Tahera Diamond Corporation

JERICHO PROJECT
WEST DAM
CONSTRUCTION SPECIFICATIONS

1100060.004

September 2005

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1.0 GENERAL

The West Dam is a zoned rockfill dam used to retain tailings within the Jericho Processed Kimberlite Tailings Facility.

The structural body of the dams is till, a frozen crushed rock core, and rockfill shell. A geocomposite clay liner will also be constructed in the dam.

2.0 DEFINITIONS OF TERMS USED

Construction Drawings:	the design drawings as issued for construction of the dams.
Construction Specifications:	this document.
Contractor:	the general contractor responsible for constructing the dam(s).
Engineer :	EBA Engineering Consultants Ltd. (EBA) representative on site during dam construction or related activities.
Owner:	Tahera Diamonds Corporation (Tahera)
Site:	the area in which dam construction or related activity is occurring
Unsuitable:	not meeting the requirements stated herein or not receiving the Engineer's approval.

3.0 MATERIALS

The material zones referenced in these specifications are designated on the Construction Drawings. Total material quantities have been estimated as follows:

TABLE 1001.1: DAM MATERIAL QUANTITIES

Structure	Geocomposite Clay Liner (m^2)	Fill Material Type			
		20 mm Minus Crush (m^3)	Transition (200 mm) (m^3)	Rock Fill Shell (m^3)	Till (m^3)
West Dam	6,100	17,000	7,600	52,000	3,100

Note: Quantities are "in-place". Seaming allowance and contingencies must be added to liner quantities. It is recommended that 20% extra quantities be available on site to allow for contingency and seaming allowances. Bulking factors and contingencies must be added to fill quantities; 20% should be added to reported quantities for stockpile volumes.

.1 Volumes have been calculated based on 1.0 m bathymetry and topographic data provided by Tahera. The survey was carried out by Sub-Arctic Surveys.

.2 The depth and volume of key trench excavation is dependent on the conditions encountered. The required depth will be determined during construction by the Engineer.

4.0 SITE CLEANUP

The Contractor shall remove all temporary structures and shall clean up the construction areas, borrow areas, and stockpile areas.

1.0 GENERAL

.1 Water control for construction of West Dam is described in this section.

.2 The key trench and dam footprint areas shall be dewatered as required to allow for fill placement in a dry environment.

.3 Water control and dewatering is the responsibility of the Contractor.

2.0 COFFERDAMS

.1 Temporary cofferdams are required to minimize water flow into the key trench excavation.

.2 Construction and design of the cofferdams is the responsibility of the contractor. The design and construction plan must be submitted to the Engineer prior to construction.

3.0 DEWATERING SUMP(S)

.1 Any inflow of ground water or surface run off water into the key trench or dam footprint must be controlled using suitably placed and sized sumps and pumps.

.2 Water collected in the sumps must be discharged into the PKCA area of the dam construction area. Discharge of water must not cause erosion.

.3 Construction, operation and maintenance of the sump(s) and pump(s) are the responsibility of the Contractor.

1.0 GENERAL

.1 Foundation preparation for dams is presented in this section.

2.0 NON-KEY TRENCH FOUNDATIONS

.1 Open graded boulders must be removed as determined by the Engineer.

.2 Ice rich or other soils beneath the liner system and deemed to be unsuitable by the Engineer must be removed.

3.0 KEY TRENCH FOUNDATION

.1 The key trench must be excavated into ice saturated, permanently frozen soil or rock as determined by the Engineer. The base of the excavation must have no natural or excavation related open voids or joints.

.2 The depth of excavation will be determined in the field by the Engineer. The depth of the key trench may be increased in some areas at the discretion of the Engineer to confirm the suitability of the foundation soils beneath the key trench.

.3 Excavation of rock shall be conducted in a manner that avoids excessive fracturing of underlying rock.

.4 The key trench can be excavated using mechanical or drill and blast means. Drill and blast excavation may be limited by the Engineer if excessive cracking of rock or soil beneath the key trench occurs.

.5 Final cleaning of the key trench must be conducted with hand excavation, brooms and compressed air or other appropriate equipment such as rippers, jack hammers etc. to remove all loose, broken or altered material from the base of the key trench. Snow and ice must be removed from the key trench prior to fill placement.

.6 Ice rich soil exposed on the upstream face of the key trench excavation shall be removed from areas underlying the liner system. Additional excavation beyond the limits of the key trench excavation may be required at the Engineer's discretion.

.7 Any inflow of water into the key trench excavation shall be controlled by sumps and pumps in a manner that minimizes thaw and erosion of the key trench base.

4.0 DRILLING AND BLASTING

.1 The Contractor is responsible for ensuring that blasting procedures used are within guidelines set by all regulatory bodies and authorities having jurisdiction on Site.

.2 The Contractor must use excavation methods that minimize fracturing beyond excavation limits.

.3 Care must be taken in locating the drill holes, orienting the drills and during drilling so that accurate positioning and alignment of the drill holes is achieved.

.4 The method of excavation must produce a key trench base that is free of abrupt changes in elevation.

.5 The Contractor will drill test holes for use in percolation tests prior to drilling and blasting in the key trench area as instructed by the Engineer.

.6 Controlled blasting techniques must be used to satisfy the excavation requirements stated herein. The initial explosive type and quantity, blasting sequence and delay pattern must be flexible in order to meet these requirements.

.7 The Contractor shall submit complete details of any proposed blast to the Engineer. Submitted data shall include the following:

- the location, depth and area of the blast,
- the type, strength, quantity, column load and distribution of explosives to be used per hole, per day and per blast,
- the sequence and pattern of the delay, and
- the description and purpose of any special methods to be adopted.

.8 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 Engineer before continuing with drilling and blasting in adjacent areas.

5.0 FOUNDATION APPROVAL

.1 The foundation must be inspected and approved by the Engineer before any fill material is placed.

1.0 GENERAL

.1 The material specifications for fill materials used in construction of the dams are presented in this section.

.2 Material quantities are presented in Section 1001

2.0 MATERIAL SOURCES

.1 No material shall be borrowed or excavated without the Owner's prior approval.

.2 Pits and quarries must be maintained and managed in accordance with the requirements set out in the Owner's Land Use and Quarry Permits.

.3 The Contractor must process all materials to meet the gradations specified herein.

.4 Bedding material may be processed from material obtained from the Jericho pit or sources approved by the Owner, provided the final product meets the requirements specified herein. Processing will be required to achieve the specified gradation.

.5 Transition (200 mm minus) material shall be obtained from Jericho pit or other sources approved by the Owner, providing the final product meets the gradations specified herein. Processing will be required to achieve the specified gradation.

.6 Run-of-Mine material (700 mm maximum) shall be obtained from Jericho pit or other sources approved by the Owner, provided the final product meets the requirements stated herein. Specific quarrying and/or processing procedures may be required to achieve the specified maximum top size.

.7 Till shall be obtained from the Jericho pit or other sources approved by the Owner,

.8 The parent rock from which all fill materials are derived from must be hard, durable rock. The rock in a potential quarry source must be approved by the Engineer prior to quarrying. The Engineer may require trial crushing and durability testing

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

3.0 MATERIAL SPECIFICATIONS

.1 20 mm minus

a. The 20 mm minus material must consist of hard, durable particles, be free of roots, topsoil or deleterious material and have a particle size distribution falling within the limits set forth in Table 1005.1.

b. The 20 mm minus material to be used in the key trench and frozen core shall be 20 mm minus crush granite. The 20 mm minus used for liner cover can be crushed granite or esker material.

TABLE 1005.1 : BEDDING MATERIAL PARTICLE SIZE DISTRIBUTION LIMITS	
Particle Size (mm)	**% Passing**
20	100
12.5	65 – 100
5	45 – 70
.63	15 - 35
.08	4 - 10

.2 Transition 200 mm minus Material

a. The Transition 200 mm minus material must be free of roots, topsoil and other deleterious material and have a particle size distribution falling within the limits presented in Table 1005.2.

TABLE 1005.2 : TRANSITION -200 MM 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 Run-of Mine Material

a. The Run-of-Mine material can have a wide variation in gradation with a maximum particle size of 700 mm. Rockfill particles must be hard, durable and angular.

b. The depth and spacing of drill holes as well as the weight and delay of charges shall be selected to produce Run-of-Mine rockfill material meeting the specification.

c. Any significant concentration of unsuitable materials must be removed and directed to a waste disposal area, other location approved by the Owner or, with the Engineer's approval, mixed with other materials to produce a material meeting specifications.

.4 Till Material

a. The Till material can have a wide variation in gradation with a maximum particle size of 300 mm. Particles must be hard, durable and angular.

1.0 GENERAL

.1 The placement methods to be used in the construction of the dams are described in this section.

.2 Construction must be performed in accordance with the best modern practice and with equipment best adapted to the work being performed. Embankment materials must be placed so that each zone is homogeneous, free of stratifications, ice chunks, lenses or pockets, and layers of material with different texture or grading not conforming to the requirements stated herein.

.3 No embankment fill material shall be placed on any part of the foundation until it has been prepared as specified herein and approved by the Engineer. Placement of fill material must conform to the lines, grades and elevations shown on the Construction 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 adjacent zones is avoided.

.4 Embankment construction must not proceed when the work can not be performed in accordance with the requirements of the Construction 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.

.5 Stockpiling, loading, transporting, dumping and spreading of all materials must 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.

.6 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.

2.0 20 MM MINUS (FROZEN CORE)

.1 The key trench foundation must be cleared of all deleterious material as described in Section 1004. The foundation area must be inspected and approved by the Engineer before fill placement proceeds.

.2 Snow and ice must be removed from the base of the key trench excavation before fill can be placed in that area.

.3 Key trench and core material placement must be conducted when air temperatures will freeze a lift of key trench material within 24 hours of placement. Experience has shown that a 250 mm thick lift freezes back within 24 hours when air temperatures

are below –15°C. The time to freezeback will depend on the moisture content, wind speed, air temperature and solar radiation.

.4 The 20 mm minus material from the stockpile must be mixed with heated water using a method approved by the Engineer to create a homogeneous mix that is fully thawed and does not contain interstitial ice. The mix must not freeze until after it is placed and compacted in the key trench excavation. The temperature of the mix water required to meet the requirements stated herein may vary depending on the air temperature, wind speed and solar radiation.

.5 The placed 20 mm minus material must have a moisture content no less than 2% above the optimum water content determined from the Density Test (ASTM D698-91).

.6 The 20 mm minus material placed in the key trench and core must be spread and levelled immediately upon placement. The material must not be reworked, disturbed or rutted after compaction. Extra care should be taken by the Contractor to ensure the surface of the first lift before liner placement is as smooth and even as possible. Additional work, described in Section 1007, may be required if the lift surface is rough or uneven.

.7 The 20 mm material placed in the key trench and core shall be compacted with a smooth drum vibratory compactor weighing not less than 10 tonnes. The material shall be compacted with at least six passes (back and forth being two passes) to achieve the maximum density possible at the placed moisture content. The number of passes may be adjusted at the Engineer's discretion to suit varying conditions.

.8 The lift thickness must be varied to achieve 100% freezeback prior to placement of the next lift. Freezeback is defined as a maximum temperature of –2°C. The lift thickness may be adjusted depending on the placed moisture content and climatic conditions and results of fill temperature monitoring. Individual lifts must have uniform thickness.

.9 The fill area must be cleared of snow, ice and loose material before a new lift is placed. The surface of each lift must be approved by the Engineer before it is covered by a subsequent lift.

.10 Small batches of 20 mm minus material may be required to provide localised levelling and smoothing of the first lift surface to ensure the liner system has a level, even subgrade beneath it. Localised frozen high points on the surface of the first lift that the Engineer believes may cause puncture or stressing of the liner system must be removed without disturbing the surrounding lift surface. Equipment suitable for this task may include, but not limited to, an excavator with a toothless bucket or jackhammer. Smoothing and patching with 20 mm minus material must be done if the lift surface is rough or pocketed after the high points is removed.

.11 The Contractor must ensure that the integrity of the liner system is not compromised during construction. Precautions the Contractor may take to avoid damaging the GCL liner may include, but will not be limited to: avoiding turning tracked vehicles on the first two lifts after liner system installation, providing light plants in the work area to improve operator visibility, or using pylons to mark the lift/liner interface or any other sensitive areas.

.12 Any damage to the GCL liner must be immediately reported to the Engineer. Repair work must commence as soon as possible. Fill placement must cease immediately in an area where the integrity of the liner or thermosyphons has been compromised. Excavation of fill surrounding the damaged GCL liner or thermosyphon may have to be excavated, without further damaging the integrity of the liner, to permit repairs to be made. Excavation methods suitable for this task may vary depending on the degree of freezing that may have already taken place.

3.0 20 MM MINUS (LINER COVER)

.1 The 20 mm minus material on the upstream liner slope shall be placed as described in Section 1007. The placement method used must ensure that segregation and nesting of coarse particles is avoided.

.2 The 20 mm minus material must be free of oversize particles, top soil, roots or other deleterious materials that may compromise the integrity of the liner system.

.3 The placed 20 mm minus material must be compacted to 95% of the maximum dry density (ASTM D698-91). Moisture conditioning may be required to achieve the specified level of compaction.

.4 The Contractor must ensure that the integrity of the GCL liner is not compromised during construction. Precautions the Contractor may take to avoid damaging the liner system may include, but will not be limited to: providing light plants in the work area to improve operator visibility or using pylons to mark the lift/liner system interface.

.5 Any damage to the GCL liner must be immediately reported to the Engineer. Repair work must commence as soon as possible. Fill placement must cease immediately in an area where the integrity of the GCL liner has been compromised. Excavation of fill surrounding the damaged GCL liner may have to be excavated, without further damaging the integrity of the liner, to permit repairs to be made. Hand excavation must be used to expose damaged portions of the liner for repair.

4.0 TRANSITION 200 MM MINUS ROCKFILL MATERIAL

.1 The Transition 200 mm minus rockfill 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 The Transition 200 mm minus rockfill material must be compacted with a smooth drum vibratory compactor weighing not less than 10 tonnes. Moisture conditioning may be required prior to compaction. The Transition 200 mm minus rockfill material must be compacted 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, amount of water added and vibration frequency for compacting the 200 mm minus rockfill material.

5.0 RUN-OF-MINE ROCKFILL

.1 The Run-of-Mine rockfill must be placed in lifts not exceeding 700 mm thickness. The placement method must ensure that segregation and nesting of coarse particles is avoided.

.2 The Run-of-Mine rockfill shall be compacted by ensuring that loaded haul truck traffic is routed over the entire surface of each lift. Particles greater than 700 mm diameter must be moved to the upstream or downstream face of the fill.

6.0 TILL MATERIAL

.1 The Till material 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 The Till material must be compacted with a smooth drum vibratory compactor weighing not less than 10 tonnes. Moisture conditioning may be required prior to compaction. The Till material must be compacted 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, amount of water added and vibration frequency for compacting the Till material.

1.0 GENERAL

.1 This section describes product installation and specifications for the Geosynthetic Clay Liner (GCL) for the West Dam.

2.0 PRODUCT

.1 The GCL shall consist of sodium bentonite between two non-woven geotextiles which are bonded by needlepunching. The GCL shall be Bentomat DN, or approved equivalent. The product shall conform to the physical, mechanical and hydraulic properties listed in Table 1007.1.

.2 The GCL manufacturer shall provide to the Engineer, prior to the shipment of the materials a signed manufacturing certification that the materials to be shipped to the site have test values which meet or exceed each property listed in Table 1007.1.

TABLE 1007.1: TECHNICAL SPECIFICATIONS FOR GEOSYNTHETIC CLAY LINER

Product Specifications				
Geotextile Property	**Test Method**	**Standard[1]**	**Units**	**Value**
Nonwoven Mass per Area	ASTM D5261	Typical	g/m^2	250
Bentonite				
Swell Index	ASTM D5890	Minimum	-	24 ml/2g
Moisture Content[2]	ASTM D4643	Maximum	%	12
Fluid Loss	ASTM D5891	Maximum	ml	18
Finished GCL				
Bentonite Mass	ASTM D5261	MARV	g/m^2	3670
Grab Strength[3]	ASTM D4632	MARV	N	660
Peel Strength	ASTM D4632	-	N	66
Permeability[3]	ASTM D5084	Maximum	cm/s	5×10^{-9}
Internal Shear Strength	ASTM D5321	Minimum	kPa	24 @ 30 kPa confining 311 @ 520 kPa confining

Notes:

(1) Minimum Average Roll Value (MARV)
(2) Oven-dried measurement reflecting a moisture content of zero.
(3) De-Aired Tap Water @ 5 psi maximum effective confining stress and 2 psi head.

3.0 SHIPPING AND STORAGE

.1 Shipping shall conform to the requirements of the manufacturer and shall be carried out in a manner which shall protect the rolls from damage or water penetration during shipment.

.2 Storage of the GCL rolls on site shall be in a secure location that will minimize exposure. It is absolutely essential that the GCL rolls are protected from exposure to water.

4.0 INSTALLATION

.1 The key trench shall be excavated as shown on the drawings. The surface for the GCL shall be made smooth with all protrusions, and angular particles larger than 20 mm removed.

.2 The installation of the GCL shall not begin until a proper subbase has been prepared and approved by the Engineer.

.3 The GCL shall be placed in the key trench in a manner that will prevent damage to the liner. The method of deployment shall be discussed with and approved by the Engineer.

.4 The GCL shall be temporarily anchored such that it does not move while backfilling.

.5 The GCL in the key trench shall be carefully covered with saturated 20 mm minus core material. The fill should be mixed and placed as described in Section 1005.

.6 The upstream of the core slope GCL subgrade should be uniformly compacted and graded and shall be free of loose material.

.7 The GCL panels should be placed perpendicular to the dam axis.

.8 GCL deployment shall not be carried out during any form of precipitation, or in periods of high wind.

5.0 LAPPING AND JOINING

.1 Unless shown otherwise on the construction drawings, the GCL shall have a minimum overlap of 500 mm.

.2 Each overlap should be treated with powdered bentonite or bentonite paste (mixed with 6 parts water to 1 part bentonite by weight), comprised of the same bentonite as used in the manufacture of the GCL. The bentonite shall be applied at the minimum rate of 0.4 kg/m of seam.

.3 All joints shall be placed such that the higher liner overlaps the lower liner.

6.0 COVER

.1 Cover material refers to the material upstream and on top of the upper GCL placed on the upstream slope and over the crest of the frozen core.

.2 Cover material shall be placed such that it is pushed across the seams from the overlap roll to the underlap roll. Care shall be taken not to push aggregate between the seam overlap. Equipment shall push the cover material ahead of the equipment, and never travel directly on the GCL.

.3 The cover material shall be processed rockfill or esker material with a maximum particle size of 20 mm.

.4 Uncovered edges of GCL panels shall be protected at the end of the working day with a waterproof sheet adequately secured with ballast.

.5 The 20 mm minus cover material shall be placed with a minimum thickness of 200 mm over the GCL.

.6 Cover shall be placed with low ground pressure equipment. Care should be taken to avoid damaging the GCL by making sharp turns or pivots with equipment as well as sudden starts or stops.

.7 A minimum thickness of 500 to 900 mm of cover, as determined by the Engineer, shall be kept between heavy equipment and the GCL at all times, except when final-grading. No heavy vehicles should be driven directly on the GCL until the proper thickness of cover has been placed.

.8 The initial lift(s) of dry cover material shall not be compacted in excess of 90 percent of the maximum dry density (ASTM D698-91) or as specified by the Geotechnical Engineer to prevent damage to the GCL.

.9 Cover should be pushed up-slope to minimize tension on the GCL when covering GCL on sloped areas.

.10 Precautions shall be taken to prevent damage to the GCL by restricting the use of heavy equipment over the liner.

7.0 DAMAGE

.1 The Engineer shall record all areas requiring repair due to damage during shipping, handling, or deployment, or manufacturing flaws. The Engineer shall prescribe the method of repair to be used.

.2 The Contractor shall report to the Engineer all areas where the GCL is damaged or seen to be damaged. The Engineer shall prescribe the method of repair to be used.

.3 All repairs made by the placement of a patch of the same material over the damage shall extend at least 500 mm beyond the flaw or damage in every direction.

1.0 GENERAL

.1 The product and installation specifications for horizontal thermosyphons are presented in this section.

Note: The evaporator piping will be installed in the key trench to enable the radiators to be added at a later date. Radiators will only be installed if required.

2.0 MATERIALS (BY MANUFACTURER)

.1 Thermosyphons shall be two-phase, liquid-vapour type thermosyphons charged with carbon dioxide refrigerant.

.2 The thermosyphons shall be constructed with A53B Schedule 40 steel pipe.

.3 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.

.4 Standard of Acceptance: Thermosyphons as manufactured by Arctic Foundations of Canada Inc., Winnipeg, Manitoba, or an approved equal.

.5 The evaporator and radiator sizes shall be as shown on the Construction Drawings.

.6 All welds shall meet ASME boiler and pressure vessel codes.

3.0 INSTALLATION

.1 The evaporator pipes shall be installed as specified on the Construction Drawings.

.2 The radiators shall be erected plumb.

.3 All piping shall be tested prior to burial as detailed in Section 1010.

4.0 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 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 Construction Drawings and as described in Section 1009 of this document.

1.0 GENERAL

.1 The required geotechnical instrumentation for monitoring the performance of the dam is presented in this section.

.2 Ground temperature cables, casings, and data logger housings will be supplied and installed by the Engineer with the Contractor's assistance when needed. The following specifications for these instruments are provided for information only.

.3 The Contractor shall be responsible for providing protection for all instruments installed before construction of the dam is complete. The method of protection must be approved by the Engineer. The Contractor may be held responsible (at the Engineer's discretion) for replacement or repair of instruments damaged during construction.

2.0 INSTRUMENTATION REQUIREMENTS

.1 Ground temperature cables must be installed as shown on the Construction Drawings to measure ground temperature during construction and operation of the dams. Ground temperature cables will be provided by the Engineer.

.2 Data logger housings for the ground temperature cables will be provided by the Engineer. The housings will be rigidly attached to steel pipe as shown on the Construction Drawings.

.3 Single bead ground temperature cables will be used to monitor the freeze back of individual lifts of the key trench backfill. These instruments will be provided by the Engineer.

.4 Settlement monuments must be installed as shown on the Construction Drawings to allow any settlements of the dams to be measured. The settlement monuments will be supplied and installed by the Contractor.

3.0 GROUND TEMPERATURE CABLE INSTALLATION

.1 Horizontal ground temperature cables must be installed during construction. Vertical ground temperature cables must be installed during construction. The locations and orientation of the ground temperature cables are shown in the Construction Drawings.

.2 Drillholes for ground temperature cable installation must be 100 mm ID or greater. Drillholes must be drilled in the presence of the Engineer to the depths shown on the Construction Drawings. Schedule 40 PVC 50 mm ID pipe, or approved equivalent, with a water tight end cap, must be placed in the hole prior to casing removal.

.3 The portion of the cable extending beyond the dam fill must be protected with a steel pipe extending 1 m above the final elevation of the dam. The steel pipe must be painted with fluorescent paint.

.4 The inside and outside of the PVC pipe must be backfilled with sand such that there are no air voids around the pipe or ground temperature cable.

.5 The location of the installed instruments must be surveyed to 100 mm horizontal and 20 mm vertical accuracy.

.6 Horizontal ground temperature cables passing through the 200 mm minus rockfill material and the run-of-mine material must be placed in a steel pipe of sufficient strength to resist crushing upon placement of fill material.

4.0 SETTLEMENT MONUMENTS

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

1.0 GENERAL

.1 The quality assurance testing required by the Engineer is described in this section.

.2 The quality testing will be conducted by the Engineer.

2.0 FILL TESTING REQUIREMENTS

.1 20 mm minus material

a. Quality control testing must be performed during the crushing operation when the 20 mm minus material is being processed. The tests and testing frequency required during processing of the 20 mm minus material are presented in Table 1010.1. Additional testing may be required at the discretion of the Engineer.

TABLE 1010.1: REQUIRED TESTING AND FREQUENCY DURING PROCESSING OF 20 MM MINUS MATERIAL

Test	Test Frequency
Particle Size Analysis	One per 500 m^3 produced
Maximum Density	One per 1000 m^3 produced

b. Additional sieve analysis testing may be conducted by the Engineer on samples collected from the dam fill to verify that the placed gradation meets the gradation requirements stated herein.

c. The compacted density of the 20 mm minus material used as core and key trench fill must be evaluated by coring samples for lab testing and in situ compaction testing. Samples of the placed fill will be obtained using a concrete coring rig. The core sample will be used to determine if the lift of key trench backfill is completely frozen and to determine the soil properties. The testing frequency may be adjusted as determined by the Engineer. The required tests and testing frequency for the core and key trench fill is presented in Table 1010.2. Additional testing may be required at the discretion of the Engineer.

TABLE 1010.2: REQUIRED CORE AND KEY TRENCH BACKFILL TESTING AND FREQUENCY		
Test	**Test Frequency of Mixed Material**	**Test Frequency for Placed Material**
Mixture Density	One per 500 m3	-
Moisture Content	One per 250 m3	4 per lift or 2 per day
Placed Bulk Density	-	4 per lift or 2 per day
Degree of Saturation	-	4 per lift or 2 per day
Particle Size Analysis	One per two days	
Specific Gravity	One per two days	

d. The compacted density of the 20 mm minus material used as liner cover material on the upstream core must be evaluated by using in situ measurements of density. In situ density measurements of the compacted material will be conducted with a nuclear densometer. Samples of the 20 mm minus material may be taken from the lift surface for additional testing at the discretion of the Engineer. The required tests and testing frequency for the 20 mm minus material placed in the superstructure of the dam is presented in Table 1010.3.

TABLE 1010.3: REQUIRED LINER COVER FILL TESTING AND FREQUENCY	
Test	**Test Frequency for Placed Material**
Moisture Content	2 per lift or 2 per day
Placed Dry Density	2 per lift or 2 per day
Particle Size Analysis	One every two days

.2 Transition 200 mm minus rockfill material

a. Samples of the Transition 200 mm minus material will be evaluated from time to time during processing and placement to ensure that the produced and placed gradation meets the specification stated herein. Additional testing may be conducted at the discretion of the Engineer.

.3 Fill Testing Methods

a. Mixture density of key trench backfill shall be determined by using a concrete yield bucket as specified in CSA Can 3-A23.2-M90 or approved equivalent.

b. Samples of placed core and key trench fill must be taken once freezeback is completed by means of a concrete coring machine. The core must extend through the lower contact of the lift. All cored samples must be evenly distributed over the lift surface. All holes must be thoroughly washed with clean water to remove any remaining drilling fluid and backfilled with saturated 20 mm minus material immediately after extraction of the core.

c. Each cored sample of core key trench fill shall be split in half longitudinally and transversely and then examined and photographed by the Engineer. The bonding between layers, ice-saturation and ice bonding will be evaluated.

d. Moisture content is defined as the ratio of the weight of water to the weight of dry soil. Moisture content testing must be conducted according to ASTM D2216.

e. The method of determining bulk density of the cored key trench material will depend on the quality of the sample. The sample volume can be determined from the dimensions if the core has uniform dimensions. The Engineer will rely on in situ measurements of core and key trench fill density with a nuclear densometer if core recovery is poor or if the recovered cores are non-uniform.

f. The degree of saturation for cored samples will be determined, when possible, from the measured moisture content, bulk density and measured specific gravity.

g. Specific gravity shall be determined using the flask method according to ASTM D854.

1.0 GENERAL

.1 Adfreeze steel pipe piles are required to support the thermosyphon radiators. Locations of the thermosyphon radiators and details of the pile installation are shown on the Construction Drawings. The product and installation specifications for the piles are described in this section.

Note: Adfreeze piles are only required if thermosyphon radiators are required at a later date.

2.0 INSTALLATION

.1 A minimum 100 mm nominal Schedule 40 pipe is recommended. The pile installation holes shall be drilled to a diameter at least 100 mm larger than the outside diameter of the pipe.

.2 The pile shall penetrate a minimum of 6.0 m below grade.

.3 Holes shall be cut on opposite sides of the pile to ensure the sand slurry fills the annulus between the steel pipe pile and the wall of the borehole. The holes also provide a mechanical interlock between the frozen sand backfill and the steel which contributes to the specified allowable bond strength. The holes shall be spaced at 500 mm and be approximately 50 mm wide by 100 mm long. Each pile shall have a minimum of sixteen holes within the frozen bond length. No holes shall be placed within the top 2 m of the pile embedment.

.4 After drilling, the hole shall be free of water, mud, slough and any other deleterious material. This procedure is very important for obtaining a suitable bond between the slurry and the pile, and between the slurry and the permafrost or rock. Loose material and oil and grease shall be completely cleaned off the pile immediately before installation. These operations shall be monitored by the Engineer.

.5 It is recommended that the pile be placed in the hole first and slurry placed down the centre of the pile. The slurry shall consist of approximately 15% to 35% water by volume. The water content shall be moist enough to attain a workable and fully saturated mixture but shall be minimized to facilitate freezeback. A pencil vibrator or a pile vibrator shall be used to densify the slurry.

.6 Aggregate used for slurry shall consist of mineral soils conforming to the following gradation limits listed in Table 1008.1.

TABLE 1008.1 TYPICAL GRADATION OF SLURRY SAND FOR BACKFILL	
Sieve Size (mm)	**Percent Passing by Weight**
10	100
5	85-100
2	60-100
0.63	20-65
0.08	0-15

.7 Water used for slurry production shall be fresh potable water. The temperature of the slurry when placed shall not exceed 10°C to minimize permafrost disturbance and freezeback time.

.8 Accurate records of slurry volumes placed down the hole shall be kept. This is to identify that there are no voids between the pile and the side of the hole.