BACK RIVER PROJECT

GOOSE LAKE TOTE STORAGE FACILITY DESIGN & CONSTRUCTION SUMMARY MEMO

DATE

31 December, 2024

REFERENCE

Type A Water License (2AM-BRP1831 Amendment No. 1)

DOCUMENT DETAILS

PROJECT NAME	Back River Project
DOCUMENT TITLE	Goose Lake Tote Storage Facility Design & Construction Summary Memo
REFERENCE NUMBER	B2Gold Nunavut Type A Water Licence (2AM-BRP1831 Amendment No.1)
Date	31 December, 2024
Version	1.0
Author	B2Gold Nunavut & SRK

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1. INTRODUCTION

The Back River Project (Project) is a gold project located within the West Kitikmeot region of south-western Nunavut. It is situated approximately 400 kilometers southwest of Cambridge Bay, 95 km southeast of the southern end of Bathurst Inlet, and 520 km northeast of Yellowknife, Northwest Territories. This project is located predominantly within the Queen Maud Gulf Watershed (Nunavut Water Regulations, Schedule 4). The Project is comprised of two main areas with interconnecting winter ice roads: Goose Property and Marine Laydown Area (MLA), which is situated along the western shore of southern Bathurst Inlet.

Goose property started to be developed in 2017. In 2024 it is still in a developing state with expected first pour (first gold) date of Q2 2025. The Project is currently accessed and supplied, using a combination of both seasonal winter roads and all-weather airstrips at the Goose Site. It is a requirement at the Back River Project to provide secondary containment for fuel and chemical storage as required by applicable standards and acceptable industry practice.

2. GOOSE TOTE STORAGE AREA

This Goose Tote Storage Area memorandum has been laid out to address each of the requirements of Part D, Item 3 of Sabina's Back River Project Type A Water Licence (2AM-BRP1831 Amendment No. 1). For ease of comparison, each subheading corresponds directly with the identically alphabetized subheading of Part D, Item 3 of Water Licence, 2AM-BRP1831.

A) DESIGN RATIONAL, REQUIREMENTS CRITERIA, PARAMTERS, STANDARDS, ANALYSIS, METHODS, ASSUMPTIONS AND LIMITIATIONS

A summary of design criteria used for the Goose Tote Storage Area is provided in Table A-1.

Table A-1: Tote Storage Area Design Criteria

Item	Value	Notes
Containment Volume	Set to be in excess of 100% of the largest vessel being stored plus 10% of all other vessels / containers	Best Management Practice (BMP) and in consideration of tank farm storage criteria. Containment established through a liner system (HDPE sandwich between two non-woven geotextile) and site containment berms (to form a bunded area). For general layouts 330 gallon chemically resistant tanks surrounded by a galvanized steel cage, with plastic pallets at the base were used for layouts. This was the general assumed style and size for the oil or lubricant "totes". The footprint of each tote is therefore around 1.25m^2 (approximate tote dimension of 48 x 40 x 53") Other codes also consulted and considered: • Canadian Council of Minister of the Environment. Code of Practice for Used Oil Management in Canada (CCME-TS/WM-TRE006E • Canadian Environmental Protection Act. Storage Tank Sytems for Petroleum Products and Allied Petroleum Products Regulations (SOR/2008-197) • Canadian Council of Minister of the Environment. Environmental Code of Practice for Above Ground Storage Tank Systems Containing Petroleum Products (PN1148 – specifically section 3.7)
Environmental Setback	Minim 31m setback from waterbodies, 50m setback where possible	In the case of the Goose tote storage area, the facility was placed well in excess of these minimum set-backs (notable distance up slope and away from Goose Lake etc..).
Rainfall / Storm Runoff	1:100 year 24hr Event	Best Management Practice (BMP) For Goose the 1:100 year, 24hr runoff is in the range of ~74.5mm For Goose the average maxim daily snowmelt around this area is typically in the range of 28mm The above was taken into consideration when designing the storage capacity. Also with the operation consideration that the seasonal floods for this area are typically snowmelt driven and typically occur in early to mid summer (more around June).
Base Slope	Based of the containment area graded towards one 'sump location'	Targeted minimum base slopes for the facility that were 0.5% or greater
Design Vehicle	CAT 962 Loader or Equivalent	A minimum 0.6m overliner thickness has been specified to ensure protection of the liner system and to allow for some flexibility in the design vehicles operating in and around this Tote Storage Facility.

The layout for the Goose Tote Storage Area has proactively included additional storage area and volume (beyond the minimum design criteria) to allow for improved operational layouts, to accommodate additional snow and rain allowances, and to help with ongoing maintenance and operations. The grading of the base will further assist with management of melt water and direct precipitation in the facility.

With the layout presented in the attached Issued For Permit (IFP) drawing (Appendix A) a total of around 800 totes could fit within this facility. This assumes that the average tote has a base area around 1.25m^2

and assumes the totes are single stacked (see Table A-1 for additional details on the design criteria). Additional totes could be placed into this facility later, if they are double stacked. The proposed tote storage facility size allows for increased operational flexibility and allows for movement of or access to and around the totes. With the current layout, the totes would be stored with a typically 15m or greater offset from existing buildings. Further, for improved snow clearing, access and operational flexibility, a 5m offset from the toe of the bunded area to the primary tote storage area, has been included in the designs. The current design, and current plans for this facility, is that this storage will be primarily used for lubricants and oils (i.e. not for reagents).

To protect the liner system 0.6 m or greater of overliner sand, or manufactured crush material (called bedding material in the technical specifications), will be placed over the liner for trafficability and for liner protection. An overview of the typical liner system is presented in the schematic below. Additional details on the Goose Tote Storage Area layout is provided in Appendix A.

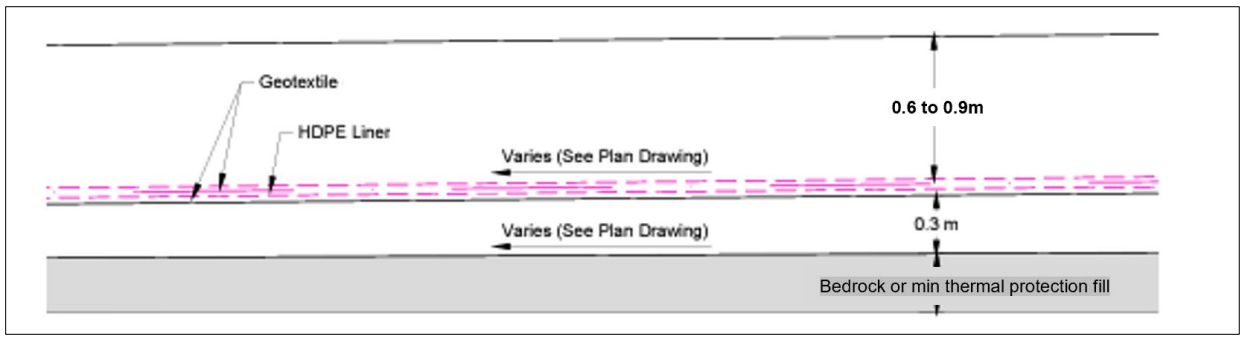


Figure - Overview of liner system used in the Tote Storage Area designs.

B) SITE SPECIFIC DATA AND ANALYSIS TO SUPPORT THE DESIGN AND MANAGEMENT DECISIONS

An overview of the completed site inspection and investigation for the Goose Tote Storage Area is provided in Appendix B.

An initial site inspection was completed by SRK Consulting in September 2024 to assist with preparing the initial facility layouts. A drilling campaign (seven drill holes) was then later complete, in December 2024, to confirm the foundation characteristics. This site inspection and investigation information was ultimately used to confirm and support the final Goose Tote Storage Area permitting designs that are presented in this memo.

C) GEOCHEMICAL ANALYSIS OF WASTE ROCK AND FILL, DEMONSTRATING THEIR ACID ROCK DRAINAGE AND METAL LEACHING CHARACTERISTICS

B2Gold Nunavut is committed to using only non-potentially acid generating (NPAG) rock for the construction of the Goose Tote Storage Area. A summary of the required geochemical segregation criteria and requisite confirmatory sampling from the Type A Water Licence Amendment (2AM-BRP1831 Amendment No. 1) is provided below. Additional information can be found in the Type A Water Licence (2AM-BRP1831 Amendment No. 1) associated documentation: Borrow Pits and Quarry Management Plan (QMP), Mine Waste Rock Management Plan (WRMP), and Geochemical Characterization Report (Main Application Document [MAD] Appendix E-3).

The criteria that will be used to classify NPAG material to be used for construction from any quarry source will be an neutralization potential/acid generation potential (NP/AP) ratio of greater than 3, or a sulphur content of less than 0.15% (Table C- 1). The classification criteria presented below is supported by the results of ABA, net acid generation (NAG) testing, and kinetic testing, and provides an appropriate level of conservatism; additional details on these testing programs and criteria rational is described in the Geochemical Characterization Report (MAD Appendix E-3)).

Table C-1: Site-Specific Geochemical Classification Criteria

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

D) CONSTRUCTION METHODS AND PROCEDURES REGARDING HOW INFRASTRUCTURE WILL BE PUT IN PLACE, INCLUDING QA/QC MEASURES AND EQUIPMENT TO BE USED

A Permit Drawing (IFP drawing GTS-01) for the Goose Tote Storage Area can be found in Appendix A. Construction procedures, quality control and quality assurance measures are outlined in the site earthwork technical specifications document (a copy provides as Appendix C). In the technical specifications document (Appendix C) Section 5 (subsection 5.1, 5.2.3, 5.2.6, 5.3, and 5.4), Section 6 (6.1, 6.2.1, 6.2.2, 6.2.4, 6.2.6, 6.2.9) and Section 7 are the primary sections related to this work.

E) TECHNICAL SPECIFICATIONS FOR SEDIMENTATION, EROSION CONTROL AND BANK STABILIZATION MEASURES, INCLUDING PROPOSED MATERIALS, LOCATION AND EXTENT, PLACE METHODS AND QUANTITIES REQUIRED

If necessary, and dependent on seasonality, the following sediment and erosion control measures will be adhered to during the construction of Goose Tote Storage Area; refer to the Type A Water Licence Road Management Plan (2021) for additional details.

- The area of landscape disturbance will be minimized, and restoration will occur as soon as possible in order 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 any waterbodies.
- Regular inspection and maintenance of erosion and sediment control measures and structures will be conducted during the course of construction.
- The Goose Tote Storage Area is provided with an impermeable liner and the finished surface is gravelled surface. Any runoff from the containment area will be released in a controlled manner only after the runoff has been sampled and complies with the discharge criteria outlined within the Type A Water Licence Amendment (2AM-BRP1831 Amendment No. 1).

Construction of Goose Tote Storage Area is expected to take place within the already disturbed footprint of the Goose Mine Site and undisturbed areas are expected not to be affected. Following the construction works, inspections and monitoring will be performed prior to, and during the spring freshet. Inspections will include visual assessments for erosion and sedimentation for the duration of the spring freshet.

F) TIMETABLE FOR SUBMISSION, INCLUDING DATE OF CONSTRUCTION AND PROPOSED DATE OF COMMISSIONING OF INFRASTRUCTURE; AND

Construction of the Goose Tote Storage Area is planned to occur in the summer season of 2025 to allow for optimal conditions for material placement and compaction. The construction duration will take approximately 8 weeks to complete; construction through commissioning.

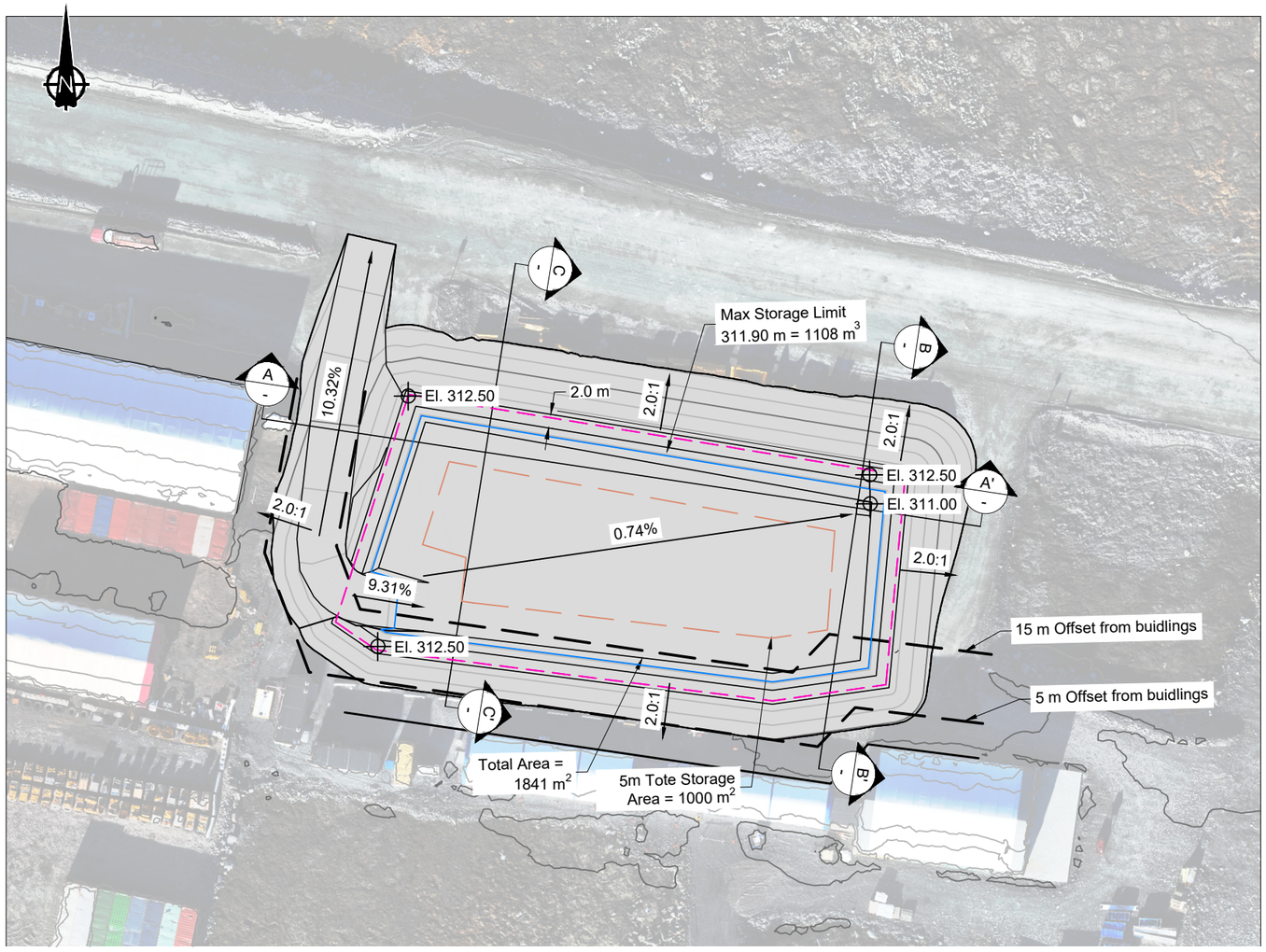
B2Gold Nunavut will submit to the NWB for review, within ninety (90) days of completion of the Goose Tote Storage Area, a Construction Summary Report in accordance with Schedule D, Item 1 of the Type A Water Licence (2AM-BRP1831 Amendment No. 1).

G) WHERE REQUIRED, SIGNATURE AND SEAL BY THE APPROPRIATELY QUALIFIED ENGINEER

Permit drawings (GTS-01) for the Goose Tote Storage Area can be found in Appendix A and an overview of the completed foundation investigation is found in Appendix B.

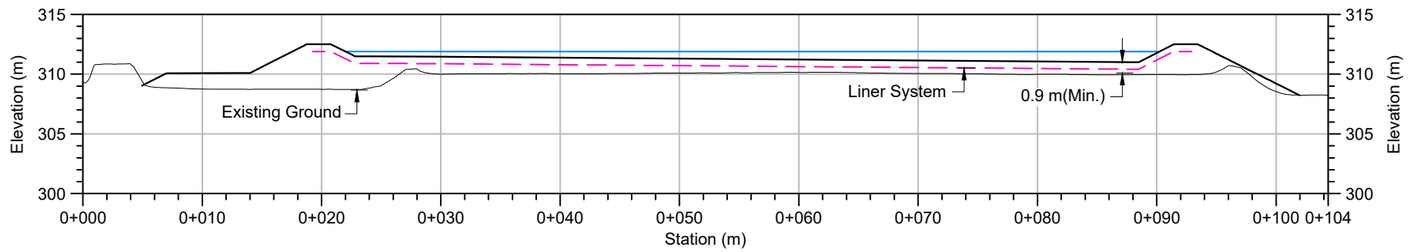
APPENDIX A ISSUED FOR PERMIT LAYOUT DRAWING (GOOSE TOTE STORAGE AREA)

Issued For Permit - Revision A

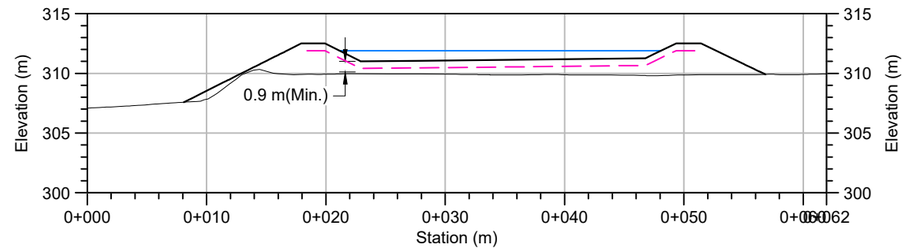


Plan

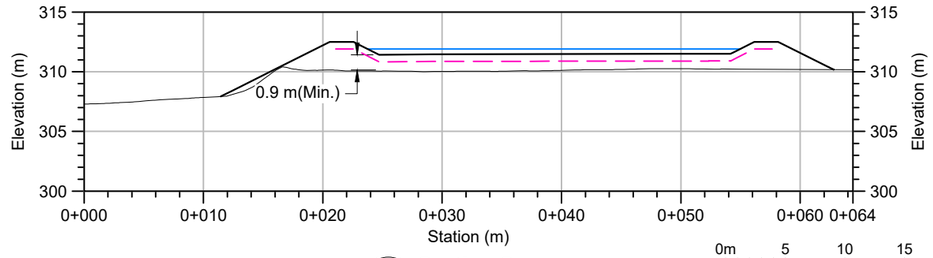
0m 10 20 30



A - **Section A**



B - **Section B**



C - **Section C**

0m 5 10 15 20

LEGEND

- Design Top
- Containment Storage Level
- Design Surface

NOTES

1. All units are in meters unless otherwise specified.
2. Contours are shown at 1.0 m intervals.
3. All slopes are 2.0:1 unless otherwise specified.

REFERENCES

NAD83 UTM Zone 13.
Aerial Imagery and Surface derived from 20240930 Drone Survey.

MATERIAL QUANTITIES

Fill	6780 m^3

All quantities presented are to neat-lines and do not allow / account for bulking, compaction, overlaps or material losses.

PERMIT TO PRACTICE
SRK CONSULTING (CANADA) INC.
Signature
Date 2024/12/31
PERMIT NUMBER: P 255
NT/NU Association of Professional Engineers and Geoscientists

REGISTERED PROFESSIONAL ENGINEER
J.B. KURYLO
LICENSEE
2024/12/31
NT/NU

srk consulting

SRK JOB NO.: CAPR003105
FILE NAME: W-Tote Storage Pad Op7C.dwg

B2GOLD

Back River

Issued For Permit

Goose Tote Storage Area
Plan View and Sections

DATE:	APPROVED:	FIGURE:
20241230	JBK	GTS-01

C:\Users\sepp\SRK Consulting\FS203 Back River (Goose and MLA) - 1040_AutoCAD\ACAD_C3D\CAPR003105_WaterMgmt_Design\Portal Site\Tote Storage\W-Tote Storage Pad Op7C.dwg

APPENDIX B SITE INSPECTION AND INVESTIGATION LETTER

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Revision 00
To: Ben Scott
Cc: Clinton Wakefield

Project: CAPR003100
December 31st, 2024

Subject Back River – Goose Tote Storage Facility - Foundation Checks and Site Inspection – Interim Letter

1 Introduction

SRK Consulting (Canada) Inc. (SRK) was contacted by B2Gold Corp (B2Gold) to perform a trade-off study and conduct a geotechnical site inspection for the Lubricant Tote Storage Facility at the Back River Project (Project). The Project is a proposed gold mine located in the territory of Nunavut, roughly 525 km northeast of Yellowknife. The focus of the inspections and checks was for a current area of active development at the Goose project site (Goose). The Goose area is located approximately 160 km south of Bathurst Inlet.

SRK is currently working on a more formal technical memorandum that summarizes and overviews the finding of this recent site visit, inspection, and data checks. Finalization of the technical memorandum will require laboratory testing data and results to be received (in progress at the time of this letter). In the interim this letter is being written to provide an update, and to overview some of the draft working notes and preliminary observations from the recent site visit. The notes and comments in this letter will be reviewed and updated as appropriate when additional survey data, lab testing and photographs are reviewed in January 2025. Following this, a final inspection memo will be prepared.

The focus of this interim update letter is only for the Lubricant Tote Storage Facility foundation checks.

These initial site checks were found to be sufficient to confirm the Issues for Permit (IFP) Tote Storage Facility layouts were appropriate to be submitted for permit and regulatory approval. The final inspection memorandum is expected to have very similar information as to what is outlined in this interim letter, but with additional information and further documentation of the subsurface conditions included. The final version of the Goose Tote Storage foundation and site inspection memo would be planned to be included in, and as part of, the as-built reporting package for this facility (to be submitted after the facility has been constructed).

2 Overview of Site Visit

A site visit and geotechnical inspection was carried out by SRK for the Lubricant Tote Storage Facility area. John Kurylo, MSc, PEng (registered in Nunavut), visited the Lubricant Tote Storage Facility area when on site in September 2024. Following this September site visit initial layouts and trade-offs for the Tote Storage Facility were prepared, discussed, and overview with input from B2Gold. From December 17th to December 27th, 2024 an additional site visit was completed by SRK. This secondary site visit specifically targeted the completion of some subsurface investigation locations at the proposed Goose

Tote Storage Facility area. This secondary site visit was completed by Anna Timchenko, PhD, EIT under the direct supervision of John. This letter presents the interim findings of these site geotechnical inspections and investigations conducted by SRK Consulting. The overview of the inspected and investigated area is presented below in Figure 1.

Figure 1 – Overview of the inspected and future area of the Goose Tote Storage Facility

During the completed inspections the following scope of work was done (linked to the Goose Tote Storage Facility area):

1. Goose Tote Storage Facility
   - Visual observation of the current Pad slopes
   - Visual observation of the engineering fill quality used for the Pad construction
   - Visual observation of the Lubricant Tote Storage Facility foundation at the toe of the Pad slopes

- Drilling of seven (7) geotechnical boreholes to obtain: the thickness of the Pad, thickness of the overburden layer and depth of the bedrock.
- Collection of grab samples of the fill and overburden material.

2. General
   - Photograph logs
   - Laboratory testing (primary indicator or index geotechnical testing).

3 Available Information

3.1 Previous Investigation Programs

Based on review of the available data there was limited information at or around the proposed Goose Tote Storage Facility area. The primary investigation programs, that were previously completed, were focused primarily on areas that were adjacent to the Underground Portal and Plant Sites. The most relevant past (previously existing) subsurface information is overviewed in Table 1 below.

Table 1: Available Drilling Information

Date	Area	Investigation Type	Installations	Laboratory/In-Situ Testing	Reference
March to April, June 2015 [1)]	Goose Property, MLA	36 drill holes at Goose Property (3 at plant site, 9 water management holes, 3 at other planned infrastructure locations, 1 under Llama Lake, 20 at TSF); 11 drill holes at MLA (spread across the Freight and Fuel Storage, Camp, and Laydown Areas); 4 hand-dug test pits at in the MLA Fuel Storage Area	10 thermistors at the TSF	Indicator testing (PSD, water contents, specific gravity, Atterberg limits, in-situ density), pore water salinity, direct simple shear, consolidation, concrete aggregate, groundwater quality	SRK (2015)[2)]
April 2017 [1)]	Goose Property	29 drill holes at Goose property (Plant Site)	-	Soil Index Testing (PSD, water content, Atterberg limits), Thaw Consolidation Testing, Point Load Testing, UCS, Specific Gravity Testing	Golder (2017)[3)]
2018 [1)]	Some additional overburden drilling was completed in 2018 by SRK at the main water infrastructure site at Goose Property.				
July 2021 [1)]	Goose Property Tank Farm	10 test pits	-	NA	SRK (2021, Summary presentation, D. Godley)

Notes:

[1] Investigation program data was used in the current work.

[2] REF: SRK (2015) Goose Property - 2015 Overburden Geotechnical Investigation Program. Project 1CS020.009. December 2015

[3] REF: Golder Associates (2017) Geotechnical Factual Report Winter 2017 Program. SBR5GAL-G-RPT-001_r0, July 7, 2017

Figure 2 provides an overview of past available geotechnical investigation data. Note that the red lines show the approximate location of the future proposed Goose Tote Storage area.

Figure 2 – Past geotechnical investigation locations; west of the proposed Tote Storage Facility

3.2 Available Survey Data

A drone survey from September 30th, 2024 and December 21st, 2024 were provided by B2Gold and used to look at aerial imagery and elevations of the existing pad. In addition to this survey data, SRK had access to pre-mining LiDAR topography information. No ground survey information was available for each lift of fill material that was placed, only survey information for the final and existing pad surface.

4 Current Conditions

The pad where the Goose Tote Storage Facility is planned to be built on, is situated in the west of the Underground Portal and Maintenance Shop site. This pad was constructed mainly using blast rock; specifically Run of Quarry (ROQ) material, potentially with some levelling fill from suitable Run of Mine

(ROM) material. B2Gold has indicated that this material is geochemically suitable (e.g., non-potential acid generating or neutral pH metal leaching). It is SRK's understanding that B2Gold has an on-site laboratory that performs acid-based accounting to ensure that no acid-generating material is used for construction. Further it was communicated that B2Golds standard protocol involves testing 20–30 samples per 100,000 tonnes of rock, typically with a minimum requirement of 8 samples per pattern. No geochemical checks or geochemical data review were completed on any of the fill material by SRK as part of this scope of work (these checks completed by and on site).

In general, the thickness of the ROQ varies from 0.5 meters in the southern part of the Pad to up to 3.6 meters in the northern part. The ROQ material was placed directly on top of the tundra. This approach is consistent with general earthworks at the Back River site as removal of the top tundra mat can further and more rapidly degrade and thermal properties of the foundations. The average outside slope of the Pad is currently approximately 1.8H:1V to 2H:1V in most areas. During visual inspection of the pad slope, it was observed that the ROQ material contained some overburden material content (blasted rock with some overburden inclusions in areas). The top approximately 0.5 to 1.0 meters of the existing Pad however was noted to be fairly clean blast rock with no or very low overburden content.

5 Geotechnical Investigation

Due to the considerable thickness at the north side of the existing pad, and from the necessity to obtain geotechnical information about the foundation soils below, it was decided to drill seven boreholes to give adequate spatial coverage over this area. Figure 1 presents an overview of the drillhole locations. A short summary of the performed site investigation is presented in Table 2.

Table 2: Summary of the performed site investigation

Drillhole ID	Coordinates		Elevation (masl)	Location	Date	Total Depth (m)	Drillhole bottom elevation (masl)	Depth to bedrock (m)	Bedrock elevation (masl)	Preliminary Profile	
	Northing	Easting									
BR24-GTS-DH01	7269705.526	431342.336	309.971	Lubricant Tote Storage Facility	25-Dec-2024	7.0	302.971	5.5	304.471	0.0 – 3.4	Fill material: 0.0 to 1.0 – Blasted rock 1.0 to 3.4 – Blasted rock with high overburden content (brown silty sand)
										3.4 – 5.5	Overburden material (gray silty sand)
										5.5 – 7.0	Bedrock
BR24-GTS-DH02	7269696.163	431393.887	309.949	Lubricant Tote Storage Facility	25-Dec-2024	6.5	303.849	4.9	305.049	0.0 – 3.4	Fill material: 0.0 to 1.0 – Blasted rock 1.0 to 3.4 – Blasted rock with high overburden content (brown silty sand)
										3.4 – 4.9	Overburden material (gray silty sand)
										4.9 – 6.5	Bedrock
BR24-GTS-DH03	7269673.338	431386.29	309.876	Lubricant Tote Storage Facility	25-Dec-2024	6.5	303.376	4.0	305.876	0.0 – 3.6	Fill material: 0.0 to 1.0 – Blasted rock 1.0 to 3.67 – Blasted rock with high overburden content (brown silty sand)
										3.6 – 4.0	Overburden material (gray silty sand)
										4.0 – 6.5	Bedrock

Drillhole ID	Coordinates		Elevation (masl)	Location	Date	Total Depth (m)	Drillhole bottom elevation (masl)	Depth to bedrock (m)	Bedrock elevation (masl)	Preliminary Profile	
	Northing	Easting									
BR24-GTS-DH04	7269682.626	431310.534	310.187	Lubricant Tote Storage Facility	25-Dec-2024	7.1	305.587	5.6	304.587	0.0 – 2.1	Fill material: blasted rock with high overburden content (brown silty sand)
										2.1 – 5.6	Overburden material (gray silty sand)
										5.6 – 7.1	Bedrock
BR24-GTS-DH05	7269689.793	431355.595	310.18	Lubricant Tote Storage Facility	25-Dec-2024	7.6	302.58	5.3	304.88	0.0 – 3.2	Fill material: 0.0 to 1.0 – Blasted rock 1.0 to 3.2 – Blasted rock with high overburden content (brown silty sand)
										3.2 – 5.3	Overburden material (gray silty sand)
										5.3 – 7.6	Bedrock
BR24-GTS-DH06	7269708.342	431324.538	308.482	Lubricant Tote Storage Facility	25-Dec-2024	5.2	303.282	3.7	304.782	0.0 – 2.2	Fill material: blasted rock with high overburden content (brown silty sand)
										2.2 – 3.7	Overburden material (gray silty sand)
										3.7 – 5.2	Bedrock
BR24-GTS-DH07	7269704.459	431403.281	307.39	Lubricant Tote Storage Facility	25-Dec-2024	5.1	302.29	3.6	303.79	0.0 – 1.5	Fill material: blasted rock with high overburden content (brown silty sand)
										1.5 – 3.6	Overburden material (gray silty sand)
										3.6 – 5.1	Bedrock

These confirmation drillholes were drilled using one of the available onsite air rotary drill rigs.

6 Discussion

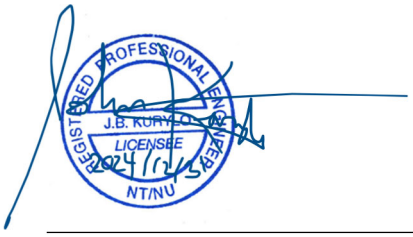
Based on the completed inspection, the foundation below the pad, where they Tote Storage Facility area is proposed to be constructed, is generally more of a sandier, to silty sand overburden material. The pad thicknesses have been constructed on site to be typically 2m+ in thickness, which is in a manner that should help to promote the active layer to raise into the base of the pad backfill (i.e. to the interface with the tundra or above). This assumes that no heated structures are placed over this area (as per the current plans). Note that typically the construction of the Tote Storage Facility will add an additional 0.9m or more of fill material. This will further help to increase the pad thickness and minimize potential foundation permafrost impacts (such as large differential settlement or volume changes from melting any ice in area where there is overburden in the foundation or even within the bottom layers of the pad). It should further be noted that the current pad has gone through multiple summer seasons already and has already experienced thawing and freezing cycles. This will aid to limit the additional settlement that may occur over this area when the Tote Storage Facility is constructed over this area. Centimeters of settlement could still be expected over this area, however those settlement ranges are able to be accommodated with / by the current Tote Storage Facility layout designs (as overviewed in the available Issued For Permit drawing).

The quality of the existing pad fill material is spatially variable. Generally, the fill material appeared to be coarse grained rockfill (consistent with much of the ROQ pads noted around site). B2Gold indicated that the northern side of the pad was constructed in compacted 1.5m lifts. SRK was not specifically involved in any site quality control or quality assurance linked to this fill placement, so they are not able to specifically comment on this. The pad thickness at the southern end decreases to 0.5–1.0 m due to the higher ground elevation and proximity to exposed bedrock; fortunately, the pad is typically thicker where greater thicknessed of overburden would be expected in the foundation.

Seven drill holes (BR24-GTS-DH01 to BR24-GTS-DH07) were completed at the Goose Tote Storage Facility area. The total depth of these drillholes ranged from 5.1 m to 7.6 m. Bedrock was typically encountered between 3.6 m and 5.6 m below the existing surface (i.e. below the top of the current pad). Bedrock Elevation varied but, based on the available data, appear to be typically between 303.79 masl and 305.876 masl. The fill material presented in the upper layers (top 0.0–3.6 m of the pad), consisting of blasted rock mixed with overburden material (brown silty sand) intermixed in some areas. The fill material however typically was noted to have a predominate rock matrix. The natural foundation overburden material, above the bedrock, was characterized as gray silty sand. The exact material characterizations will be revisit and any updates made when the laboratory testing information becomes available (in January 2025).

The site inspections and investigation data indicated fairly consistent stratigraphy across the proposed Tote Storage Facility site, with the layering typically being pad fill material, transitioning to a relatively thin horizon of foundation overburden, before ultimately reaching underlying bedrock.

Regards,
SRK Consulting (Canada) Inc.



John Kurylo, MSc, PEng
Principal Consultant (Geotechnical)

Within input and site support completed by:

Anna Timchenko, Ph.D., E.I.T (SRK Senior Consultant)

This is an interim update letter. Once additional laboratory testing information is received, and additional data review completed, then an updated and finalized site inspection memorandum will be produced and submitted to B2Gold. This updated and final memo is expected to be included as part of the future as-built reporting package for the Goose Tote Storage Facility.

APPENDIX C EARTHWORK TECHNICAL SPECIFICATIONS DOCUMENT

Technical Specifications Earthworks and Geotechnical Engineering
Back River Gold Project, Nunavut Canada
Revision 03 – Issued for Construction

Prepared for

B2Gold Corp.

Prepared by

SRK Consulting (Canada) Inc.
CAPR003100
April 2024

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1 General Requirements

1.1 Part 1 – General

1.1.1 Documents

1. This section of the Specifications forms part of the Contract Documents and are to be read, interpreted and coordinated with all other parts.

1.1.2 Revision Summary

2. Table 1.1 provides a summary of the revision history of this Technical Specification.

Table 1.1: Revision history of this Technical Specification

Revision	Status	Date	Major Changes
A	2018 Construction – Limited Scope	March 2018	Initial revision
0	Issued for Construction	April 2018	Minor text edits. Reviewed by Sabina
1	Issued for Construction	Aug 2022	Minor updates, additional checks linked to pond construction
2	Issued for Construction	Jan 2023	Added new elements related to construction of Primary Pond Dam and additional definitions and details based on KIA and CIRNAC comments
3	Issued for Construction	April 2024	Updated gradation of the fly ash amended sandfill based on material encountered in the field. Address concerns regarding screening of bedding and transition material used in the construction of the dam shell.

1.1.3 Definitions

1. The following definitions and interpretations shall apply to these Technical Specifications:

   (1) PROJECT means the total Back River Project Construction contemplated, of which the Works described in this Document may be the whole or part.

   (2) WORKS is defined as the entire completed construction as defined by this Document, or the various separately identifiable parts thereof, required to be furnished under the Contract Documents. Works is the result of performing services, furnishing labour, and furnishing and incorporating materials and equipment into the construction, all as required by the Contract Documents.

   (3) CONTRACT DOCUMENTS are defined as the agreement, addenda (which pertain to the Contract Documents), Contractor's bid (including documentation accompanying the bid and any post-bid addenda submitted) when attached as an exhibit to the agreement, the bonds, the general conditions, the supplementary conditions, these Specifications, the Drawings, together with all Modifications issued after the execution of the agreement.

(4) SPECIFICATIONS are defined as this Document of Specifications prepared by SRK Consulting (Canada) Inc. on behalf of the Owner. These Specifications are to be read, interpreted and coordinated with all Drawings and Modifications, or any other relevant documents produced by the Engineer.

(5) DRAWINGS are defined as all Engineering Drawings, plans, sketches and maps issued with these Specifications, or subsequently, as deemed necessary by the Engineer.

(6) MODIFICATIONS are defined as changes made to the Specifications and/or Drawings, which have been approved by the Engineer in writing. These modifications can be issued at any time, including after issuance of these Specifications and any accompanying Drawings and/or other Modifications.

(7) SUBMITTALS are defined as any documentation, as outlined in this Document, that are used as formal means of communication during execution of the Works, and originated by any of the Responsible Parties.

(8) Responsible Parties:

a) OWNER is defined as Sabina Gold & Silver Corp., or an authorized representative of the company. Sabina Gold & Silver Corp., Owner, and Sabina shall have common meaning.

b) ENGINEER (also, ENGINEER-OF-RECORD) is defined as a representative appointed and authorized by the Owner for those Works described in this Document. The Engineer shall be a registered Professional Engineer in the Territory of Nunavut, or a designated site representative under direct supervision of the Engineer during construction. At the time of issuing this Document, the Engineer-of-Record is a designated employee of SRK Consulting (Canada) Inc. (SRK). The Engineer has a direct contract with the Owner, and reports to the Owner. The Engineer may not communicate directly with the Contractor and Environmental Monitor, unless approved by the Owner.

c) CONTRACTOR is defined as the party or appointed representative of the party that has an agreement with the Owner to execute the Works defined in this Document. At the time of issuing this Document, the earthworks Contractor is Nuna Logistics Limited (NUNA). The Contractor may not communicate directly with the Engineer or the Environmental Monitor, unless approved by the Owner.

d) SUB-CONTRACTOR is defined as the party or appointed representative of the party that has an agreement with the Contractor or Owner to execute specialized components of the Works defined in this Document that cannot be carried out by the Contractor.

e) ENVIRONMENTAL MONITOR is defined as the party or appointed representative of the party that has an agreement with the Owner to act as Environmental Monitor for the Project, including the Works defined in this Document. At the time of issuing this Document, the Environmental Monitor is the Owner.

f) SURVEYOR is defined as the party or appointed representative of the party that has an agreement with the Contractor and/or Owner to act as Site Surveyor for the execution of the Works defined in this Document. The Surveyor shall have equipment and means on site to carry out horizontal and vertical ground surveys with an accuracy of ±2 mm. The Surveyor shall also have the equipment and means to prepare Digital Terrain Models (DTM) and Drawings on site that is compatible with AutoCAD 2017 or later. The Surveyor reports to the Contractor, but will be available for use by the Engineer as required, provided the Engineer has requested such needs through the Owner.

g) QUALITY CONTROL TEAM is defined as the individual(s) working under the direction of the Owner and/or Contractor to perform on site Quality Control (QC) for the Works defined in this Document.

h) QUALITY ASSURANCE TEAM is defined as the individual(s) working under the direction of the Engineer to perform on-site Quality Assurance (QA) for the Works defined in this Document.

(9) ON-SITE MATERIAL is defined as borrow materials obtained from within designated on-site facility excavations.

(10) OFF-SITE MATERIAL is defined as material obtained from sources other than on-site.

(11) RECORD DOCUMENTS are defined as the documents prepared and certified by a Land Surveyor, Material Testing Technician, Quality Control and/or Quality Assurance Personnel, Specialist Professionals, or any other parties documenting any aspect of the Works.

(12) PRODUCTS are defined as processed fill material, machines, components, equipment, fixtures, and systems forming the Works. This does not include machinery and equipment used for preparation, fabrication, conveying, and erection of the Works. Products may also include existing material or components required for reuse.

(13) SLOPES are defined in all instances in these Specifications and on Drawings in terms of horizontal distance to vertical distance (i.e., 2H:1V shall be read as 2 Horizontal to 1 Vertical).

(14) PLANT means all the fixed equipment and structures used in fill processing, concrete mixing and explosives production.

(15) EQUIPMENT means all mobile construction equipment that will be used in execution of the Works.

1.1.4 Summary of Works

1. The Contractor, with support from the Owner, will be responsible for ensuring that all the Works defined in this Document will be executed in accordance with all appropriate permits and approvals. Furthermore, the Contractor is responsible for ensuring that all the Works are carried out in accordance with the Owners Environmental Management Plans and Procedures (EMPs).

2. The Works covered by this Specification include, but is not limited to the following:

   (16) Implementation, operation, maintenance and removal of temporary construction runoff management and sediment control measures.

   (17) Construction of permanent surface water management structures.

   (18) Operation and management of permanent surface water management structures up to the time of complete demobilisation.

   (19) Clearing, stripping and excavation in required areas.

   (20) Development of borrow areas and borrow access roads. This includes quarry development, management and closure.

   (21) Production of construction material specified in the Specifications, and on the Drawings.

   (22) Construction of earthworks components of all-weather roads.

   (23) Construction of earthworks components of road turnouts and caribou crossings along all-weather roads.

   (24) Construction of earthworks components of laydown areas.

   (25) Construction of earthworks components of camp/mill pads.

   (26) Construction of Primary Pond dam.

   (27) Construction of spillway.

   (28) Installation of permanent monitoring instrumentation for the Works including, ground temperature cables, settlement plates, slope inclinometers, and survey beacons.

   (29) Construction of earthworks components (including liner) of landfarm.

   (30) Construction of earthworks components (including liner) of tank farm.

   (31) Construction of earthworks components of waste rock pile pad.

   (32) Construction of earthworks components of permanent explosives storage facility pads.

   (33) Removal of temporary structures used during construction of the Works and clean-up of the construction areas, borrow areas, and stockpile areas.

   Note that once construction is completed, and a handover from the Contractor to Owner has resulted, then operation and management of permanent surface water management structures become part of the Owners responsibility.

3. Electrical, instrumentation (other than specified), mechanical, concrete, and structural work are excluded from this scope of work.

1.1.5 Contradictions

1. Should any contradiction, either implied or real, exist between the Specifications and the Drawings, the Contractor shall:

   (1) Notify the Owner and the Engineer.

   (2) Stop all Works that concern the contradiction until the contradiction is remedied or clarified by the Engineer.

1. The decision of the Engineer is final.

1.1.6 Owner Responsibilities

1. The Owner, in the context of the Works defined in this Document, shall:

   (1) Be the formal liaison between all parties.

   (2) Be responsible for overseeing execution of the Works, in accordance with the Engineer's Specifications and Drawings.

   (3) Be responsible for procurement of all materials to execute the Works.

   (4) Become familiar with all relevant permits, approvals and any other administrative matters which may impact the Works. The Engineer will assume that all appropriate approvals have been obtained and that all conditions have been satisfied when giving technical approvals to proceed with the Works.

   (5) Before proceeding with the Works, examine all Drawings and Specifications and report to the Engineer any apparent discrepancies or interferences. The Engineer shall always retain the right to make revisions to the Drawings and the Specifications.

   (6) Ensure an appropriate workspace, necessary facilities and transportation equipment is available to the Engineer or the Engineer's representatives to perform their duties on site.

   (7) Ensure that the Engineer and the Engineer's representatives receive appropriate site-specific health and safety training and/or orientation whilst on site.

1.1.7 Contractor's Responsibilities

1. The Contractor, in the context of the Works defined in this Document shall:

   (1) Comply with Nunavut Worker Compensation Board, Northern Canada Mine Safety Act and any other relevant required health and safety regulations.

   (2) Comply with Owner's Environmental Management Plan and Procedures (EMPs).

   (3) Provide the Owner with a copy of the Health and Safety Plan, which has been specifically prepared for this Project.

   (4) Become familiar with the relevant regional and site-specific conditions that deviate from the Specification and Drawings and inform the Engineer through the Owner when a problem or delay is anticipated.

(5) Be responsible for making independent measurements and installing the Works to fit the conditions encountered.

(6) Before proceeding with the Works, examine all Drawings and Specifications and report to the Engineer via the Owner any apparent discrepancies or interferences. The Engineer shall always retain the right to make revisions to the Drawings and the Specifications.

1.1.8 Engineer's Responsibilities

1. The Engineer, in the context of the Works defined in this Document, shall:

(1) Comply with Owner's Environmental Management Plans and Procedures (EMPs).

(2) Provide the Owner and Contractor with Drawings and Specifications, including Revisions and Modifications, to be able to conduct the Works defined in this Document.

(3) Provide the Owner and Contractor with digital Drawing files to facilitate setting out the Works defined in this Document.

(4) Provide full-time site Engineer(s) during construction of the Works as defined in this Document. The Engineer will monitor construction activities to ensure that the Works are constructed in accordance with the Drawings and Specifications.

(5) Ensure timely response as defined in this Document, to Submittals pertaining to the Drawings or Specifications submitted by the Owner and Contractor.

1.1.9 Codes and Standards

1. The Quality Control and Assurance Program (QA/QC) as described in this Document, shall use testing procedures from, but not limited to the list of American Society of Testing and Materials Standards in Table 1.2.

Table 1.2: List of Codes and Standards

Test	Topic
ASTM D2487	Classification of Soils for Engineering Purposes
ASTM D4083	Standard Practice For Description Of Frozen Soils (Visual-Manual Procedure)
ASTM D2216	Water (Moisture) Content in Soil and Rock
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D854	Specific Gravity of Soils
ASTM D698	Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D2922	Density of Soil in Place by Nuclear Methods

1.1.10 Quality Control

1. The Contractor will carry out Quality Control (QC) for the Works defined in this Document and will undertake testing at a frequency and at the locations specified in the various sections of these Specifications and Drawings, or as defined in their approved Quality Control program.
2. The Contractor shall submit a copy of the QC program for review by the Engineer and Owner at least seven (7) days prior to commencement of the Works.
3. All QC or other test data, survey data or the like, collected by the Contractor, shall be made available to the Owner and Engineer on request.
4. The Owner and Contractor shall provide all the necessary equipment and technicians for materials and product testing required to execute the QC program.
5. QC shall be done continuously, as specified in this Document, to ensure the quality of products and Works.
6. The Contractor's QC shall be done independently from the Engineer's Quality Assurance (QA).
7. QA, or any other form of performance testing by the Engineer or Owner, shall in no way relieve the Contractor of its sole responsibility for completing the Works in accordance with the specified requirements.
8. Geochemical testing of any construction material will be the responsibility of the Owner and will be controlled by the Owner. The Contractor is however responsible to ensure that any applicable testing has been carried out and that any construction material has been approved for use.

1.1.11 Quality Assurance

1. The Engineer will carry out Quality Assurance (QA) for the Works defined in this Document and will undertake testing at a frequency and at the locations specified in the various sections of these Specifications and Drawings. The Engineer may undertake any additional testing which is deemed necessary on any part of the Works.
2. This Document, and the Drawings outline the Engineer's QA program, and is subject to review by the Owner and Contractor.
3. All QA or other test data, collected by the Engineer, shall be made available to the Owner and Contractor on request.
4. The Contractor and Owner shall render such assistance as is necessary to enable QA sampling and testing to be carried out expeditiously, and provide all the necessary equipment, including an adequately equipped on-site laboratory.
5. The Engineer's QA shall be done independently from the Contractors QC.

6. QA, or any other form of performance testing by the Engineer or Owner, shall in no way relieve the Contractor of its sole responsibility for completing the Works in accordance with the specified requirements.

7. Geochemical testing of any construction material will be the responsibility of the Owner and will be controlled by the Owner. The Contractor is however responsible to ensure that any applicable testing has been carried out and that any construction material has been approved for use.

1.1.12 Submittals

1. The Contractor shall submit information as specified and requested from the Engineer through the Owner. All submittals required by the Engineer will be requested through the Owner.

2. The Engineer has the right to request as a Submittal any other information deemed necessary throughout execution of the Works. This includes information not currently defined as Submittal information on the Drawings and Specifications.

1.1.13 Construction Schedule

1. Construction scheduling is the responsibility of the Owner; however, the Contractor and Owner is reminded of the following very important facts:

   (1) Access directly over the tundra should be expected to be limited in the summer, and avoided wherever possible, to avoid permafrost damage and degradation.

   (2) In the winter snow and ice cover over the tundra would be expected to be required on access routes, again to avoid permafrost damage and degradation.

   (3) Timelines for instream or near stream works exist for all fish bearing streams. Typically, no construction can result at these crossing (or culvert locations) between May and the end of July (to be confirmed with the Owner and as per all applicable permits).

   (4) The excavation and backfill of the key trench (to the original ground level) for the Primary Pond dam can ONLY be completed in the winter when ambient outside air temperature is a maximum of -8^{o}C.

   (5) Construction of the minimum winter construction components of the embankment (as shown in the Engineering Drawings) for the Primary Pond dam can ONLY be completed when ambient outside air temperature is a maximum of -2^{o}C. The portion of the embankment outside of the minimum winter construction components can be constructed during other periods of the year with approval from the project engineer.

   (6) The Contractor and Owner must submit a detailed schedule for the dam construction to the Engineer at least 14 days prior to commencement of construction. The Engineer reserves the right to halt the start of construction of the dams, if in its opinion there is an unacceptable risk that the construction cannot be completed under the required ambient temperatures.

(7) Any excavations into soil permafrost are typically expected to be required to result in the winter; specifically when average daily ambient air temperature is below -10^{o}C.

1.1.14 Construction Drawings

1. Drawings will be issued by the Engineer specific to construction needs prior to commencement of the Work. Drawings shall be reviewed by the Owner and Contractor to ensure all aspects of the construction needs are covered, and report to the Engineer any discrepancies and interferences. The Owner shall notify and inform the Engineer of construction progress and Drawing requirements four (4) weeks prior to commencement of any Works.
2. Only Drawings explicitly marked with the following words and without any other stamps or notes in contradiction are considered acceptable for Construction: ISSUED FOR CONSTRUCTION, or IFC.

1.1.15 Construction Specifications

1. Specifications will be issued by the Engineer specific to construction needs prior to commencement of the Work. Specifications shall be reviewed by the Owner and Contractor to ensure all aspects of the construction needs are covered, and report to the Engineer any discrepancies and interferences. The Owner shall notify and inform the Engineer of construction progress and Specification requirements four (4) weeks prior to commencement of any Works.
2. Only Specifications explicitly marked with the following words are considered acceptable for Construction: ISSUED FOR CONSTRUCTION, or IFC.

---------- END OF SECTION 1 ----------

2 Clearing and Stripping

2.1 Part 1 – General

2.1.1 Documents

1. This section of the Specifications forms part of the Contract Documents and are to be read, interpreted, and coordinated with all other parts.

2.1.2 Definitions

1. The following words and terms, unless the context otherwise requires, in this Specification, shall have the meanings set out below:

   (1) CLEARING means Works involved in the removal of snow and ice on natural ground or subgrade surface to the satisfaction of the Engineer.

   (2) STRIPPING means Works involving excavation and removal of unsuitable material including but not limited to organics and ice rich materials.

2.1.3 Description

1. The Works covered by this section consists of supplying all labour, materials, and equipment, and performing all Works necessary for clearing and stripping.
2. The Contractor shall clear and/or strip the Works areas as required including, but not limited to borrow areas, disposal areas, stockpile areas, laydown areas, water management areas, foundation zones and between individual lifts of fill placement, as shown on the Drawings, or inferred by these Specifications or as directed by the Owner with explicit approval from the Engineer.
3. Clearing and stripping in all areas shall require approval by the Engineer before such Works begins.
4. It is the Owner’s responsibility to identify and acquire all necessary permits and approvals for stockpiling and storage of materials removed through the process of clearing and/or stripping.

2.1.4 Submittals

1. At least seven (7) days prior to clearing, stripping, or clearing and stripping in any specific area, the Contractor shall submit to the Engineer and Owner, for approval, a Clearing and Stripping Work Plan describing the schedule, locations and extent of the clearing and stripping, and the proposed methods for disposal of clearing and stripping products.
2. Work shall not start until applicable approvals are obtained from the Owner in writing.
3. Approval of submittals shall not relieve the Contractor of its sole responsibility to construct the Works in accordance with specified requirements.

2.1.5 Permits and Regulations

1. The Owner shall conduct all work in accordance with the Owner's and all applicable Federal, Territorial, local or landowner regulations and licences regarding the disposal of materials from clearing and stripping.
2. It is the Owner's responsibility to be familiar with all said regulations, conditions and permits.

2.1.6 Protection

1. Unless otherwise instructed, the Contractor is to take all necessary precautions to prevent damage to natural and man-made features, including, but not limited to survey monuments, survey markers, archaeological sites, monitoring instrumentation and the sensitive tundra landscape.
2. The Contractor may not perform any Works outside of the permitted and approved construction area.

2.2 Part 2 – Execution

2.2.1 Preparation

1. The Contractor shall confirm the clearing or stripping limits by having the Surveyor lay out and flag the extents of all areas of work, prior to commencement of clearing or stripping. The Engineer will inspect these demarcated areas and confirm all clearing or stripping limits before giving approval to proceed to the Owner. The Owner will in turn authorize the Contractor to proceed with the Works.
2. The Contractor shall inspect the Works site and verify with the Engineer and the Owner any restrictions within or adjacent to the clearing limits.
3. Unless specifically instructed otherwise, the Contractor shall locate and protect natural and man-made features, including, but not limited to survey monuments, survey markers, archaeological sites, monitoring instrumentation and sensitive tundra landscape.

2.2.2 Clearing

1. Snow and ice shall be removed from all construction footprint areas, prior to undertaking any work in that area, with a maximum tolerance of 10 cm of uncompacted snow material left above natural ground, or otherwise approved by the Engineer.
2. Should snow fall on previously cleared or stripped surfaces that have been prepared and approved for construction, including between individual lifts of fill placement, the Contractor will carry out any additional clearing as requested by the Engineer.
3. The Contractor shall take all necessary precautions to prevent damage to natural and frozen ground, unless specifically instructed otherwise by the Engineer.

2.2.3 Stripping

1. Where required, and as a minimum in areas to be excavated, areas subjected to clearing shall undergo stripping to the depth necessary to remove all soil, including permafrost and other organic material necessary to expose bedrock, or other suitable foundation conditions as directed by the Engineer.
2. Should blasting be required of permafrost soils, the Contractor will comply to all Specifications associated with blasting, in addition to those listed in this Section.

2.2.4 Finished Surface

1. The Contractor shall leave the cleared and/or stripped surface clear, smooth, debris- and snow-free, in a condition suitable for inspection by the Engineer.

2.2.5 Disposal

1. Snow and ice cleared off the construction area shall be stockpiled downstream and outside of the construction area where it will not affect the construction or any constructed elements during thaw. The stockpile area shall be proposed by the Contractor and approved by the Owner. A Water Management Plan, prepared by the Contractor, and approved by the Owner, must be in place prior to stockpiling snow and ice in the specified area.
2. Soil and organic material stripped off the construction areas shall be stockpiled in designated areas approved by the Owner with proper sediment control as instructed in permit requirements.

2.3 Part 3 – Quality Control

1. Submit a Clearing and Stripping Work Plan as defined in Section 2.1.4 of this Document.
2. Confirm with Owner that all permits and approvals are in place prior to commencing any work.
3. Physically demarcate, for review and approval by the Owner and Engineer, the Works area that will be cleared and/or stripped using appropriate survey control. Within this zone clearly identify natural and man-made features that require protection as defined in this Document.
4. Implement measures, including spotters as needed, to allow visual inspection of clearing and/or stripping activities during execution to ensure it is done in accordance with the Specifications as defined in this Document.
5. Conduct field surveys, and submit As-built Drawings, in electronic format of any cleared and/or stripped areas, as requested by the Engineer or Owner.

2.4 Part 4 – Quality Assurance

1. Review the Contractor’s Clearing and Stripping Work Plan as defined in Section 2.1.4 of this Document and submit review comments back to the Contractor via the Owner.

2. Visually inspect the demarcated zone prepared by the Contractor for clearing and/or stripping and inform the Contractor via the Owner if changes are required.
3. Visually inspect the cleared and/or stripped areas and inform the Contractor via the Owner if changes are required.
4. Review As-built Drawings submitted by the Contractor of cleared and/or stripped areas and inform the Contractor via the Owner if any changes are required.

---------- END OF SECTION 2 ----------

3 Excavation and Water Control

3.1 Part 1 – General

3.1.1 Documents

1. This section of the Specifications forms part of the Contract Documents and are to be read, interpreted, and coordinated with all other parts.

3.1.2 Description

1. The excavation Works entails removal of soil and other materials below existing ground surface to neat lines and grades as indicated on the Drawings.
2. The Works to be done under this Section consists of furnishing all labour, material, plant and equipment, and the performance of all Works necessary to carry out rock, soil and permafrost excavation as shown on the Drawings, and as specified herein.
3. The Works shall also include the loading, transportation and permanent disposal of all excavated materials which are deemed by the Engineer to be surplus, or unsuitable for use as construction material, and the loading, transportation and possible temporary stockpiling and re-handling of acceptable materials to locations where they can either be used as part of the temporary or permanent structures or stockpiled in readiness for future temporary or permanent use.
4. The Owner and Contractor will be responsible to locate suitable stockpile locations for any excavated material, whether temporary or permanent. The Engineer will however have the right to reject any identified sites, if in his opinion it may interfere with any of the Works.

3.1.3 Exclusions

1. The Contractor is responsible for quarry development. The Engineer does however reserve the right to request modifications to the quarry development plan if the materials being produced do not meet Specifications. Any such requests must be submitted through the Owner.

3.1.4 Definitions

1. The following words and terms, unless the context otherwise requires, in this Specification, shall have the meanings set out below:
   (1) SOIL and OVERBURDEN meaning is interchangeable and means general overburden material including glacial marine clays, silty clays, sand, gravel, till and any combination of these materials, which can be used in part for concrete aggregate if they are free of contaminants, snow, ice, and organic material, and if approved by the Engineer.
   (2) PERMAFROST means soil that is permanently frozen, in accordance with the appropriate normal geotechnical definitions.

(3) HYPERSALINE SOIL for this Project is defined as soil where salinity values are above 25 ppt.

(4) MASSIVE ICE for this Project is defined as soil where visible ice content is in excess 20% (over 1m depth interval).

(5) FROZEN SOIL for this Project is referred to material used for fill placement and defined as cohesive ice bonded soil particles. The Engineer is to inspect for presence of “clumps” of material prior to placement that would impact placement and achieving compaction requirement.

(6) ROCK means quarried material from a designated quarry site, or from a designated foundation excavation.

(7) UNSUITABLE MATERIAL means any soil or rock that does not meet the Specifications for the use of this project.

(8) BLASTED MATERIAL means any material produced by production blasting at all quarry or excavation sites.

(9) NEAT LINE means the final line or grade to which excavation is to be performed.

(10) QUARRY and BORROW AREA meaning is interchangeable and means a designated location from where construction materials can be obtained.

(11) COMMON EXCAVATION means excavation of all materials, including rock, weathered bedrock, soil, permafrost, and unsuitable material by mechanical means.

3.1.5 Procedures

1. The details of the surface excavations shown in Drawings represent an engineered design encompassing drainage under assumed conditions. Variations in site conditions may require adjustments to the excavation shape, slope reinforcement and drainage under the Engineer’s direction.

2. If, in a specific area, a plan that has been previously adopted does not fit the site conditions in accordance with the requirements of these Specifications, the Engineer shall submit a revised plan to the Owner before continuing excavation in identified areas.

3. All earthworks that will potentially disturb original ground shall be constructed during the winter season to prevent damage to the tundra. All construction Works and traffic shall be within the constructed footprint during summer months.

4. Water management measures shall be constructed and implemented during the winter months as directed by the Owner, and only emergency adjustments can be made during the following spring and summer as approved by the Owner.

3.1.6 Submittals

1. The Contractor shall submit a detailed excavation plan to the Owner and the Engineer outlining the intended methods for excavation within a given area at least seven (7) days prior to the commencement of Works including, but not limited to the following details:
   (1) Typical equipment deployment.
   (2) Sediment and runoff control around the intended Works.
   (3) Water control and dewatering plan for Works where inflow of ground water or surface runoff could occur.
   (4) Typical blast method including hole size, depth, spacing, burden and loading details for production, buffer, pre-split holes, if required.
2. The Contractor's excavation plan must be approved by the Owner and the Engineer.
3. Work shall not start until applicable approvals are obtained from the Owner in writing.
4. Approval of submittals shall not relieve the Contractor of its sole responsibility to construct the Works in accordance with specified requirements.

3.2 Part 2 – Execution

3.2.1 Preparation

1. Prior to beginning a grading or excavation operation in any area, all necessary clearing and/or stripping in that area shall have been performed in accordance with the Specifications.
2. The Contractor shall confirm to its satisfaction the character, quantity, and distribution of all the material to be excavated.
3. The Contractor shall have in place a contingency plan for sudden unforeseeable change of weather conditions prior to excavation commencement. The Contractor shall have a daily Works plan in relation to the weather conditions, equipment, operator availability, area of Works, and schedule.
4. The Contractor shall be responsible for sediment and runoff control around the construction area to ensure there is minimal impact on the natural state of the surrounding environment in accordance with all issued regulations, licenses and permits.
5. The Contractor shall be responsible for all dewatering and water control to allow for fill placement in a dry, ice-free environment.

3.2.2 Common Excavation Methods

1. Common excavation of weathered bedrock and soil, including permafrost, shall be performed to the lines, grades, and elevations as indicated on the Drawings, or as directed by the Engineer, and shall be finished to a reasonable smooth and uniform surface.

2. Should the Contractor, through carelessness or other fault, excavate beyond the designated grades, it shall replace the excavation using an approved method, in accordance with the Specification, or any modification thereof as directed by the Engineer.

3. All excavated material determined unsuitable by the Engineer shall be disposed of as directed by the Owner.

4. At all times during construction, the Contractor shall adopt excavation procedures such that at no time shall the stability of any slope be impaired. The Engineer reserves the right to stop work if it deems the conditions to be unsafe.

3.2.3 Excavation in Quarry Areas

1. Borrow excavation shall be performed to the lines, grades, and elevation as indicated on the Drawings or as directed by the Engineer.

2. Borrow development will be the responsibility of the Contractor in accordance with staged plans submitted to the Owner and Engineer for approval prior to undertaking the Works.

3. Methods of access and excavation in the borrow areas will be determined by the Contractor, unless otherwise directed by the Owner or Engineer.

4. The Contractor shall use appropriate blasting methods to control the height of each bench and associated material gradation. The Contractor is responsible for fragmentation and throw of the material to ensure ease of excavation.

5. Excavation in the borrow area should be optimized by the Contractor for safety of equipment operation, water control, and bench stability.

6. Prior to excavation of the material, certified personnel must inspect the blast pattern to ensure all blasting agents were ignited and none were left behind.

3.2.4 Control of Water

1. Surface water flows during the melting seasons shall be directed away from the Works by means of diversion berms, ditches, or other acceptable means and, in any case, all surface flows on the Works area shall be satisfactorily controlled, and to the environmental standards specified.

2. Any inflow of ground water or surface runoff water an excavation must be controlled using suitably placed and sized sumps and pumps.

3. Any water collected in the sumps must be discharged in an approved manner to a designated area away from the construction activities. A pumping and discharge contingency plan should be discussed with and submitted to the Engineer and Owner for approval prior to construction.

4. The construction, operation, and maintenance of the sump(s) and pump(s) are the responsibility of the Contractor.

3.2.5 Scaling, Slope Stability and Safety

1. Immediately following excavation and at any time during the Works, all loose material on slopes, which appears to be unsafe or to endanger workmen, structures, or equipment, shall be scaled and removed.
2. All slope stability measures will be considered incidental to the Works and will be the responsibility of the Contractor with inspections done by the Owner and Engineer.

3.3 Part 3 – Quality Control

1. Submit an Excavation Plan (including a water management and dewatering plan, if required) as defined in Section 3.1.6 of this Document.
2. Confirm with Owner that all permits and approvals are in place prior to commencing any Works.
3. Physically demarcate, for review and approval by the Owner and Engineer, the Works area that will be excavated using appropriate survey control.
4. Implement measures, including spotters and frequent survey control as needed, to allow visual inspection of excavation activities during execution to ensure it is done in accordance with the Drawings and Specifications as defined in this Document.
5. Implement measures to ensure adequate water management and dewatering as necessary.
6. Advise the Engineer and Owner when an excavation has been completed and is ready for inspection and/or approval. Interim survey control may be requested by the Engineer via the Owner to confirm lines and grades have been met.
7. Conduct a field survey and submit As-built Drawings, in electronic format, of any excavated area to the Engineer and Owner.

3.4 Part 4 – Quality Assurance

1. Review the Excavation Plan (including a water management and dewatering plan, if required) as defined in Section 3.1.6 of this Document and submit review comments back to the Contractor via the Owner.
2. Visually inspect the demarcated zone, and any associated survey files prepared by the Contractor for excavation and inform Contractor via the Owner if changes are required.
3. Visually inspect the excavated area, and any associated survey files, and inform the Contractor via the Owner if changes are required.
4. Visually inspect water management and dewatering if required and inform the Contractor via the Owner if changes are required.
5. Review As-built Drawings submitted by the Contractor of excavated areas and inform the Contractor via the Owner if any changes are required.

---------- END OF SECTION 3 ----------

4 Drilling and Blasting

4.1 Part 1 – General

4.1.1 Documents

1. This section of the Specifications forms part of the Contract Documents and are to be read, interpreted, and coordinated with all other parts.

4.1.2 Description

1. All blasting operations must be performed in accordance with the Owners EMPs and all Federal and Territorial Regulations and Licences.
2. Blasting near water bodies frequented by fish will require lower powder factors, as determined by Guidelines issued by the Department of Fisheries and Oceans.
3. The Contractor will be responsible to become familiar with all appropriate conditions and constraints that apply to blasting.
4. The Works to be done under this Section consists of supplying all labour, materials, plant, and equipment, and performing all Works necessary to carry out drilling and blasting with certified personnel and chemical agents as shown on Drawings and specified herein.
5. The Works shall include; but are not limited to:
   (1) Provide a typical list of safety protocols, chemical blasting agents, blast patterns and powder factors suitable for carrying out the Works, and for producing the specified construction materials.
   (2) Drilling with appropriate equipment, to appropriate depth and grade to execute the Works, develop rock quarries and any other common excavation as shown on the Drawings, or as directed by the Engineer.
   (3) Provide suitably qualified personnel, with current blasting certificates, to carry out all safety protocols for blasting required by the regulations prior to ignition.

4.1.3 Definitions

1. The following words and terms, unless the context otherwise requires, in this Specification, shall have the meanings set out below:
   (1) CERTIFIED PERSONNEL mean a suitably qualified person holding current blasting certificates issued by the appropriate Territorial and Federal Regulatory agencies with jurisdiction over the Project.
   (2) CHEMICAL BLASTING AGENTS means any form of explosive materials, and components thereof, that are suitable for use in the Project.
   (3) DETONATOR and BLASTING CAP meaning is interchangeable and means any suitable form of explosive charge used to initiate the detonation of the chemical blasting agents.

(4) DETONATOR CORD, DETCORD, and PRIMER CORD meaning is interchangeable and means a waterproof, flexible tube containing a high explosive designed to transmit the detonation wave.

4.1.4 Submittals

1. The Contractor shall submit a Drilling and Blasting Plan to the Engineer and Owner describing the schedule, and proposed methods for borrow development and common excavation, at least seven (7) days prior to the commencement of Works.
2. Work shall not start until applicable approvals are obtained from the Owner in writing.
3. Approval of submittals shall not relieve the Contractor of its sole responsibility to complete the Works in accordance with specified requirements.

4.2 Part 2 – Products and Personnel

1. The Contractor is responsible to procure all necessary supplies and equipment for drilling and blasting operations, excluding the chemical blasting agents, detonators, and detonator cords, which will be supplied by the Owner.
2. The Contractor is responsible to acquire all required licenses and notifications from Territorial and Federal Regulatory Agencies.
3. The Contractor is responsible to have appropriately qualified and certified persons to handle all aspects of the drilling and blasting Works, including, but not limited to management of inventory, mixing of explosives, storage of explosives, transportation of explosives, placing of detonators, initiation of blasts, and clearing of explosives after blast.
4. The Contractor is responsible for management, maintenance, and security of the Explosives Facility, whether temporary or permanent.

4.3 Part 3 – Execution

4.3.1 Drilling

1. The Contractor will lay out the appropriate blast pattern for the specified material grade required, at appropriate locations.
2. The Contractor will drill the blast holes in accordance with the blast pattern requirements, taking due care to prevent over-breaking.
3. The Contractor will ensure that the appropriate surface water containment and management procedures are followed when drilling.

4.3.2 Blasting

1. The Contractor’s Health and Safety Plan, list of blasting agents, technician’s certificates, and proposed methods of blasting will be provided by the Contractor prior to blasting operation, for Owner’s approval.

2. The Contractor will provide appropriately qualified and certified personnel to manage all aspects of the blasting.
3. The Contractor will be responsible for notifying all air and land traffic of the time and location of any blast at least 24 hours in advance.
4. The Contractor will be responsible for putting in place all protocols and physical barriers to warn and prevent land and air traffic from entering the designated blast zone, according to all applicable Territorial and Federal Regulations and the Contractors Health and Safety Plan.
5. The Contractor should use controlled blasting methods to ensure production of specified materials, ease of excavation and to minimize processing requirements.
6. Certified Personnel must inspect the blast pattern post blasting to ensure there are no unexploded blasting agents and blasting caps left behind prior to excavation. If unexploded material is found in the pattern, Certified Personnel must remove the dangerous material according to normal practice and the Contractor's Health and Safety Plan.

4.3.3 Key Trench Drilling and Blasting

1. The Contractor must use excavation methods that minimize fracturing beyond excavation limits.
2. Care must be taken in locating the drill holes, orienting the drills, and monitoring drilling so that accurate positioning and alignment of the drill holes is achieved.
3. The method of excavation must produce a key trench base that is free of abrupt changes in elevation.
4. Controlled blasting techniques must be used to satisfy the excavation requirements stated herein. The blasting agent type and quantity, blasting sequence, and delay pattern must be flexible to meet these requirements.
5. The contractor shall submit complete details of any proposed blast to the Owner and the Engineer. Submitted data shall include the following:
   (1) The location, depth and are of the blast;
   (2) The type, strength, quantity, column load, and distribution of explosives to be used per hole, per day, per blast;
   (3) The sequence and pattern of the delay; and
   (4) The description and purpose of any special methods to be adopted.
6. If, in a specific area, a plan that was previously adopted does not produce conditions in accordance with the requirements stated herein, the Contractor must submit a revised blasting plan to the Owner and Engineer before continuing with drilling and blasting in adjacent areas.

4.4 Part 3 – Quality Control

1. Submit a Drilling and Blasting Plan as defined in Section 4.1.4 of this Document.
2. Confirm with the Owner that all permits and approvals are in place prior to commencing any work.
3. Physically demarcate the Works area that will be drilled and blasted, using proper survey control, for review and approval by the Owner and the Engineer.
4. Implement and follow appropriate established protocols prior to and immediately following any Blast in compliance with all appropriate Rules and Regulations.

4.5 Part 4 – Quality Assurance

1. Review the Drilling and Blasting Plan as defined in Section 4.1.4 of this Document and submit review comments back to the Contractor via the Owner.
2. Visually inspect the demarcated zone, and any associated survey files prepared by the Contractor for drilling and blasting and inform the Contractor via the Owner if changes are required.

---------- END OF SECTION 4 ----------

5 Fill Material Specifications

5.1 Part 1 – General

5.1.1 Documents

1. This section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.

5.1.2 Description

1. The sources and borrow areas of all fills are shown on the Drawings or as designated by the Engineer. For the types of material and related Specifications, refer to the Drawings. The material types required for completion of the Works are labeled as:
   (1) Riprap;
   (2) Run-of-Quarry;
   (3) Transition;
   (4) Surfacing; and
   (5) Bedding
   (6) Fly Ash Amended Sand Fill
2. All construction materials shall be non-acid generating, free of organic matter or similar impurities, as well as snow and ice.
3. The Contractor is responsible for supplying, installing, operating, and maintaining all the necessary plant, equipment, materials, labour, and supervision to produce and test the suitability of the specified construction material on site.
4. The Contractor must process all materials to meet the gradations specified herein.

5.1.3 Submittals

1. The Contractor shall submit the information requested in the Quality Control program listed in Section 5.3 to the Engineer and Owner in a timely manner, understanding that approvals to proceed with the Works may be contingent on review and approval of these submittals.
2. Work shall not start until applicable approvals are obtained from the Owner in writing.
3. Approval of submittals shall not relieve the Contractor of its sole responsibility to construct the Works in accordance with specified requirements.

5.2 Part 2 – Product

5.2.1 General

1. Quarry areas

(1) Fill, required for the Works, shall be obtained, and manufactured by the Contractor from designated borrow areas as shown on the Drawings, and from the excavation of select foundations.

(2) The parent rock sources for all fill materials must be inspected by the Engineer throughout the material processing and construction activities to ensure the requirements stated herein are being met.

(3) Excavated material that is unsuitable for the Works shall be disposed of in a designated onsite disposal area as directed by the Owner.

(4) If the Contractor proposes to obtain fill from an area not within the excavations or designated areas shown on the Drawings, it shall communicate its intention to the Owner. The Owner then shall first obtain the necessary approvals and permits to carry out such sub-surface investigation and obtain and submit such samples, as are required, to enable the Engineer to assess the suitability of the fill for the Works.

(5) The Contractor shall keep accurate exploration records of any test pit, trench, or drill hole which it makes for the purpose of investigating borrow material, and a copy of such records shall be submitted to the Owner and to the Engineer within seven (7) days of the completion of such exploration Works.

(6) The Contractor shall give the Owner no less than 14 days' notice, of the intention to develop any potential borrow area not shown on the Drawings.

(7) The Contractor shall make its own determination of the adequacy of any borrow source it intends to exploit.

2. Foundation excavation

(1) Fill acquired from foundation excavation shall meet the Specifications; otherwise, it will be considered as unsuitable material and disposed of accordingly.

(2) Unsuitable material from the excavation for the Works shall be disposed of in a designated onsite disposal area as directed by the Owner.

(3) Fill shall be used in place with minimum handling to minimize degradation and segregation.

5.2.2 Riprap

1. Riprap material shall be competent non-acid generating rock sourced from the quarries or foundation excavations, and that is free from organic matter, snow, and ice.

2. Riprap shall be made of sound, durable quarry rock that will not deteriorate during freeze-thaw cycles or on exposure to water or the atmosphere. Durability testing (e.g., ASTM D3744, D4644 or as determined appropriated by the Engineer) and approval of rock sources may be required. Average solid density shall not be less than 2.6 tonnes per cubic metre.

3. Riprap shall be clean with no fine-grained material and a minimum boulder size of 1,000 mm and maximum boulder size of 1,500 mm or as specified on the Drawings.

4. Basic screening or manual selection may be used to achieve the desired gradation.

5. The Riprap material shall be washed to remove blast residue and/or fines, unless otherwise directed by the Engineer.

5.2.3 Run-of-Quarry Material

1. Run-of-Quarry (ROQ) material shall consist of competent non-acid generating rock sourced from the quarries or foundation excavations, and that is free of organic matter, frozen soil, snow, and ice. Definition for frozen soil is provided in Section 3.1.4.

2. ROQ material shall be well-graded, containing enough unfrozen gravel, sand, and silt sized material to allow the material to be compacted. In areas where the overall ROQ fill thickness is less than 0.85 m, the maximum boulder size shall not exceed 500 mm, as measured in any direction. In areas where the overall ROQ fill thickness is greater than 0.85 m, the maximum boulder size shall not exceed 900 mm as measured in any direction.

3. Basic screening or crushing and screening may be used to achieve the desired gradation.

4. The ROQ material shall be washed to remove blast residue, unless otherwise directed by the Engineer.

5.2.4 Transition Material

1. The Transition material shall consist of competent non-acid generating material from the quarries or foundation excavations, and that is free of organic matter, frozen soil, snow, and ice. Definition for frozen soil is provided in Section 3.1.4.

2. The Transition material shall have a particle size distribution falling within the limits presented in Table 5.1.

Table 5.1: Transition material particle size distribution limits

Particle Size (mm)	% Passing
200	100
100	60-100
50	40-70
20	20-50
10	0-30
5	0-10

3. Crushing and screening may be required to meet the specifications in the key trench base. Crushing and screening will be required to create specification-adherent material for use in the dam shell construction.

4. For the dam shell construction, the particles' shape should be angular or sub-angular; any rounded or sub-rounded particles should be removed from the transition material.

5. The Transition material shall be washed to remove blast residue, unless otherwise directed by the Engineer.

5.2.5 Surfacing Material

1. Surfacing material shall consist of competent non-acid generating rock from the quarries or foundation excavations, and that is free of organic matter, frozen soil, snow, and ice. Definition for frozen soil is provided in Section 3.1.4.

2. The Surfacing material shall have a particle size distribution falling within the limits presented in Table 5.2.

Table 5.2: Surfacing material particle size distribution limits

Particle Size (mm)	% Passing
38.0	100
25.0	60-100
12.5	25-100
5.0	10-50
0.63	2-20
0.08	1-15

3. Crushing and screening will be required to meet the Specifications.

4. The Surfacing material shall be washed to remove blast residue, unless otherwise directed by the Engineer.

5.2.6 Bedding Material

1. Bedding Material shall consist of competent non-acid generating material from the quarries or foundation excavations, including unfrozen soil, and that is free of organic matter, frozen soil, snow, and ice. Definition for frozen soil is provided in Section 3.1.4.

2. The bedding material shall have a particle size distribution falling within the limits precented in Table 5.3.

Table 5.3: Bedding material particle size distribution limits

Particle Size (mm)	% Passing
25.0	100
20.0	90-100
12.5	50-100
10.0	30-100
5.0	10-80
0.63	2-35
0.08	1-15

3. Crushing and screening may be required to meet the specifications in the key trench base. Crushing and screening will be required to create specification-adherent material for use in the dam shell construction.

4. For the dam shell construction, the particles' shape should be angular or sub-angular; any rounded or sub-rounded particles should be removed from the bedding material.

5. The Bedding material shall be washed to remove blast residue, otherwise directed by the Engineer.

5.2.7 Fly Ash Amended Sand Fill

1. Fly ash amended sand fill shall only be used to help fill in discrete pockets in the upstream face of the key trench only where voids or undulations are encountered, to ensure the geomembrane subbase is appropriate for installation.

Fly ash amended sand fill shall consist of four (4) parts sandy aggregate, one (1) part fly-ash and one (1) part Type 10 Portland cement by weight.

2. The sand aggregate used in the mix shall consist of competent non-acid-generating material from the quarries or foundation excavations, including unfrozen soil, and that is free of organic matter, frozen soil, snow, and ice. Definition for frozen soil is provided in Section 3.1.4.

3. The sand aggregate shall have a particle size distribution falling within the limits precented in Table 5.4.

Table 5.4: Sand aggregate particle size distribution limits

Particle Size (mm)	% Passing
25	100
20	85-100
12.5	65-100
10	50-100
5	35-100
2.5	25-85
0.63	20-50
0.08	0-20

4. Crushing and screening may be required to meet the Specifications

5. The sand aggregate material shall be washed to remove blast residue, otherwise directed by the Engineer.

6. Fly ash specifications:

   (1) Fly ash used in the mix shall be in accordance with ASTM C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

(2) The fly ash shall be stored in a dry area and shall not be used if hydrated.

(3) Contractor shall submit the manufacturer's product specification for approval by the owner and the Engineer, 14 days prior to procurements.

5.3 Part 3 – Quality Control

1. The Contractor shall carry out Quality Control testing during the production of construction materials as outlined in Table 5.5.

Table 5.5: Required QC testing during production of construction materials

Material Type	Sample Location	Sample Type	Test Type	Test Location	Expected Turnaround Time	QC Test Frequency	Submittal
Riprap	At Quarry	n/a	Particle Size Analysis (Visual)	n/a	n/a	Ongoing	None
Riprap	At Quarry	Grab	Durability Test	On Site	24-hrs	One per 500 m^3	Test Certificate
Run-of-Quarry	At Quarry	n/a	Particle Size Analysis (Visual)	n/a	n/a	Ongoing	None
Transition	At Crusher	n/a	Particle Size Analysis (Visual)	n/a	n/a	Ongoing	None
Surfacing	At Crusher	Grab	Particle Size Analysis (ASTM C136)	On Site	24-hrs	One per 3,000 m^3	Test Certificate
Bedding	At Crusher	Grab	Particle Size Analysis (ASTM C136)	On Site	24-hrs	One per 1,000 m^3	Test Certificate
Bedding	At Crusher	Grab	Maximum Density (ASTM C698)	On Site	24-hrs	One per 2,000 m^3	Test Certificate
Bedding	At Crusher	Grab	Water Content (ASTM D2216)	On Site	24-hrs	One per 2,000 m^3	Test Certificate
Sand Aggregate (for fly ash amended sand fill)	At Crusher	Grab	Particle Size Analysis (ASTM C136)	On Site	24-hrs	Two samples per batch	Test Certificate
Fly Ash (for fly ash amended sand fill)	At Site Batch Plant	Grab	Particle Size Analysis (ASTM C136)	On Site	24-hrs	Two samples per batch	Test Certificate
Fly Ash Amended Sand Fill	At Site Batch Plant	Grab	Particle Size Analysis (ASTM C136)	On Site	24-hrs	Two samples per batch	Test Certificate

5.4 Part 4 – Quality Assurance

1. The Engineer shall carry out Quality Assurance testing during the production of materials as outlined in Table 5.6.

Table 5.6: Required QA testing during production of construction materials

Material Type	Sample Location	Sample Type	Test Type	Test Location	Expected Turnaround Time	QA Test Frequency	Submittal
Riprap	At Quarry	n/a	Particle Size Analysis (Visual)	n/a	n/a	Ongoing	None
Riprap	At Quarry	Grab	Durability Test	On Site	24-hrs	One per 1,000 m^3	Test Certificate
Run-of-Quarry	At Quarry	n/a	Particle Size Analysis (Visual)	n/a	n/a	Ongoing	None
Transition (General)	At Crusher	n/a	Particle Size Analysis (Visual)	n/a	n/a	Ongoing	None
Transition (Dam Construction)	At Crusher	Grab	Particle Size Analysis (ASTM C136)	On Site	24-hrs	One on upstream slope; One on downstream slope	Test Certificate
Surfacing	At Crusher	Grab	Particle Size Analysis (ASTM C136)	On Site	24-hrs	One per 6,000 m3	Test Certificate
Bedding	At Crusher	Grab	Particle Size Analysis (ASTM C136)	On Site	24-hrs	One per 2,000 m^3	Test Certificate
Bedding	At Crusher	Grab	Maximum Density (ASTM C698)	On Site	24-hrs	One per 4,000 m^3	Test Certificate
Bedding	At Crusher	Grab	Water Content (ASTM D2216)	On Site	24-hrs	One per 4,000 m^3	Test Certificate
Fly Ash Amended Sand Fill	At Site Batch Plant	Grab	Particle Size Analysis (ASTM C136)	On Site	24-hrs	One sample per batch	Test Certificate

---------- END OF SECTION 5 ----------

6 Fill Placement

6.1 Part 1 – General

6.1.1 Documents

1. This section of the Specifications forms part of the Contract Documents and are to be read, interpreted, and coordinated with all other parts.

6.1.2 Description

1. The Works specified in this section includes furnishing all supervision, labour, materials, tools, and equipment for placement of fill material to the lines and grades shown on the Drawings and specified herein.
2. The Works shall include, but are not limited to the following:
   (1) Foundation preparation to receive fill.
   (2) The supply, hauling, placing, and compacting of the specified fill materials as shown on the Drawings.
   (3) All related surveys for layout and control of the Works.
   (4) The Contractor shall assist the Engineer when necessary while Engineer is performing QA testing. In addition, the Contractor shall submit a copy of Contractor's QC results.
   (5) Maintenance of haul roads (as applicable) including snow and ice removal.
   (6) The development, maintenance, and restoration of fill material borrow areas.
   (7) Any other related Works not covered elsewhere.
3. Fill materials required to be placed include, but are not limited to the following:
   (1) Haul, place, and compact Run-of-Quarry (ROQ) material as base layer, as a thermal protection layer, as an erosion protection layer, as a bulk fill material, or as a dam shell material.
   (2) Haul, place and compact Transition material as a transition or filter layer between the ROQ and finer crush material (e.g., surfacing material), to asset in acting as thermal protection layer, to act as a capping layer over overburden, or as a bulk fill material.
   (3) Haul, place, and compact Surfacing material as final trafficking surfaces.
   (4) Haul and place Riprap as an erosion protection or wave energy dissipation layer.
   (5) Haul, place and compact Bedding material as a liner bedding and cover material.
   (6) Haul, place, and compact Transition material as a filter layer between Bedding and ROQ material.

6.1.3 Submittals

1. The Contractor shall submit the information requested in the Quality Control Plan listed below in Section 6.3 to the Engineer and Owner in a timely manner, understanding that approvals to proceed with the Works may be contingent on review and approval of these submittals.
2. Work shall not start until applicable approvals are obtained from the Owner in writing.
3. Approval of submittals shall not relieve the Contractor of its sole responsibility to construct the Works in accordance with specified requirements.

6.2 Part 2 - Execution

6.2.1 Compaction Equipment

1. The compaction equipment shall be the appropriate size and type to achieve the specified densities of the respective fill materials.
2. Where compaction procedures (lift thickness, number of passes, compactor type) are specified the Contractor shall provide compactors that meet or exceed those described in the Specification.
3. A vibratory plate tamper, or other suitable equivalent hand operated compactor will be required for compaction around instrumentation, or in confined spaces. The hand compactor shall be rated to provide sufficient pressure to meet compaction requirements.
4. Notwithstanding the requirements stated above, the equipment and compaction procedures employed by the Contractor shall be subject to approval from the Engineer.

6.2.2 Snow Removal Equipment

1. Care shall be taken when clearing snow above or adjacent to previously placed compacted material to avoid ripping and subsequent damage. Any material, which, in the opinion of the Engineer, has been damaged, shall be removed and replaced.
2. Care shall be taken when clearing snow from original ground to prevent damage to the tundra.
3. If deemed necessary by the Engineer, the Contractor shall use manual labour to clear snow.

6.2.3 Foundation Preparation

1. The Contractor shall prepare an acceptable foundation surface to receive the specified fill material. An acceptable foundation surface is a surface which is clean, sound and firm, and which does not contain any loose, softened, or disturbed foundation material as determined by the Engineer.
2. Based on percolation testing results outlined in Section 9, if hypersaline soils or massive ice are encountered in the range of 2 to 5 m below the existing ground surface, additional excavation below the depth of design key trench in those areas will be evaluated by the

Engineer to determine if additional soil removal is required. Definition for massive ice and hypersaline soil are provided in Section 3.1.4.

3. Riprap, ROQ, Transition, Bedding and Surfacing materials shall be graded in accordance with the Drawings, compacted in lifts and be free of snow, ice, and any other loose or deleterious material.

4. Dense foundation surfaces to receive fill shall be free from noncompacted fill, snow, ice, or other unsuitable materials. The surfaces shall be inspected by the Engineer, who may direct proof rolling with a loaded haul truck, and/or local over excavation and backfilling with approved material. Placement shall be completed as outlined in the applicable sections of these Specifications.

5. Exposed bedrock surfaces shall be reasonably smooth and free of loose or broken rock. Ripping and scraping the fractured bedrock may be required to remove unsuitable rock, as directed by the Engineer.

6. Where depressions or holes exist in the foundation material, acceptable fill shall be placed in depressions, as directed, and compacted as specified herein. Special techniques, handwork and the like shall be required as necessary.

7. Fill shall not be placed on the prepared foundations until they have been inspected and approved by the Engineer.

6.2.4 Fill Placement (General – All Products)

1. Construction must be performed in accordance with the best modern practice and with equipment best adapted to the work being performed. Materials must be placed so that each zone is homogenous, free of stratifications, ice, snow, frozen soil, ruts, and layers of material with different texture or grading not conforming to the requirements stated herein. Definition for frozen soil is provided in Section 3.1.4.

2. No fill material shall be placed on any part of the foundation until it has been prepared as specified herein and approved by the Engineer. The placement of fill material must conform to the lines, grades and elevations shown on the Drawings, as specified herein or as per the direction of the Engineer. Fill placement must be conducted in such a manner that mixing of fill materials with fill materials in the adjacent zones is avoided.

3. Embankment construction shall not proceed when the work cannot be performed in accordance with the requirements of the Specifications. Any part of the embankment that has been damaged by the action of rain, snow or any other cause must be removed and replaced with the appropriate material conforming to the requirements stated herein before succeeding layers are placed.

4. Stockpiling, loading, transporting, dumping, and spreading of all materials shall be carried out in such a manner to avoid segregation or any other condition that does not meet the requirements stated herein. Segregated materials must be removed and replaced with materials meeting the requirements stated herein and receiving the Engineer’s approval.

5. The Contractor must remove all debris, vegetation or any other material not conforming to the requirements stated herein. The Contractor must dispose of these materials in an area approved by the Owner.

6. The compaction operations for fill shall be conducted within the same workday to provide a smooth compact surface. Adjacent individual passes of the compactor shall overlap by approximately 1/3 of the width of the compactor's drum. New fill shall be "keyed" into existing approved fill. Keying in is by placing new fill adjacent to exposed compacted fill. The Contractor is responsible to repair all damages on unfinished work from the previous workday.

7. Unless otherwise specified by the Engineer construction material maximum lift thicknesses and compaction requirements shall be as indicated herein or otherwise specified on the Drawings.

6.2.5 Riprap Material Placement

1. The Riprap material must be placed in accordance with the Drawings, or otherwise as directed by the Engineer.

6.2.6 Run-of-Quarry Material Placement

1. The Run-of-Quarry material must be placed in lifts not exceeding 0.85 m thickness if the total fill thickness is less than 0.85 m. The ROQ material must be placed in lifts not exceeding 1.85 m thickness if the total fill thickness is greater than 1.85 m. The placement method must ensure that segregation and nesting of coarse particles is avoided.

2. Compaction Trials (see Section 6.2.12) shall be used to develop a site-specific Method Specification for compaction of ROQ material.

3. Unless otherwise defined by a Method Specification, the ROQ material (each lift) shall be compacted in accordance with either of the following standards:

   (1) Compacted with a smooth drum vibratory compactor weighing no less than 10 tonnes, with at least eight passes of the compactor (back and forth being two passes). Rolling patterns must be used throughout construction to optimize the number of passes, and vibration frequency for compaction of the ROQ material.

   (2) Compacted by ensuring that loaded haul truck traffic is routed over the entire surface of each lift with a minimum of 4 passes (back and forth being two passes).

6.2.7 Transition Material Placement

1. The Transition material must be placed in lifts not exceeding 500 mm thickness. The placement method used must ensure that segregation and nesting of coarse particles is avoided.

2. Compaction Trials (see Section 6.2.12) shall be used to develop a site-specific Method Specification for compaction of Transition material.

3. Unless otherwise defined by a Method Specification, the Transition material (each lift) shall be compacted in accordance with either of the following standards:

   (1) Compacted with a smooth drum vibratory compactor weighing no less than 10 tonnes, with at least six passes of the compactor (back and forth being two passes). Rolling patterns must be used throughout construction to optimize the number of passes, and vibration frequency for compaction of the Transition material.

   (2) Compacted by ensuring that loaded haul truck traffic is routed over the entire surface of each lift with a minimum of 4 passes (back and forth being two passes).

6.2.8 Surfacing Material Placement

1. The Surfacing material must be placed in lifts not exceeding 200 mm thickness. The placement method used must ensure that segregation and nesting of coarse particles is avoided.

2. Compaction Trials (see Section 6.2.12) shall be used to develop a site-specific Method Specification for compaction of Surfacing material.

3. Unless otherwise defined by a Method Specification, the Surfacing material (each lift) shall be compacted in accordance with either of the following standards:

   (1) Compacted with a smooth drum vibratory compactor weighing no less than 10 tonnes, with at least four passes of the compactor (back and forth being two passes). Rolling patterns must be used throughout construction to optimize the number of passes, and vibration frequency for compaction of the Surfacing material.

   (2) Compacted by ensuring that loaded haul truck traffic is routed over the entire surface of each lift with a minimum of two (2) passes (back and forth being two passes).

6.2.9 Bedding Material Placement

1. The Bedding material underlying geosynthetic products must be placed in lifts not exceeding 300 mm thickness. The placement method used must ensure that segregation and nesting of coarse particles is avoided.

2. Bedding material overlying geosynthetic products must be placed in lifts no less that 300 mm thickness if low ground pressure equipment is used. The contractor must submit a work plan outlining the Bedding material strategy to the Engineer and the Owner for review and approval prior to covering geosynthetics, to allow this specification to be modified to suit.

3. Bedding material underlying geosynthetic products must be compacted to 95% of the maximum dry density (ASTM D698). Moisture conditioning may be required to achieve the specified level of compaction.

4. The first lift of bedding material overlying geosynthetic products shall be compacted to a maximum of 90% of the maximum dry density (ASTM D698) or as specified by the Engineer to prevent damage to the geosynthetic products. Subsequent lifts, if required, of the Bedding material over the geosynthetic product shall be compacted to 95% of the maximum dry

density (ASTM D698). Moisture conditioning may be required to achieve the specified level of compaction.

5. The Contractor must ensure that the integrity of the geosynthetic product is not compromised during construction.

6. Any damage to geosynthetic products must be immediately reported to the Engineer and Owner. Repair work must commence as soon as possible. Fill placement must cease immediately in an area where the integrity of the geosynthetic product has been compromised. Excavation of fill surrounding the damaged geosynthetic products, to allow repairs to be made, must be done without further damaging the integrity of the products. Hand excavation may be required.

6.2.10 Fly Ash Amended Sand Fill Placement

1. The fly ash amended sand fill must be placed in lifts not exceeding 200 mm thickness. The placement method used must ensure that segregation and nesting of coarse particles is avoided.

2. Fly ash amended sand fill shall be compacted using a Method Specification that will ensure a firm competent surface.

6.2.11 Tolerances

1. Fill shall be placed in horizontal lifts to the lines and levels shown on the Drawings, or as directs by the Engineer.

2. Unless specifically detailed on the drawings or from direct communication from the Engineer, then fill and cut surfaces should be completed to an accuracy of ±5 cm or less.

6.2.12 Compaction Trials

1. Compaction trials shall be performed upon production of fill material to determine site specific parameters such as density and compaction standards. The trials shall be carried out as part of the fill placing operation.

2. The Engineer may request through the Owner to periodically conduct field trials to optimize moisture conditioning, lift thickness and compaction effort.

3. The compaction trials on the material in question shall be done using a survey method according to the general procedure detailed below, or as specified by the Engineer:

   (1) A rectangular pad made with the approved material of approximately 7 m width by 20 m length with specified thickness associated with the specified material with placement method according to this Specification.

   (2) A set of survey points with accuracy of ±5 mm shall be laid out as specified by the Engineer in a grid pattern.

   (3) The elevations of each survey points shall be recorded immediately after placement and after each compaction effort.

(4) The compaction be done upward of 10 passes in accordance with this Specification or otherwise specified by the Engineer and survey recorded after each pass.

(5) This process shall be repeated to simulate construction as directed by the Engineer.

4. The Owner and or the Contractor shall obtain the Engineer's approval before implementing any change to the Specifications.

6.2.13 Restrictions Due to Weather and Suspension of Operations

1. The Contractor shall not place any fill when conditions for such operations are unsatisfactory due to heavy snowfall, extraordinarily freezing conditions, or any other reason determined by the Engineer.

2. Where operations have been discontinued by the Contractor or suspended by the Engineer, the effects of adverse conditions shall be assessed by the Engineer and the surficial layers of fill treated or replaced to the satisfaction of the Engineer before resumption of fill placement.

3. In freezing conditions, the Contractor shall:

(1) Provide satisfactory snow and ice removal from subgrade surface.

6.2.14 Sediment and Runoff Control

1. The Owner is responsible to provide the Contractor the locations and methods to construct facilities such as diversion berms, sediment ponds, and other measures as are required to prevent the discharge of fines from construction areas and from entering any natural water courses downstream of the Works during the spring melt season immediately following construction.

2. In general, when placing fill material, the Contractor shall slope the surfaces toward collection channels for surface water management.

3. The Contractor shall not excavate any ditches in the original ground, especially in permafrost overburden. Diversion berms will be the preferred method to re-route surface water.

6.3 Part 3 – Quality Control

1. The Contractor shall be responsible for the quality of fill as described in Section 5.

2. The Contractor shall conduct regular topographic surveys to demonstrate the placement of fill to the specified lines, levels, grades, and tolerances. The Engineer may from time-to-time witness survey checks. Survey results shall be reported to the Engineer and Owner within 24 hours of the completion of each survey.

3. The Contractor shall carry out Quality Control testing during fill placement as outlined in Table 6.1.

Table 6.1: Required QC testing during placement of construction material

Material Type	Sample Location	Sample Type	Test Type	Test Location	Expected Turnaround Time	QC Test Frequency	Submittal
Riprap	In-Place	n/a	Particle Size Analysis (Visual)	n/a	n/a	Ongoing	None
Riprap	In-Place	n/a	Visual and Survey Controlled	n/a	24-hrs	Ongoing	Survey Report
Run-of-Quarry	In-Place	n/a	Particle Size Analysis (Visual)	n/a	n/a	Ongoing	None
Run-of-Quarry	In-Place	n/a	Lift Thickness (Survey Control)	n/a	Hold Point - Before Next Lift is Placed	Every Lift	Survey Report
Run-of-Quarry	In-Place	n/a	Compaction (Visual)	n/a	n/a	Ongoing	None
Transition	In-Place	n/a	Particle Size Analysis (Visual)	n/a	n/a	Ongoing	None
Transition	In-Place	n/a	Lift Thickness (Survey Control)	n/a	Hold Point - Before Next Lift is Placed	Every Lift	Survey Report
Transition	In-Place	n/a	Compaction (Visual)	n/a	n/a	Ongoing	None
Surfacing	In-Place	Grab	Particle Size Analysis (ASTM C136)	On Site	24-hrs	One per 3,000 m^3	Test Certificate
Surfacing	In-Place	n/a	Lift Thickness (Survey Control)	n/a	Hold Point - Before Next Lift is Placed	Every Lift	Survey Report
Surfacing	In-Place	n/a	Compaction (Visual)	n/a	n/a	Ongoing	None
Bedding	In-Place	Grab	Particle Size Analysis (ASTM C136)	On Site	24-hrs	One per 1,000 m^3	Test Certificate
Bedding	In-Place	n/a	Lift Thickness (Survey Control)	n/a	Hold Point - Before Next Lift is Placed	Every Lift	Survey Report
Bedding	In-Place	n/a	Compaction (Visual)	n/a	n/a	One per 100 m^2/Lift	Test Certificate
Fly Ash Amended Sand Fill	In-Place	n/a	Lift Thickness (Survey Control)	n/a	Hold Point - Before Next Lift is Placed	Every Lift	Survey Report
Fly Ash Amended Sand Fill	In-Place	n/a	Compaction (Visual)	n/a	n/a	Ongoing	None

6.4 Part 4 – Quality Assurance

1. QA testing shall be carried out across the full length, width, and depth of the various fill zones to fully represent the overall quality of the structure.

2. The Contractor shall conduct regular topographic surveys to demonstrate the placement of fill to the specified lines, levels, grades, and tolerances. The Engineer may from time-to-time conduct survey checks. Survey results shall be reported to the Engineer and Owner within 24 hours of the completion of each survey.

3. Final acceptance of earthworks will be made only after fill materials have been dumped, spread, moisture conditioned, and compacted, as required and tests and surveys have demonstrated compliance with the Specifications.

4. If based on the sampling and testing, or if in the opinion of the Engineer, an area of the fill does not meet the specified requirements; such fill shall be removed and replaced with conforming material. Rejection of fill material by the Engineer may be made at source, in transporting vehicles, or in place.

5. The Engineer can re-inspect previously approved areas for damages and instruct the Contractor to repair said damages in accordance with the Specifications.

6. The Engineer shall inspect the excavated/blasted key trench for presence of massive ice and log the stratigraphy using geotechnical (ASTM 2488-17) and permafrost logging (ASTM D4083) procedures.

7. The Engineer shall carry out Quality Assurance testing during fill placement as outlined in Table 6.2. Additional testing may be conducted at the discretion of the Engineer.

Table 6.2: Required QA testing during placement of construction materials

Material Type	Sample Location	Sample Type	Test Type	Test Location	Expected Turnaround Time	QA Test Frequency	Submittal
Riprap	In-Place	n/a	Particle Size Analysis (Visual)	n/a	n/a	Ongoing	None
Riprap	In-Place	n/a	Visual and Survey Controlled	n/a	24-hrs	Ongoing	Survey Report
Run-of-Quarry	In-Place	n/a	Particle Size Analysis (Visual)	n/a	n/a	Ongoing	None
Run-of-Quarry	In-Place	n/a	Lift Thickness (Survey Control)	n/a	Hold Point - Before Next Lift is Placed	Every Lift	Survey Report
Run-of-Quarry	In-Place	n/a	Compaction (Visual)	n/a	n/a	Ongoing	None
Transition	In-Place	n/a	Particle Size Analysis (Visual)	n/a	n/a	Ongoing	None
Transition	In-Place	n/a	Lift Thickness (Survey Control)	n/a	Hold Point - Before Next Lift is Placed	Every Lift	Survey Report
Transition	In-Place	n/a	Compaction (Visual)	n/a	n/a	Ongoing	None
Surfacing	In-Place	Grab	Particle Size Analysis (ASTM C136)	On Site	24-hrs	One per 6,000 m^3	Test Certificate

Material Type	Sample Location	Sample Type	Test Type	Test Location	Expected Turnaround Time	QA Test Frequency	Submittal
Surfacing	In-Place	n/a	Lift Thickness (Survey Control)	n/a	Hold Point - Before Next Lift is Placed	Every Lift	Survey Report
Surfacing	In-Place	n/a	Compaction (Visual)	n/a	n/a	Ongoing	None
Bedding	In-Place	Grab	Particle Size Analysis (ASTM C136)	On Site	24-hrs	One per 2,000 m^3	Test Certificate
Bedding	In-Place	Grab	Maximum Density (ASTM D698)	On Site	24-hrs	One per 3,000 m^3	Test Certificate
Bedding	In-Place	Grab	Water Content (ASTM D2216)	On Site	24-hrs	One per 3,000 m^3	Test Certificate
Bedding	In-Place	n/a	Lift Thickness (Survey Control)	n/a	Hold Point - Before Next Lift is Placed	Every Lift	Survey Report
Bedding	In-Place	n/a	Compaction (ASTM D2922)	On Site	Immediate	One per 400 m^2/Lift	Test Certificate
Fly Ash Amended Sand Fill	In-Place	n/a	Lift Thickness (Survey Control)	n/a	Hold Point - Before Next Lift is Placed	Every Lift	Survey Report
Fly Ash Amended Sand Fill	In-Place	n/a	Compaction (Visual)	n/a	n/a	Ongoing	None

---------- END OF SECTION 6 ----------

7 Geosynthetics

7.1 Part 1 – General

7.1.1 Documents

1. This section of the Specifications forms part of the Contract Documents and are to be read, interpreted, and coordinated with all other parts.

This section specifies requirements for the supply and installation of the following geosynthetic products:

(1) Textured High Density Polyethylene (HDPE) Liner;

(2) Non-Woven Geotextile Fabric;

(3) Extrusion rods;

7.1.2 Description

1. The Works to be done under this Section consist of furnishing all labour, materials and equipment and the performance of all Works necessary to carry out geosynthetic installations as shown on the Drawings and as specified herein.

7.2 Part 2 – Products

7.2.1 Submittals

1. The Owner will submit the following information at least 14 days prior to material arrival at the designated marshalling area:

(1) Manufacturer's written certification that the geosynthetic products to be used meet the Specifications and have been continuously inspected.

(2) The certification shall identify the origin and the manufacturer of any resin used in manufacturing of the geosynthetic product.

2. Work shall not start until applicable approvals are obtained from the Owner in writing.

Approval of submittals shall not relieve the Contractor of its sole responsibility to construct the Work in accordance with specified requirements.

7.2.2 Definitions

1. The following words and terms, unless the context otherwise requires, in this Specification, shall have the meanings se out below:

(1) GEOSYNTHETICS included textured HDPE liner, geotextile and other supplies used in liner, geotextile deployment.

(2) HDPE Liner means textured High Density Polyethylene liner, as specified.

(3) GEOTEXTILE means woven or non-woven geotextile, as specified.

(4) EXTRUSION RODS mean HDPE rods that are fed into an apparatus for extrusion welding.

7.2.3 Product Specifications

1. The High Density Polyethylene (HDPE) liner shall be textured and have a nominal thickness of at least 1.4mm (57 mil). The basic liner requirements are listed in Table 7.1.

Table 7.1: HDPE liner specifications (typical product)

Parameter	Standard	HDPE 60 Textured
Nominal Thickness	ASTM D5199	1.42 mm (57 mil)
Density (Untextured)	ASTM D792	0.94 mg/l
Tensile Strength Modified Type IV Die	ASTM D638 (Stress at Yield)	22.0 kN/m (126 ppi)
	ASTM D638 (Stress @ Break)	15.8 kN/m (90 ppi)
	ASTM D638 (Strain @ Yield 33mm Gauge)	12%
	ASTM D638 (Strain @ Yield 50mm Gauge)	100%
Tear Resistance	ASTM D1004	187 N (42 lbs)
Dimensional Stability	ASTM D1204 (Max Cng).	± 2%
Notched Constant Load ESCR	ASTM D5397	200 Hours
Puncture Resistance	ASTM D4833	400N (90 lbs)
Carbon Black Content	ASTM D1603	2.0 – 3.0%
Carbon Black Dispersion	ASTM D5596	CAT 1 or 2
Bonded Seam Strength Test Temp 23°C, 73°F	ASTM D6392	21 N/mm (120 ppi)
Peel Adhesion Test (FTB) Test Temp 23°C, 73°F	ASTM D6392	14 N/mm (78 ppi)

The geotextile shall be a non-woven needle-punched fabric with a nominal weight of at least 385 g/m^2 (12 oz) and must satisfy the Specifications listed in Table 7.2.

Table 7.2: Geotextile specifications (typical product)

Parameter	Standard	LP12
Grab Tensile	ASTM D4632	1,330 N
Elongation	ASTM D4632	50%
Tear	ASTM D4533	510 N
Puncture	ASTM D4833	775 N
Mullen Burst	ASTM D3786	3,995 kPa
AOS	ASTM D4751	150 microns
Permittivity	ASTM D4491	0.9 sec^{-1}
Water Flow	ASTM D4491	2,648 l/min/m^2

Weight	ASTM D5261	385 g/m^2 (Nominal)
Thickness[1]	ASTM D5199	3.0 mm (Nominal)
UV (500 hrs)	ASTM D4355	70%
Roll Size	n/a	4.57 X 91.4 m
Roll Weight[1]	n/a	181 kg

Notes:

[1] Typical value. All other values are minimum average roll values (MARV)

Extrusion rods and other welding supplies shall conform to the following Specifications:

(1) Extruded material shall be made from the same type of resin as the HDPE liner.

(2) The extrusion rod has compatible diameter for proposed apparatus.

(3) Contractor shall submit product certificates for the Owner and the Engineer's approval prior to deployments.

(4) Additives shall be thoroughly dispersed.

(5) Material shall be free of contamination by moisture or foreign matter.

7.2.4 Equipment

1. The Owner shall ensure the Contractor supplies proper handling equipment, as recommended by the manufacturer, for the geosynthetic installation, which does not pose any danger to installation personnel or risk damage or deformation of the geosynthetics. Examples of suitable handling equipment include, but is not limited to:

   (1) Spreader bar assembly;

   (2) Stinger;

   (3) Roller cradles; and

   (4) Straps.

2. Equipment for welding HDPE:

   (1) A self-propelled fusion wedge welder and an extrusion welding apparatus from a recognised manufacturer.

   (2) The fusion wedge welder shall have certified working gauges showing working temperature and speed.

   (3) An adequate number of extrusion welding apparatus shall be available to maximize production.

   (4) The Contractor must supply an adequate power source, capable of providing constant voltage under combined line load.

(5) The Contractor must provide suitable shelter and heater to ensure that a suitable environment can be created for completion of seams according to the Specifications.

7.2.5 Delivery, Storage and Handling

1. Delivery, storage, and handling shall conform to the requirements of the manufacturer and shall be carried out in a manner which shall protect the geosynthetics from damage or water penetration during shipment.

Packing and shipping shall as a minimum conform to the following:

(1) Supply geosynthetic in rolls with straps for unloading.

(2) Supply geosynthetic marked or tagged with the following information:

a. Manufacturer's name

b. Product information

c. Roll number

d. Batch or lot number

e. Roll Dimensions

(3) Ensure that geosynthetics are properly loaded and secured to prevent damage during transit.

(4) Protect geosynthetics from excessive cold, heat, puncture, cutting, or other damaging or deleterious conditions.

(5) Ensure personnel responsible for loading, transport and unloading of geosynthetics are familiar with the handling and transport constraints imposed by the manufacturer.

Acceptance at Works site shall as a minimum conform to the following:

(1) Engineer may perform inventory and surface inspection for defects and damage of geosynthetic rolls upon delivery.

(2) The Engineer will unroll and inspect any geosynthetic roll that may appear to be damaged below surface layers.

(3) The Contractor will repair damage resulting from handling and transport of geosynthetics. If irreparable, in the opinion of the Engineer, the Owner will replace damaged materials.

Storage and protection shall as a minimum conform to the following:

(1) Contractor will provide on-site area for storage of geosynthetic rolls from time of delivery until installation with the approval from the Engineer.

(2) Prepare storage area so that the geosynthetic products are stored off the ground and protected from elements (e.g., ultraviolet light, water, moisture, etc.).

(3) After removing material from storage area, protect geosynthetic from puncture, dirt, groundwater, moisture, mud, mechanical abrasion, excessive heat and cold, ultraviolet light exposure, and other sources of damage. Keep geotextile rolls in relatively opaque and watertight wrappings.

(4) Preserve integrity and readability of the geosynthetics roll labels, and store such that Engineer shall have access to the package slips or roll labels for each roll to verify roll acceptance.

7.3 Part 3 – HDPE Liner Installation

7.3.1 Installation

1. Deployment:

(1) The Contractor must submit a proposed liner layout 14 days prior to deployment for Engineer's approval through the Owner.

(2) The key trench shall be excavated as shown on the Drawings. The surface prepared for the geomembrane shall be smooth with all protrusions and angular particles larger than 20 mm removed.

(3) Fly ash amended sand fill shall only be used to help fill in discrete pockets in the upstream face of the key trench only where voids or undulations are encountered, to ensure the geomembrane subbase is appropriate for installation.

(4) The installation of the geomembrane shall not begin until a proper subbase has been prepared and approved by the Engineer.

(5) An anchor trench shall be excavated, or weight ballast constructed by the Contractor to the lines and grades shown on the Drawings or as directed by the engineer.

(6) The liner should cover the depth and width plus minimum 200 mm slack beyond the width of the trench.

(7) The liner shall not be excessively dragged across the subgrade.

(8) Assist each panel a simple and logical identifying code. The coding system shall be subject to Engineer's approval.

(9) Visually inspect the geomembrane during deployment for imperfections and mark faulty or suspect areas.

(10) Deployment of geomembrane panels shall be performed in a manner that will comply with the following guidelines:

a. Unroll the geomembrane using methods that will not damage geomembrane and will protect the underlying surface from damage.

b. Unroll the geomembrane with the textured surface on top. Its purpose for this Project is to provide some slip resistance for worker, as opposed to structural integrity.

c. Place ballast on geomembrane which will not damage on puncture the geomembrane to prevent wind uplift.

d. Personnel working on geomembrane shall not engage in activities or wear shoes that could damage the liner. Smoking will not be permitted on geomembrane.

e. Do not allow heavy vehicular traffic directly on geomembrane. Low bearing vehicles under 42 kPa might be permitted with Engineer's approval.

f. Protect geomembrane in areas of heavy traffic by placing protective cover over the liner. The protective cover should at a minimum consist of 300 mm of approved fill material. This thickness is subject to change by the Engineer depending on site conditions.

(11) The contractor shall determine to his own satisfaction that sufficient extra material for anchor embedment, seams, slack, thermal expansion ad contraction of the material and waste are included on top of the neat area given.

2. Field seaming:

(1) Fusion weld seams shall meet the following requirements:

a. To the maximum extent possible, orient seams parallel to line of slope.

b. Minimize number of field seams in corners, odd-shape geometric locations and outside corners.

c. Slope seams shall extend a minimum of 1.5 m beyond the grade break into the flat area.

d. Use a sequential seam numbering system compatible with panel numbering system that is acceptable to the engineer.

e. Align seam overlaps consistent with the requirements of the welding equipment being used. A minimum 150 mm overlap is recommended to ensure proper welding.

f. Use manufacturer's recommended temperature and speed for the wedge welders.

g. Clean seam area of dust, mud, moisture, and debris immediately ahead of wedge welder.

h. Protect against moisture build-up between sheets due to condensation.

(2) Extrusion welding:

a. Hot-air track adjacent pieces together using procedures that do not damage the geomembrane.

b. Clean and roughen geomembrane surfaces by disc grinder or equivalent.

c. Purge extrusion welding apparatus of heat-degraded extrudate before welding.

(3) Seaming shall not proceed when ambient air temperature or adverse weather conditions jeopardize the integrity of the liner installation. Contractor shall demonstrate that acceptable seaming can be performed by completing a weld and obtaining approval by the Engineer.

(4) Repair and non-destructively test each suspect location in both seam and non-seam areas. Do not cover geomembrane at locations that have been repaired until test result with passing values are available to the Engineer.

7.3.2 Seam Testing and Repair

1. Non-destructive testing may be carried out as the seaming progresses.

   (1) Vacuum testing shall be performed in accordance with ASTM D5641, Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.

   (2) Air Pressure testing shall be performed in accordance with ASTM D5820, Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembrane.

2. Destructive Testing procedures:

   (1) One sample per 450 m liner seam length or at Engineer's request.

   (2) Contractor shall cur samples at locations designated by the Engineer as the seaming progresses in order to obtain field laboratory test results.

   (3) Destructive testing shall be performed in accordance with ASTM D6392, Standard Test Method for Determining the Integrity of Non-Reinforced Geomembrane Seams Produced Using Thermo-Fusion Method.

3. Failed Seam procedures:

   (1) Reconstruct the seam between any two passed test locations, or,

   (2) Trace the weld to intermediate location at least 3 m minimum, or where the seam ends in both directions from the location of failed test.

   (3) Extrude weld or cap the failed section tying onto passes seam.

4. Repair procedure:

   (4) Contractor shall be responsible for repair of defective areas.

   (5) Remove damaged geomembrane and replace with acceptable geomembrane material if damage cannot be satisfactorily repaired.

5. All repairs shall be verified by the Engineer.

7.3.3 Liner Cover

1. All exposed HDPE liner will be covered with minimum 300 mm of Bedding material unless stated otherwise. The material shall be deployed with care to ensure that the liner will not be

damaged during operation. The material is to be spread evenly without any compaction. Traffic shall not be permitted directly on the geomembrane.

2. A minimum thickness of 600 mm, as determined by the Engineer, shall be kept between heavy equipment and the geomembrane at all times, except during final grading. Heavy vehicles should not be driven directly on the geomembrane until the proper thickness of cover has been placed. If the final design thickness of over liner cover is less than 600 mm, then the cover shall be cut back/ reduced to the design thickness as the equipment work is over.

3. Unless specifically indicated by the Engineer, HDPE liner shall at all times be placed between two geotextiles

7.4 Part 4 – Geotextile Installation

7.4.1 Geotextile Deployment

1. The Contractor shall submit a proposed panel layout 14 days prior to deployment for Engineer's approval through the Owner.

2. The Contractor shall have enough ballast weights, such as sandbags, during the deployment to hold and keep the deployed panels in place as protection against wind.

3. The geotextile shall be unrolled as smoothly as possible on the prepared subgrade in the direction of construction traffic.

4. Geotextile rolls shall be overlapped in the direction of sub-base placement.

5. The geotextile shall be 200 mm minimum overlapped and stitched or heat bonded together. The Engineer will inspect the stitching or heat bonding to ensure quality of Works.

6. On Curves, the geotextile may be folded or cut and overlapped to conform the curve.

7. The fold or overlap shall be in the direction of construction and shall be held in place as prescribed above.

8. The geotextile shall not be excessively dragged across subgrade.

9. Damaged geotextile, as identified by the Engineer, shall be repaired immediately. The damaged area plus as additional 1 m around the damaged area shall be cleared of all fill material. A geotextile patch extending 1 m beyond the perimeter of the damage shall be installed as directed by the Engineer.

10. A method of attaching the geotextile patch may be required over soft subgrade as directed by the Engineer.

7.5 Part 5 – Quality Control

1. The Owner and Contractor must ensure that all geosynthetic manufacturers have an internal product GC program that meets contract requirements.

2. The Owner and Contractor are responsible to ensure that all geosynthetic material delivered to site meet the Specifications.

3. Geosynthetics that do not mee the Specifications will be rejected. The Owned and Contractor will replace any rejected material with new material that meets the Specifications
4. The Owner and Contractor must ensure that the geosynthetic installations are carried out by a suitably qualified and experienced team or subcontractor.
5. The Contractor shall supply a QC program for installation of the geosynthetics for review and approval by the Owner and the Engineer.
6. The Contractor shall supply all testing technicians and equipment required in the QC program.
7. The Contractor, or his designated Subcontractor's testing technicians shall be responsible for panel labeling, destructive testing, repair labelling and inspections, overall QC of Works, as outlined in the QC program, and record keeping.
8. The Contractor shall generate, and submit for review to the Engineer and Owner, an As-built QC report that includes:
   (1) Record of material deployment.
   (2) As-built panel layout with panel number and associated roll number finalized in AutoCAD 2007 or later format.
   (3) All destructive test results with panel numbers and associated roll numbers.

7.6 Part 6 – Quality Assurance

1. The Engineer will confirm that all geosynthetic material delivered to site meet the Specifications. This will be done through visual inspection, and through review of product certificates.
2. Geosynthetics that do not meet the specifications will be rejected. The Owner and Contractor will replace any rejected material with new material that meets the Specifications.
3. The Engineer will review the Contractor's QC program for installation of the geosynthetics and inform the Contractor via the Owner if changes are needed.
4. The contractor shall supply all testing technicians and equipment required in the QC program and make the personnel and equipment available to the Engineer for QA testing, over and above continuous visual inspection.
5. The Engineer shall review the Contractor's As-built QC report and inform the Contractor via the Owner if changes are needed.

---------- END OF SECTION 7 ----------

8 Instrumentation

8.1 Part 1 – General

8.1.1 Documents

1. This section of the Specifications forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.

8.1.2 Definitions

1. The following words and terms, unless the context otherwise requires, in this Specification, shall have the meanings set out below:
   (1) GROUND TEMPERATURE CABLE means manufactured cable with thermistor beads that allow in-situ ground temperature measurement.
   (2) THERMISTOR BEAD means an individual sensor used to measure in-situ ground temperature.
   (3) SETTLEMENT MONUMENT means an instrument capable of measuring in-situ ground deformations.

8.1.3 Materials

1. The ground temperature cables shown on the Drawings will by manufactured and supplied by a specialist contractor.
2. Ground temperature cables, casing, and datalogger housing will be supplied by the Contractor and Owner, with explicit direction provided by the Engineer.
3. The settlement monuments will be supplied and installed by the Contractor, with explicit direction provided by the Engineer.
4. The Contractor shall be responsible for providing protection for all instrumentation installed before construction of the dam is complete. The method of protection must be provided by the Engineer. The contractor may be held responsible (at the Engineer's discretion) for replacement or repair of instruments damages during construction.

8.1.4 Procedures

1. Ground temperature cables must be installed as shown in the Drawings to measure ground temperature during construction and operation of the dams.
2. Settlement monuments must be installed as shown on the Drawings to allow any settlements of the dams to be measured.

8.1.5 Submittals

1. At least seven (7) days prior to installation of the ground temperature cables, the Contractor shall submit to the Engineer and Owner, for approval, the Manufacturer's Calibration Certificates for each ground temperature cable.

8.2 Part 2 – Execution

8.2.1 Ground Temperature Cable Installation

1. Horizontal and vertical ground temperature cables must be installed during construction. The locations and orientation of the ground temperature cables are shown in the Drawings.
2. Drill holes for ground temperature cables installation must be between 100 mm and 150 mm in diameter. Drill holes must be drilled in the presence of the Engineer to the depths shown on the Drawings.
3. Vertical ground temperature cables shall be installed inside a 1” to 2” diameter PVC pipe that has been installed in the drillhole.
4. The drill hole with installed ground temperature cable must be backfilled with slurry to prevent air voids around the ground temperature cable or PVC.
   (1) The slurry shall consist of approximately 15% to 35% water by volume. The water content shall be moist enough to attain workable and fully saturated mixture but shall be minimized to facilitate freeze back. A pencil vibrator or a pile vibrator shall be used to densify the slurry.
   (2) Aggregate used for slurry shall consist of mineral soils conforming to the following gradation limits listed in Table 8.1.

Table 8.1: Typical gradation of slurry sand for backfill

Particle Size (mm)	% Passing
10	100
5	85-100
2	60-100
0.63	20-65
0.08	0-15

   Water used for slurry production shall be fresh potable water. The temperature of the slurry when placed shall not exceed 10^{o}C to minimize permafrost disturbance and freeze back time.

   (3) Accurate records of slurry volumes placed down the hole shall be kept. This is to identify that there are no voids between the cable and the side of the hole.
5. The potion of the cable extending beyond the dam fill must be protected with a steel pile extending 1 m above the final elevation of the dam. The steel pipe must be painted with fluorescent paint.
6. Contractor is responsible for protecting the above surface portion of the instrument from damage by construction equipment and animals.

7. The location of the installed instruments must be surveyed.

8.2.2 Settlement Monuments Installation

1. Settlement monuments must be supplied and installed by the Contractor according to the Drawings and as directed by the Engineer.

8.3 Part 3 – Quality Control

1. Physically demarcate, for review and approval by the Owner and Engineer, the Works area where the instrumentation will be installed using proper survey control.
2. Conduct field surveys, and submit As-built Drawings, in electronic format of the installed instrumentation.

8.4 Part 4 – Quality Assurance

1. Visually inspect the demarcated zone prepared by the contractor for installing the instrumentation and inform the Contractor via the Owner if changes are required.
2. Visually inspect the installed instrumentation and inform the Contractor via the Owner if changes are required.
3. Review As-built Drawings submitted by the Contractor of installed instrumentation and inform the Contractor via the Owner if any changes are required.
4. Review the manufacturer’s Calibration certificates for the ground temperature cables and inform the Contractor via the Owner if any changes are required.
5. Confirm that each ground temperature cable is functioning prior to installation and throughout the construction stage.

---------- END OF SECTION 8 ----------

9 Percolation

9.1 Part 1 – General

9.1.1 Documents

1. This section of the Specifications forms part of the Contract Documents and are to be read, interpreted, and coordinated with all other parts.

9.1.2 Definitions

1. The following words and terms, unless the context otherwise requires, in this Specification, shall have the meanings se out below:

(1) PERCOLATION TEST means a test within the footprint of the dam key trench prior to excavation to confirm the base of the key trench is founded within saturated frozen soil.

9.2 Part 2 – Execution

9.2.1 Test Procedure

1. Survey and mark the layout of the percolation test holes within the footprint of the proposed key trench area.
2. Drill the percolation test holes using an air-track drill and air flush with a minimum hole diameter of 100 mm. The depth of the test holes will depend on the local geotechnical conditions defined by the Engineer.
3. Drill cutting samples should be collected and bagged every 500 mm during drilling to a depth of 4 m, and every 1,000 mm between a depth of 4 m and 10 m. Material returned from a depth greater than 10 m should be sampled every 2,000 mm. Photographs should be taken of the collected samples. A box, board, or shovel placed near the test hole during drilling may be used to collect samples of the drill cuttings.
4. The samples collected during drilling of the percolation holes should be logged using geotechnical and permafrost logging procedures to develop a soil profile log.
5. Moisture content determinations should be completed on all the samples collected. Salinity testing should be carried out on approximately 30% of the samples collected or as directed by the Engineer. The samples for salinity testing should be determined based on varying depths and material type changes.
6. Upon completion of drilling, the top of the percolation hole should be insulated until ready for testing. Insulation can be fiberglass batting, or other equivalent material, which should penetrate about 600 mm down the percolation hole.
7. When ready for testing, remove the insulation and fill the percolation hole with water that has a temperature of approximately 15^{o}C (holes are filled only once). Where possible, record the volume of water required to fill the hole. Volume estimation may be achieved through use of 20-lnet pails.

8. Record the change of the water level in the percolation hole using a measuring tape. Readings should be taken at suitable time intervals to determine the rate of water level change and at which level there is no further change of the water level. For example, the reading schedule can be: 0 min, 1 min, 2 min, 5 min, 10 min, 15 min, 30 min, 45 min, 60 min, 90 min, 2 hrs, 8 hrs, 16 hrs, 24 hrs, and 36 hours.
9. Keep the percolation holes insulated between water level readings.
10. Following the completion of percolation testing, all percolation holes with a final depth to ice greater than 1 m should be backfilled with 20 mm crush and water and allowed to freeze back after percolation testing is completed.

9.3 Part 3 – Quality Control

1. The Contractor shall carry out Quality Control testing during percolation testing, including, but not limited to:
   (1) Survey control of the percolation test hole locations.
   (2) Survey control of the percolation test hole dimeter and final depth.

9.4 Part 4 – Quality Assurance

1. The Engineer shall carry out Quality Assurance testing during percolation testing, including, but not limited to:
   (1) Recording of percolation test conditions as specified in this document.
   (2) Logging of percolation test holes, including completion of moisture content testing, and conducting two (2) to three (3) salinity tests per percolation test hole.

---------- END OF SECTION 9 ----------

10 Horizontal Thermosyphons

10.1 Part 1 –General

10.1.1 Documents

1. This section of the Specifications forms part of the Contract Documents and are to be read, interpreted, and coordinated with all other parts.

10.1.2 Definitions

1. The following words and terms, unless the context otherwise requires, in the Specification, shall have the meanings set out below:

   (1) THERMOSYPHON means a passive heat transfer system using a combination of evaporator pipes and radiators to ensure that the base of the key trench remain frozen for the design life of the dam.

   (2) RADIATOR means a manufactured product with fins to enhance heat transfer from the evaporator pipes to ensure efficient working of the thermosyphon.

   (3) EVAPORATOR PIPE means the steel pipe installed at the base of the dam key trench to transfer heat from the ground to the atmosphere via the radiator.

10.1.3 Materials

1. The horizontal thermosyphons shown on the drawings will be manufactured, supplied, and installed by a specialist contractor.
2. The thermosyphons shall be two-phase, liquid-vapour type thermosyphons charged with carbon dioxide refrigerant.
3. The thermosyphons shall be constructed with A53B Schedule 40 steel pipe.
4. The radiators shall be 75 mm O.D. pipe with 32 mm high x 0.012 mm nominal thickness carbon steel fins. Fin density shall be four (4) rows of fins per 25 mm of pipe.
5. Standard of Acceptance: Thermosyphons as manufactured by Arctic Foundations of Canada Inc., Winnipeg, Manitoba, or an approved equal.
6. The evaporator and radiator sizes shall be as shown on the Drawings.
7. All welds shall meet ASME boiler and pressure vessel Code B31.3.

10.2 Part 2 – Execution

10.2.1 Installation

1. The evaporator pipes shall be installed as specified on the Drawings.
2. The radiators shall be erected plumb.
3. All piping shall be tested by the installer prior to burial.

10.2.2 Monitoring

1. The operation of the thermosyphons shall be monitored with a contact thermometer or an infrared surface temperature measuring device to verify operation. Operation is generally indicated by a thermosyphon radiator and condenser surface temperature being a few degrees warmer than the air temperature. Monitoring shall be carried out twice a month during the first three months in which the thermosyphons are expected to be operational. The thermosyphons will only be operational during the period when the air temperatures are colder than the ground temperatures.
2. Performance of the thermosyphons shall be evaluated with ground temperature cables as shown on the Drawings and as described in Section 8 of this document.

10.3 Part 3 – Quality Control

1. Physically demarcate, for review and approval by the Owner and Engineer, the Works area where the thermosyphons will be installed using proper survey control.
2. Conduct field surveys, and submit As-built Drawings, in electronic format of the installed thermosyphons.
3. Conduct a pressure test on each individual completed thermosyphon and submit the results of the test to Owner and the Engineer for review.

10.4 Part 4 – Quality Assurance

1. Visually inspect the demarcated zone prepared by the Contractor for installing the thermosyphons and inform the Contractor via the Owner if changes are required.
2. Visually inspect the installed thermosyphons and inform the Contractor via the Owner if changes are required.
3. Review As-built Drawings submitted by the Contractor of installed thermosyphons and inform the Contractor via the Owner if any changes are required.
4. Review the results of the pressure tests conducted on the thermosyphons and inform the Contractor via the Owner if any changes are required.
5. Monitor the thermosyphon temperatures and inform the Contractor and Owner is trends emerge suggesting non-performance of the system.

---------- END OF SECTION 10 ----------