose Plant Site
- OD1 - Ore Stockpile
- OD2 - Plant Site Pond
- SWP - Saline Water Pond
- TWD1 - TSF WRSA
- TWD2 - TSF WRSA Downstream Seepage Collection
- UCP1 - Primary Pond
- UCP2 - Umwelt WRSA Pond
- UP - Umwelt Pit
- UU - Umwelt Underground Pad
- UWD1 - South Umwelt WRSA
- UWD2 - North Umwelt WRSA

NOTES

1. Contours are shown at 5.0m intervals.
2. All units are in meters unless otherwise specified.

REFERENCES

1. NAD83 UTM Zone 13.
2. Footprint obtained from client.
3. Hydrography data obtained from Geogratis, © Department of Natural Resources Canada. All rights reserved.

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- -	- -						A	Permit Amendment Dwg	JBK	CP	20/06/05
REFERENCE DRAWINGS		REVISIONS									

For Permit Amendment

PROFESSIONAL ENGINEERS STAMP

srk consulting

DESIGN: JBK	DRAWN: TAH	REVIEWED: JBK
CHECKED: JBK	APPROVED: CP	DATE: 2020/06/05

FILE NAME: 1CS020.018 - Site Overview - WS.dwg

Sabina GOLD & SILVER CORP.

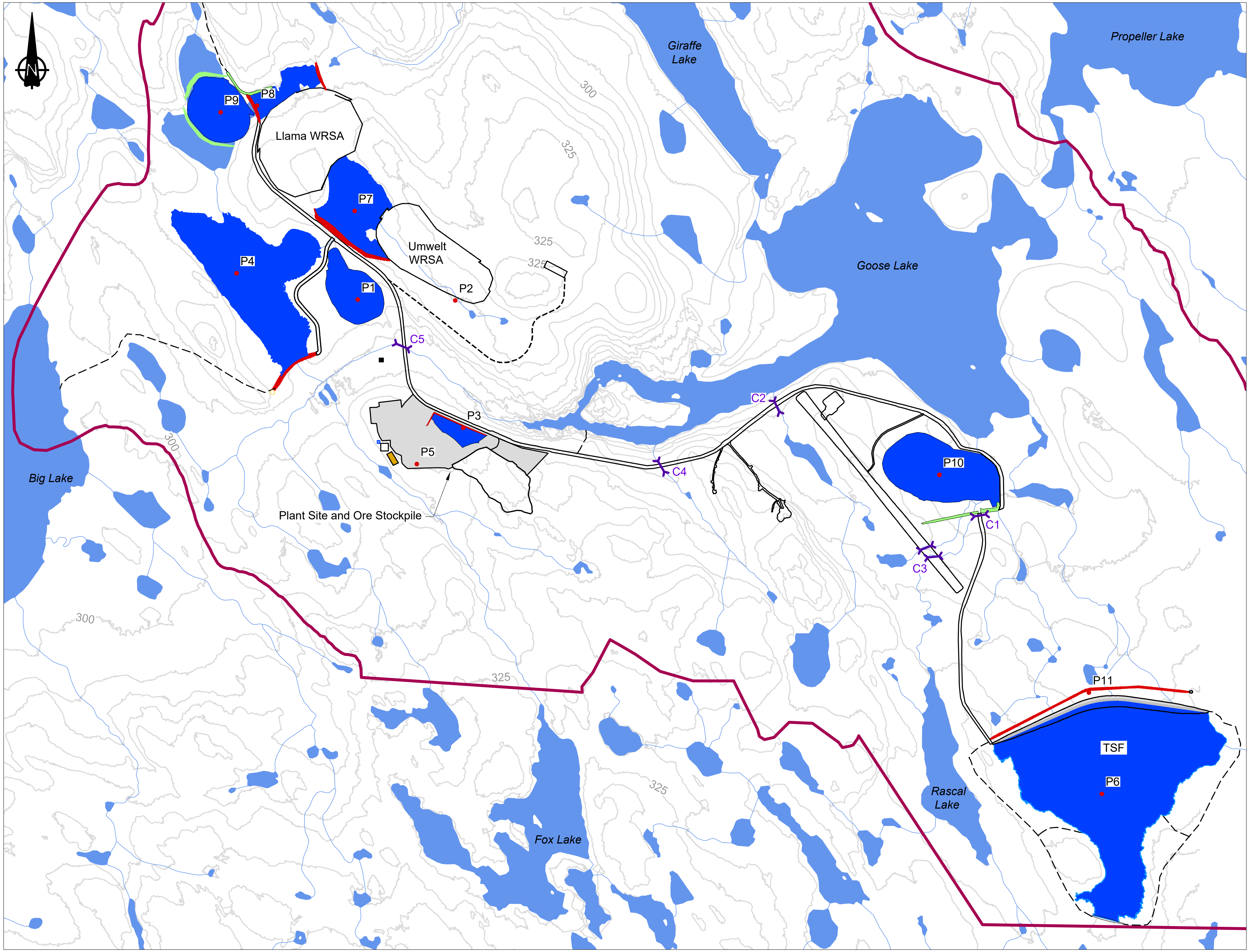
Back River Project

SRK JOB NO.: 1CS020.018

Water Licence Phase

DRAWING TITLE: Goose Property Catchments

DRAWING NO.: A-01 | SHEET: 1 OF 26 | REVISION NO.: A



LEGEND

- Pump
- Culvert
- Site Infrastructure
- Watercourses
- Contact Water Containment Dam (Lined)
- Non-contact Water Diversion Berm(Unlined)
- Landfarm
- Pond / Sump Location
- Potential Development Area
- Waterbody

CULVERT LEGEND

Culvert ID	Name
C1	Goose Culvert
C2	Gander Pond Culvert
C3	Goose Airstrip Culvert
C4	Echo Culvert
C5	Goose Creek Culvert

PUMP LEGEND

Pump ID	Name
P1	Umwelt Pit
P2	Umwelt WD Sump
P3	Plant Site Pond
P4	Saline Water Pond
P5	Water Treatment Plant
P6	TSF
P7	Primary WD Pond
P8	Llama WD Pond
P9	Llama Pit
P10	Goose Main Pit
P11	TSF WRSA Diversion Berm

NOTES

1. Contours are shown at 5.0m intervals.
2. All units are in meters unless otherwise specified.

REFERENCES

1. NAD83 UTM Zone 13.
2. Footprint obtained from client.
3. Hydrography data obtained from Geogratis, © Department of Natural Resources Canada. All rights reserved.

DRAWING NO.	DRAWING TITLE	NO.	DESCRIPTION	CHK'D	APP'D	DATE	NO.	DESCRIPTION	CHK'D	APP'D	DATE
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REFERENCE DRAWINGS

REVISIONS

For Permit Amendment

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DESIGN: JBK DRAWN: TAH REVIEWED: JBK

CHECKED: JBK APPROVED: CP DATE: 2020/06/05

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Sabina GOLD & SILVER CORP.

Back River Project

SRK JOB NO.: 1CS020.018

Water Licence Phase

DRAWING TITLE: Goose Property Pumping and Culvert Schematic

DRAWING NO. A-02 SHEET 2 OF 26 REVISION NO. A

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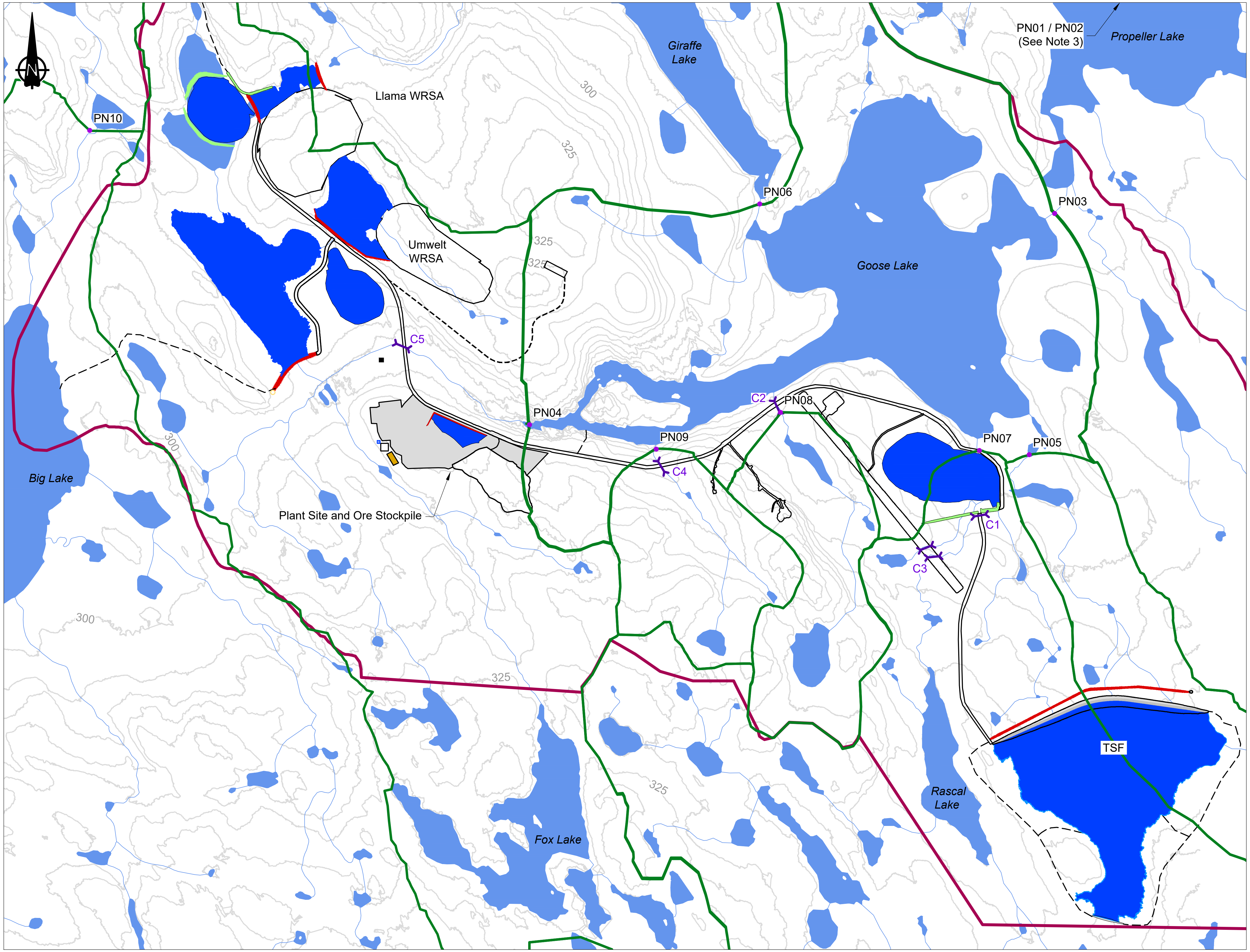

LEGEND

- Prediction Note (W&LB)
- Culvert
- Site Infrastructure
- Watercourses
- Pre-mining Catchments
- Contact Water Containment Dam(Lined)
- Non-contact Water Diversion Berm(Unlined)
- Landfarm
- Pond / Sump Location
- Potential Development Area
- Waterbody

NODE LEGEND

Node ID	Easting	Northing	Name
PN01	492324	7341050	Ellice River at RDA (See note 3)
PN02	435853	7479860	PL-H1 Propeller Outflow (See note 3)
PN03	434920	7271480	CP4 Goose Outflow
PN04	431063	7269930	CP1 Goose Inflow – Goose Neck
PN05	434733	7269710	CP3 – East of Goose Pit
PN06	432754	7271550	Giraffe Outflow
PN07	434367	7269740	CP3a Downstream of Goose Pit Diversion
PN08	432907	7270020	GL-H3 Gander Outflow
PN09	431994	7269750	CP2 Echo Outflow
PN10	427834	7272090	Mam Lake Outflow

NOTES

1. Contours are shown at 5.0m intervals.
2. All units are in meters unless otherwise specified.
3. PN02 located at Propeller Lake outlet, PN01 is downstream of Propeller Lake outlet.

REFERENCES

1. NAD83 UTM Zone 13.
2. Footprint obtained from client.
3. Hydrography data obtained from Geogratis, © Department of Natural Resources Canada. All rights reserved.

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FILE NAME: 1CS020.018 - Site Overview - Prediction nodes.dwg

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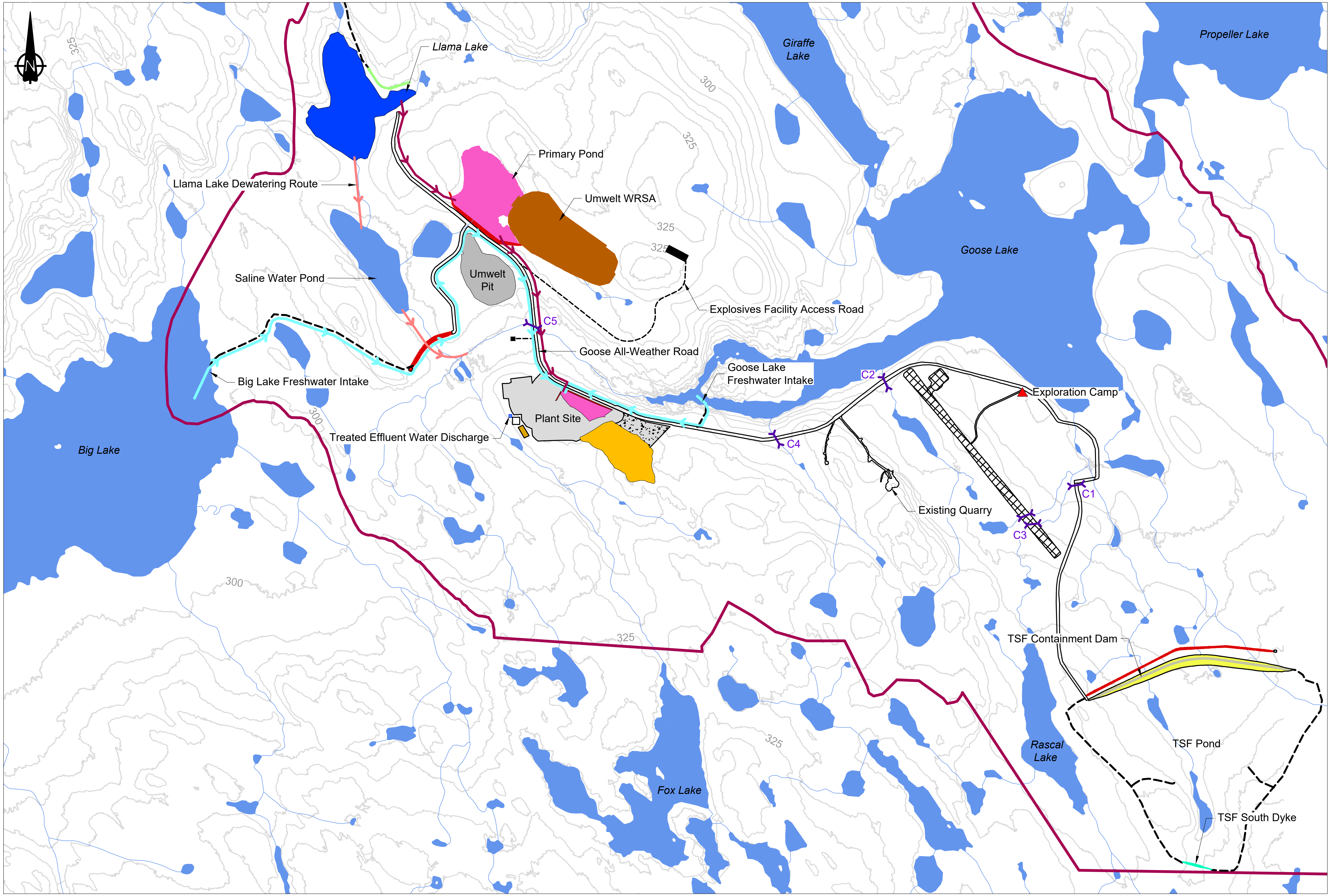
Water Licence Phase

DRAWING TITLE: Goose Property - Prediction Nodes

DRAWING NO. A-03 | SHEET 3 OF 26 | REVISION NO. A



LEGEND

- Culvert
- Service Road
- Water Intake Pipeline
- Pumped Contact Water Pipeline
- Dewatering Pathway
- Site Infrastructure
- Watercourse
- Contact Water Containment Dam (Lined)
- Non-contact Water Diversion Berm (Unlined)

GOOSE LAYOUT

- Airstrip
- U/G Laydown Area
- Other Infrastructure
- Resource Pit
- Camp / Plant Site
- TSF Containment Dam Embankment
- TSF South Dyke
- Contact Water Event Pond
- Haul Road
- Landfarm
- Potential Development Area
- Waste Rock Storage Area
- Ore Stockpile
- Waterbody

NOTES

1. Contours are shown at 5.0m intervals.
2. All units are in meters unless otherwise specified.

REFERENCES

1. NAD83 UTM Zone 13.
2. Footprint obtained from client.
3. Hydrography data obtained from Geogratis, © Department of Natural Resources Canada. All rights reserved.

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SRK JOB NO.: 1CS020.018

Water Licence Phase

DRAWING TITLE: Phase 1: Construction (Year -3 to-1)

DRAWING NO. A-04 | SHEET 4 OF 26 | REVISION NO. A

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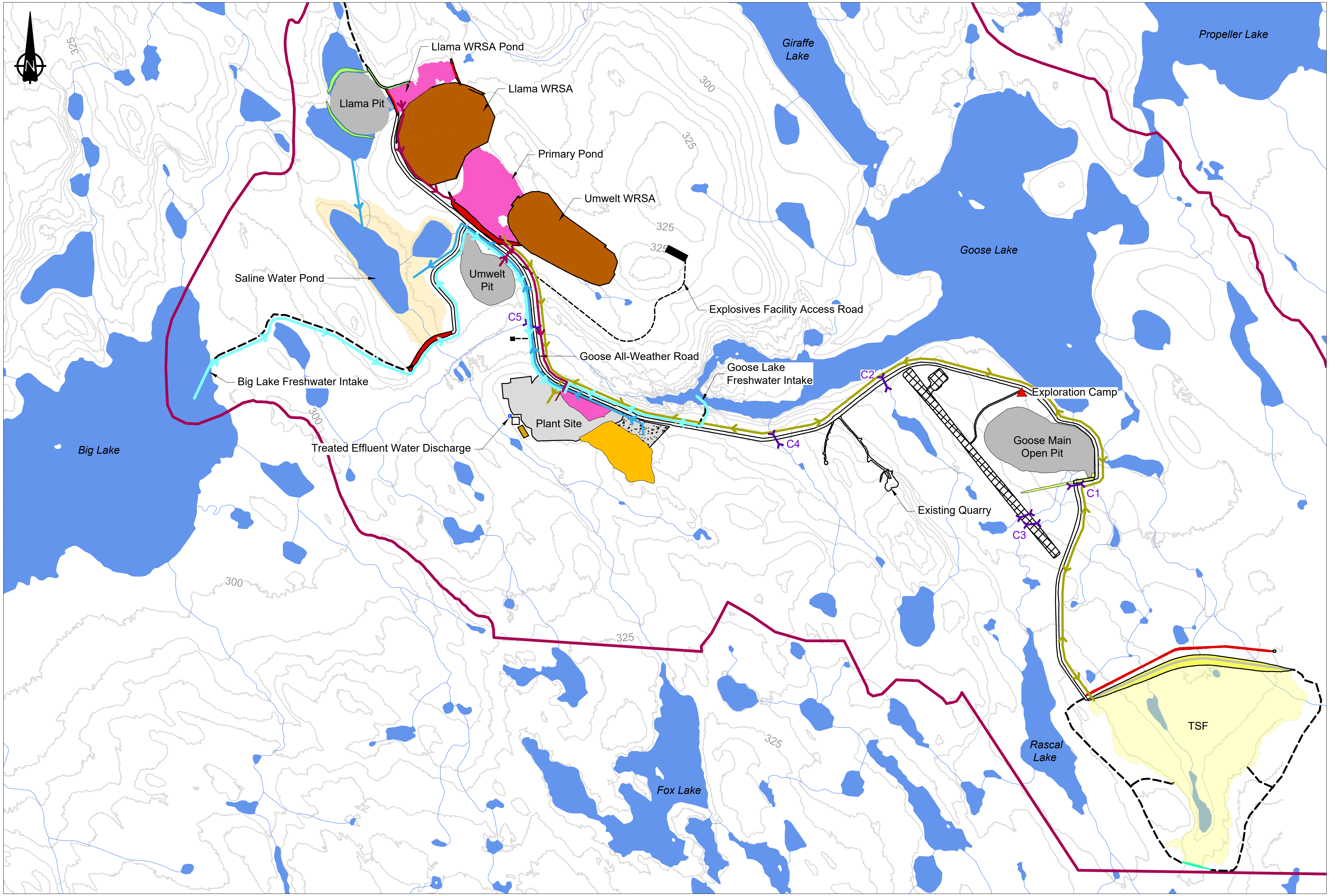

LEGEND

- Culvert
- Contact Water Pipeline
- Saline Water Flow
- Reclaim Water / Slurry Pipeline
- Site Infrastructure
- Service Road
- Water Intake Pipeline
- Watercourse
- Water Treatment Plant
- Contact Water Containment Dam (Lined)
- Non-contact Water Diversion Berm (Unlined)

GOOSE LAYOUT

- Airstrip
- U/G Laydown Area
- Other Infrastructure
- Resource Pit
- Camp / Plant Site
- Waste Rock Storage Area
- TSF Containment Dam Embankment
- TSF South Dyke
- Contact Water Event Pond
- Haul Road
- Landfarm
- Potential Development Area
- Active TSF
- Saline Water Pond
- Waterbody

NOTES

1. Contours are shown at 5.0m intervals.
2. All units are in meters unless otherwise specified.

REFERENCES

1. NAD83 UTM Zone 13.
2. Footprint obtained from client.
3. Hydrography data obtained from Geogratis, © Department of Natural Resources Canada. All rights reserved.

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Water Licence Phase

DRAWING TITLE: Phase 2, Stage 1 (TSF): Operations Year 1 to 5

DRAWING NO.: A-05 — SHEET 5 OF 26 — REVISION NO.: A

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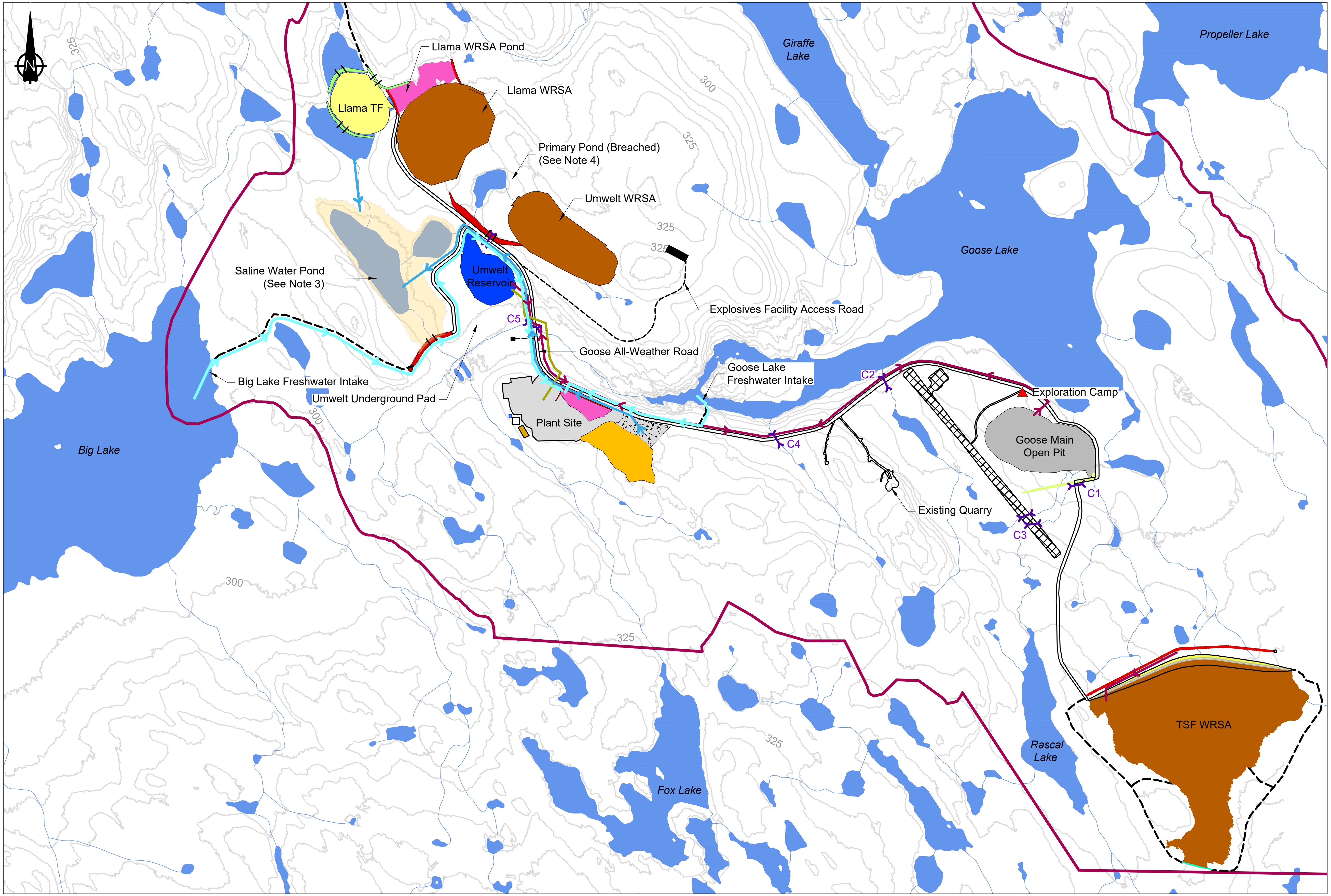

LEGEND

- Breach Berm Location
- Culvert
- Contact Water Pipeline
- Non-Contact Water Pipeline
- Saline Water Flow
- Reclaim Water / Slurry Pipeline
- Site Infrastructure
- Service Road
- Water Intake Pipeline
- Watercourse
- Active TF
- Contact Water Containment Dam (Lined)
- Non-contact Water Diversion Berm (Unlined)

GOOSE LAYOUT

- Airstrip
- U/G Laydown Area
- Other Infrastructure
- Resource Pit
- Camp / Plant Site
- Waste Rock Storage Area
- TSF Containment Dam Embankment
- TSF South Dyke
- Contact Water Event Pond
- Haul Road
- Landfarm
- Potential Development Area
- Saline Water Pond
- Waterbody

NOTES

1. Contours are shown at 5.0m intervals.
2. All units are in meters unless otherwise specified.
3. When Saline Water Pond is breached flow discharges to Goose Lake through natural drainage.
4. The Primary Pond is dewatered and breached via culverts beneath the haul road, allowing contact water to drain by gravity to Umwelt Reservoir.

REFERENCES

1. NAD83 UTM Zone 13.
2. Footprint obtained from client.
3. Hydrography data obtained from Geogratis, © Department of Natural Resources Canada. All rights reserved.

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Water Licence Phase

DRAWING TITLE:
Phase 2, Stage 2 (Llama TF): Operations - Year 5 to 12

DRAWING NO. A-06 | SHEET 6 OF 26 | REVISION NO. A

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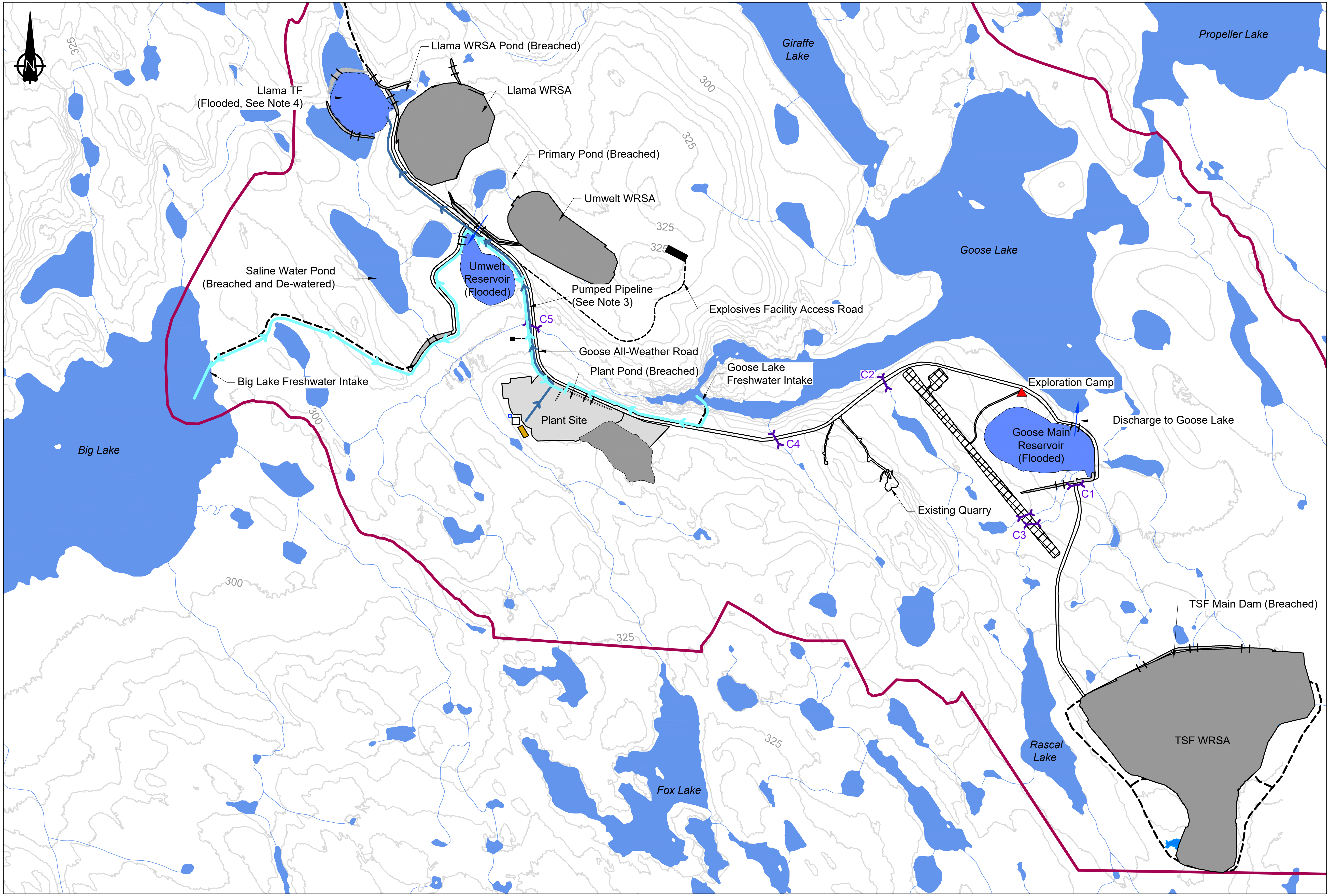

LEGEND

- Breach Berm Location
- Culvert
- Water Treatment Pipeline
- Service Road
- Water Intake Pipeline
- Watercourse
- Berm
- Proposed Airstrip
- Decommissioned Pads
- Other Infrastructure
- Potential Development Area
- Haul Road
- Inactive Waste Rock Storage Area
- Landfarm
- Pit Lake (Closed)
- Waterbody

NOTES

1. Contours are shown at 5.0m intervals.
2. All units are in meters unless otherwise specified.
3. Treated water from Llama TF is pumped back to Llama TF in parallel pipeline.
4. Treated water flow from Llama TF travels to the breached Saline Water Pond area then through Goose Creek / Goose Neck into Goose Lake.

REFERENCES

1. NAD83 UTM Zone 13.
2. Footprint obtained from client.
3. Hydrography data obtained from Geogratis, © Department of Natural Resources Canada. All rights reserved.

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Back River Project

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Water Licence Phase

DRAWING TITLE: Phase 3: Closure Year 13 to Year 20

DRAWING NO.: A-07 | SHEET: 1 OF 26 | REVISION NO.: A

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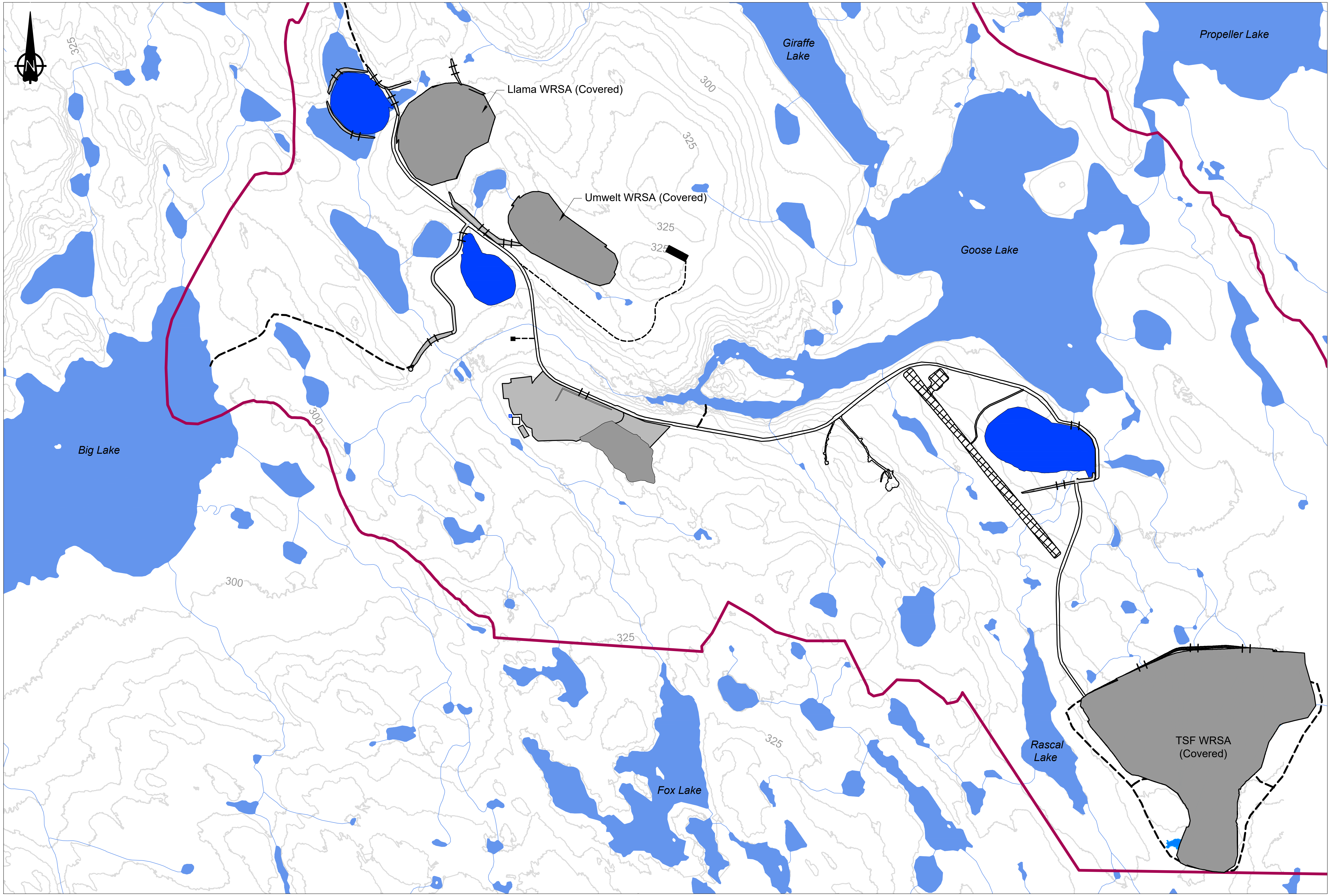

LEGEND

- Breach Berm Location
- Service Road
- Watercourse
- Breached Berm
- Potential Development Area

GOOSE LAYOUT

- Proposed Airstrip
- Decommissioned Pads
- Other Infrastructure
- TSF Containment Dam Embankment
- Decommissioned Berms
- Haul Road
- Inactive Waste Rock Storage
- Pit Lake (Closed)
- Waterbody

NOTES

1. Contours are shown at 5.0m intervals.
2. All units are in meters unless otherwise specified.
3. TSF WRSA pond breached to Goose Main TF.

REFERENCES

1. NAD83 UTM Zone 13.
2. Footprint obtained from client.
3. Hydrography data obtained from Geogratis, © Department of Natural Resources Canada. All rights reserved.

0m 300 600 900 1200

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Water Licence Phase

DRAWING TITLE: Phase 4: Post-Closure Year 21+

DRAWING NO.: A-08 | SHEET 1 OF 26 | REVISION NO.: A

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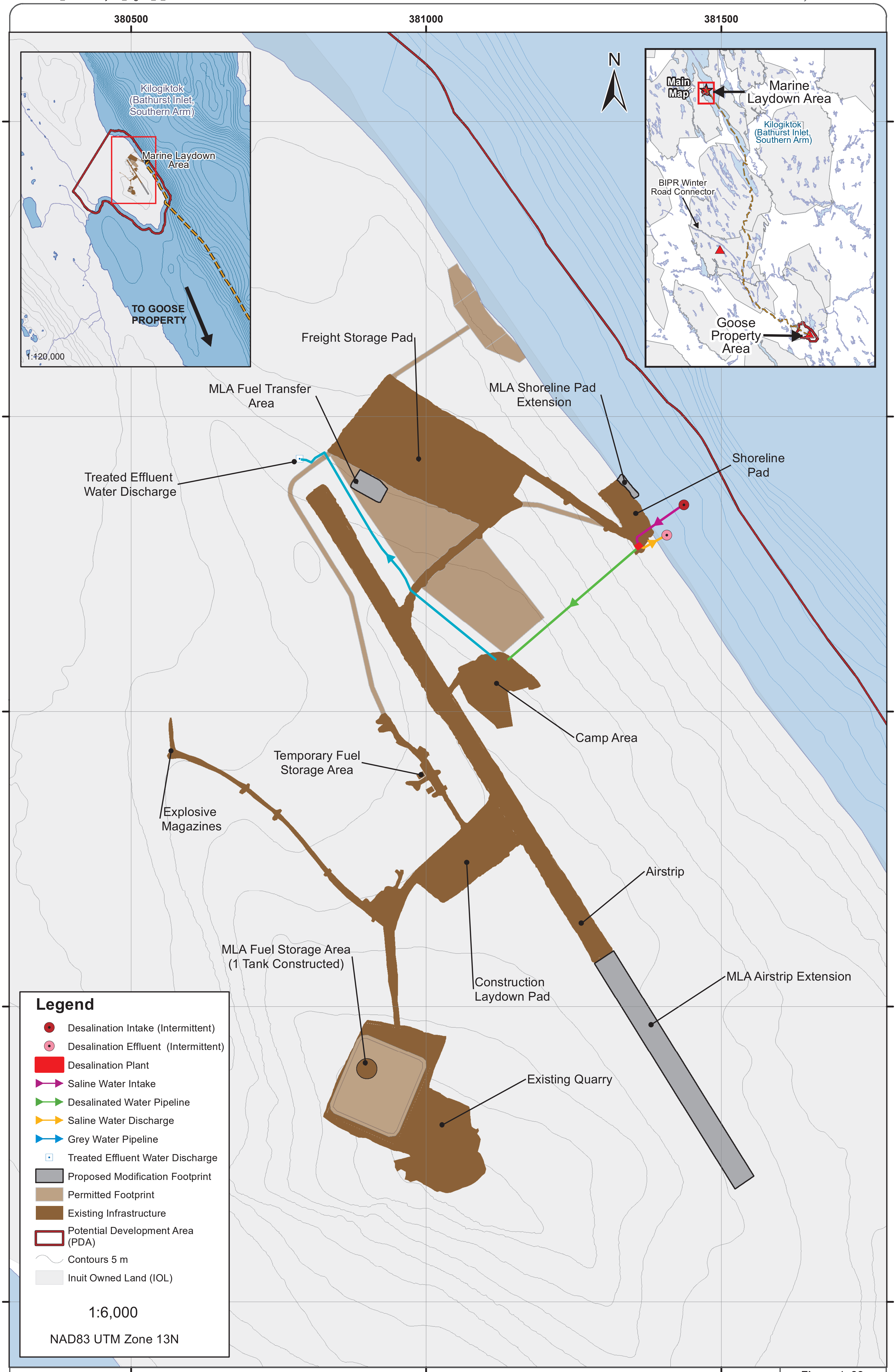

Figure A-09

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Back River Project - Marine Laydown Area
Potential Development Area and Layout
2020 Modification Package

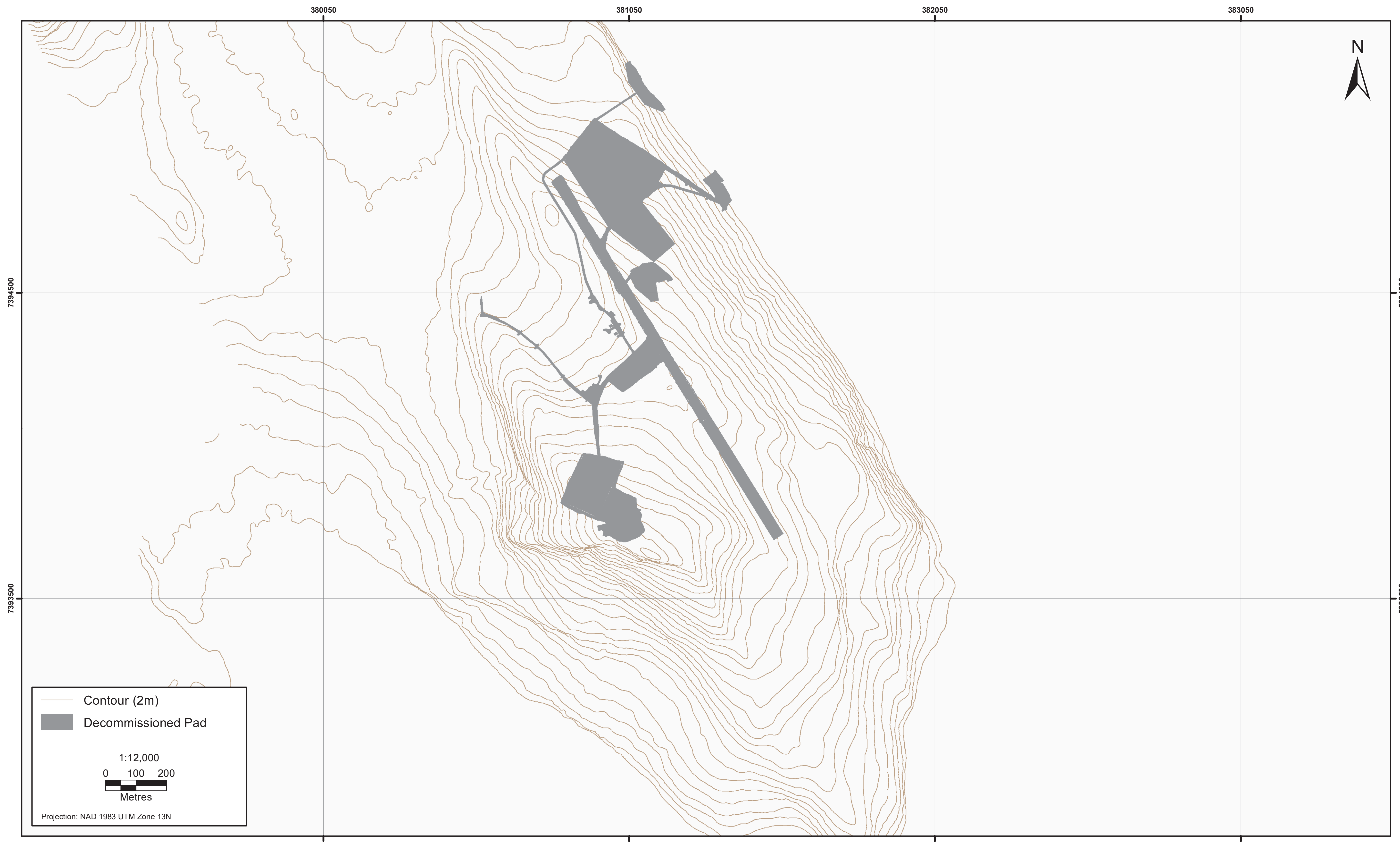
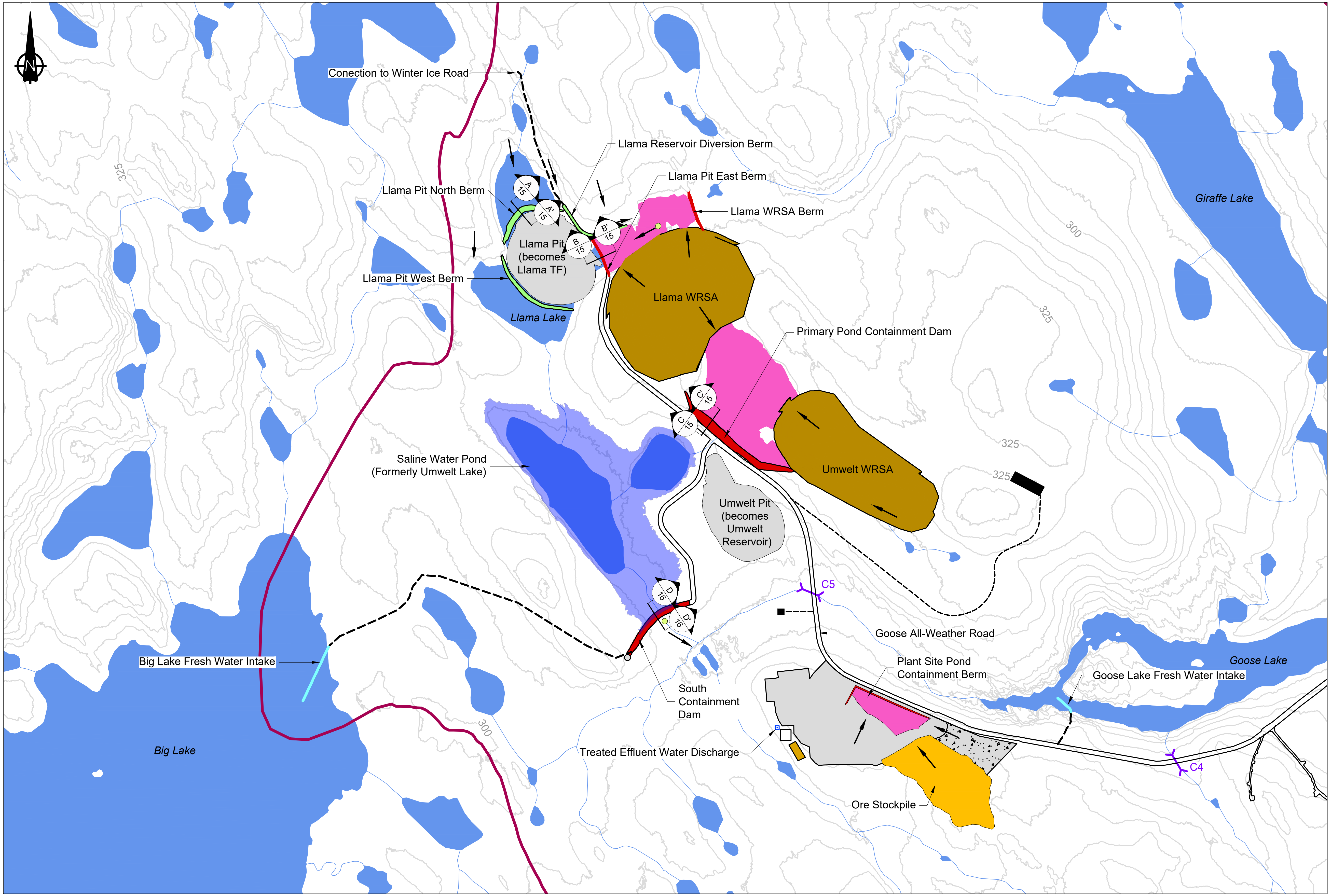


Figure A-10

Sabina
GOLD & SILVER CORP.

Phase 3 & 4 Closure & Post Closure
Marine Laydown Area (Year 13+)



LEGEND

- Discharge Location
- Culvert
- Flow Direction
- Service Road
- Water Intake Pipeline
- Watercourse
- Contact Water Pond
- Contact Water Containment Dam (lined)
- Non-contact Water Diversion Berm (unlined)

GOOSE LAYOUT LEGEND

- U/G Laydown Area
- Other Infrastructure
- Resource Pit
- Camp / Plant Site
- Waste Rock Storage Area
- Ore Stockpile
- Haul Road
- Landfarm
- Potential Development Area
- Waterbody

NOTES

1. Contours are shown at 5.0m intervals.
2. All units are in meters unless otherwise specified.

REFERENCES

NAD83 UTM Zone 13.

0m 200 400 600 800

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FILE NAME: 1CS020.018 - General Arrangements.dwg

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SRK JOB NO.: 1CS020.018

Water Licence Phase

DRAWING TITLE: Goose Property General Arrangement Sheet 1 of 2

DRAWING NO. A-11 | SHEET 11 OF 26 | REVISION NO. A

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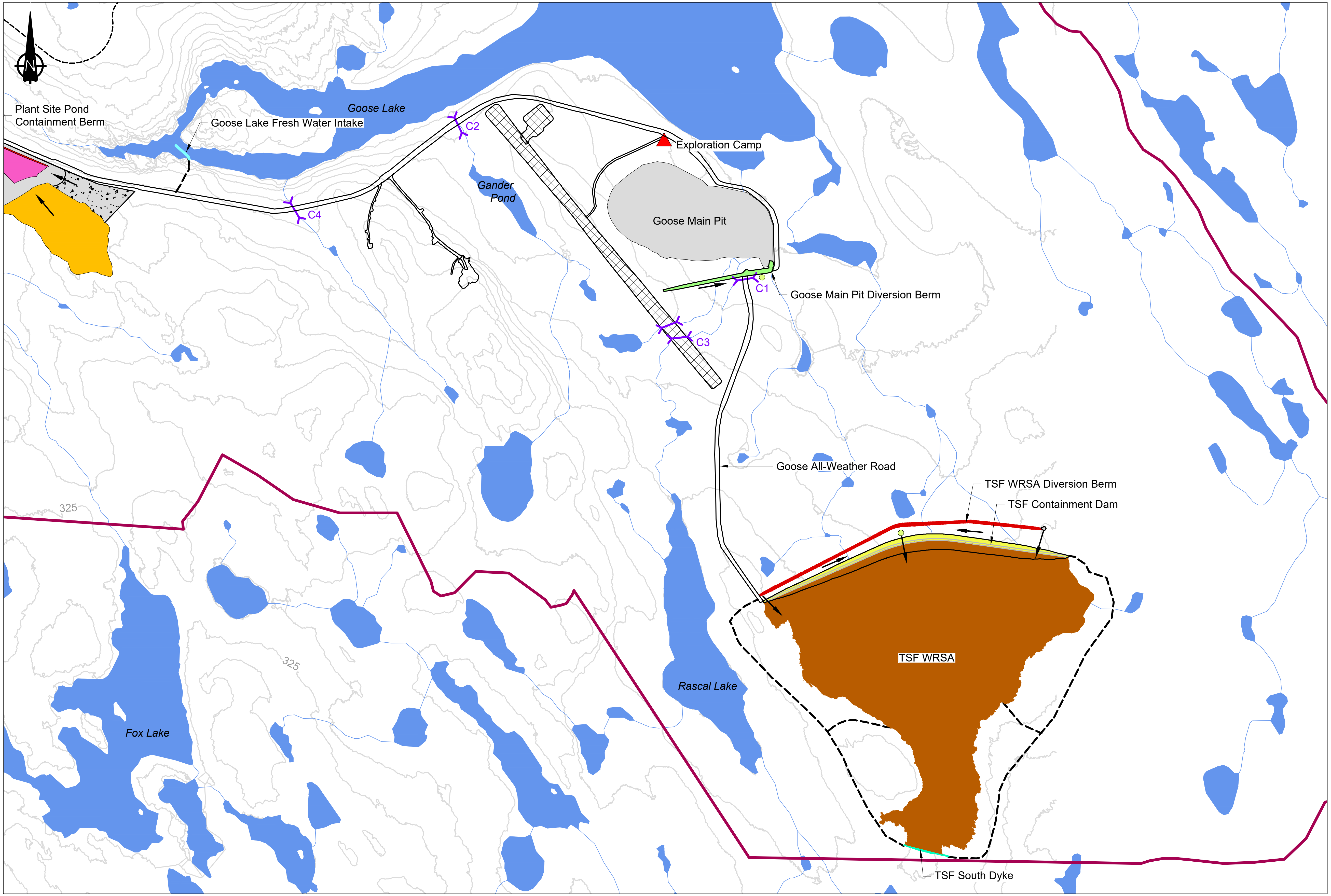

LEGEND

- Discharge Location
- Culvert
- Flow Direction
- Service Road
- Water Intake Pipeline
- Watercourse
- Contact Water Pond
- Contact Water Containment Dam (lined)
- Non-contact Water Diversion Berm (unlined)

GOOSE LAYOUT LEGEND

- Other Infrastructure
- Resource Pit
- Camp / Plant Site
- Waste Rock Storage Area
- Ore Stockpile
- Haul Road
- Potential Development Area
- Waterbody

NOTES

1. Contours are shown at 5.0m intervals.
2. All units are in meters unless otherwise specified.

REFERENCES

NAD83 UTM Zone 13.

0m 200 400 600 800

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DRAWING TITLE:

Goose Property General Arrangement Sheet 2 of 2

DRAWING NO. A-12 | SHEET 12 OF 26 | REVISION NO. A

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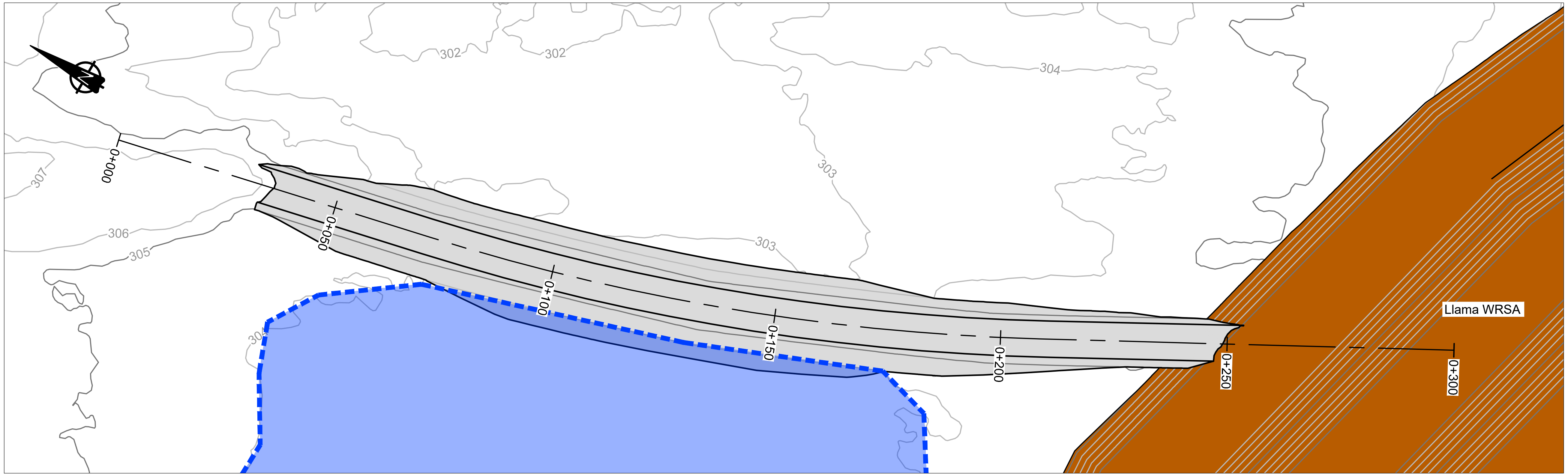


LEGEND

- Full Supply Level (Elev. 304.0m)
- Design Infrastructure
- Waste Rock Storage Area
- Rockfill
- Maximum Water Level (304.0m)

NOTES

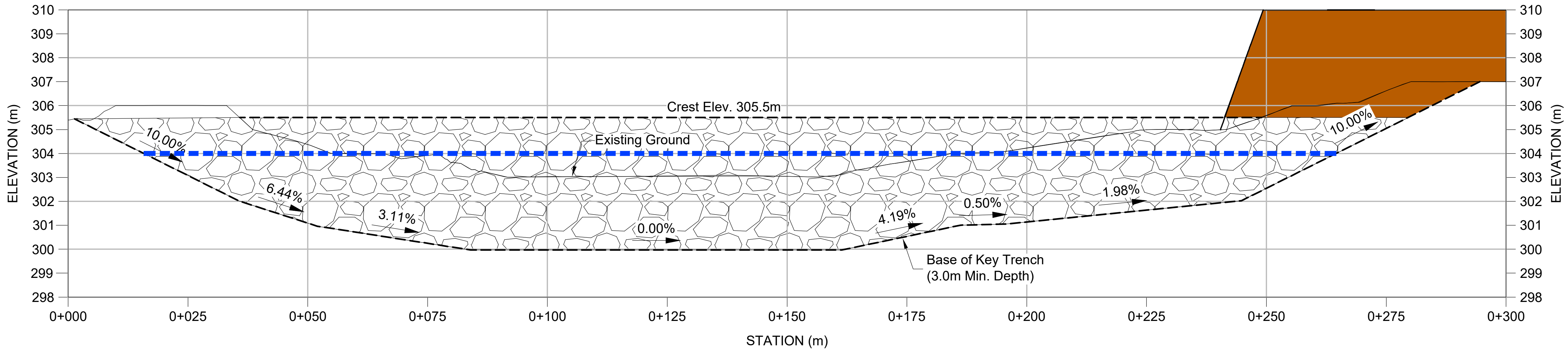
1. Contours shown at 1.0m intervals.
2. All units are in meters unless otherwise specified.
3. Required key trench depth and dam and berm cross sections designs to be confirmed at detailed design stage.

REFERENCES

NAD83 UTM Zone 13.

Llama Reservoir East Dam

0m 10 20 30 40



Llama Reservoir East Dam Profile

0m 2 4 6 8

0m 10 20 30 40

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FILE NAME: 1CS020.18 - Llama Reservoir.dwg

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DRAWING TITLE: Llama Reservoir WRSA Containment Dam Plan and Profile

DRAWING NO. A-13 | SHEET 13 OF 26 | REVISION NO. A

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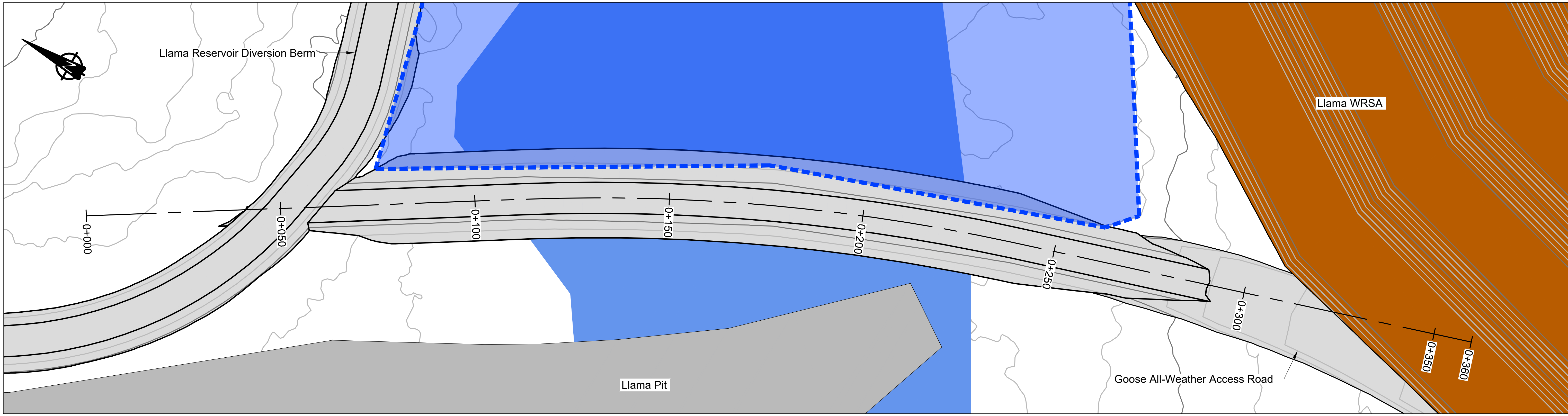
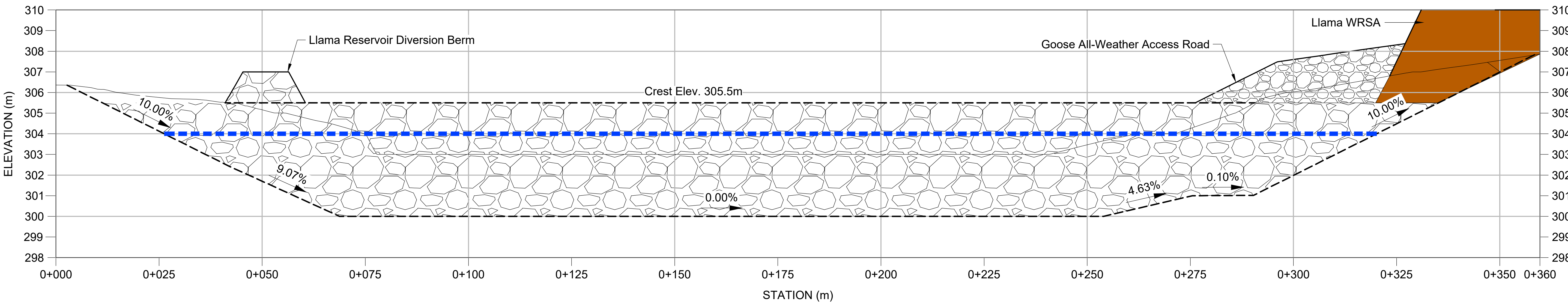


Llama Pit East Dam

0m 10 20 30 40



Llama Pit East Dam Profile

0m 2 4 6 8

0m 10 20 30 40

LEGEND

- Full Supply Level (Elev. 304.0m)
- Design Infrastructure
- Waste Rock Storage Area
- Rockfill
- Maximum Water Level (304.0m)

NOTES

1. Contours shown at 1.0m intervals.
2. All units are in meters unless otherwise specified.
3. Required key trench depth and dm and berm cross sections designs to be confirmed at detailed design stage.

REFERENCES

NAD83 UTM Zone 13.

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DRAWING TITLE: Llama Pit East Dam Plan and Profile

DRAWING NO. A-14 | SHEET 14 OF 26 | REVISION NO. A

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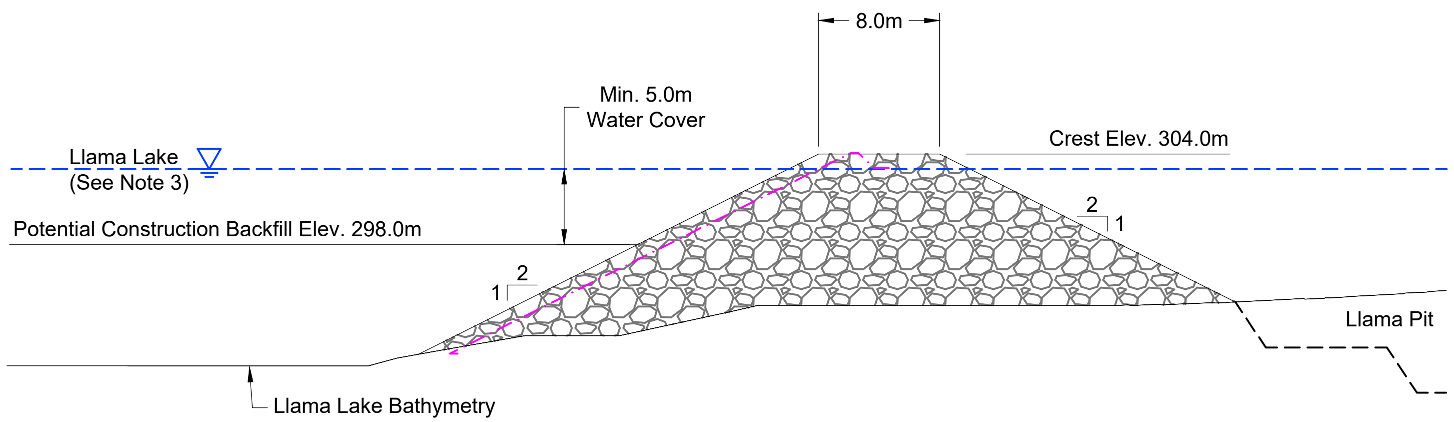
LEGEND

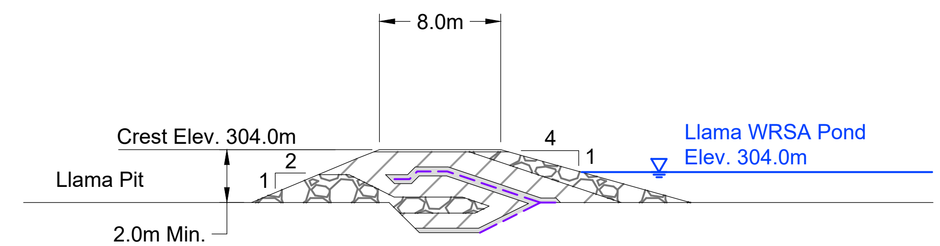
- Non-woven Geotextile
- Liner System
- Full Supply Water Level
- Run of Mine Material
- Rockfill Material
- Transition Material
- Bedding Material
- Surfacing Material

NOTES

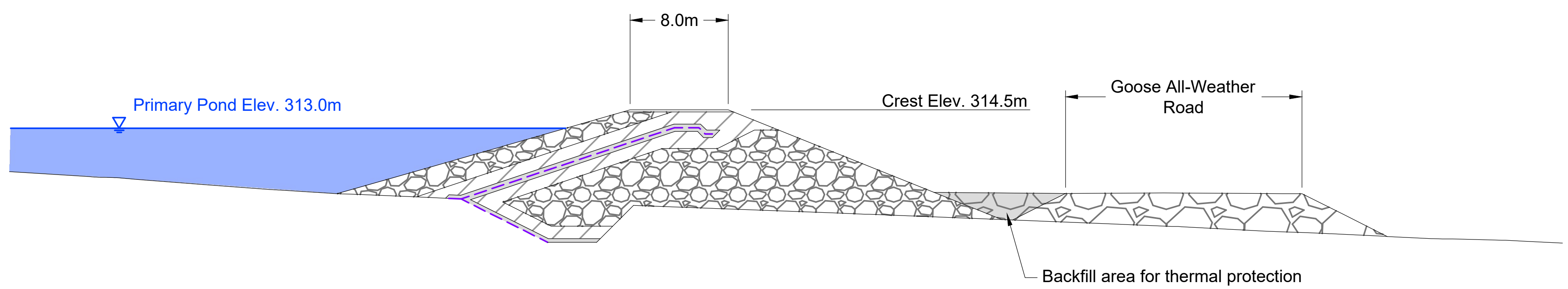
1. Remove 1.0m organics at ground surface along berm / dam contact area.
2. All dimensions are in meters unless otherwise noted.
3. Lake dewatered for mining activities then berm breached and pit flooded at closure.
4. Required key trench depth and dam and berm cross sections designs to be confirmed at detailed design stage.



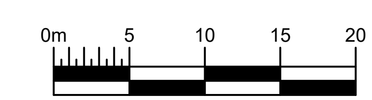
A/11 **Cross Section A-A' - Llama Pit North Berm**



B/11 **Cross Section B-B' - Llama Pit East Dam**



C/11 **Cross Section C-C' - Primary Pond Dam**



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FILE NAME: 1CS020.018 - Typical Sections.dwg

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Water Licence Phase

DRAWING TITLE: Typical Dam Sections (Sheet 1 of 2)

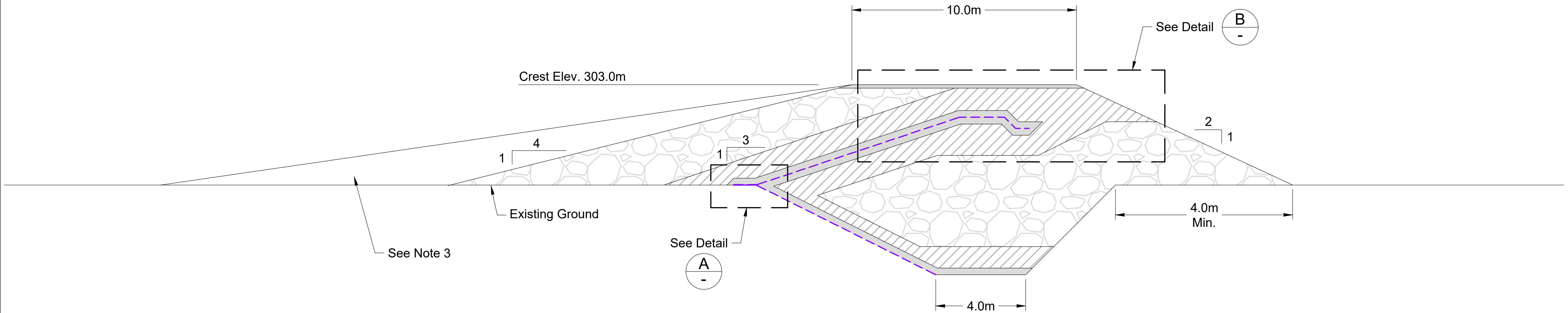
DRAWING NO.: A-15 | SHEET: 15 OF 26 | REVISION NO.: A

LEGEND

- Liner System
- Full Supply Water Level
- ROM
- Engineered Fill
- Bentonite Plug

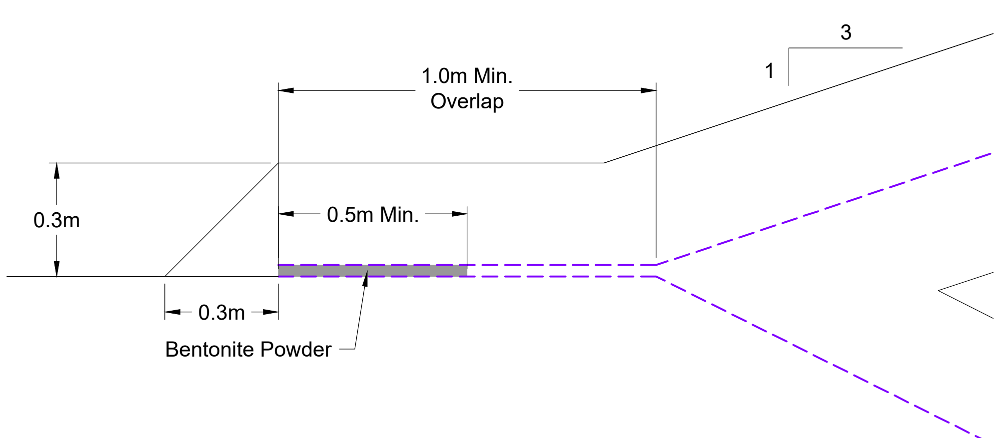
NOTES

1. Existing ground is based on a 2012 LiDAR survey reduced to 1m horizontal resolution provided by Sabina.
2. All dimensions are in meters unless otherwise noted.
3. Overburden may be placed off the upstream face for the Saline Water Pond to help spread out the seepage pathway and limit long-term thermal impacts on the foundation.
4. Required key trench depth and dam and berm cross sections designs to be confirmed at detailed design stage.



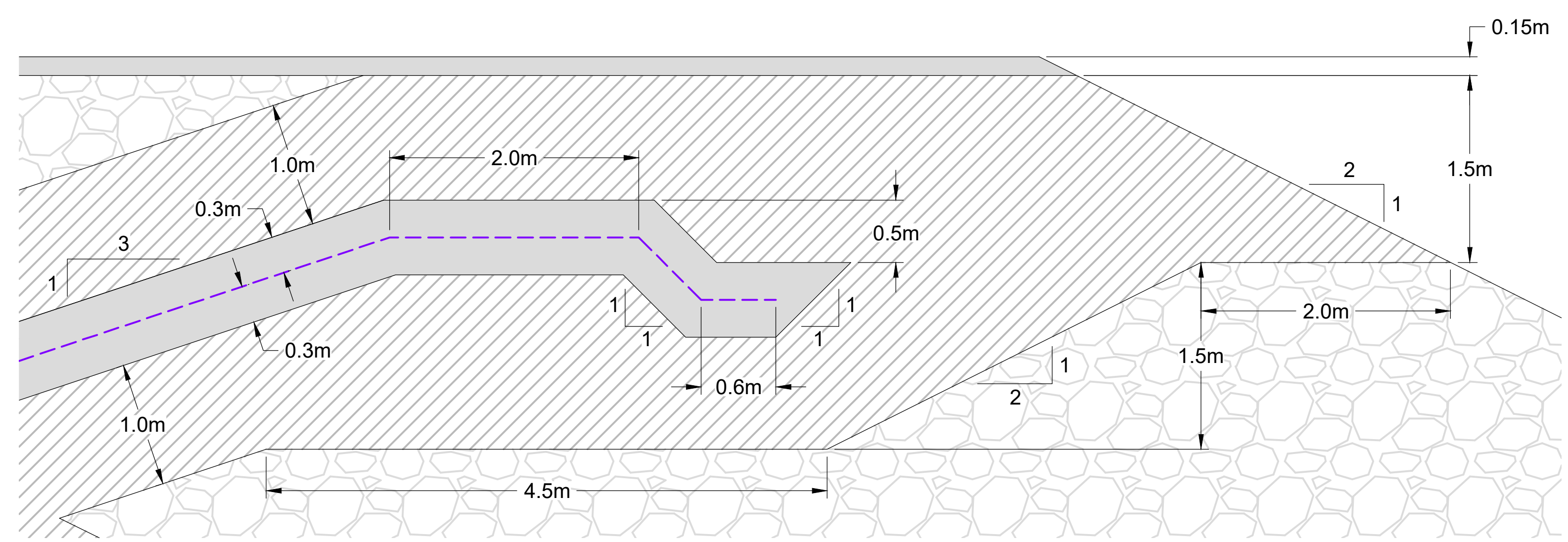
D 11 **Cross Section D-D' - Saline Water Pond South Dam**

0m 2 4 6 8



1 - **Typical Upper and Lower GCL Joint Detail**

0 200 400 600 800mm



2 - **Typical Liner Anchor Trench Bedding Detail**

0m 0.5 1.0 1.5 2.0m

DRAWING NO.	DRAWING TITLE	NO.	DESCRIPTION	CHK'D	APP'D	DATE	NO.	DESCRIPTION	CHK'D	APP'D	DATE
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REFERENCE DRAWINGS — REVISIONS

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srk consulting

DESIGN: JBK | DRAWN: TAH | REVIEWED: JBK
CHECKED: JBK | APPROVED: CP | DATE: 2020/06/05

FILE NAME: 1CS020.018 - Typical Sections.dwg

Sabina GOLD & SILVER CORP.

Back River Project

SRK JOB NO.: 1CS020.018

Water Licence Phase

DRAWING TITLE: Typical Dam Sections and Details (Sheet 2 of 2)

DRAWING NO. A-16 | SHEET 16 OF 26 | REVISION NO. A

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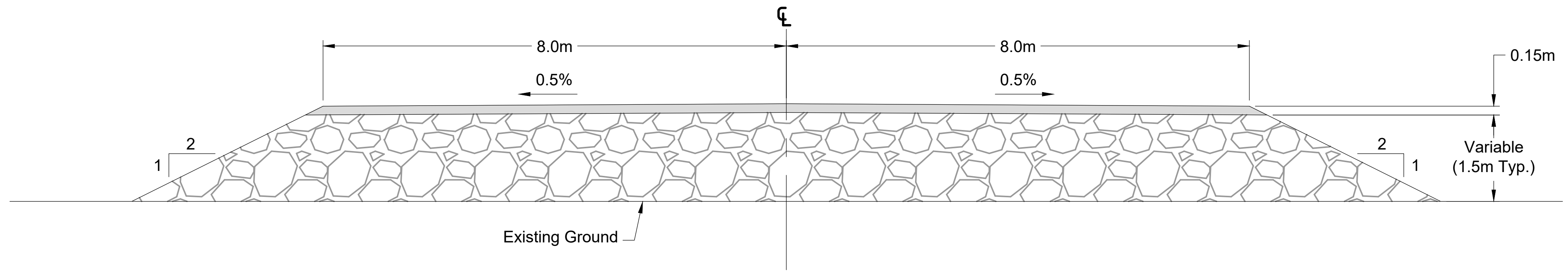
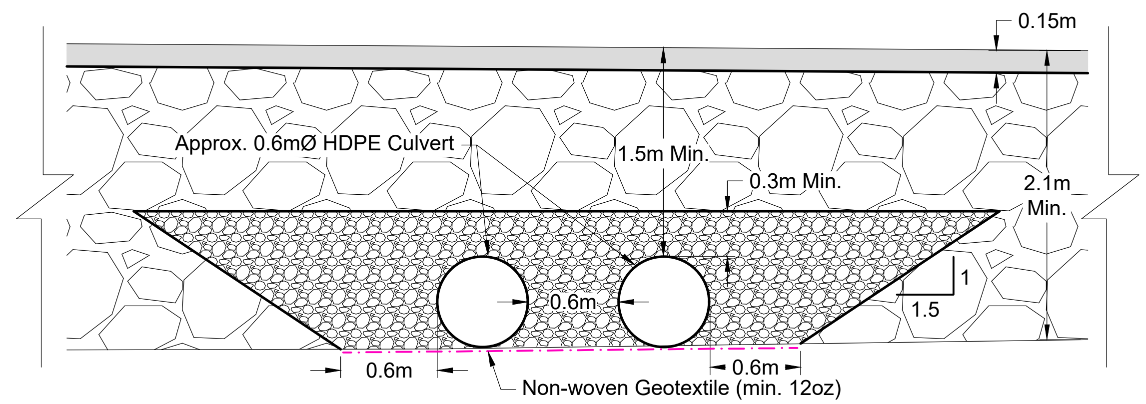


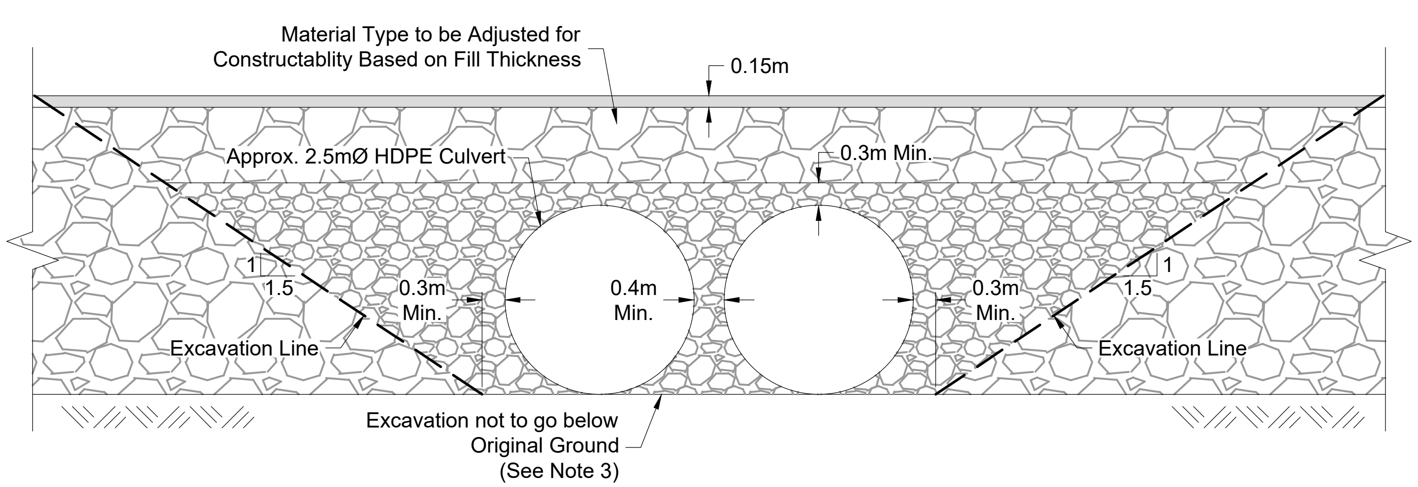
Typical Road Section

0m 1 2 3 4



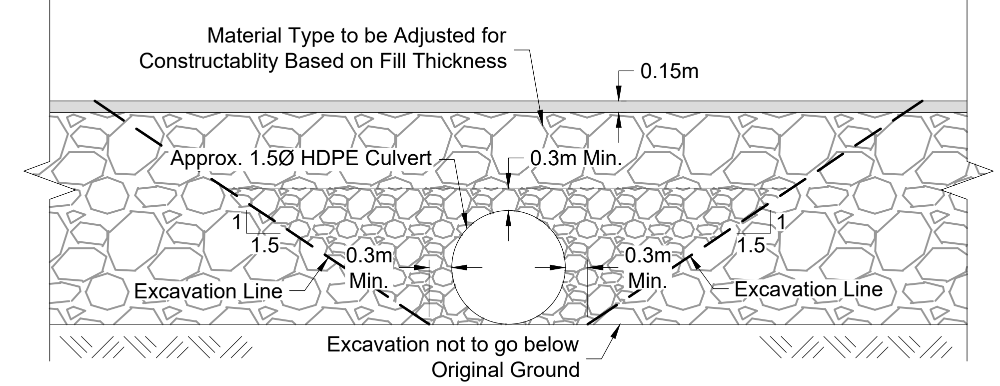
3 - **Detail 3 - Typical Cross Section of Small Diameter Double HDPE Culvert Crossing**

0m 0.5 1.0 1.5 2.0



4 - **Detail 4 - Typical Cross Section of Large Diameter Double Culvert Crossing**

0m 1 2 3 4



5 - **Detail 5 - Typical Cross Section of Single Culvert Crossing**

0m 1 2 3 4

LEGEND

- Non-Woven Geotextile
- ROM Material
- Engineered Fill / Crush material
- Surfacing Material

NOTES

1. All dimensions in meters unless otherwise stated.
2. Installation of culverts to follow the manufacturers assembly and installation guide.
3. Total depth of cover above culvert, including bedding material, surfacing material, and ROQ material, will be 1.5m minimum.
4. For safety barrier sizing, height to be a minimum ¾ the diameter of the largest vehicle tire.
5. If natural ground is less that 1% grade, fill material (surfacing material) to be placed below culvert to establish minimum 1% grade.
6. Non-woven geotextile is suggested to be placed below all culvert pipes to help low rates of permafrost degradation from surface water flow, and to help reduce differential settlement.
7. Ultimate crest width of roads will be set based on the design vehicles. The minimum road crest width of single land traffic shall be twice the width of the largest design vehicle as per WSCC (2015). Dual lane traffic requires road width three times the largest design vehicle.
8. Culverts on site may be HDPE (High-density polyethylene) or CSP (corrugated steel pipe). Final materials to be determined during detailed design.

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DESIGN: JBK | DRAWN: TAH | REVIEWED: JBK
CHECKED: JBK | APPROVED: CP | DATE: 2020/06/05
FILE NAME: 1CS020.018 - Typical Sections.dwg

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Back River Project

SRK JOB NO.: 1CS020.018

Water Licence Phase

DRAWING TITLE: Typical Road and Crossing Sections

DRAWING NO.: A-17 | SHEET 17 OF 26 | REVISION NO.: A

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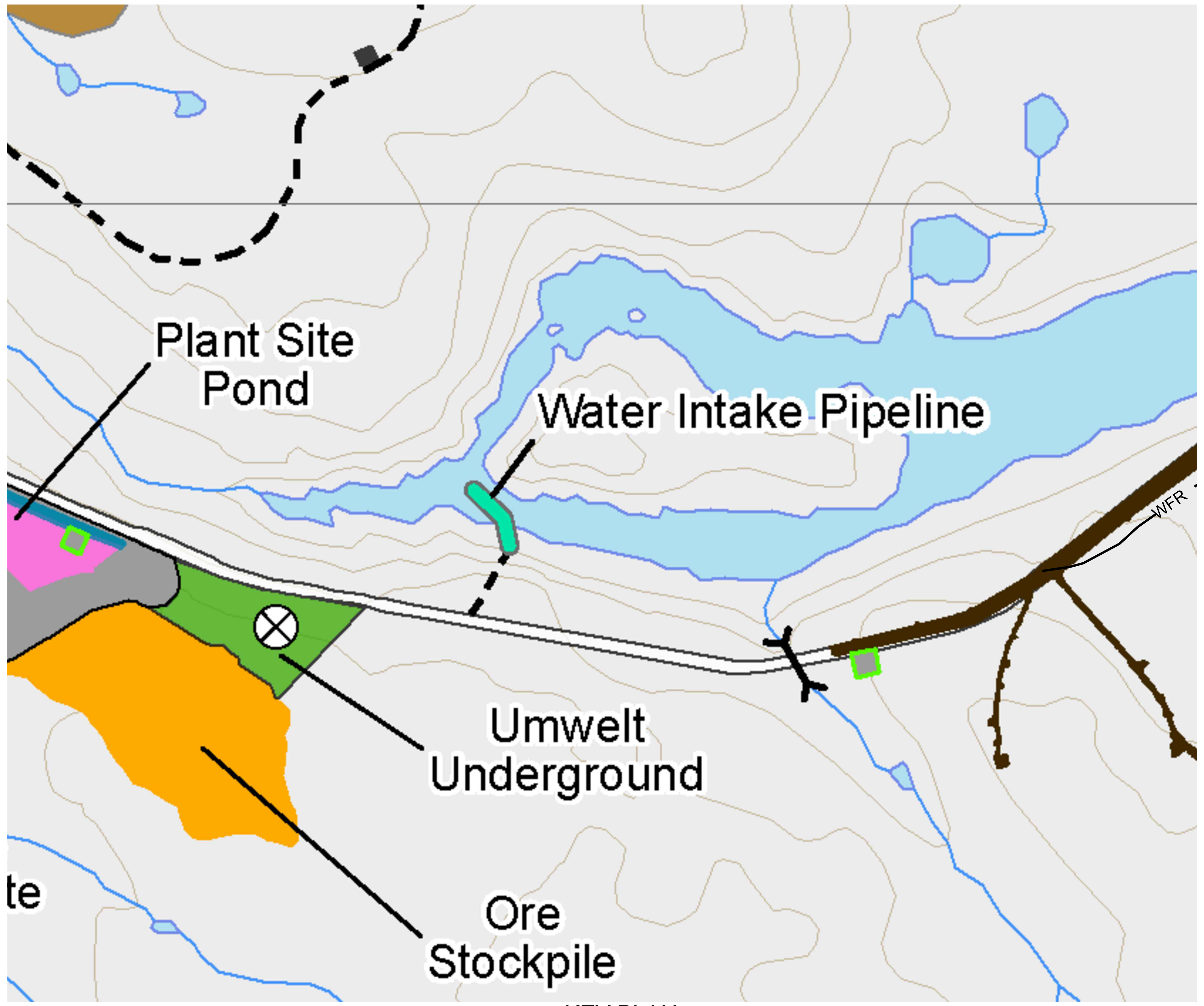
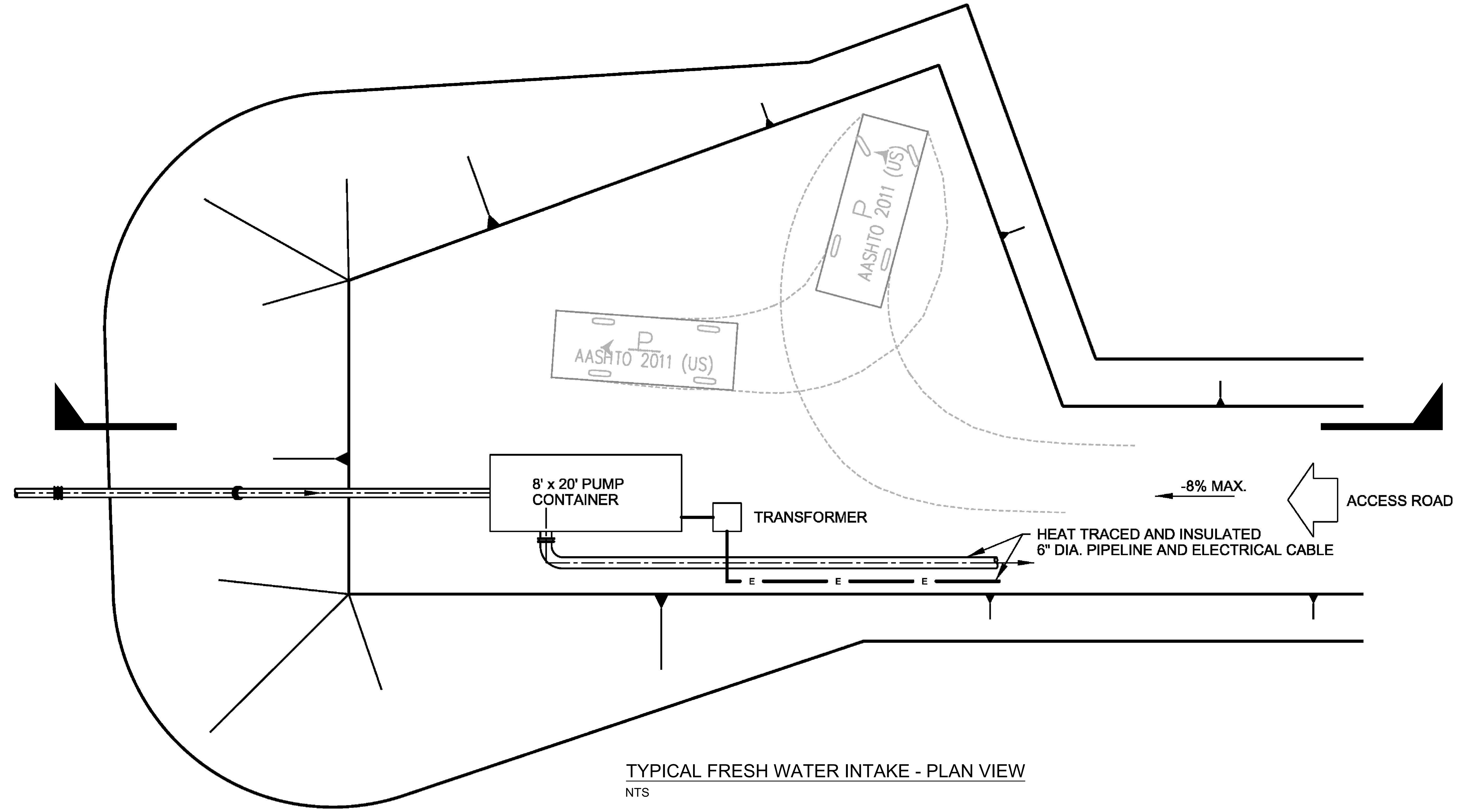
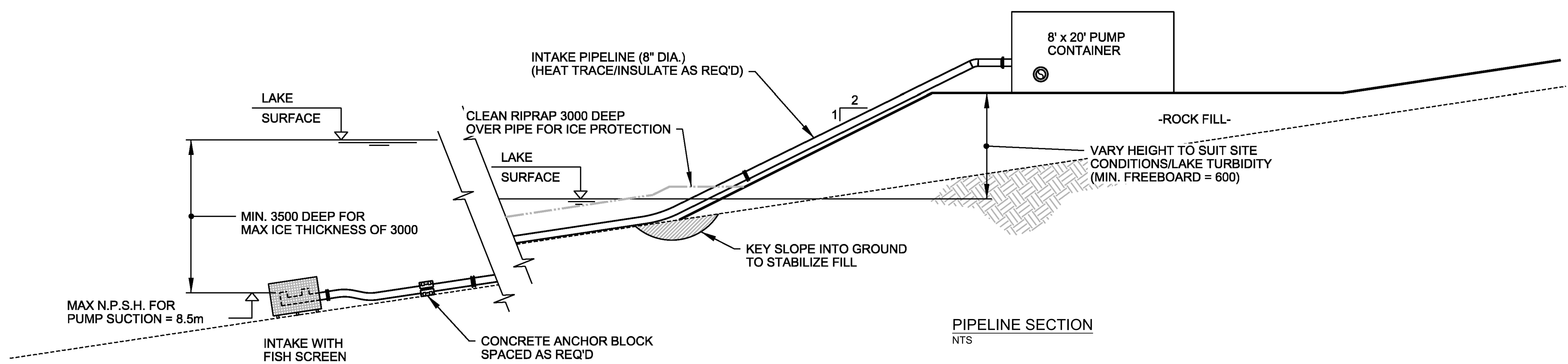


KEY PLAN
NTS



TYPICAL FRESH WATER INTAKE - PLAN VIEW
NTS



PIPELINE SECTION
NTS

LEGEND

⊗	UNDERGROUND PORTAL
(green line)	WATER INTAKE PIPELINE
(blue line)	WATER MANAGEMENT STRUCTURE
(green square)	TAILINGS EMERGENCY POND
(light blue fill)	WATER BODIES

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
2. ENGINEERING DESIGN IS CONSISTENT FOR ALL FRESHWATER INTAKES (GOOSE LAKE AND BIG LAKE).

REFERENCES

1. BASE DRAWING OBTAINED FROM SRK CONSULTING. FILE NAME: 1CS020.011_WMP_FIGURE_A-20.DWG. RECEIVED DATE: 2017-06-02.
2. KEY PLAN OBTAINED FROM SABINA GOLD & SILVER. FILE NAME: GSE_FEIS_NA_TAB_GOOSE_WL_2020_COPY.PDF

YYYY-MM-DD	2020-05-13
DESIGNED	SRK
PREPARED	AF
REVIEWED	DRW
APPROVED	

CLIENT
Sabina GOLD & SILVER CORP.

CONSULTANT
GOLDER

PROJECT
BACK RIVER PROJECT
2020 MODIFICATION PACKAGE

TITLE
FRESH WATER INTAKE TYPICAL PLAN AND SECTION

PROJECT NO.	FIGURE	REV.
	A-18	A

GIS # BAC-01-057b_WL_A W:\BackRiver\04_Exploration\BackRiverRegion\GIS_Products\ESRI_MXD\Water_Permitting\FINAL FIGURES\BAC-01-057b_WL_A.mxd April 30 2020

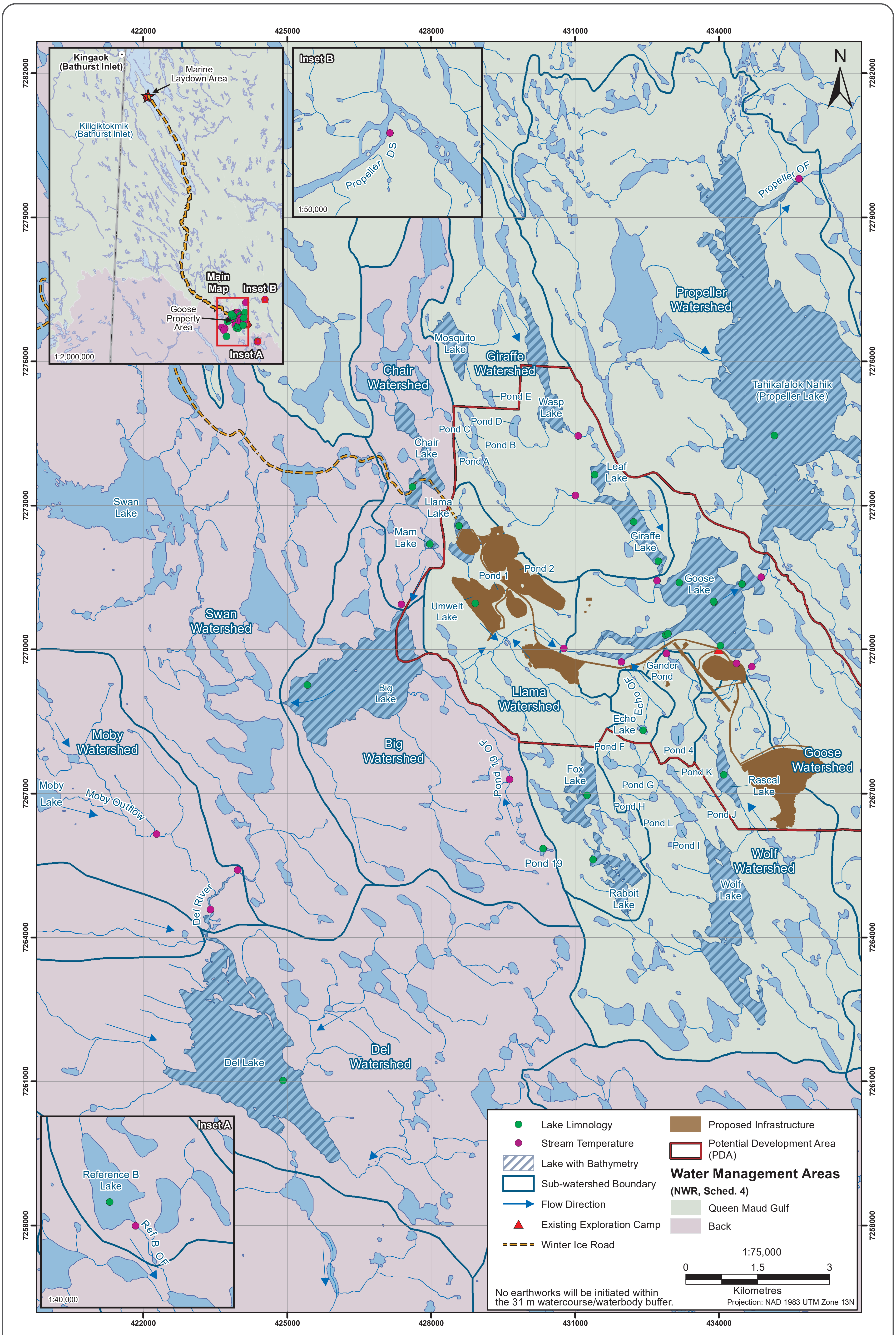
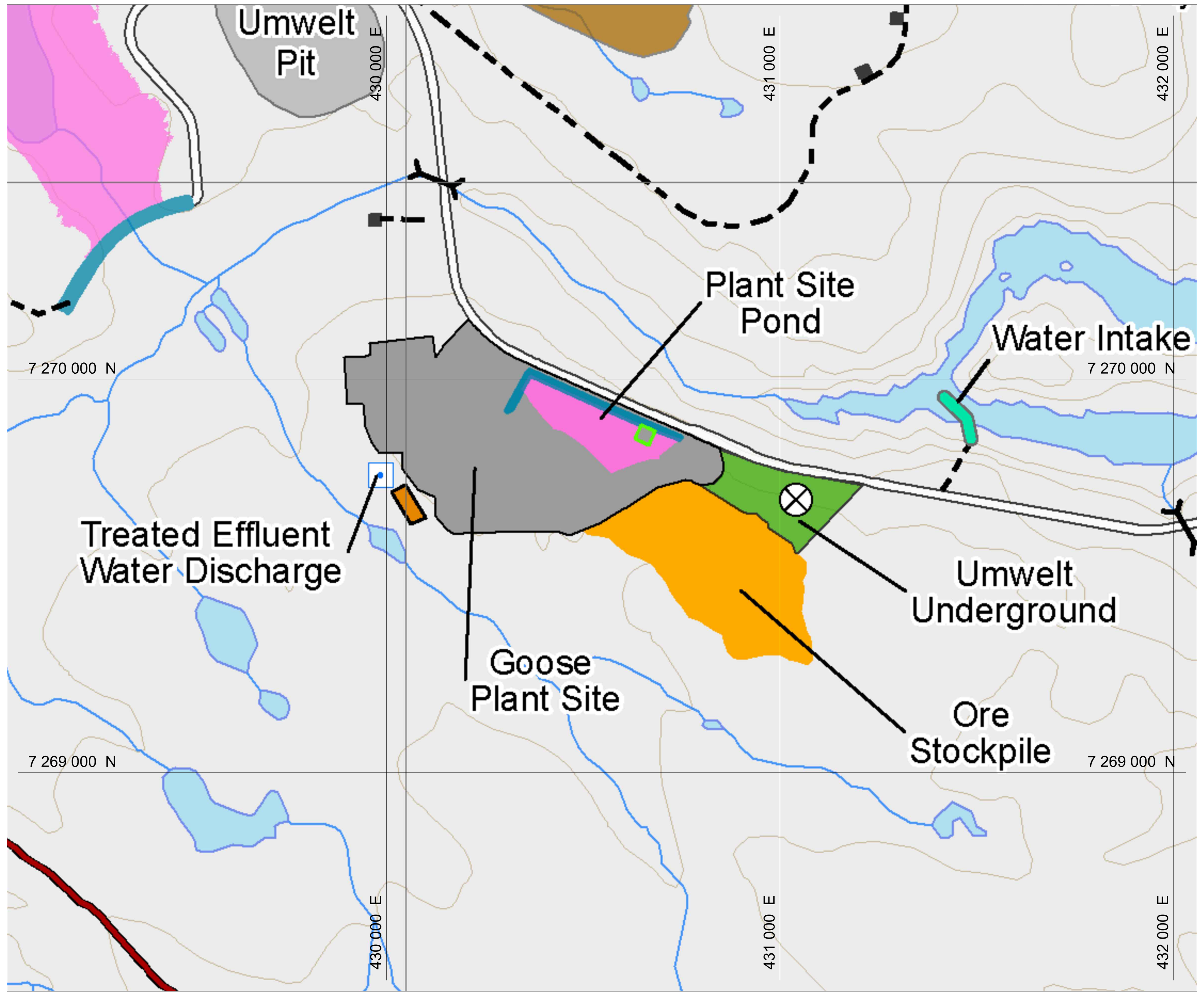


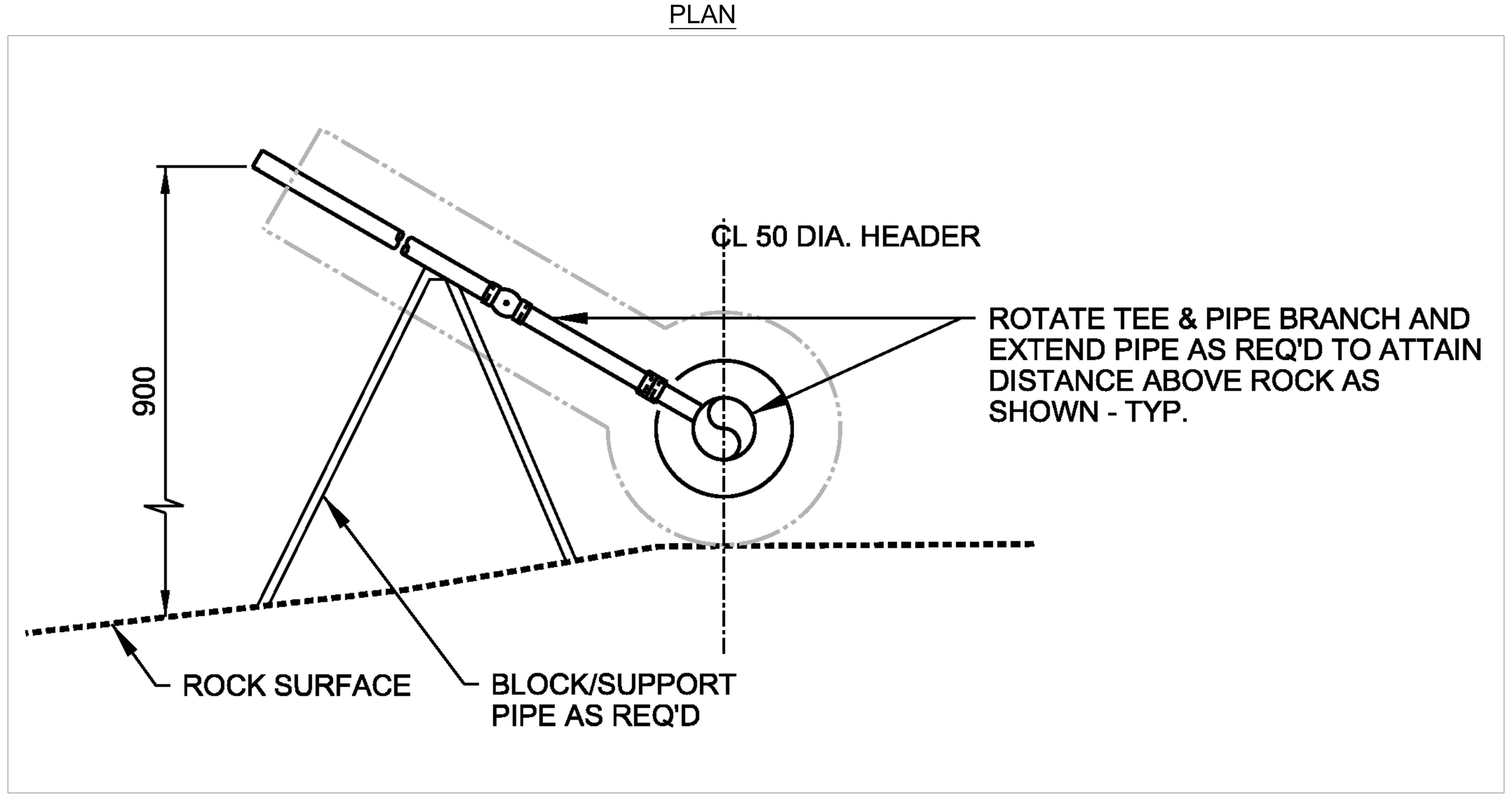
Figure A-19

Sabina

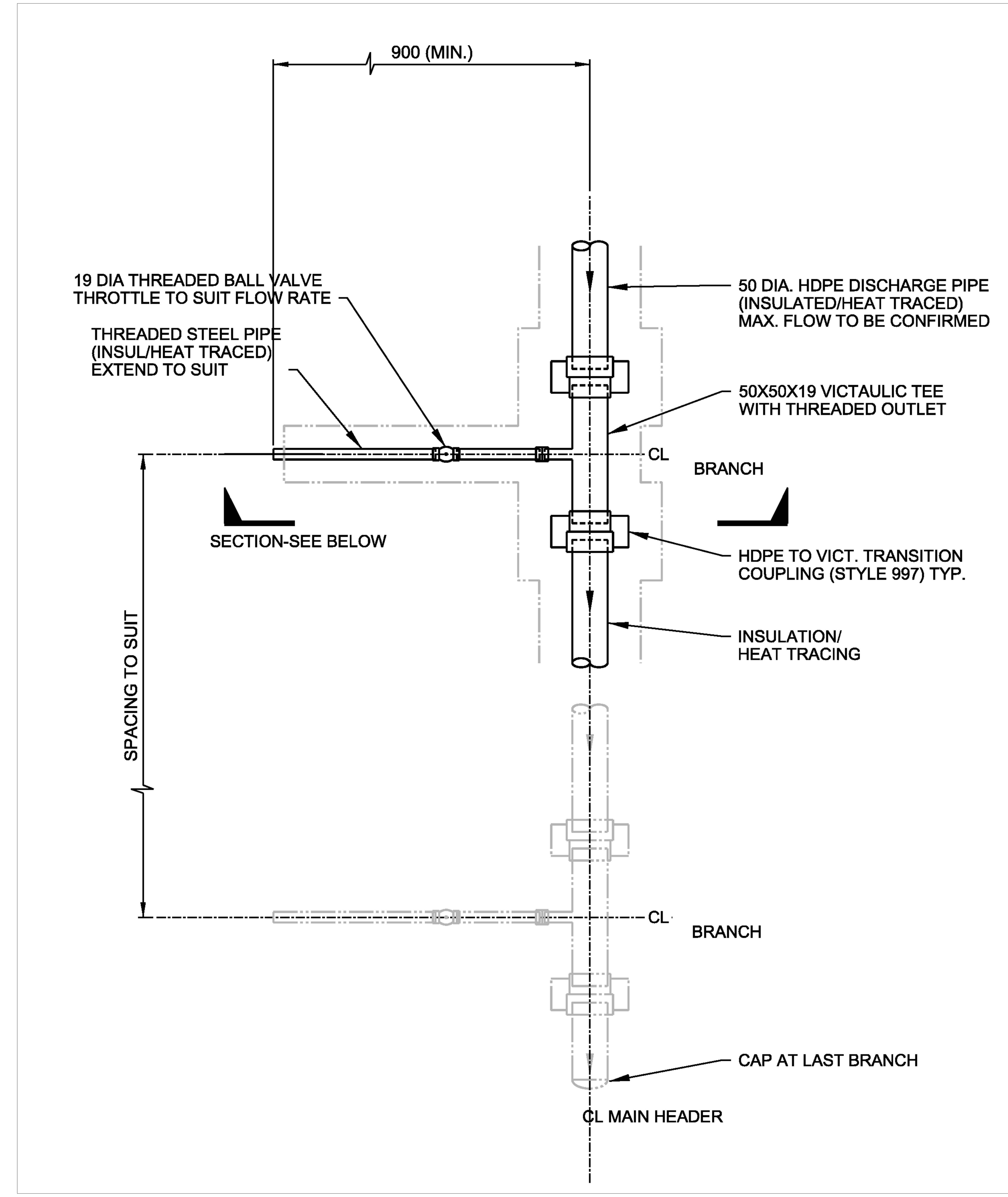
Limnology and Bathymetry Sampling Conducted in the Goose Property Area for the Back River Project, 1994 to 2013



PLAN



SECTION



S.T.P. TREATED WATER OUTLETS - PLAN VIEW
(# OF OUTLETS AND PIPE DIA. TO SUIT FINAL S.T.P. DISCHARGE)

LEGEND

- UNDERGROUND PORTAL
- WATER INTAKE PIPELINE
- WATER MANAGEMENT STRUCTURE
- TAILINGS EMERGENCY POND
- WATER BODIES

NOTES

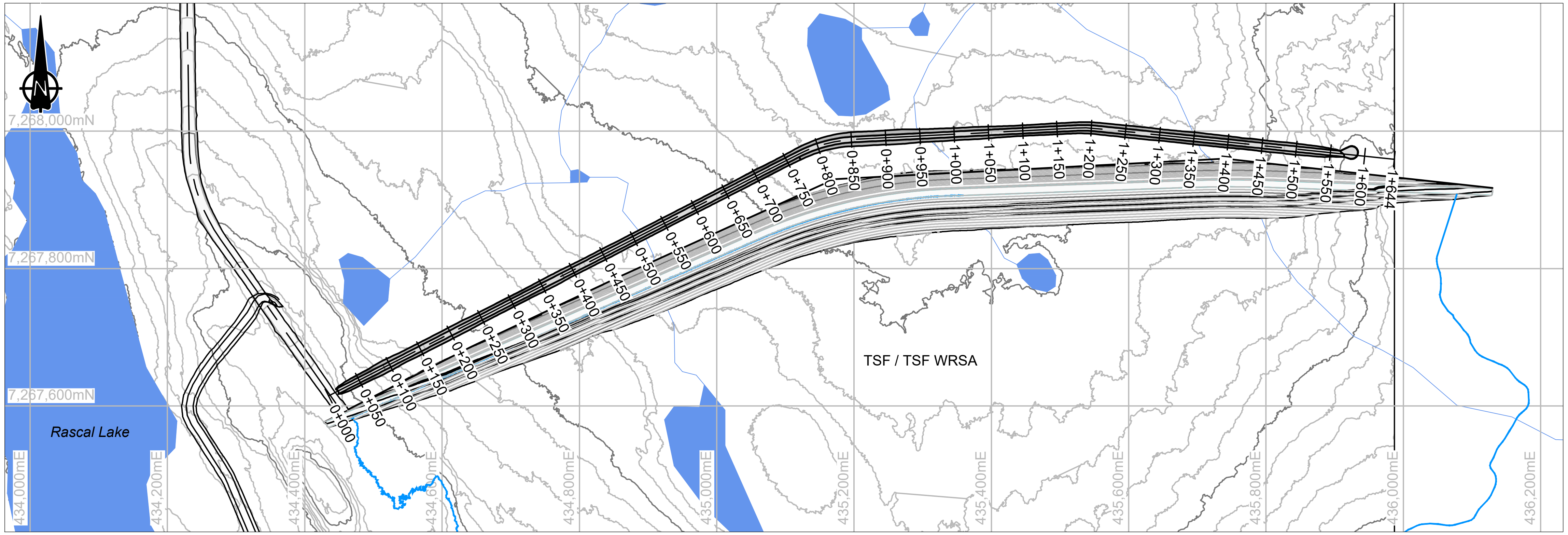
1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

REFERENCES

1. BASE DRAWING OBTAINED FROM SRK CONSULTING. FILE NAME: 1CS020.011_WMP_FIGURE_A-20.DWG. RECEIVED DATE: 2017-06-02.
2. KEY PLAN OBTAINED FROM SABINA GOLD & SILVER. FILE NAME: GSE_FEIS_NA_tab_Goose_WL_2020_Copy.pdf

YYYY-MM-DD	2020-05-13	CLIENT: Sabina GOLD & SILVER CORP.	PROJECT: BACK RIVER PROJECT 2020 MODIFICATION PACKAGE
DESIGNED	SRK		
PREPARED	AF	CONSULTANT: GOLDER	TITLE: S.T.P TREATED WATER DISCHARGE PLAN AND SECTION
REVIEWED	DRW		
APPROVED			PROJECT NO. / FIGURE A-20 / REV. A

25 mm
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D



TSF WRSA Diversion Berm Plan

0m 50 100 150 200 250 300

LEGEND

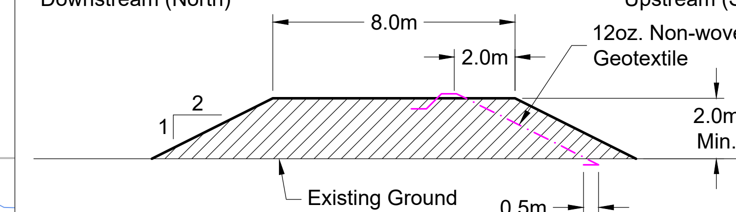
Design Infrastructure

NOTES

1. Contours shown at 1.0m intervals.
2. All units are in meters unless otherwise specified.
3. A minimum fill thickness of 2.0m or greater must be maintained for the entire TSF Containment Dam Berm.
4. Required key trench depth and dam and berm cross sections designs to be confirmed at detailed design stage.

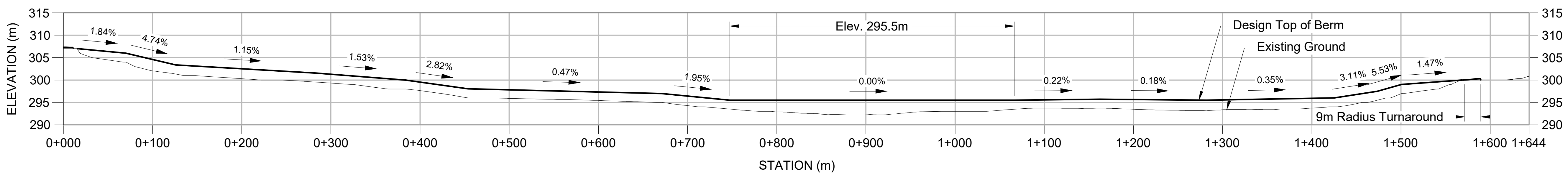
REFERENCES

NAD83 UTM Zone 13.



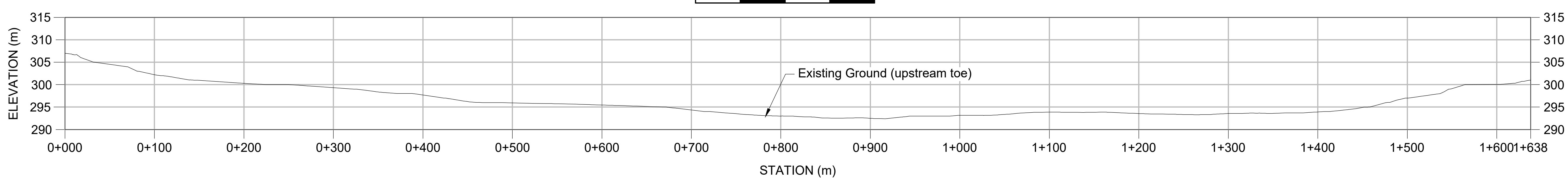
TSF WRSA Diversion Berm Typical Section

0m 2 4 6 8 10



TSF WRSA Diversion Berm Centerline Profile

0m 50 100 150 200



TSF WRSA Diversion Berm Upstream Toe Profile

0m 50 100 150 200

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FILE NAME: 1CS020.018 - TSF Berm.dwg

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Back River Project

SRK JOB NO.: 1CS020.018

Water Licence Phase

DRAWING TITLE: TSF WRSA Diversion Berm Plan and Profile

DRAWING NO.: A-21 | SHEET 21 OF 26 | REVISION NO. A

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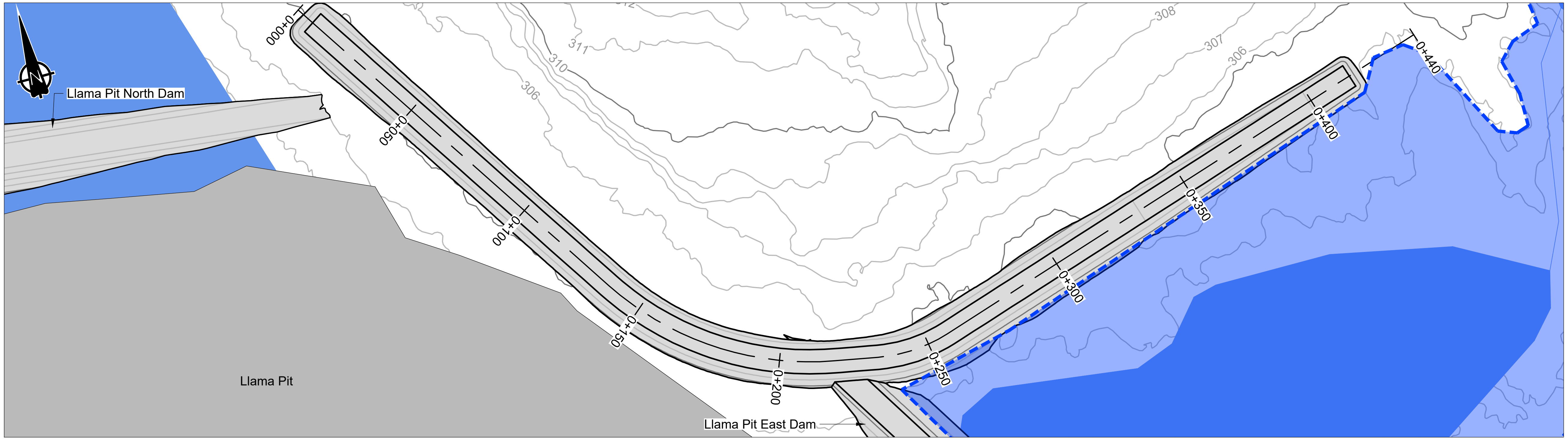


LEGEND

- Full Supply Level (Elev. 304.0m)
- Design Infrastructure
- Rockfill
- Maximum Water Level (304.0m)

NOTES

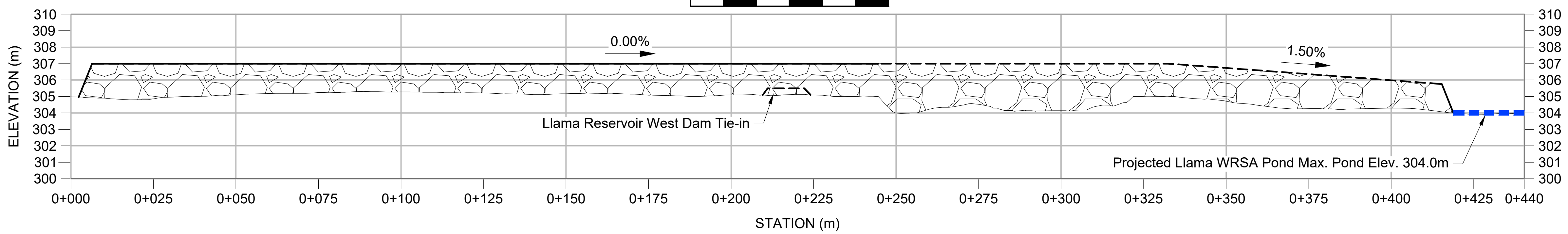
1. Contours shown at 1.0m intervals.
2. All units are in meters unless otherwise specified.
3. Water diversion / conveyance will be at the upstream / upslope toe. Contours will be required to be confirmed to ensure that minimum 0.5% grade established / maintained.
4. Additional fill material or alignment adjustment expected to be required to ensure that water will not pond against berm. Final alignment optimizations to be based on field ground survey.
5. Required key trench depth and dam and berm cross sections designs to be confirmed at detailed design stage.

REFERENCES

NAD83 UTM Zone 13.

Llama Reservoir Diversion Berm

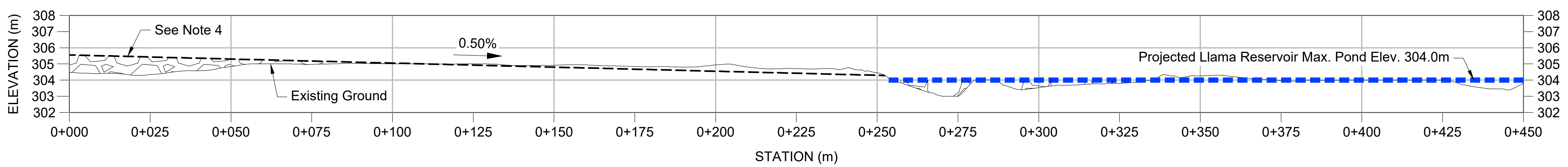
0m 10 20 30 40 50 60



Llama Reservoir Diversion Berm Centerline Profile

0m 3 6 9 12
Vertical

0m 10 20 30 40 50 60
Horizontal



Llama Reservoir Diversion Berm Upstream Toe Profile

0m 3 6 9 12
Vertical

0m 10 20 30 40 50 60
Horizontal

DRAWING NO.	DRAWING TITLE
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CHECKED: JBK	APPROVED: CP	DATE: 2020/06/05

FILE NAME: 1CS020.18 - Llama Reservoir.dwg

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Back River Project

SRK JOB NO.: 1CS020.018

Water Licence Phase

DRAWING TITLE: Llama Reservoir Diversion Berm Plan and Profile

DRAWING NO.	SHEET	REVISION NO.
A-22	22 OF 26	A

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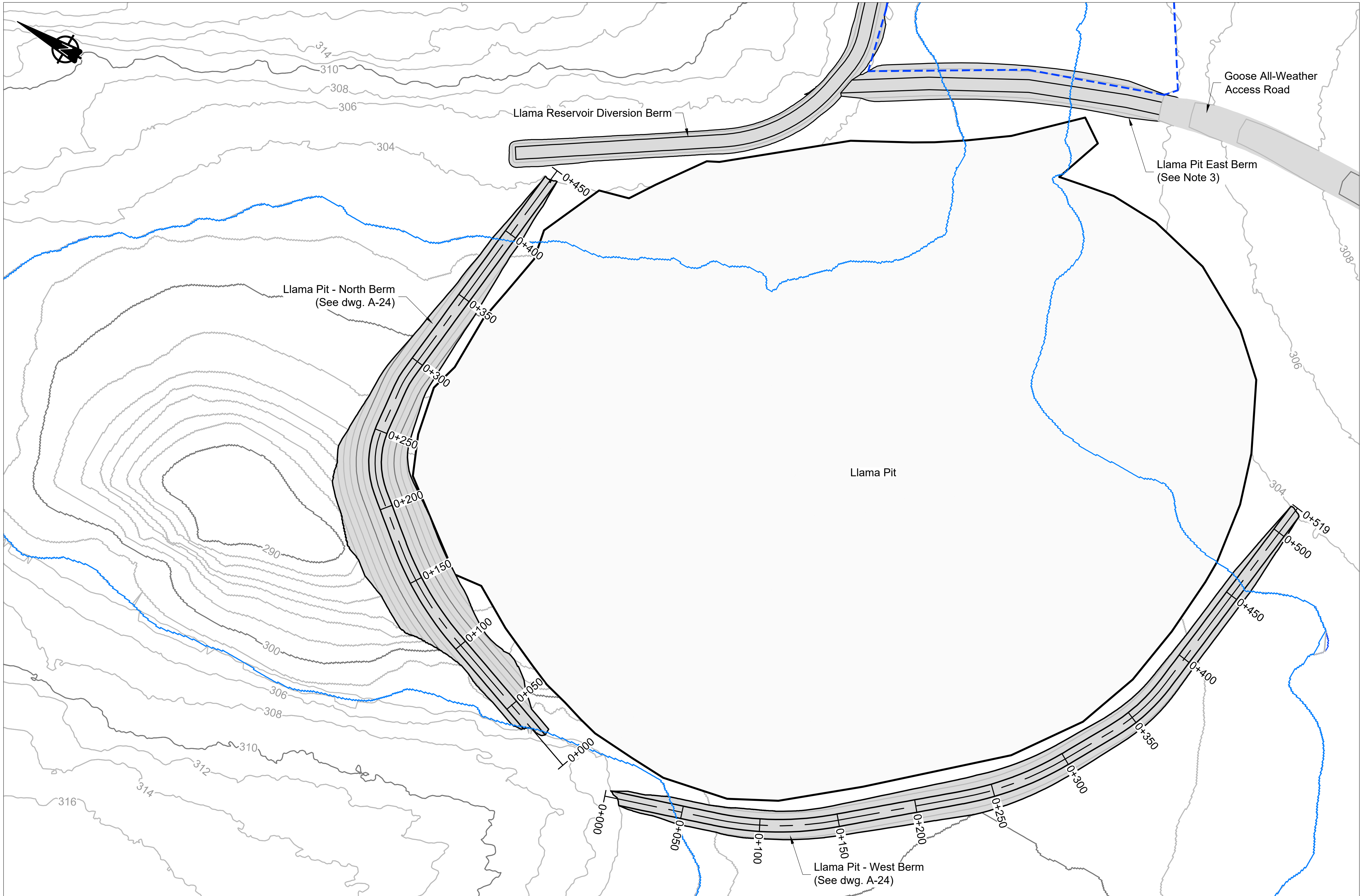

LEGEND

- Full Supply Level (Elev. 304.0m)
- Design Infrastructure
- Pit Outline
- Previous Llama Lake Water Level

NOTES

1. Contours are shown at 2.0m intervals.
2. All units are in meters unless otherwise specified.
3. Required key trench depth and dam and berm cross sections designs to be confirmed at detailed design stage.
4. Any backfill at or around the mined out Llama Pit to have a minimum 5.0m water cover.

REFERENCES

NAD83 UTM Zone 13.

0m 20 40 60 80 100

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FILE NAME: 1CS020.18 - Llama Pit.dwg

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Water Licence Phase

DRAWING TITLE: Llama Pit North and West Diversion Berms

DRAWING NO. A-23 | SHEET 26 OF 26 | REVISION NO. A

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LEGEND

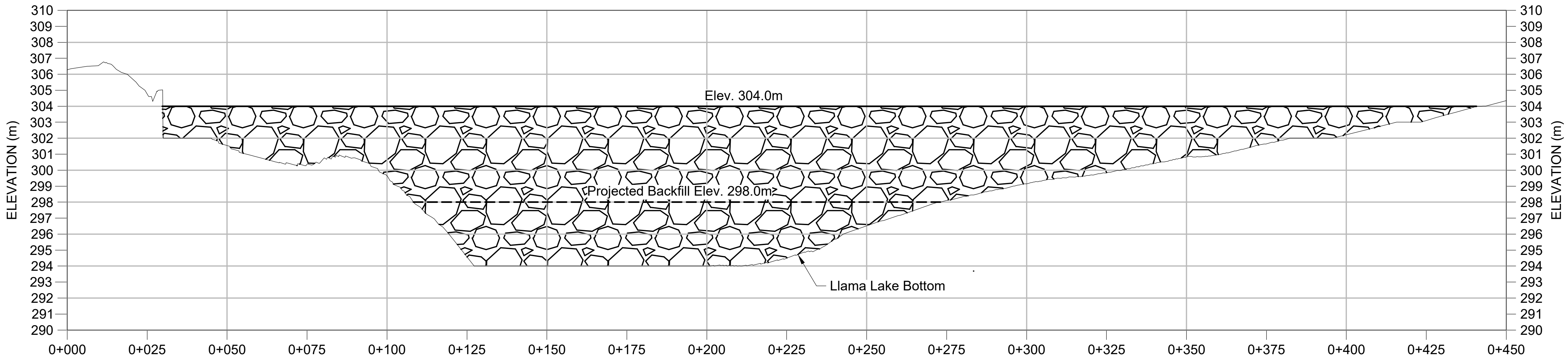
Rockfill

NOTES

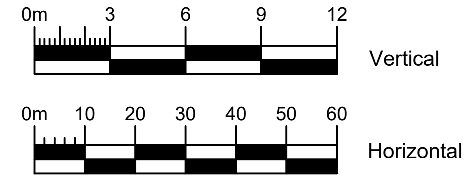
1. All units are in meters unless otherwise specified.
2. Required key trench depth and dam and berm cross sections designs to be confirmed at detailed design stage.
3. Any backfill at or around the mined out Llama Pit to have a minimum 5.0m water cover.

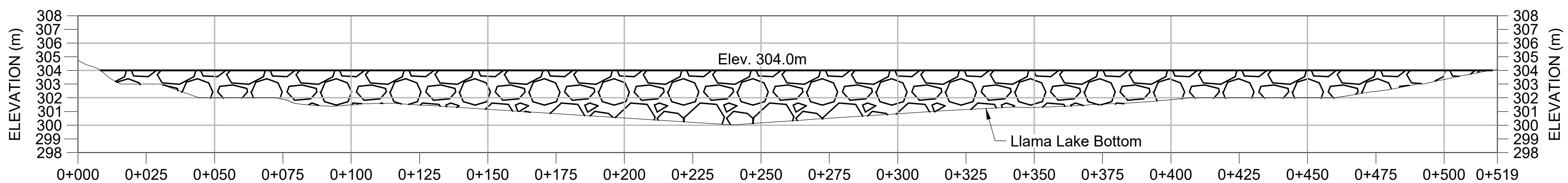
REFERENCES

NAD83 UTM Zone 13.

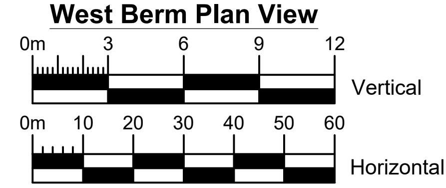


North Berm Plan View





West Berm Plan View



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REFERENCE DRAWINGS		REVISIONS									

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CHECKED: JBK | APPROVED: CP | DATE: 2020/06/05
FILE NAME: 1CS020.18 - Llama Pit.dwg

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Water Licence Phase

DRAWING TITLE: Llama Pit North Berm and West Berm Profiles

DRAWING NO.: A-24 | SHEET 24 OF 26 | REVISION NO. A

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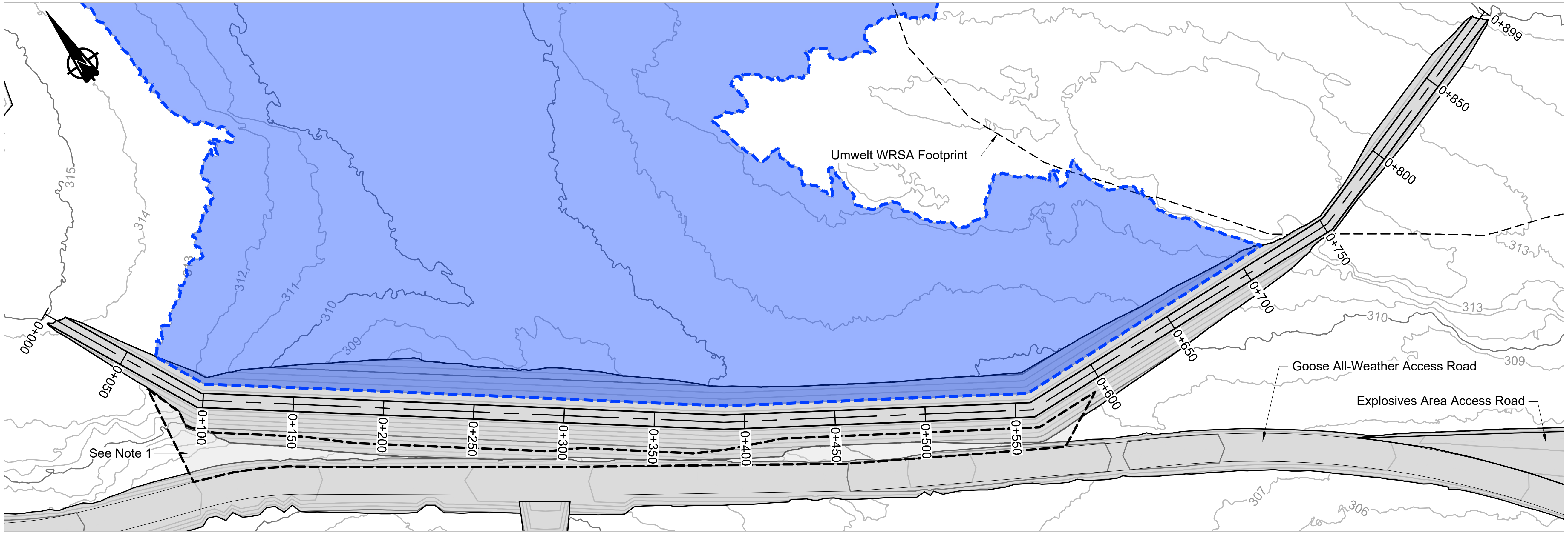
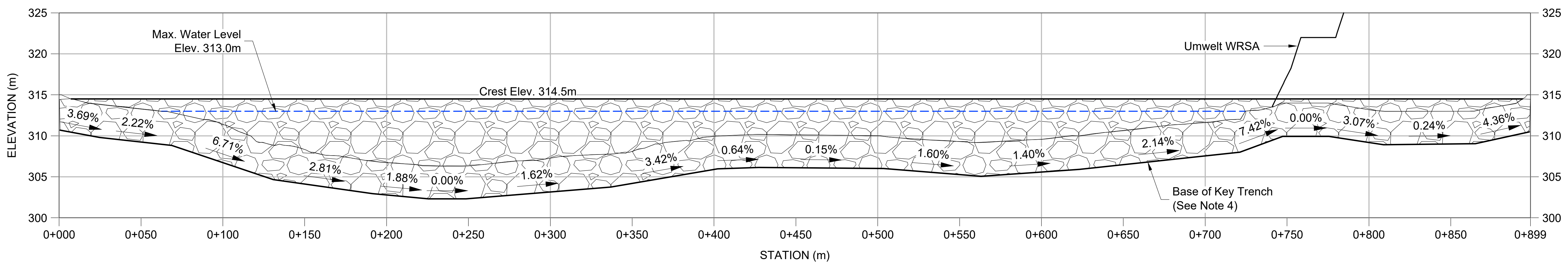


Primary Pond Diversion Berm

0m 20 40 60 80 100



Primary Pond Diversion Berm Profile

0m 5 10 15 20 Vertical

0m 20 40 60 80 100 Horizontal

LEGEND

- Design Infrastructure
- Rockfill
- Maximum Water Level (313.0m)

NOTES

1. Contours shown at 1.0m intervals.
2. All units in meters unless otherwise stated.
3. The downstream area between the Goose All-Weather Road (AWR) and downstream side of the Primary Pond Dam to be filled with a minimum 2.0m thick layer of bulk rockfill to assist with thermal protection of the downstream toe of the Primary Pond. Extreme care must be taken when building the AWR in the area and the road should be built to a minimum 2.0m thickness in this area to ensure that the downstream areas from the Primary Pond does not become thermally degraded / impacted.
4. Required key trench and dam and berm cross sections designs to be confirmed at detailed design stage.

REFERENCES

NAD83 UTM Zone 13.

DRAWING NO.	DRAWING TITLE
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REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE
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NO.	DESCRIPTION	CHK'D	APP'D	DATE
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CHECKED: JBK	APPROVED: CP	DATE: 2020/06/05

FILE NAME: 1CS020.018 - Primary Pond.dwg

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Back River Project

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Water Licence Phase

DRAWING TITLE: Primary Pond Dam Plan and Profile

DRAWING NO. A-25 | SHEET 25 OF 26 | REVISION NO. A

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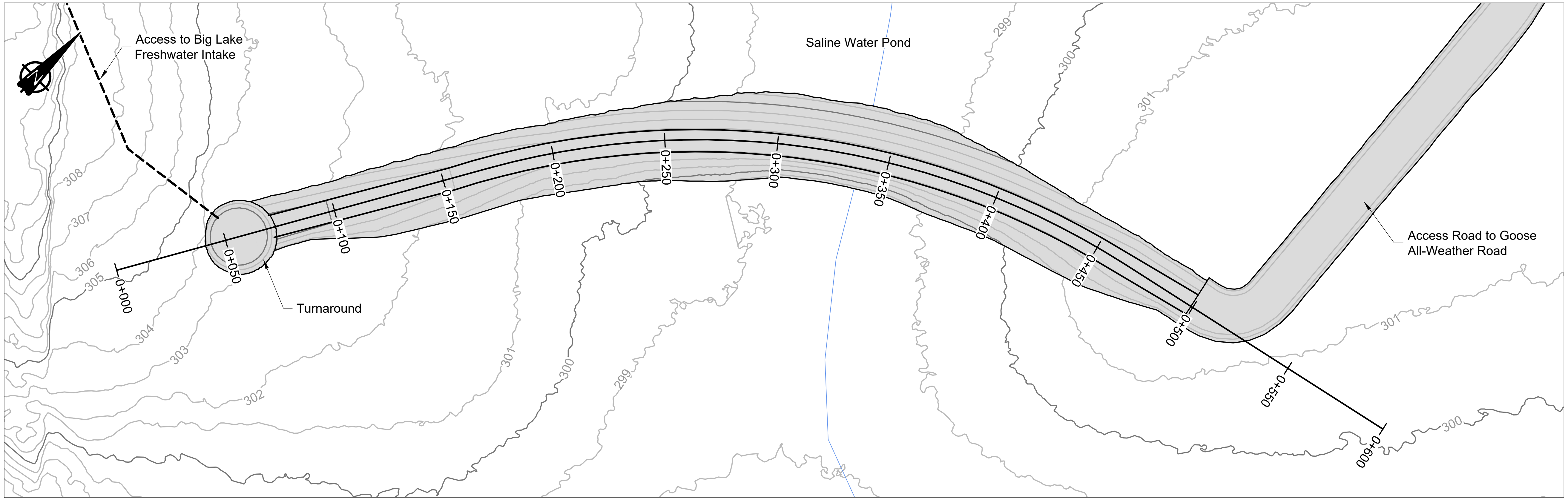
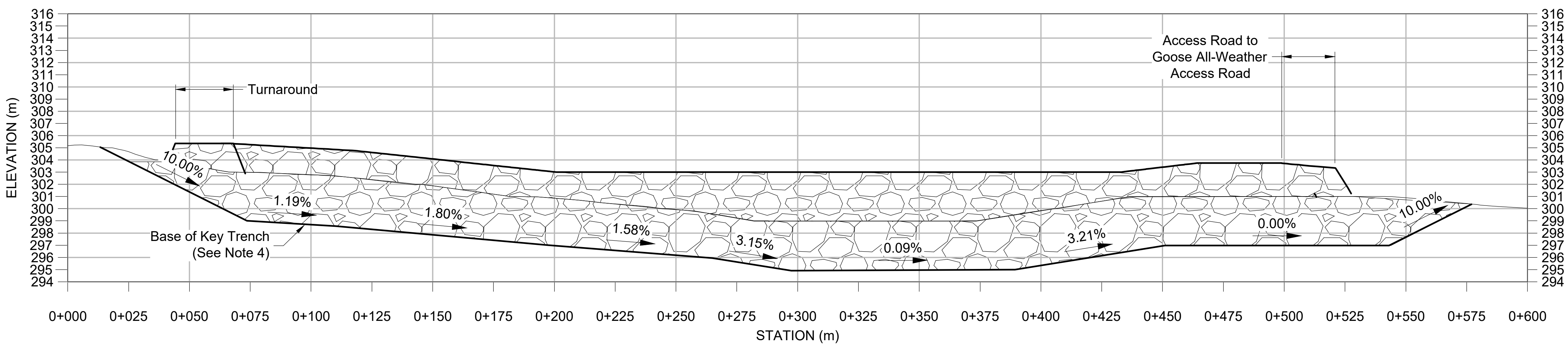


Saline Water Pond Dam

0m 20 40 60 80



Saline Water Pond Dam Profile

0m 4 8 12 16 Vertical

0m 20 40 60 80 Horizontal

LEGEND

- Design Infrastructure
- Rockfill

NOTES

1. Contours shown at 1.0m contours.
2. All dimensions shown in meters unless otherwise stated.
3. Overburden may be placed off the upstream face for the Saline Water Pond to help spread out the seepage pathway and limit long-term thermal impacts on the foundation.
4. Required key trench and dam and berm cross sections designs to be confirmed at detailed design stage.

REFERENCES

NAD83 UTM Zone 13.

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- -	- -	- -	- -	- -	- -	- -	A	Permit Amendment Dwg	JBK	CP	20/06/05

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FILE NAME: 1CS020.018 - SWP.dwg

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Back River Project

SRK JOB NO.: 1CS020.018

Water Licence Phase

DRAWING TITLE: Saline Water Pond Dam Plan and Profile

DRAWING NO.: A-26 | SHEET 26 OF 26 | REVISION NO. C

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Appendix B. Water Quality Monitoring

All water on the Project is categorized into three types: contact water (i.e., impacted by mine workings), non-contact water (i.e., undisturbed areas runoff), and saline water (i.e., groundwater). Only non-contact water will be diverted off-site without treatment.

Each type of water will be managed separately throughout each Project Phase.

<u>Construction Phase</u>

The following monitoring activities are proposed during the Construction Phase:

- Visual inspections to confirm that mitigation measures identified in this document and other relevant management plans (i.e., the Environmental Management and Protection Plan [WL SD-20], Borrow Pits and Quarry Management Plan [WL SD-03]) are implemented satisfactorily.
- Visual inspections to monitor the effectiveness of sediment and erosion control and runoff collection measures on a regular basis (daily or weekly as appropriate).
- Monitor treated sewage effluent discharges on a weekly basis for key indicators (i.e., TSS and ammonia), and monthly sampling using laboratory analysis for the parameters listed in Table B-01.
- Periodically sample runoff at active construction fronts for the parameters listed in Table B-03.
- Monitoring of runoff from quarries and borrow pits in relation to the quarry runoff criteria identified in Table 7.5-1.
- Monitoring of runoff at the Umwelt WRSA Pond and the Plant Site Pond for compliance with MDMER limits.
- Recording daily and monthly water consumption.
- Monitoring of waste and water management aspects including remediated soil, oily water, and landfill seepage.
- Monitoring of water quantity and quality will occur during all dewatering activities. The volume of water transferred will be measured on a continuous basis using appropriate flow meters.
- Field turbidity and TSS will be monitored daily. As data becomes available, a TSS and turbidity curve will be generated to manage dewatering activities. Water transferred during dewatering activities will meet a TSS or turbidity threshold discharge criteria. The trigger level to suspend dewatering activities will be 90% of the limit to avoid releasing water above the threshold. Clean lake water will be transferred and monitored until the trigger level is reached. When the TSS trigger level is reached, lake water will be treated for TSS through the WTP before discharge into Goose Lake.
- If released volumes of water change stream base flows or water levels by greater than 10% of baseline, then water transfer rates will be adjusted as required.
- During Construction, the emphasis of monitoring will be on the implementation and success of mitigation at construction areas. Toward the end of Construction, Operations Phase monitoring activities will be implemented, and monitoring will shift to include the relevant aspects of Operations Phase monitoring. Operations Phase activities beginning before the end of the Construction Phase will include the installation of Operations Phase water management facilities, milling, pre-stripping and mining of open pits and underground facilities, and the development of WRSAs.

Operations Phase

In addition to the above efforts during Construction, the following is proposed for monitoring during the Operations Phase:

- Recording daily and monthly water consumption;
- Regular visual monitoring of Operations Phase water management facilities;
- Visual inspections and monitoring of construction areas as described in Section 8.4 of the Environmental Management and Protection Plan (WL SD-20);
- Daily monitoring of the tailings discharge and the supernatant water level within the TSF;
- Monitoring of effluents prior to discharge in relation to the criteria identified for various effluents within the tables of Section 7.5;
- Underground mine inflows will be sampled to verify water quantity predictions and verify storage requirements;
- Monitoring of desalination discharge water to Bathurst Inlet to ensure that the salinity of the water remains within natural variability or CCME guidelines in sensitive marine areas;
- Monitoring of mine contact water effluent discharges as prescribed by a study design developed under the MDMER; and
- Implementation of the future AEMP to monitor effects to downstream aquatic environments.

During Operations, the emphasis will be on inspecting and monitoring construction fronts as aspects of construction will be ongoing throughout the mine life. The Operations Phase monitoring program will also incorporate the monitoring of mining activities and water management systems associated with the active tailings management facilities, pits, WRSA ponds, and the Saline Water Pond.

Closure Phase

The following is proposed for monitoring during Closure:

- Regular inspections to confirm that closure activities are being undertaken as identified in the final approved Mine Closure and Reclamation Plan;
- Construction-type monitoring is undertaken during decommissioning activities as described above;
- TSF/TF water quality monitoring until water quality objectives are met;
- Water quality monitoring of water being discharged from pits and the WRSAs to confirm all meet water quality objectives; and
- Water quality monitoring in Llama TF to confirm treatment is progressing as planned such that the discharge schedule may go ahead.

Due to the relatively long Closure Phase, there will be sufficient opportunities to conduct post-closure monitoring of the closed-out Project features. The WRSAs will be substantively closed during Operations, and the open pits will overtop and be closed early in the Closure Phase; this will allow for a number of years of post-closure monitoring during the Passive Closure Stage. Closure monitoring at receiving waters will be measured against water quality objectives.

Post-Closure Phase

Post-Closure monitoring is expected to be required for five years after completion of closure activities and the completion of water treatment in Llama TF. This is consistent with mine reclamation at other northern sites and is believed to be a reasonable monitoring period given the amount of verification monitoring that can performed during the Operations and Closure phases. Post-Closure monitoring is expected to include:

- Water quality sampling at mine contact water discharge locations in accordance with water quality objectives; and
- Final Environmental Effects Monitoring studies in accordance with the water quality objectives needed to obtain status as a recognized closed mine from ECCC.

Sampling Plan

The sampling plan has been designed to consider the various phases of the Project, but updates will be made as based on advancement of the Project and outcome of monitoring results.

Environmental monitoring station locations are shown on Figure B-01 and Figure B-02 for the Goose Property and MLA, respectively. In addition, Table B-01 and Table B-02 summarizes proposed water quality and flow monitoring of the Project during the Construction, Operations, Closure phases, and includes monitoring station location, monitoring type, description, purpose, mine phase, parameters grouping, and sample frequency for each location. The list of constituents in each parameter group is provided in Table B-03. It is anticipated that some locations will be initiated in Construction and maintained through Post-Closure, while other locations will come on-line in Operations once water is present. Proposed locations will be confirmed in the field.

To the extent practical, water samples will be analyzed for the same suite of constituents as analyzed for the AEMP. This will aid interpretation of AEMP results and linkages to mine related effects.

Figures and details regarding physical, chemical, and biological parameters in the AEMP sampling program are provided in the AEMP (WL SD-21); full details regarding marine monitoring are provided in the Marine Monitoring Plan (WL SD-23).

Sabina committed to developing a stand-alone marine monitoring plan (Term and Condition FA-ECCC-T-1). While, marine monitoring is outside the jurisdiction of the NWB, details on marine monitoring can be found in the Marine Monitoring Plan (WL SD-23).

Sample Collection

Field measurements of specific conductivity, pH, and temperature will be recorded whenever samples are collected using a multi-meter (e.g., YSI 6-Series Multimeter), along with measurements of total water depth, and sample collection depth.

Water quality samples will be collected from specific sampling stations (coordinates still to be confirmed) using a grab sampler or directly into bottles provided by an accredited analytical laboratory. Water quality samples will be analyzed by an accredited laboratory at detection limits less than aquatic life guidelines or as appropriate for site contact water type samples. The specific limits will be provided once the analytical laboratory has been selected.

Quality Assurance and Quality Control

Samples will be collected following standard sampling protocol (e.g., see the Quality Assurance and Quality Control Plan [WL SD-24]) by qualified personnel using suitable sampling equipment. Water samples for laboratory analysis will be filtered and preserved (as required) and stored in a cool environment before shipping to the laboratory. Quality control samples (i.e., blanks and duplicates) will be collected at a quantity of 10% of all samples collected.

Reporting

Results collected in any given year will be included in the annual report. Descriptive summary statistics will be calculated, and results will be analyzed by comparison to Water Licence criteria and aquatic life guidelines (CCME 1999) or baseline conditions, as appropriate.

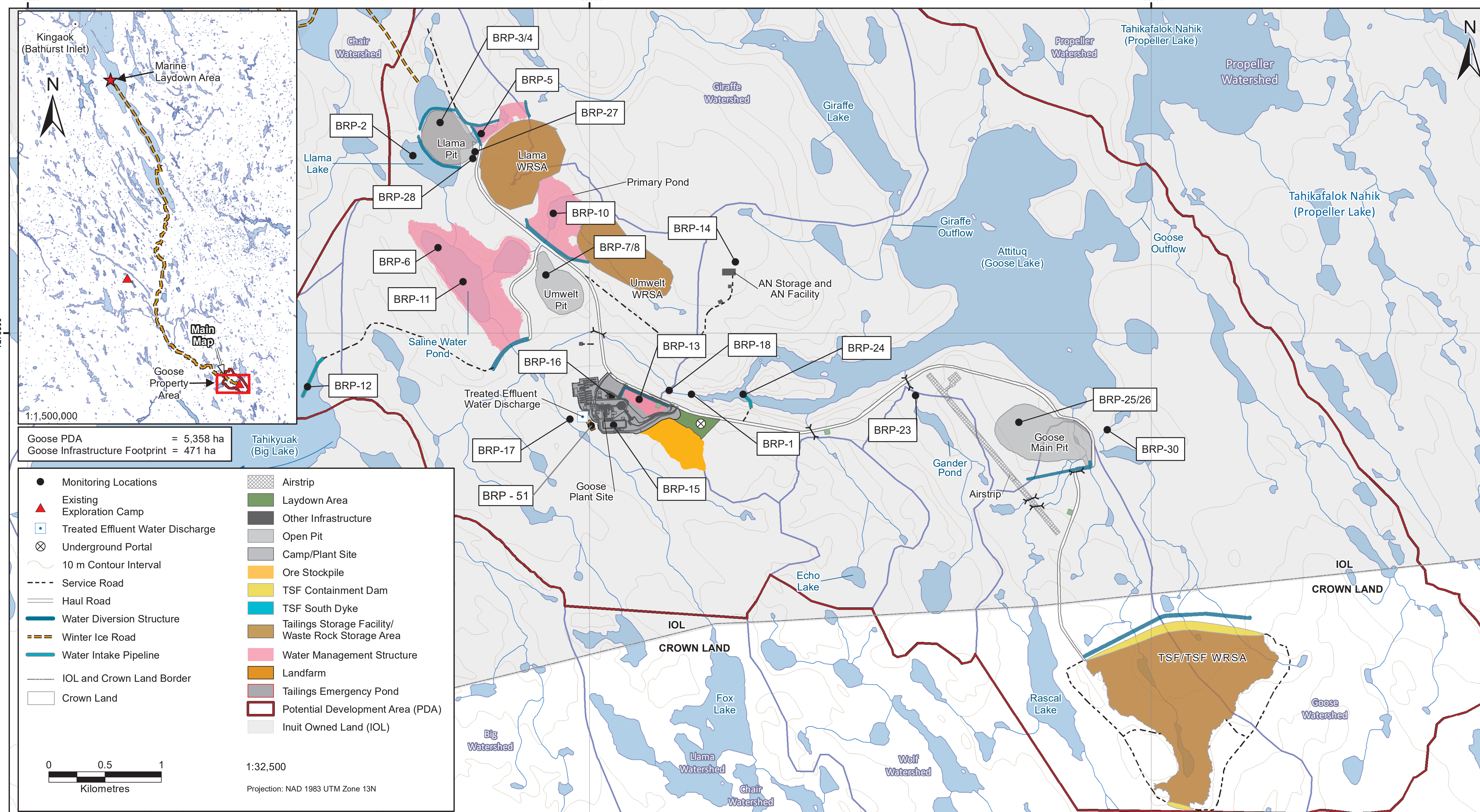

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Figure B-02

Proposed Surface Water Monitoring Locations
Goose Property Area, Back River Project

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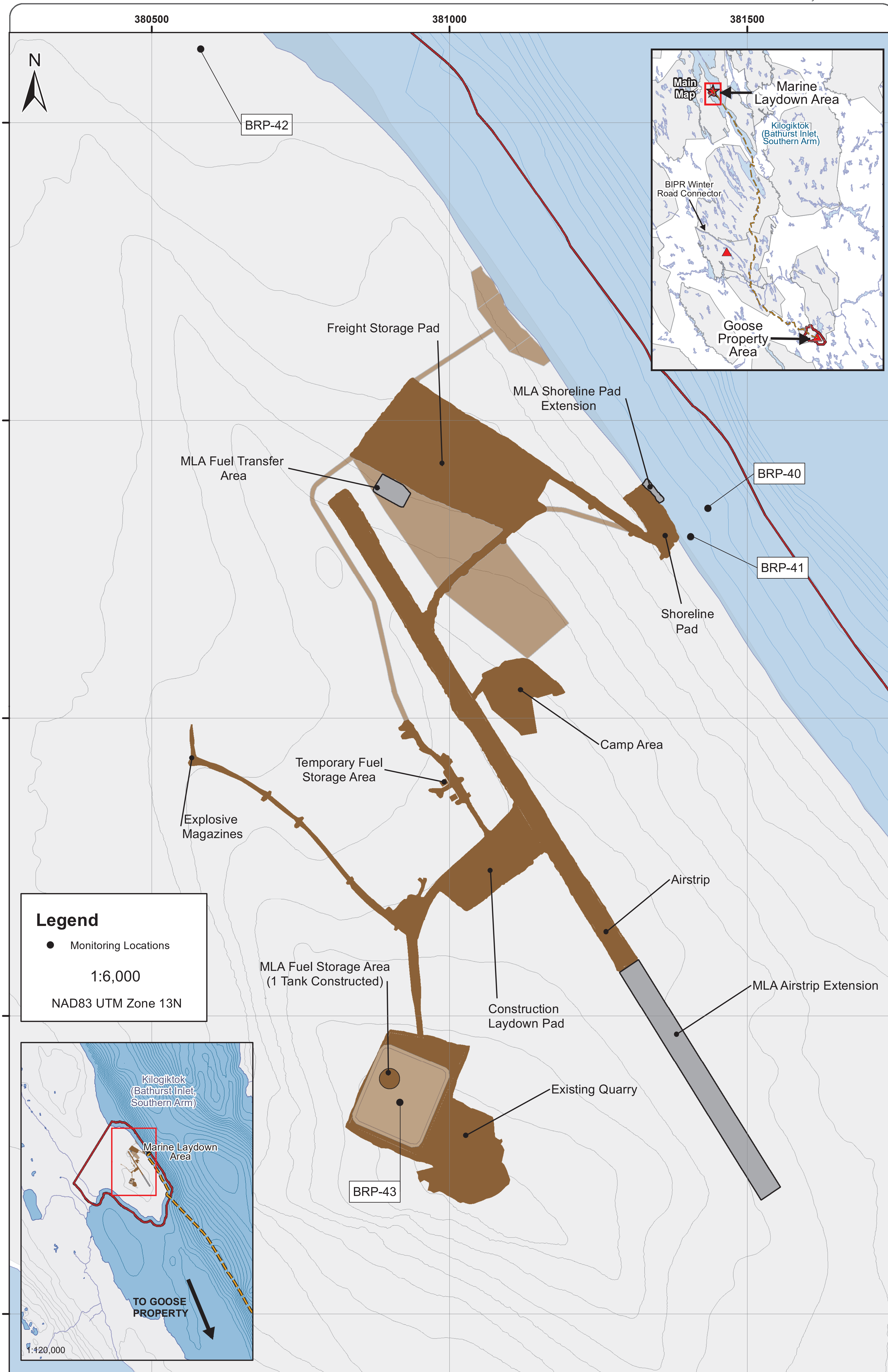

Figure B-02

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Proposed Surface Water Monitoring Locations
Marine Laydown Area, Back River Project

Table B-01. Proposed Water Quality Monitoring for the Project during Construction, Operations, and Closure in Goose Property Area

Status	2020 Modification Package Revision	Monitoring Location Number	Monitoring Type	Description	Purpose	Mine Phase	Parameter Group Code[5]	Frequency
Active	No Change	BRP-G-01 to BRP-G-TBD	Regulated Monitoring[1]	General Site Runoff including Quarries - both Goose and MLA	Applies anywhere on the site; monitoring for erosion and sedimentation	Construction	C	Weekly if flow enters a waterbody
Active	Updated Location	BRP-01	Regulated Monitoring[2]	Discharge to Goose Lake (after treatment)	Test of dewatering discharge (i.e., effluent), at final point of control. If water does not meet TSS discharge criteria, water will be treated prior to release[2].	Construction	A, B, G	Weekly during dewatering
							D	Four times during dewatering, at the same time as the weekly samples
							H	Once per month during dewatering, at the same time as groups D and F
							I	One time during dewatering, at the same time as groups D and F
Active	No Change	BRP-02	General Monitoring	Llama Lake Dewatering (prior to treatment) if required	If treatment is required, this station will test pretreated water.	Construction	C (TSS only)	Weekly if treatment is required; no sample if treatment is not required
Active	No Change	BRP-03	Verification Monitoring	Llama Pit	Pit water quality prior to transfer to a tailings facility	Operations (Stage 1) to Operations (Stage 2)	A, G	See note [6]
Active	No Change	BRP-04	General Monitoring	Llama Pit Lake	During pit flooding and before overflow to the downstream environment	Closure to Post-closure	A, D	Twice per year
Active	No Change	BRP-05	Verification Monitoring	Llama WRSA Pond	Test quality of drainage water from Llama WRSA	Operations (Stage 1) to Closure	A, G	See note [6]
Active	No Change	BRP-06	General Monitoring	Umwelt Lake Dewatering (prior to treatment) if required	If treatment is required, this station will test pretreated water.	Construction	C (TSS only)	Weekly if treatment is required; no sample if treatment is not required
Active	No Change	BRP-07	Verification Monitoring	Umwelt Pit	Pit water quality prior to transfer to a tailings facility	Construction to Operations (Stage 2)	A, G	See note [6]

Status	2020 Modification Package Revision	Monitoring Location Number	Monitoring Type	Description	Purpose	Mine Phase	Parameter Group Code[5]	Frequency
Active	No Change	BRP-08	General Monitoring	Umwelt Pit Lake	During pit flooding and before overflow to the downstream environment	Closure to Post-closure	A, D	Twice per year
Inactive	Not Shown	BRP-09	Verification Monitoring	Umwelt WRSA Pond	Test quality of drainage water from Umwelt WRSA. A landfill is located in this WRSA. Appropriate landfill parameters will be tested for; see the LWMP (WL SD-10) for details.	Construction to Closure (early)	A, G	See note [6]
Active	Updated Purpose	BRP-10	Verification Monitoring	Primary Water Pond	Test quality of water in pond for industrial water use. Test quality of drainage water from Umwelt WRSA. A landfill is located in the Umwelt WRSA. Appropriate landfill parameters will be tested for; see the LWMP (WL SD-10) for details.	Construction to Closure (early)	A, D, G	See note [6]
Active	No Change	BRP-11	Verification Monitoring	Saline Water Pond	Test quality of water in pond; Formerly Umwelt Lake	Construction (late) to Closure (early)	A, D	See note [6]
Active	No Change	BRP-12	General Monitoring	Big Lake Intake;	Source intake water quality for potable and industrial use	Construction to Closure	A, D	Four times per year
							B	Weekly
Active	Updated Location & Description	BRP-13	Verification Monitoring	Plant Site Pond (formerly Ore Stockpile Pond)	Test quality of drainage water from Ore stockpile	Construction to Closure (early)	A, D	See note [6]
Active	No Change	BRP-14	Verification Monitoring	ANFO Plant	Test quality of runoff water in the ANFO plant containment area	Construction to closure	A, E	See note [6]
Active	Updated Location	BRP-15	Regulated Monitoring[3]	Goose Fuel Tank Farm	Test quality of runoff water in the Fuel Tank Farm containment area	Construction to closure	A, E	Prior to discharge or transfer of water
Active	Updated Location	BRP-16	Regulated Monitoring[3]	Goose Hazardous Waste Mgmt Area	Test quality of runoff water in the Hazardous Waste Management containment area	Construction to closure	A, E	Prior to discharge or transfer of water

Status	2020 Modification Package Revision	Monitoring Location Number	Monitoring Type	Description	Purpose	Mine Phase	Parameter Group Code[5]	Frequency
Active	Updated Location	BRP-17	Regulated Monitoring[4]	Treated sewage discharge to land	Test quality of sewage effluent discharge water quality	Construction to closure	A, E	Prior to discharge or transfer of water
Active	Updated Frequency	BRP-18	General Monitoring	Llama Watershed Outflow (PN04 from water and load balance)	Test quality of non-contact water runoff from the "Llama" watershed	Construction to closure	A, D	Once during freshet, and monthly during upstream construction while visible flow is present at the stations
Inactive	Not Shown	BRP-19	General Monitoring	Echo Outflow (PN09 from water and load balance)	Test quality of non-contact water runoff from the "Echo" watershed	Operations (Stage 1) to Closure	A, D	Once during freshet, and monthly during upstream construction while visible flow is present at the stations
Inactive	Not Shown	BRP-20	Verification Monitoring	Echo Pit	Pit water quality prior to transfer to a tailings facility; Echo underground water is always directed to the TSF	Operations (Stage 2)	A, G	See note [6]
Inactive	Not Shown	BRP-21	General Monitoring	Echo Pit Lake	During pit flooding and before overflow to the downstream environment	Closure to Post-closure	A, D	Twice per year
Inactive	Not Shown	BRP-22	Verification Monitoring	Echo WRSA Pond	Test quality of drainage water from Echo WRSA	Operations (Stage 2) to Closure (early)	A, G	See note [6]
Active	Updated Frequency	BRP-23	General Monitoring	Gander Pond Outflow (PN07 from water and load balance)	Test quality of non-contact water runoff from the "Gander" watershed	Operations (Stage 1) to Closure	A, D	Once during freshet, and monthly during upstream construction while visible flow is present at the stations
Active	Updated Location	BRP-24	General Monitoring	Goose Lake Intake	Source intake water quality; for operational use (mill water make-up)	Operations (Stage 2) to Closure (early)	B	Weekly
Active	Updated Purpose	BRP-25	Verification Monitoring	Goose Main Pit	Pit water quality prior to transfer to a tailings facility	Operations (Stage 1) to Operations (Stage 2)	A, G	See note [6]
Active	No Change	BRP-26	General Monitoring	Goose Main Pit Lake	During pit flooding and before overflow to the downstream environment	Closure to Post-closure	A, D	Twice per year

Status	2020 Modification Package Revision	Monitoring Location Number	Monitoring Type	Description	Purpose	Mine Phase	Parameter Group Code[5]	Frequency
Active	Updated Location, Description, & Mine Phase	BRP-27	Verification Monitoring	Llama TF Intake; collected at "inlet" to treatment facility	Pre-treatment quality	Operations (Stage 2) to Closure	A, G	See note [6]
Active	Updated Location, Description, & Mine Phase	BRP-28	Verification Monitoring	Llama TF Discharge into Llama TF (after treatment); collected at "outlet" of treatment facility; no discharge to the receiving environment	Post-treatment quality to confirm treatment efficiency	Operations (Stage 2) to Closure	A, G	See note [6]
Inactive	Not Shown	BRP-29	Verification Monitoring	TSF WRSA Pond	Test quality of drainage water from TSF; A landfill is located in this WRSA. Appropriate landfill parameters will be tested for; see the LWMP (WL SD-10) for details.	Operations (Stage 1) to Closure	A, G	See note [6]
Active	No Change	BRP-30	General Monitoring	Goose Southeast Inflow (PN06 from water and load balance)	Test quality of non-contact water runoff from the "TSF" watershed	Operations (Stage 1) to Closure	A, D	Once during freshet
Active	Updated Location	BRP-51	Regulated Monitoring[3]	Goose Landfarm	Test quality of runoff water in the Landfarm containment area	Construction to Closure	E	Prior to discharge or transfer of water

Notes BRP = Back River Project; MLA = Marine Laydown Area
1) See Table 7.5-2 (Dewatering Discharge Criteria) in the Water Management Plan
2) See Table 7.5-1 (Site Runoff Discharge Criteria) in the Water Management Plan
3) See Table 7.5-3 (Discharge to Land Criteria) in the Water Management Plan
4) See Table 7.5-4 (Treated Sewage Effluent Criteria) in the Water Management Plan
5) See Table B-03 for parameters in each monitoring group
6) Monitoring parameters and frequency at the discretion of Sabina as results from the verification stations are used for operational and management purposes

Table B-02. Proposed Water Quality Monitoring for the Project during Construction, Operations, and Closure in Marine Laydown Area

Status	2020 Modification Package Revision	Monitoring Location Number	Monitoring Type	Description	Purpose	Mine Phase	Parameter Group Code[4]	Frequency
Active	No Change	BRP-G-01 to BRP-G-TBD	Regulated Monitoring[1]	General Site Runoff including Quarries - both Goose and MLA	Applies anywhere on the site; monitoring for erosion and sedimentation	Construction	C	Weekly if flow enters a waterbody
Active	Updated Location	BRP-40	General Monitoring	Bathurst Inlet Intake (pre-treatment)	Source intake water quality for potable and industrial use	Construction to Closure	A, D	See note [5]
							B	See note [5]
Active	Updated Location	BRP-41	General Monitoring[1]	Bathurst Inlet Discharge (post treatment)	Test quality at final point of control	Construction to Closure	A, J	See note [5]
Active	Updated Location	BRP-42	Regulated Monitoring[2]	MLA Treated Effluent Discharge Location to land (greywater)	Confirm quality of greywater before release	Construction to Closure	A, F	Prior to discharge or transfer of water
Active	No Change	BRP-43	Regulated Monitoring[3]	MLA Fuel Tank Farm	Test quality of runoff water in the Fuel Tank Farm containment area	Construction to closure	A, E	Prior to discharge or transfer of water
Inactive	Not Shown	BRP-44	Regulated Monitoring[3]	MLA Landfarm	Test quality of runoff water in the Landfarm containment area	Construction to closure	A, E	Prior to discharge or transfer of water
Inactive	Not Shown	BRP-45	Regulated Monitoring[3]	MLA Hazardous Waste Mgmt Area	Test quality of runoff water in the Hazardous Waste Management containment area	Construction to closure	A, E	Prior to discharge or transfer of water

Notes BRP = Back River Project; MLA = Marine Laydown Area
1)Marine Discharge Criteria not required for the Water Licence
2) See Table 7.5-4 (Treated Sewage Effluent Criteria) in the Water Management Plan
3) See Table 7.5-3 (Discharge to Land Criteria) in the Water Management Plan
4) See Table B-03 for parameters in each monitoring group
5) Monitoring parameters and frequency at the discretion of Sabina as results from the verification stations are used for operational and management purposes

Table B-03. List of Constituents in Each Parameter Group

Parameter Group	Parameter Group Code	Specific parameters
Field Chemistry	A	pH, specific conductivity, and temperature.
Flow	B	Flow datalogger, calculated volume
General Surface runoff	C	Total Suspended Solids (TSS), Oil and Grease, pH
General Chemistry	D	<u>Conventional</u>: turbidity, hardness, alkalinity, calcium, chloride, fluoride, magnesium, potassium, sodium, sulphate, total dissolved solids, TSS, total cyanide, free cyanide, and weak acid dissociable (WAD) cyanide. <u>Nutrients</u>: ammonia, nitrate, nitrite, total phosphorus (TP), and dissolved organic carbon. <u>Total and dissolved metals</u>: aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, thallium, uranium, and zinc <u>Other</u>: radium-226, *Escherichia coli,* and Total coliforms, when required
Secondary Containment	E	TSS, pH, ammonia, total arsenic, total copper, total lead, total nickel, total zinc, benzene, toluene, ethylbenzene, xylene, Oil and Grease
Sewage	F	Biochemical Oxygen Demand (5-day), TSS, Fecal coliform, ammonia, phosphorus, Oil and Grease, pH, Acute toxicity (Rainbow Trout and Daphnia magna)
MDMER deleterious substances	G	TSS, total cyanide, total arsenic, total copper, total lead, total nickel, total zinc, and radium-226
MDMER toxicity	H	Acute toxicity (Rainbow Trout and Daphnia magna)
MDMER sublethal toxicity	I	Sublethal toxicity (Fathead Minnow or Rainbow Trout, Ceriodaphnia dubia, Lemna minor, Pseudokirchneriella subcapitata)
Discharge to Marine	J	Salinity, total metals (aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, thallium, uranium, and zinc), oil and grease

Note: Detection limits may vary for site monitoring and for downstream receiving environment monitoring

REFERENCES

1985. *Fisheries Act*. R.S.C. 1985, c. F-14.

1988. *Environmental Protection Act*. RSNWT (Nu) 1988, c E-7.

1993. *Nunavut Agreement Act*. S.C. 1993, c. 29.

CCME (Canadian Council of Ministers of the Environment). 1999 (with updates to 2017). Canadian Environmental Quality Guidelines for the Protection of Aquatic Life – Summary Table. Available at: http://st-ts.ccme.ca/.

Appendix C. Saline Water Management Plan

Water Management Plan

Appendix C: Saline Water Management Plan

June 2020

BACK RIVER PROJECT
SALINE WATER MANAGEMENT PLAN

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Revision Log

Version	Date	Section	Page	Revision
1	June 2018	All	All	Addition of Appendix C: Saline Water Management
2	June 2020	All	All	Updated to reflect the 2020 Modification Package changes, and as a Supporting Document for the Type A Water Licence Application; submitted to the Nunavut Water Board for review and approval.

Acronyms

CCME	Canadian Council of Ministers of the Environment
MDMER	Metal and Diamond Mining Effluent Regulations
MAD	Main Application Document, submitted October 2017 (2AM-BRP1831)
NWB	Nunavut Water Board
Project	Back River Project
Sabina	Sabina Gold & Silver Corp.
SD	Supporting Document
SWMP	Saline Water Management Plan
SWP	Saline Water Pond
TF	Tailing Facility
WMP	Water Management Plan

1. Introduction

The Saline Water Management Plan (SWMP or the Plan) is developed as an appendix to the Water Management Plan (WMP) to provide additional details related to the management of saline groundwater in compliance with the Type A Water Licence, 2AM-BRP1831. The WMP outlines the procedures required to manage the quantity and quality of water interacting with Project components throughout the Construction, Operations, Closure, and Post-Closure phases of the Project.

The SWMP outlines the procedures required to manage the quantity and quality of saline groundwater interacting with Project components throughout the mine life, and characterization of saline water inflows into the underground mine workings. The Plan also includes monitoring of thermal conditions, monitoring of saline water at the Goose Property, mitigation measures designed to address the potential for higher-than-predicted volumes of saline water inflows into the open pits and the underground mine, and potential water treatment and disposal methods.

2. Scope and Objectives

The SWMP is provided as an addendum to the WMP with the objective of further detailing the saline water management strategies and designs for the Project, including considerations about contingencies, monitoring, and potential adaptive management strategies. The SWMP applies to all phases of the Project during which saline water will be managed. The SWMP has been written to meet requirements of the Type A Water Licence (2AM-BRP1831) and NIRB Project Certificate (No. 007).

The purpose of the SWMP is to:

- outline procedures and processes specific to management of saline water through all phases of the Project, as proposed in the WMP;
- summarize designs of infrastructure dedicated to management of saline water;
- meet relevant laws and regulations;
- detail mitigation (adaptive management) strategies to manage potential adverse environmental effects; and
- define steps that will be taken to monitor potential mitigation measures for success.

The WMP incorporates strategies for saline water management that allow full containment of saline water within the Project site throughout the various phases of the Project. Additional details related to the closure and reclamation of saline water management structures can also be found in the Interim Closure and Reclamation Plan (WL SD-26).

The SWMP, as part of the WMP, will be updated as needed to reflect changes in operations and technology. Any updates will be filed with the Annual Report submitted under the Type A Water Licence, or as otherwise directed by the NWB.

The SWMP is divided into the following sections:

- Applicable Legislation and Guidelines (Section 3);
- Saline Water Management Strategy (Section 4);
- Monitoring and Reporting Program (Section 5);
- Quality Assurance/Quality Control Procedures (Section 6);
- Adaptive Management (Section 7); and
- Reclamation (Section 8).

2.1 RELATED DOCUMENTS

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

- Hydrogeological Characterization and Modelling Report (Sabina 2017, Appendix F-5);
- Environmental Management and Protection Plan (WL SD-20);
- Water Management Plan (Appendix B to the 2020 Modification Package);
- Aquatic Effects Management Plan (WL SD-21);
- Road Management Plan (WL SD-02);
- Interim Closure and Reclamation Plan (WL SD-26);
- Quality Assurance / Quality Control Plan (WL SD-24);
- Hydrology Report (Sabina 2015, Appendix V2-7B);
- Water and Load Balance Report (Appendix E of the WMP); and

3. Applicable Legislation and Guidelines

Specific legislation, regulations, and guidelines related to water management in Canada, and specifically within Nunavut, are summarized in the Table 3-1 of the WMP.

Sabina is bound by the terms and conditions of its land use permits issued by the Kitikmeot Inuit Association for Inuit Owned Land, Crown-Indigenous Relations and Northern Affairs Canada for Crown Land, and the Type A Water Licence (2AM-BRP1831).

4. Saline Water Management Strategy

As defined in the WMP, saline water for the Project is the groundwater that flows into Llama Open Pit (only pit not in permafrost) and the underground workings, refer to Figure A-11 and A-12 of the WMP for the location of Goose Property infrastructure and the Saline Water Pond. A small volume of brine water may be used for drilling in the underground mine workings. This brine water would be recirculated during drilling as much as feasible, with any excess managed synonymously with other saline water from the Project as described below.

This section provides a description of the saline water management strategy throughout the Construction, Operations, and Closure phases of the Project. In summary, the saline water management strategy consists of collecting saline water from Llama Open Pit and the underground mine workings, and temporarily storing this groundwater in a dedicated storage facility until it can be returned back into the mined-out underground workings and the exhausted Umwelt Open Pit.

4.1 PERMAFROST CHARACTERISTICS AND GROUNDWATER INFLOWS

The Back River Property is located in the continuous permafrost region of the Canadian Arctic. While permafrost may extend in excess of 400 metres below the ground surface (mbgs), it is expected that some of the underground development will extend below this depth into unfrozen rock and soil. In addition, Llama Open Pit will be located within a through talik underneath Llama Lake.

As part of the Project, a groundwater prediction model was completed to estimate potential groundwater inflows during mining at the Goose Property (Sabina 2017, Appendix F-5); this model was employed in both the FEIS (Sabina 2015) and the Type A Water Licence Application (Sabina 2017). Sabina subsequently scaled the quantity and quality of groundwater inflows predicted to match the new mine schedule. A summary of the estimated quarterly groundwater inflows at the Goose Property and corresponding Total Dissolved Solids (TDS) concentrations is provided in Table 4.1-1 and Table 4.1-2, for Llama Pit and Umwelt Underground, respectively.

Table 4.1-1. Llama Open Pit Quarterly Groundwater Inflows and TDS Concentrations

Mine Year	Inflow		Total Dissolved Solids	
	Volume (m^3)	Rate (m^3/day)	Mass (tonne)	Concentration (mg/L)
Y1Q3	82,200	900	700	8,500
Y1Q4	48,300	500	400	9,300
Y2Q1	21,500	200	200	9,800
Y2Q2	20,100	200	200	10,100
Y2Q3	49,100	500	500	9,900
Y2Q4	28,800	300	300	9,600
Y3Q1	38,400	400	400	9,300
Y3Q2	35,700	400	300	9,300
Y3Q3	46,800	500	400	7,800
Y3Q4	44,600	500	300	7,600

(continued)

Table 4.1-1. Llama Open Pit Quarterly Groundwater Inflows and TDS Concentrations (completed)

Mine Year	Inflow		Total Dissolved Solids	
	Volume (m^3)	Rate (m^3/day)	Mass (tonne)	Concentration (mg/L)
Y4Q1	32,900	400	200	7,300
Y4Q2	37,700	400	200	6,500
Y4Q3	35,300	400	200	5,900
Y4Q4	44,400	500	200	5,600
Y5Q1	48,800	500	300	5,800

Table 4.1-2. Umwelt Underground Quarterly Groundwater Inflows and TDS Concentrations

Mine Year	Inflow		Total Dissolved Solids	
	Volume (m3)	Rate (m3/day)	Mass (tonne)	Concentration (mg/L)
Y1Q1	11,000	100	300	29,000
Y1Q2	27,000	300	900	33,300
Y1Q3	38,200	400	1,400	37,500
Y1Q4	60,500	700	2,500	41,000
Y2Q1	71,200	800	3,100	43,400
Y2Q2	74,400	800	4,400	59,000
Y2Q3	74,400	800	4,400	59,000
Y2Q4	74,400	800	4,400	59,000
Y3Q1	74,400	800	4,400	59,000
Y3Q2	74,400	800	4,400	59,000
Y3Q3	62,000	700	3,000	48,900
Y3Q4	51,900	600	2,600	49,400
Y4Q1	45,700	500	2,300	49,500
Y4Q2	45,700	500	2,400	53,500
Y4Q3	63,500	700	3,800	60,500
Y4Q4	74,400	800	4,400	59,000
Y5Q1	72,900	800	4,100	56,900
Y5Q2	60,500	700	3,500	57,000
Y5Q3	54,500	600	3,100	57,200
Y5Q4	51,100	600	2,900	57,300
Y6Q1	48,100	500	2,800	57,500
Y6Q2	44,700	500	2,600	57,700
Y6Q3	43,300	500	2,500	57,900
Y6Q4	42,200	500	2,500	58,200
Y7Q1	40,700	400	2,400	58,400
Y7Q2	38,700	400	2,300	58,700
Y7Q3	38,000	400	2,200	58,900

(continued)

Table 4.1-2. Umwelt Underground Quarterly Groundwater Inflows and TDS Concentrations (completed)

Mine Year	Inflow		Total Dissolved Solids	
	Volume (m3)	Rate (m3/day)	Mass (tonne)	Concentration (mg/L)
Y7Q4	37,400	400	2,200	59,200
Y8Q1	36,500	400	2,200	59,500
Y8Q2	35,000	400	2,100	59,700
Y8Q3	34,600	400	2,100	60,000
Y8Q4	34,300	400	2,100	60,200
Y9Q1	33,700	400	2,000	60,500

At the Goose Property, groundwater modelling and analysis determined that inflows are expected from Llama Open Pit, and Umwelt Underground. Llama open pit mining will be developed below Llama Lake within a through talik that is connected to the groundwater system. It is also expected that Umwelt underground workings will intercept the groundwater system below the basal permafrost layer. The remaining developments (Umwelt Open Pit, and Goose Main Open Pit) are not expected to have notable groundwater inflows.

The inflows and concentrations in Table 4.1-1 and Table 4.1-2 were derived from hydrogeological parameters obtained from the field investigation program results, including installation of the Westbay Well to conduct groundwater quality sampling at the Goose Property. Multiple hypothetical scenarios were modelled to assess the sensitivity of groundwater model predictions to hydraulic conductivity (K) values, the potential presence of fault conduits, lake sediment K values, and permafrost distribution. The hypothetical scenarios were used to contextualize the overall groundwater model in terms of both quantity and quality of water estimated to report to the mine workings.

Groundwater inflows in Table 4.1-1 and Table 4.1-2 represent quarterly average flows, meaning they are estimated as the total annual inflow volumes equally distributed over three months. As such, these inflow volumes do not fully account for the actual schedule of mining completion in the last year of facility. If the facilities are completed in the first few weeks of the production quarter, the inflow rates for those months would be higher than the quarterly average inflow rates, as the total annual estimated inflow volume would be concentrated in a period of time shorter than three months. Linear interpolation was assumed for groundwater flow into Llama Open Pit during pit flooding; this is further described in Water and Load Balance Report, Appendix E of the WMP.

A detailed description of the groundwater prediction model and results through all mine phases can be found in the Hydrogeological Characterization and Modelling Report for the Project (Sabina 2017, Appendix F-5).

4.2 SALINE WATER MANAGEMENT STRATEGY AND ASSOCIATED CONTROL STRUCTURES

Sabina recognizes that there is a chance that groundwater flow in the mine workings may be dominated by specific fractures or features that are intercepted. This uncertainty exists for all mining projects and is never completely alleviated, which is the reason why structural geology and hydrogeology data are regularly collected from mining operations. The influx of groundwater into a mine is a normal and well understood phenomenon and is regularly managed by standard operating procedures in operating mines. Sabina is aware of the uncertainty related to fault zones and will take advanced actions where feasible to help safely and appropriately manage groundwater inflows reporting to the mine workings. These actions may include use of surface and underground exploration information to identify enhanced permeability that may be intercepted by the mine workings, advancing cover and probe drilling (i.e., exploration drainage holes), and interpretation of groundwater pressure and inflow data when high permeability formations are encountered.

A series of options to manage saline water as it reports to the mine workings was identified and assessed during the development of the WMP. These options included, but were not limited to, physical barriers to cut off inflow, temporary and/or permanent storage in dedicated storage facilities, and an array of pumps and sumps to collect and transfer saline water. Potential saline water management options are listed in order of preference (from most preferred or applicable to least preferred or applicable) in Table 4.2-1, along with a discussion of the applicability of each option given the current mine plan.

Table 4.2-1. Saline Water Management Options Considered

Management Option/Location	Discussion of Applicability
Exhausted open pits (Umwelt, Llama, Goose Main, or other open pits)	A possible option if the future pit lake could be managed to support meromictic conditions, resisting turnover due to pit lake geometry, and therefore unlikely to result in a discharge of saline water to local freshwater streams. Currently, Umwelt Pit is expected to be developed as meromictic, but depending on the developing mine plan, all pits could be considered for the possibility of temporary or permanent saline water storage. In-pit tailings disposal in all pits would be prioritized over disposal of saline water. The use of exhausted open pits, along with mined-out underground workings, provide the most suitable permanent saline water disposal locations; however, the timing of saline water discharges, relative to the availability of either as permanent storage, may not match.
Closed U/G workings (Umwelt or other underground workings)	A possible temporary or final disposal option. It is noted that underground workings are the main source of saline water and could not be used for disposal until mining is completed. The use of mined-out underground workings, along with exhausted open pits, provide the most suitable permanent disposal locations; however, the timing of saline water discharges, relative to the availability of either as permanent storage, may not match.
Modified natural containment area (Llama Lake or Umwelt Lake)	A modified natural containment area (for example, Llama or Umwelt lakes) could be suitable as a temporary saline water storage area and could be used for permanent saline water storage as long as any overflow meets appropriate discharge criteria. A modified natural containment area is technically feasible and economically viable. Impacts to fish and fish habitat for use of Umwelt Lake and dewatering of Llama Lake have already been assessed (refer to Fish Out Plan [Sabina 2015, Volume 10, Chapter 21] for details). No additional impacts to fish or fish habitat would be realized as a result of using Llama or Umwelt lakes as modified natural containment areas. Llama Lake is the only natural containment area currently identified that provides the estimated required storage volume (approximately 1.1 M-m^3). Current water management planning identifies Umwelt Lake as the Saline Water Pond; it is the preferred temporary saline water storage area and could be used if inflow volumes are greater than anticipated.

(continued)

Table 4.2-1. Saline Water Management Options Considered (completed)

Management Option/Location	Discussion of Applicability
Tailings Storage Facility / Tailings Facility	Supernatant pond water from the active Tailings Storage Facility (TSF) or Tailings Facility (TF) will be reclaimed for the Process Plant. The Process Plant cannot easily tolerate the expected high salinity levels in the saline water, and as such, storing saline water in the active TSF/TF is not the preferred option. However, saline water may be sufficiently diluted in the supernatant pond to temporarily provide storage for limited periods (i.e., months), if required, and not upset the process. In addition, if the groundwater is of better quality than currently predicted, or salinity tolerances in the Process Plant are higher, saline water could be permanently stored with the supernatant pond. Once a TF is no longer used for Process Plant reclaim (i.e., tailings deposition moved to the next TF), the facility could be used to store saline water as long as an appropriate freshwater cover was maintained over existing tailings, and discharge criteria are met for overflows.
Man-made surface containment ponds	Similar to the modified natural containment area, man-made surface containment ponds could be constructed (or a current water management pond could be utilized) to temporarily or permanently store saline groundwater; this would be at a higher (than other options) cost and could increase the footprint of the surface disturbance within the Property. The man-made surface containment ponds would be designed and constructed to avoid additional impacts to fish or fish habitat.
Local watercourses following treatment	Saline groundwater could be processed in a reverse osmosis (or similar) water treatment process for discharge to the environment. Saline water treated to meet effluent discharge criteria acceptable to the NWB could be released to a local watercourse. However, such treatment produces a small volume of high salt brine that would require management and disposal.
Transport and disposal to Bathurst Inlet	Should on-site storage volumes be insufficient, saline water, or high salt brine from reverse osmosis treatment, could be transported to Bathurst Inlet and discharged via a diffuser. Should this option be required it is noted that significant additional regulatory requirements (including MDMER) may be required.
Physical barriers to cut off groundwater inflow	Current data suggest that permafrost and tight ground conditions will limit the volume of inflows. Use of physical barriers to cut off groundwater inflows prior to it reporting to the mine workings is a high cost measure, especially if used on a large scale, and is therefore not the preferred option for the Project. However, this option will be considered as an adaptive management measure to mitigate local, higher than expected inflows, if encountered.

The availability and applicability of the above options depend upon a number of factors, including timing (when the saline water will be generated relative to when the appropriate storage location is available), actual Project development schedule, the need for prioritizing the disposal of tailings over saline water, and the fact that, unlike solid mine wastes such as tailings or waste rock, saline groundwater can be temporarily stored more easily as it can be moved (i.e., pumped) to its final disposal location with relative ease.

Selection of the available permanent storage location for saline water is a function of current Project timing. As the Umwelt Pit will become available for storage in Year 3, this is the basis for selecting this location as permanent storage for saline water. In addition, this location is close to the temporary saline water storage in the former Umwelt Lake (called the Saline Water Pond [SWP]). The underground workings at Umwelt become available in the later years of the mine life and can be used to store any remaining saline water at that time, if necessary.

Should contingency measures for saline water storage in open pits or other above-listed storage locations be identified (other than what is currently captured in the mine plan), Sabina intends to provide the NWB at least 60 days' notice prior to implementation with the following: water disposal volumes, disposal timing, maximum pit/storage capacity, effects to pit closure, and appropriate mitigation and monitoring plans.

4.3 SALINE WATER POND DESIGN CRITERIA

The Saline Water Pond (SWP), in the former Umwelt Lake, was selected as the preferred alternative for the temporary storage of Project saline water before permanent storage capacity becomes available in Umwelt Pit. Details on the SWP design are provided in Section 6 of the WMP.

The SWP will have one containment dam located south end of the Umwelt Lake basin (WMP Figure A-11). The design event for the containment structures was defined based on a qualitative assessment of the risk level associated with overtopping or breaching of the structure. The SWP Containment Dam was assigned a “high risk” classification based on the consideration that discharge from these structures in the unlikely event of an overtop/breach would be directly into the environment; this consideration is consistent with overall Project design criteria.

In 2018, Sabina completed a geotechnical drill program at the Goose Property that included field characterization at the SWP location at that time (which has now been updated). In part based on this drilling, the decision was made to move the SWP Containment Dam slightly south of the previously proposed location, that appears more geomorphologically favourable (Figure A-26 of the WMP). Sabina will be conducting more field characterization studies in support of final design of the SWP, and further characterization, in the form of drilling and field percolation testing, will be carried out immediately prior to construction of the facility. The information from the field characterization will verify that the design meets the required intent of full containment of the saline water and will inform Sabina on the need for implementation of additional measures to provide containment of saline water. Information, including geological cross sections, collected in support of final designs of the infrastructure, will be provided to the NWB, and any additional information relevant to the design gathered during construction will be documented in the as-built drawings for the facility.

4.4 EXISTING GROUNDWATER MANAGEMENT CONTROL STRUCTURES

There are currently no existing groundwater management control structures in place at the Project.

4.5 SALINE WATER MANAGEMENT SCHEDULE

Table 4.5-1 outlines the timeline for key saline water management activities, including tasks and facilities. A detailed Mine schedule for overall Mine Water Management (e.g., building of culverts, berms, and containment dams) is presented in the WMP.

During Phase 1 (Construction), Umwelt Lake will be dewatered to construct the SWP. The SWP Containment Dam will be constructed before the pumped saline water level requires containment.

For Phase 2 (Operations), saline water from the Umwelt underground mine and the Llama Open Pit will be collected and pumped to the SWP. In Year 3, saline water from the SWP will be pumped at a rate of around 13,000 m^3/day to the bottom of Umwelt Reservoir (formerly Umwelt Open Pit). A freshwater cap will be generated from contact and non-contact runoff water, creating a meromictic (stratified) lake. In total, approximately 1.3 Mm^3 of saline water will be pumped into the Umwelt Reservoir. Saline water will also be pumped into the mined-out Umwelt Underground, after mining of Umwelt Underground is complete in Year 10.

Following the dewatering of the SWP, sediment in the basin will be tested, and removed, if required, to meet defined discharge water quality criteria; see Section 5.2 for additional details. The containment dam will be breached once water from the SWP area is deemed suitable for discharge.

Table 4.5-1. Overview of Saline Water Management Activities

Activity	Mine Year	Notes
Umwelt Lake is fished out in preparation for lake dewatering	-2	
Umwelt Lake is dewatered to Goose Lake to allow for construction of the Saline Water Pond.	-1	Portion of water is treated for TSS.
The Saline Water Pond is constructed.	-1	
Saline water from Umwelt Underground mine is pumped to the Saline Water Pond.	1	Approximately until end of Year 2, Q2
Saline water inflow from Llama Open Pit is pumped to the Saline Water Pond.	1	Approximately until end of Year 2, Q2
Saline water from the Saline Water Pond will be pumped to the bottom of Umwelt Reservoir to create a meromictic lake.	3	In total, approximately 1.3 Mm^3 of saline water will be pumped into the Umwelt Reservoir.
Saline water is pumped from the Umwelt Reservoir into the Umwelt Underground mine.	10+	Umwelt Reservoir volume currently conservatively assumes no saline water is pumped into the underground, which creates additional storage capacity of this facility.
Surficial soils in the footprint of former Umwelt Lake lakebed are excavated and placed in the Llama TF	4	Top 1-2m will be removed.
Decommissioning of Saline Water Pond Containment Dam	4	After dewatering of Saline Water Pond and removal of soils.

Source: Water Management Plan

5. Monitoring and Reporting Program

This section presents a summary of the saline water monitoring and reporting programs that will be carried out during Construction and Operations related to mine development water quantity and quality.

As part of effective mine water management, monitoring is important to verify the predicted water quality and quantity trends and conduct adaptive management should differing trends be observed. Monitoring will occur at three levels:

- Regulated discharge monitoring occurring at monitoring points specified in the approved Licence or regulations.
- Verification monitoring carried out for operational and water management purposes by Sabina. This monitoring data will not be reported to the Regulators in the Annual Water Licence Report but can be provided upon request by the Regulators.
- General monitoring included in the Licence requirements and subject to compliance assessment to confirm sampling was carried out using established protocols, including quality assurance/quality control provisions, and addressing identified issues. General monitoring is subject to change as directed by an Inspector, or by the Licensee, subject to approval by the NWB.

All three types of monitoring will be used at the Mine. Appendix B of the WMP presents the monitoring plan relating to water management during Construction, Operations, and Closure. More detailed information on the planned monitoring programs for the Project are provided in the Environment Management and Protection Plan (WL SD-20).

5.1 WATER QUANTITY

The volume of saline water being collected and transferred to and from the SWP will be measured using flow meters. This data will be supplemented by periodic seepage surveys which will record visually observed groundwater inflows in the open pits and underground mines. Measured groundwater inflow rates will be compared to model predictions on an annual basis. If significant variations from model predictions are observed, the assumptions behind the analysis will be reviewed and the analysis updated, if required. In addition, updates to the groundwater model may be required based on operational changes as the Project advances.

The prediction node PN04 will illustrate flows downstream of Umwelt Open Pit and the SWP.

5.2 WATER QUALITY

Saline water quality will be monitored in the SWP to assess the quality of groundwater flowing into Llama Open Pit and the underground workings. The Water Quality Monitoring for the Project (WMP Appendix B) provides information on proposed water quality sampling stations to be monitored. Saline water inflows from Llama Open Pit and underground mines will be monitored. The proposed BRP-11 monitoring station at the SWP will be used monitor the quality of water in this pond. Refer to WMP Appendix B, Table B-01, Figures B-01 and B-02 for exact location of monitoring stations.

To understand and plan for treatment requirements at surface, if deemed necessary, water accumulating in sumps underground will also be sampled on a monthly basis prior to recirculation for underground use or pumping to the SWP.

Water quality results will be compared to regulated water licence requirements, Metal and Diamond Mining Effluent Regulations (MDMER; Canada Gazette 2017), Canadian Council of Ministers of the Environment (CCME), and Site-Specific Water Quality Objectives guidelines.

Sabina notes the potential for chloride concentrations within sediments encountered at the bottom of the Saline Water Pond, once the saline water has been removed. Sabina has identified a number of mitigation measures to reduce chloride concentrations within the sediment, including removal of sediments for disposal within Llama TF. Sabina will track sediment and pore water chloride concentrations for the SWP in order to ensure appropriate water quality for the reconnection of Umwelt Lake to surface waters. A target chloride concentration of 120 mg/L (following the CCME guideline for the Protection of Aquatic Life) would be achieved at the receiving environment (defined as per the *Fisheries Act*).

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

5.3 THERMAL CONDITIONS MONITORING

The potential effect of the underground operations to the permafrost thermodynamics and hydrogeological system will consist of minor local modification of the thermal regime at the vicinity of the underground workings and a mobilization of frozen groundwater into the regional system.

During Operations, the underground workings will be backfilled progressively with waste rock and the groundwater encountered at depth will be pumped to the SWP (or Umwelt Reservoir) at surface. Once mining and backfilling are complete, the saline water stored in the SWP will be pumped into the remaining underground void space. As water saturates the mined-out areas, the heat will transfer to the surrounding permafrost and generate local thawing of the frozen ground surrounding the workings. The underground areas will be expected to freeze back where the minimum ground temperature is less than -2°C (above ~350 mbgs depth). However, it is possible that parts of the underground areas will not completely freeze back due to the large latent heat requirements combined with relatively warm permafrost temperatures at depth.

The underground mines are in competent rock and the structural stability of this bedrock does not rely on permafrost. The Project mine design parameters for the permafrost and talik zones are identical demonstrating that the structural integrity of the mines does not rely on presence of permafrost. There are therefore no concerns that permafrost thawing would lead to subsidence at surface. Pending final engineering designs and additional field characterization, Sabina will review and assess the requirements associated with thermal conditions monitoring. Sabina will undertake verification monitoring if needed.

6. Quality Assurance/Quality Control Procedures

Quality Assurance refers to plans or programs that encompass a wide range of internal and external management and technical practices designed to ensure the collection of data of known quality that matches the intended use of the data. Quality Control is a specific aspect of Quality Assurance that refers to the internal techniques used to measure and assess data quality.

Quality Assurance and Quality Control specific guidelines for the Project are provided in the Quality Assurance / Quality Control Plan (WL SD-24). These guidelines will equally apply to the saline water management structures and the saline water monitoring program.

7. Adaptive Management

The mine design, including the management of saline water, 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 were limited, conservative assumptions were consistently applied. While there is a high level of confidence that the plans are viable and realistic, it is understood that mining activities are by nature inherently uncertain. Therefore, additional mitigation or adaptive management may be required as an outcome of monitoring activities described in Section 5. This may include changes to saline water management as a result of operational, engineering, and/or environmental monitoring. Any additional mitigation or adaptive management that is found to be required will be implemented in a timely manner.

Possible upset scenarios, and contingency strategies to address, are outlined Table 7-1.

Table 7-1: Saline Water Contingency Strategies

Possible Scenario	Contingency Strategy
Saline inflow volumes into the mine workings are greater than expected.	Modification and/or adjustment of the mine plan to avoid areas of concern, or to use mined-out underground stopes to provide surge capacity. Additional sump capacity to handle higher than predicted inflows. Pre-grouting of highly conductive structures prior to intersection with the mine workings. Isolation of mining sections with bulkheads to control or minimize mine inflows. If the average long-term groundwater inflows are higher despite these measures, the meromictic lake in the Umwelt Reservoir has extra capacity for saline water storage. Additional storage locations could be identified, blending of saline water with other contact water may be investigated, or treatment to desalinate the water may be required.
Water quality in the Saline Water Pond does not meet wildlife guidelines and wildlife (such as migratory waterfowl or caribou) are found to be using the pond or drinking from the pond.	Wildlife will be excluded from the ponds following an adaptive management approach.
Underground mining operations cease prior to the underground deposition of the required volume of saline water from the Saline Water Pond.	Additional storage locations will need to be identified, or treatment to desalinate the water may be required. If necessary, the meromictic lake in the Umwelt Reservoir has extra capacity for saline water storage.
Chloride sediments are encountered at the bottom of the Saline Water Pond once the saline water has been removed.	Sediments will be excavated and deposited in Llama Tailings Facility (TF). Alternatively, the base of the dewatered SWP could be washed down with freshwater and the rinse water will be pumped out. If necessary, this rinsing method would be repeated until the salinity of the rinse water is acceptably low (i.e., chloride concentration of 120 mg/L or less).
Water quality within the re-watered Umwelt Lake does not meet the requirements (Section 5.2) at the time of release.	Additional water treatment may be necessary.

The SWMP is part of a continually evolving process that relies not only on the efficacy of data collection and analytical results, but is also dependent on feedback from the communities, government, Indigenous groups, and the public. Having an adaptive and flexible program allows for appropriate and necessary changes to the design of monitoring studies, and the mitigation and monitoring plans. Some changes may come about through the observation of unanticipated effects or inadequacies in the sampling methods to detect measurable effects. Other changes may result from ecological knowledge acquired through working with Indigenous community members and discussions with Elders, both in the field and through workshops.

The SWMP will be reviewed on a regular basis to incorporate lessons learned, major changes to facility operation or maintenance, and environmental monitoring results relating to the management of saline water at the Project. Any updates will be filed with the Annual Report submitted under the Type A Water Licence (2AM-BRP1831), unless otherwise directed by the NWB.

8. Reclamation

The majority of the SWP closure activities will occur as progressive reclamation with the remainder occurring in the Closure Phase. The SWP will be dewatered to the Umwelt Reservoir using separate pumping and pipeline infrastructure during Operations. In addition, a portion of saline water stored in Umwelt Reservoir will be pumped back into the Umwelt Underground as part of closure of this facility.

Once the SWP has been dewatered, sediments will be tested and if the chloride content would be considered to be too high to achieve Site-specific Water Quality Objectives and/or CCME guidelines for the Protection of Freshwater Aquatic Life when the facility was re-watered, these sediment would be removed and placed in the Llama TF. Based on average hydraulic conditions, the Llama TF will take approximately six years to fill with water (i.e., the facility is expected to overflow in Year 11). Therefore, SWP sediments placed in the Llama TF will have six years to settle prior to overflows from the facility are anticipated. This is considered a sufficient length of time for the sediments to settle; however, the water will be tested prior to overflow, and treatment for suspended sediment will be implemented if necessary.

Once the water in the re-watered SWP meets Site-specific Water Quality Objective and/or CCME guidelines for the Protection of Freshwater Aquatic Life, the SWP Containment Dam will then be breached allowing Umwelt Lake to re-establish.

Additional details pertaining to reclamation and closure are provided in the Interim Closure and Reclamation Plan (WL SD-26).

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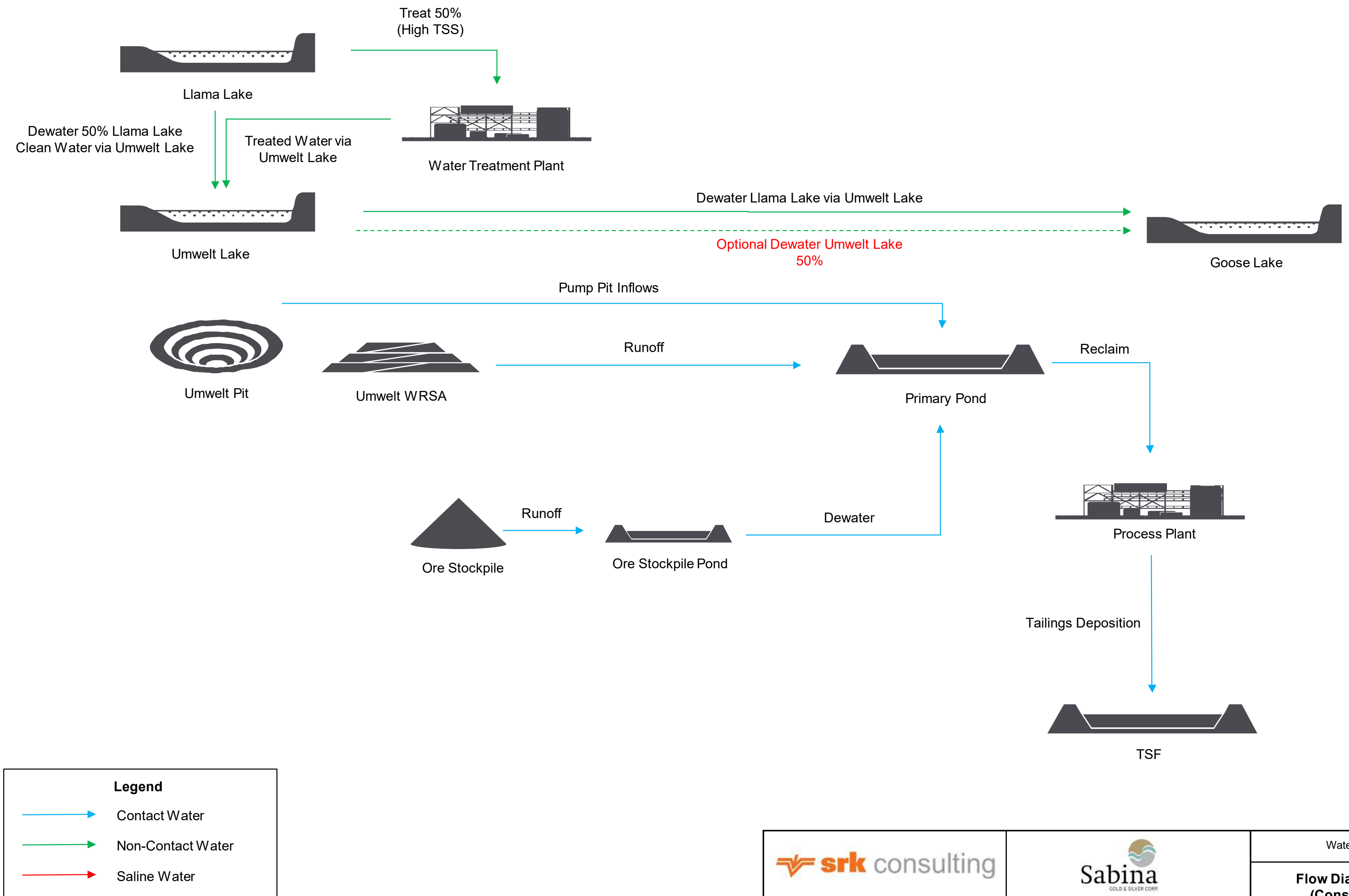
Appendix D. Water Management Flowsheets



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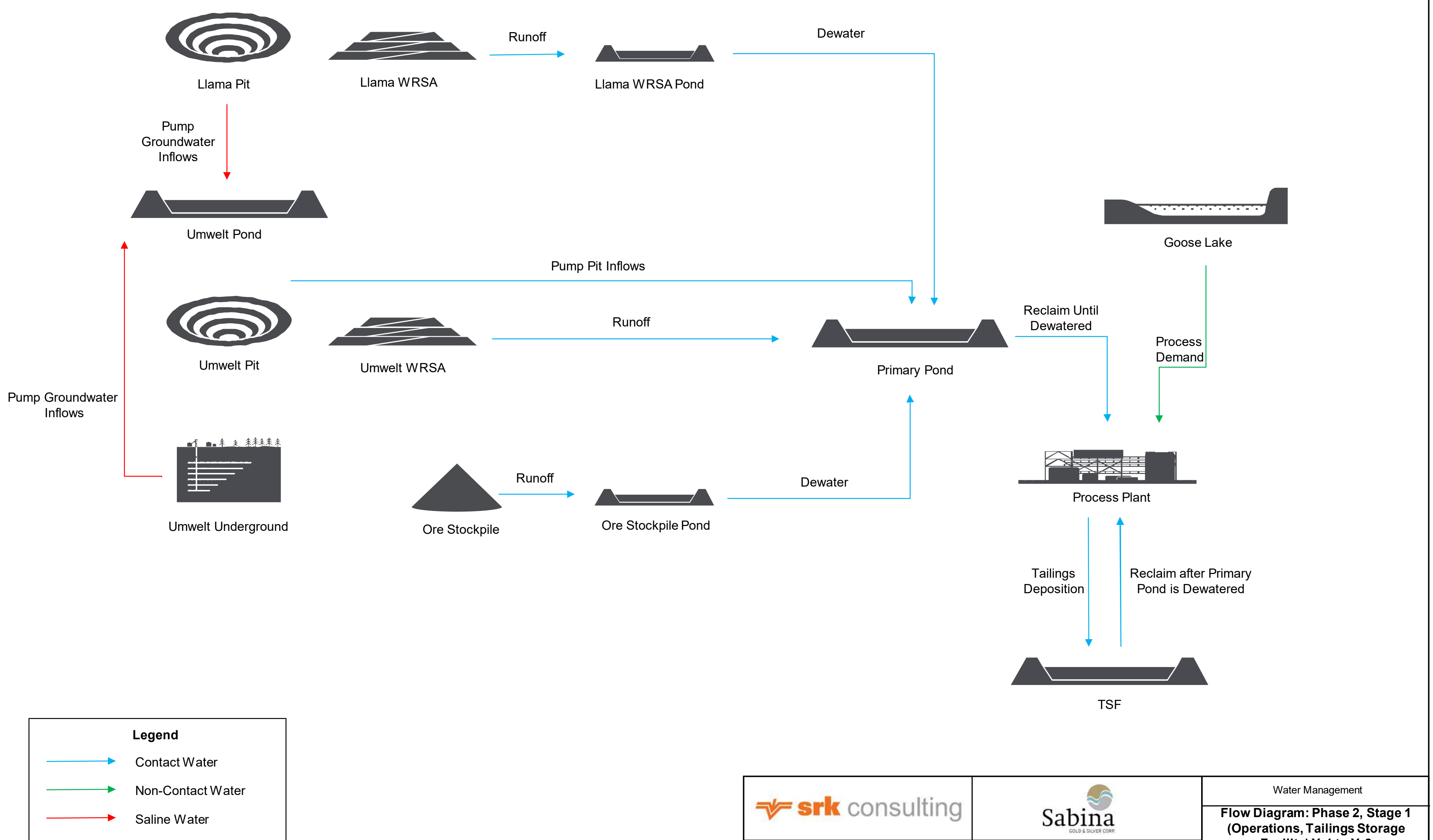

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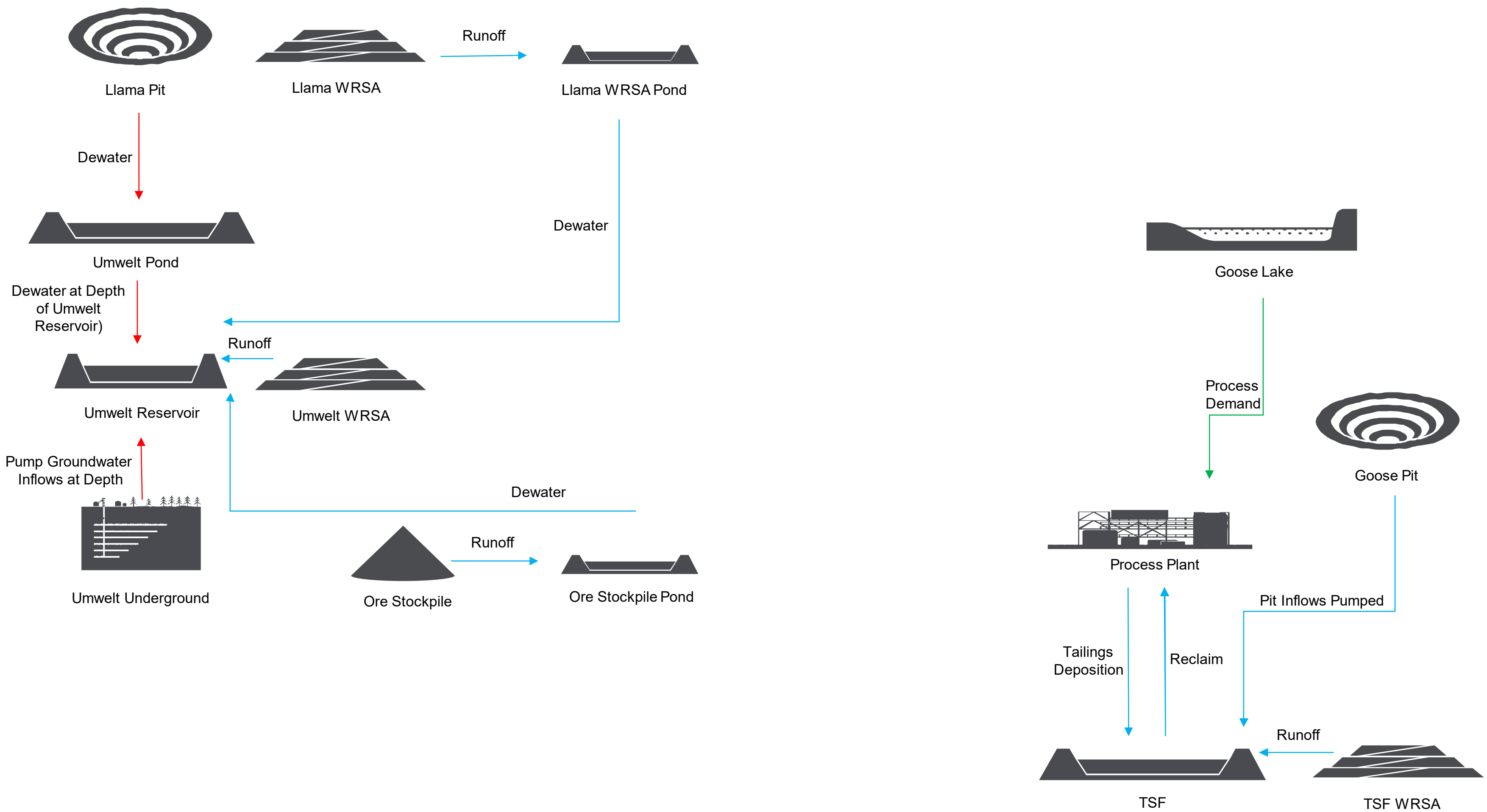

Legend

- Contact Water
- Non-Contact Water
- Saline Water

Water Management	
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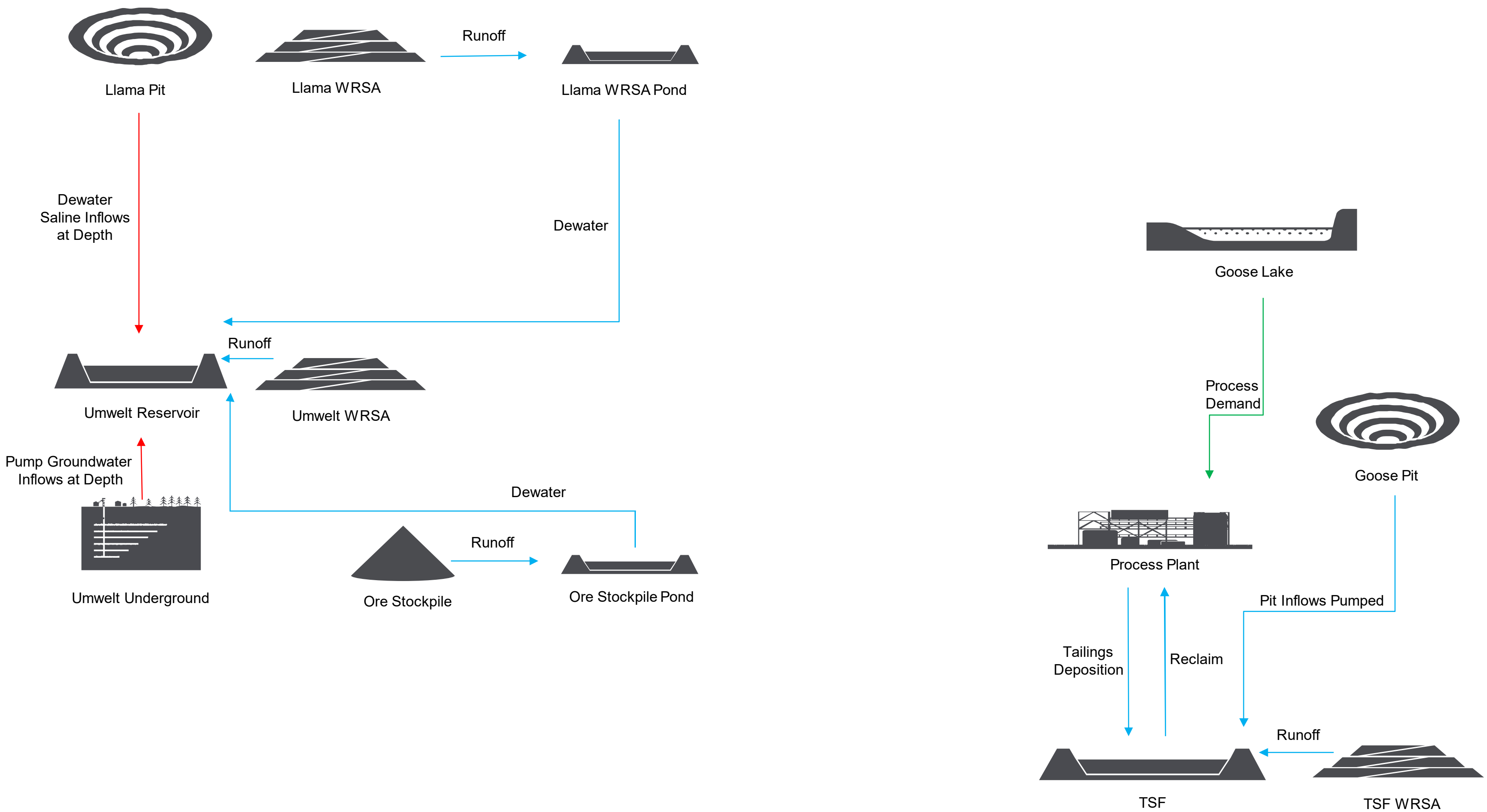

Legend

- Contact Water
- Non-Contact Water
- Saline Water

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Flow Diagram: Phase 2, Stage 1 (Operations, Tailings Storage Facility) Yr4 to Yr 5

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Back River

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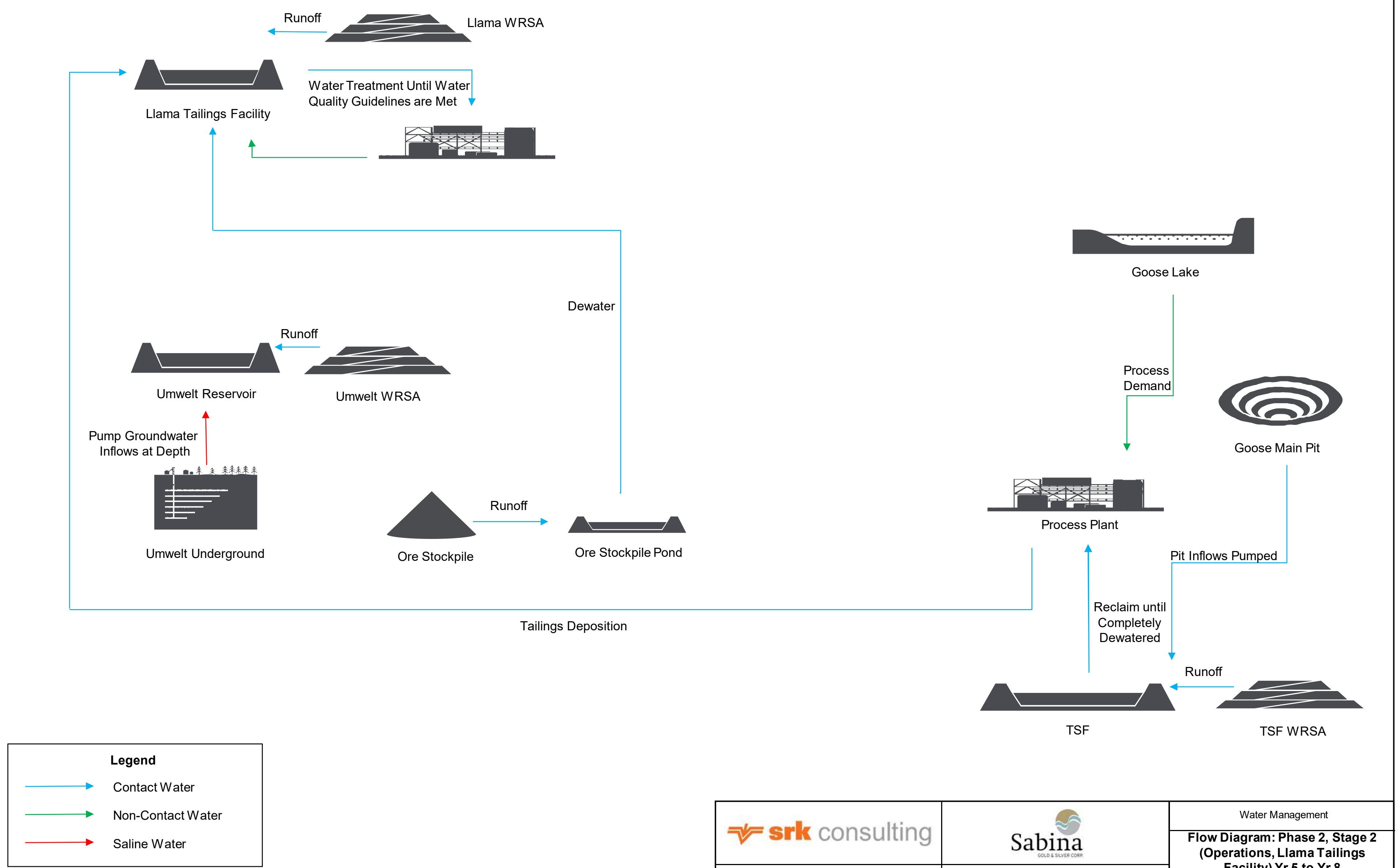

srk consulting	Sabina	Water Management
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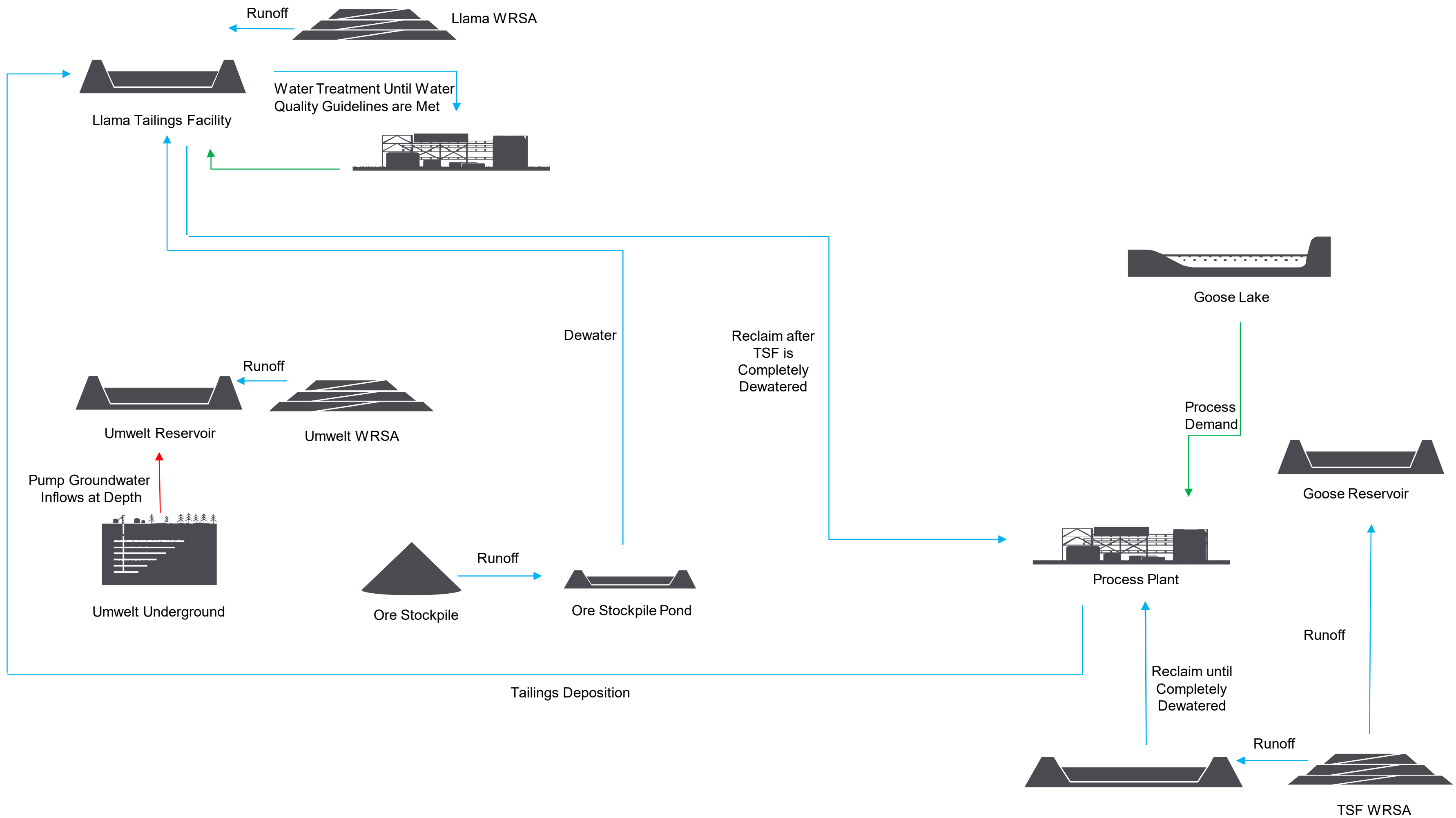
Date: 2019-05-03 | Approved: MGS | Figure: 5



Legend

- Contact Water
- Non-Contact Water
- Saline Water

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Job No: 1CS020.016

Filename: BackRiver_WaterMgmt_FlowDiagram.pptx

Back River

Water Management

Flow Diagram: Phase 2, Stage 2 (Operations, Llama Tailings Facility) Yr8 to Yr12

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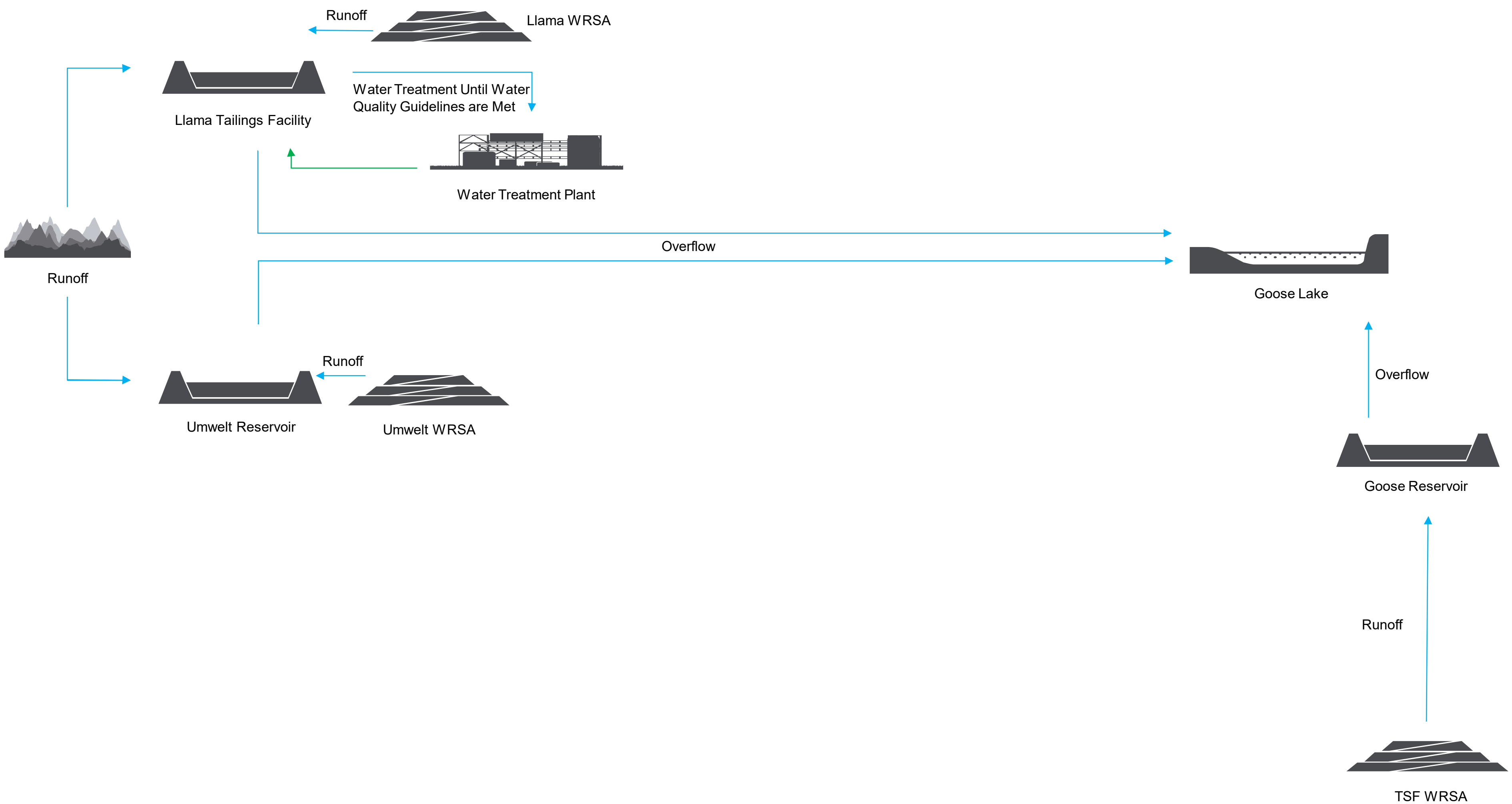

Legend

- Contact Water
- Non-Contact Water
- Saline Water

srk consulting	Sabina GOLD & SILVER CORP.	Water Management
		Flow Diagram: Phase 3-4 (Closure and Post-Closure) Yr13+
Job No: 1CS020.016 Filename: BackRiver_WaterMgmt_FlowDiagram.pptx	Back River	Date: 2019-05-03 / Approved: MGS / Figure: 8

Appendix E. Water and Load Balance Report

(Pending – to be provided)