MOUNT POLLEY MINING CORPORATION
MOUNT POLLEY MINE

REPORT ON FEASIBILITY DESIGN OF TEST HEAP LEACH PAD (REF. NO. VA101-00001/15-2)

Rev. No.	Revision	Date	Approved
0	Issued in Final	September 15, 2006	KIB

MOUNT POLLEY MINING CORPORATION
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EXECUTIVE SUMMARY

MPMC is currently mining the Bell and Wight Pits with the tailings material being deposited as slurry into the Tailings Storage Facility (TSF). Process water is collected and recycled back to the mill for reuse in the milling process. The average throughput for 2005 was approximately 15,000 tpd. Exploration at the Springer Zone has confirmed the presence of a significant body of copper-gold mineralization beneath the reserve outlined by previous drilling. The Springer Zone is fully permitted for mining and is expected to provide long term millfeed upon completion of mining at the Bell and Wight Pits. Surficial copper mineralization at the Springer Zone is highly oxidized and cannot be processed through the existing mill circuit. Laboratory testwork has indicated that this surficial copper mineralization is amenably to heap leaching. The scope of this report is to present a feasibility level design for the test heap leach pad and in-pad pond located on top of the old mine waste dump and to investigate the heap leaching process.

The test heap leach pad will consist of a single lift at a maximum thickness of 8 metres. The test heap leach pad will comprise of an area approximately 18,000 m^2 and will be double lined with an engineered HDPE liner system and leak collection and recovery system for in-heap storage of solutions. The pad has been built into the mine waste dump utilizing 3:1 horizontal to vertical slopes with a maximum depth of 8m at the southwest end rising at a 2 percent grade to a depth roughly 2 metres below the mine waste dump ground elevation at the northeast end.

Solutions from the test heap leach pad will be collected from the pad and removed by a network of solution collection pipes that drain by gravity to the sump. The in-pad storage area has been designed to have a 10 hour working solution of approximately 500 m^3. The maximum potential inflow of solution and the maximum design precipitation was estimated to be approximately 10,650 m^3. The test heap leach pad has been designed as a zero discharge facility. The total volume of the test heap cell below the perimeter berm has been calculated to be approximately 60,000 m^3. The calculated pore volume storage for solution retention in the pad is 21,000 m^3. This means an approximate additional 10,000 m^3 is available for surplus solution storage. The design of the pad also includes a 1.5 metre high perimeter berm around the heap for containment. Capital and Closure Costs estimates have been completed by others.

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MOUNT POLLEY MINING CORPORATION
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SECTION 1.0 - INTRODUCTION

1.1 PROJECT DESCRIPTION

The Mount Polley gold and copper mine is owned by Mount Polley Mining Corporation (MPMC). It is located 56 kilometres northeast of Williams Lake, in central British Columbia. The project site is accessible by paved road from Williams Lake to Morehead Lake and then by gravel road for the final 12 km. The location of Mount Polley Mine is shown on Figure 1.1. Mount Polley Mine started production in 1997 and had milled approximately 27.5 million tonnes of ore prior to temporarily suspending operations from October 2001 to March 2005. Between October 2001 and March 2005 the mine operated under a care and maintenance program. MPMC is currently mining the Bell and Wight Pits with the tailings material being deposited as slurry into the Tailings Storage Facility (TSF). Process water is collected and recycled back to the mill for reuse in the milling process. The average throughput for 2005 was approximately 15,000 tpd.

Exploration at the Springer Zone has confirmed the presence of a significant body of copper-gold mineralization beneath the reserve outlined by previous drilling. The Springer Zone is fully permitted for mining and is expected to provide long term millfeed upon completion of mining at the Bell and Wight Pits.

1.2 SCOPE OF REPORT

Near surface copper mineralization at the Springer Zone is highly oxidized and cannot be processed by conventional sulphide flotation methods using the existing mill circuit; therefore MPMC is evaluating a process of heap leaching the near surface copper mineralization from the Springer Pit. The scope of this report is to present the design for the test heap leach pad that will contain approximately 200,000 tonnes of ore and will utilize in-heap storage of process solutions. This report provides details on the following:

- design criteria and assumptions used in the study;
- a brief description of the layout;
- stability overview of the leach pad geometry and heap configuration;
- preliminary quantities.

SECTION 2.0 - SITE CHARACTERISTICS

2.1 METEOROLOGY

The project area is subject to a relatively temperate climate with warm summers and cool winters. Precipitation is well distributed throughout the year. Precipitation data at the site is limited and thus precipitation records for climatologically similar stations in the area were used to estimate mean annual site precipitation values. A mean annual precipitation of 755 mm was used for the Leach Pad Area and an annual evaporation rate of 423 mm at the site has been assumed to be constant for all years of operation and precipitation conditions.

2.2 SEISMICITY

2.2.1 Regional Seismicity

Mount Polley is situated within the interior of BC, an area of historically low seismicity. The site is located within the Northern BC (NBC) source zone, close to the boundary with the South-eastern B.C. (SBC) source zone, as defined by Basham et al (1982). Basham assigns a maximum earthquake magnitude of 5.0 for the NBC zone, which is one-half magnitude higher than the observed maximum magnitude of 4.5. Similarly, a maximum magnitude of 6.5 has been set for the SBC zone, based on historic earthquake data.

There has been much debate in recent years concerning the possibility of a large interplate earthquake of magnitude 8 or 9 along the Cascadia subduction zone. However, such an event would be located at over 400 km west of the project and therefore is unlikely to have a significant impact at the site. Southwest of the site lies the Northern Cascades region where a maximum earthquake magnitude of 7.5 has been estimated, based on historic seismic records and geologic data (Leader Lake Seismic Risk Assessment). This potential source zone lies at a minimum distance of about 200 km and, as above, is therefore unlikely to have a significant impact at the site.

2.2.2 Seismic Design Parameters

A seismic hazard assessment for the site was previously completed for the design of the initial leach pad and ponds in 2004. This assessment used both probabilistic and deterministic methods. This assessment determined the seismic ground motion parameters for both the Design Basis Earthquake (DBE) and Maximum Design Earthquake (MDE).

The probabilistic analysis was carried out by the Pacific Geoscience Centre based on the method presented by Cornell (1968). The results are:

Return Period (Years)	100	200	475	1000
Maximum Ground Acceleration (g)	0.021	0.028	0.037	0.046
Maximum Ground Velocity (m/sec)	0.043	0.056	0.077	0.094

The Design Basis Earthquake (DBE) for operations of the Phase 1 test heap leach pad will be taken as the 1 in 100-year return period event with a maximum firm ground acceleration of 0.021 g and maximum ground velocity of 0.043 m/sec. These parameters have been assumed to be current and unchanged, therefore will be used for the design of all sequent earthwork structures.

SECTION 3.0 - GEOTECHNICAL SITE CHARACTERISTICS

3.1 GENERAL

The test heap leach pad will be located on the east waste dump site. The original ground slopes north to south at an average slope of 4% under the test leach pad area. Cross sections were created to identify the best possible site for the leach pad. The pad location and orientation has been based on the original topography and the current ground topography to minimize the potential for differential settlement. Settlements were calculated at both ends of the test pad to determine the maximum probable settlement that will occur under an 8 metre lift. The maximum differential settlement for both ends of the pad are considered to be within reasonable levels for the pad and the HDPE liner system. Material specifics for the mine waste dump were unknown during the design of test pad so conservative values were used for the mine waste dump material.

3.2 LEACH PAD

The heap leach pad site foundation comprises of fill from the mine waste rock, which covers the entire site at an average fill depth of 23 metres. The original ground slopes north to south at an average slope of 4% under the test pad area.

3.3 MATERIALS TESTING

3.3.1 Leach Ore

A material testing program was completed for the Report on Feasibility Design of Leach Pad and Ponds (Ref. No. VA101-00001/2-1) on the pre and post leached ore samples provided by Mount Polley Mine, to assess the particle size distribution and permeability of the pre and post leach ore material. These values are part of the design criteria for the test heap leach pad since the material that will be placed is part of the same mineral body from the previous Report on Feasibility Design of Leach Pad and Ponds. Key information for the leach ore relating to the test heap leach pad have been reproduced in this section for completeness.

The original materials testing of the pre and post leach ore material consisted of the following tests:

- Particle Size Distribution;
- Specific Gravity;
- Constant Head Permeability.

The results of the laboratory testwork completed on the pre and post leached samples are included in Appendix A of the Report on Feasibility Design of Leach Pad and Ponds (Ref. No. VA101-00001/2-1).

The pre leached ore had a gravel size proportion that ranged between 28.2 and 34.0 percent, a sand size proportion ranging between 54.1 and 59.7 percent, with a fines

content ranging between 11.8 and 12.1 percent. Atterberg Limit testwork on the pre leached ore yielded a liquid limit of 25 percent, a plastic limit ranging between 22 and 23 percent, and plasticity indices ranging between 2 and 3 percent.

The post leached ore had a gravel size proportion that ranged between 45.7 and 47.7 percent, a sand size proportion ranging between 40.4 and 42.9 percent, with a fines content ranging between 11.4 and 11.9 percent. Atterberg Limit testwork on the pre leached ore yielded a liquid limit ranging between 29 and 31 percent, a plastic limit ranging between 25 and 26 percent, and plasticity indices ranging between 4 and 5 percent.

Constant head permeability tests were performed on the pre and post leached ore samples at confining pressures of 172, 344, 689, and 1378 kPa, corresponding to heap heights of approximately 10, 20, 41 and 82 m.

The calculated permeabilities for the various equivalent heap heights are tabulated below:

Calculated Permeability (cm/s)	**Simulated Heap Height (metres)**			
	10	**20**	**40**	**80**
Pre-Leached Ore	8×10^{-3}	9×10^{-3}	1×10^{-3}	3×10^{-3}
Post-Leached Ore[1]	3×10^{-2}	8×10^{-3}	4×10^{-3}	2×10^{-3}
Post-Leached Ore	*9×10^{-2}*	*7×10^{-2}*	*5×10^{-2}*	*2×10^{-2}*

Note 1: A preferred seepage path was observed upon breaking down the apparatus upon completion of the first permeability test on the Post-Leached Sample. The sample was retested with the retest results in italics.

For the test heap leach pad the values stated above for the particle size distribution, specific gravity and the constant head permeability have been considered to be relevant and will be used in the design of the test heap leach pad.

SECTION 4.0 - DESIGN OF TEST HEAP LEACH PAD

4.1 DESIGN OBJECTIVES

The principle objectives of the design of the test heap leach pad are to:

- Ensure complete protection of the regional groundwater and surface water flows both during operations and in the long-term.
- Determine that the site will provide a safe and stable base with minimal settling during operation and in the long term especially relating to differential settling.
- Provide permanent, secure storage and total confinement of the leach ore within a fully engineered facility.
- Effectively collect and convey solutions to ensure maximum recovery.
- Provide safe and secure solution transportation to and from the heap.
- Minimize the quantity of surface water runoff entering the facility and coming in contact with the process solutions by providing surface water diversion around the pad.

4.2 DESIGN BASIS AND CRITERIA

The design of the test heap leach pad is based on providing storage for approximately 200,000 tonnes of leach ore at a bulk density of 1.8 tonnes/m^3. The heap stacking production rate will average 4000 tonnes per day for approximately 50 days at 10 hrs/day 7 days a week. Solution application onto the heap will occur for 300 days at 8-10 liters/hr-m^2 with a design flow rate onto the pad area of 50 m^3/hr. The leach ore will be crushed to 80% passing the ½-inch sieve and placed on the pad to form a single 8 metre high lift. A summary of the design criteria for the various engineered components are listed on Table 4.1.

4.3 DESIGN FEATURES

The test heap leach pad will be constructed on top of the mine waste dump and solutions will be stored in-heap. The test heap leach pad will cover an area approximately 18,000 m^2. The pad has been built into the mine waste dump utilizing 3:1 horizontal to vertical slopes with a maximum depth of 8m at the southwest end rising to a depth at a 2 percent grade to roughly 2 metres below the mine waste dump ground elevation at the northeast end. The pad area will be lined with an engineered double liner system and a leachate recovery system for in-heap collection and recovery to contain the solutions. The maximum potential inflow has been calculated to be 10,650 m^3. The maximum potential inflows comprises of the following:

- 1 in 100 yr – 24 hour storm event (77 mm) – 1,540 m^3;
- 10 hours of working solution – 500 m^3;
- Process solution drain down for tonnes under leach – 1,550 m^3;
- Spring snowmelt in an average year (353 mm) – 7,060 m^3.

The maximum pore volume storage available is 17,640 m^3 which exceeds the maximum potential inflow.

A network of solution collection pipes collect solutions at the base of heap and drain by gravity to the sump, which has an approximate working volume of 500 m^3.

The location of the test pad has been placed in such a manner as to minimize the potential for differential settlement. This was accomplished by choosing an orientation with the least amount of elevation change in the original topography. Three surface movement monuments to monitor any movement that may occur from the additional weight of the placed ore on the test heap leach pad will be installed. The monuments have been placed at both ends and on one side of the pad just outside the anchor trench area.

The general arrangement along with the grading plan and the piping plan of the facility is shown on Drawing 100 with sections and details on Drawing 200.

4.4 LINER SYSTEM DESIGN

A high integrity low permeability double lined engineered liner system will be constructed over the entire leach pad area and will extend beyond the pad area to control any seepage. The proposed engineered double lined system for the pad area is shown on Drawing 200 and will contain the following components from top to bottom:

- 150 mm Prepared Subgrade (Zone F);
- 500 mm Soil Liner (Zone S);
- Flexible Geomembrane Inner and Outer Liners with a Geonet between them;
- 500 mm Protective / Drainage Layer.

The proposed engineered liner system for the sump area is shown on Drawing 200 and will contain the following components:

- 150 mm Prepared Subgrade (Zone F);
- 500 mm Soil Liner (Zone S);
- LCRS Gravel Layer wrapped in geotextile;
- Flexible Geomembrane Inner and Outer Liners Separated by Geonet;
- 500 mm Protective / Drainage Layer;
- Drain Rock covering 600 mm Diameter riser pipe.

4.4.1 Zone F – Prepared Subgrade

The Prepared Subgrade (Zone F) material will be in direct contact with the Zone S soil liner to provide a suitable base and to provide a filter relationship between the rockfill and the low permeability soil for the test heap leach pad. The Prepared Subgrade (Zone F) material will be a minimum 150 mm thick and will be free of any large sharp protrusions. The gradation curve limits can be found on Drawing 400.

4.4.2 Zone S – Soil Liner

A soil liner will be prepared as a non-yielding base and will be in direct contact with the 60 mil HDPE geomembrane outer liner to form a composite liner. The Zone S material

will be a minimum of 500 mm thick, and have a smooth surface free from sharp protrusions. Removal of rocks from this layer will require an extensive effort using a combination of agricultural techniques and manual labour. The gradation curve limits can be found on Drawing 400.

4.4.3 Flexible Geomembrane Liner

Smooth 60-mil thick high density polyethylene (HDPE) has been selected for the flexible geomembrane liner for the pad area, based on the following criteria:

- Maintain material properties from chemical exposure;
- Foundation smoothness;
- Drainage layer material type;
- Method of placement and seaming;
- Cold temperature behaviour;
- Stresses from heap;
- Liner strength.

4.4.4 LCRS System

A leak collection and recovery system (LCRS) comprises the following components:

- A geonet drainage layer located above the outer geomembrane liner
- A 10 oz geotextile wrapped around the LCRS gravel layer
- A sump for collection of leakage; and
- A mechanical pump solution removal system.

The LCRS System includes a geonet drainage layer draining towards the lowest portion of the sump area. A high compressive strength, high density polyethylene (HDPE) geonet is proposed for this application. Solution will be removed by submersible pump in a collection sump comprised of a single 200 mm diameter SDR 17 HDPE sloping riser pipe located in a 1000 mm thick LCRS drainage layer between the two liners. The limits for the LCRS drainage layer are shown on Drawing 200 along with details for the LCRS sloping riser pipe and sump. LCRS gravel shall be clean free-draining sand-gravel material composed of rounded, tough, durable particles which are relatively free from thin, flat and elongated pieces. The material shall not contain organic matter or soft, friable particles. The gradation curve limits can be found on Drawing 400.

4.4.5 Protective / Drainage Layer

A protective / drainage layer controls the hydraulic head above the flexible inner geomembrane liner. The protective / drainage layer will consist of processed, crushed low grade leach ore or waste rock that is free draining, durable and has been screened to produce a material ranging in particle size from 20 mm to 6 mm. A network of perforated corrugated smooth interior high density polyethylene (CPT) pipes will enhance the drainage system. The thickness of the drainage layer across the pad area will be approximately 500 mm. The gradation curve limits can be found on Drawing 400.

4.4.6 Drain Rock

Drain rock shall be clean free-draining cobbles and gravel composed of rounded, tough, durable particles which are relatively free from thin, flat and elongated pieces. The material shall not contain organic matter or soft, friable particles. This material shall be processed from the leach ore to produce a material with a maximum particle size of 150 mm which conforms to the gradation limits found on Drawing 400.

4.4.7 Predicted Leakage Rates Through the Liner System

Leakage rates through the inner and outer liners for environmental impact assessment purposes were estimated for the in-heap storage area and the pad area using empirical equations proposed by Bonaparte et al. (1989). The formulas used in the leakage estimates are listed below:

Inner Liner: $Q = 3a^{0.75}h^{0.75}k_d^{0.5}$
Outer Liner: $Q = 0.21a^{0.1}h^{0.9}k_s^{0.74}$

where:

Q = steady state rate of leakage through one hole in the liner (m^3/s).
a = area of the hole (m^2).
h = hydraulic head on top of the geomembrane (m).
k_d = hydraulic conductivity of the material overlying the geomembrane (m/s).
k_s = hydraulic conductivity of the material underlying the geomembrane (m/s).

In general, for the purposes of estimating potential environmental impacts, it is assumed that one hole per acre (4,047 m^2) with an effective area of 10 mm^2 would have a reasonable potential to exist for a geomembrane liner placed with a high level of quality control. The resulting predicted leakage rates in no way reflect the expected operational levels, but represent reasonable worst case conditions for assessment of environmental impact. The leach pad was divided into two areas for leakage estimates:

- Base area (16,000 m^2), 4 holes are expected.
- Side slope area (2,000 m^2), 1 hole is expected.

Using the above formulas and the following parameters:

	a (m^2)	H (m)	k (m/s)
Inner Liner	1×10^{-5}	4.5	5×10^{-4}
Outer Liner	1×10^{-5}	0.5	1×10^{-8}

The predicted leakage rates are as follows:

	In-Heap
Inner Liner	15.92 m^3/day
Outer Liner	0.019 m^3/day

The worst case condition for the inner liner estimated a leakage rate of 15.92 m^3/day with this leakage being collected by the LCRS System. The worst case condition for the outer liner estimated a leakage rate of 0.019 m^3/day.

4.5 SOLUTION MANAGEMENT AND STORAGE

The test heap leach pad has been designed as a zero discharge facility. The zero discharge facility incorporates a 1.5 metre high perimeter berm and a double lined HDPE liner system into the design to provide secure containment. The design allows in heap storage of solution while maintaining appropriate leakage protection. The total volume below the perimeter berm is approximately 60,000 m^3. The calculated pore volume available for pore volume storage is 21,000 m^3. This means that the maximum inflow of 10,650 m^3 for the test heap leach pad is well below the maximum estimated limits. In order to maintain a minimum solution retention volume of 10,650 m^3 for the maximum potential inflow, the in-pad pond working solution level below the perimeter berm must be less than 10,350 m^3. A level probe will be used as a monitoring device to ensure that the pad maintains adequate volume at all times for any sudden inflow. The entire pad area has been sloped towards the sump end to allow for the solutions to be collected. A network of collection pipes has been incorporated into the design to assist in the solution collection. The sump size is 38 metres by 76 metres and has a maximum height of 2m and a 10-hour solution working volume of 500 m^3. The sump area below the base of the pad floor has a capacity of approximately 3000 m^3. Solution levels in the sump area will be a minimum of 0.5 m and during normal operating conditions will be on average 1.0 metre.

A system of diversion ditches will be constructed around the lined pad area to divert water away from the test heap leach pad. The ditches will be kept fully functional at all times while the pad is in operation. The slope on the bottom of the ditch will be approximately 1% and the ditches are to be sized to carry the estimated runoff produced from a 1 in 100 year – 24-hour storm event.

4.6 SOLUTION COLLECTION SYSTEMS

The solution collection system has been designed to efficiently remove and convey pregnant leachate solution (PLS) and rainfall infiltration from the pad with a maximum working solution volume of 4 metres to eliminate the possibility of surface spills of solution from the confines of the lined facility.

The solution collection system will consist of 100 mm diameter perforated smooth interior corrugated high density polyethylene collection (CPT) pipes spaced at 10 metres on centre in a herringbone pattern across the pad. These collection pipes will be connected to 300 mm

diameter perforated smooth interior corrugated high-density polyethylene (CPT) main collection header running down the centre of the pad. The solution collection piping plan is shown on Drawing 100 and it also includes the general arrangement of the test pad.

4.7 STABILITY ASSESSMENT

A stability analysis was completed to consider both static and earthquake conditions using similar ore placement at 2H:1V side slopes onto a heap leach pad. It was found that stability was not an issue with factors of safety well within reasonable limits. The factor of safety for the static condition was determined to be 1.81. The analysis also found that the seismic stability of the heap leach pad would not be of concern for the 1 in 100 year return period event as greater critical accelerations than the determined maximum acceleration of 0.06g were required to reduce the factor of safety to 1.

Stability at the test leach heap pad is also considered to not be an issue as the ore is confined within the excavated cell and by the 1.5 metre high berms. The 2% slope of the pad towards the sump end and the interface friction angle between the geosynthetics are well within industry accepted standards as long as the ore is placed in the up-slope direction during loading.

4.8 ESTIMATED QUANTITIES

Quantities have been estimated from the preliminary layout for the test heap leach pad. The estimated quantities are for earthworks, geosynthetics, and pipeworks and appurtenances. The estimated quantities are summarised on Table 4.2. Capital costs and closure costs have not been included for this feasibility design report.

4.9 CLOSURE REQUIREMENTS

The reclamation and closure plan provides a systematic approach to decommissioning and returning all disturbed areas to a habitat similar to pre-mining conditions.

The following performance goals have been proposed for closure of the heap leach facility:

- The long-term preservation of water quality within and downstream of decommissioned operations.
- The long-term stability of engineered structures.
- The removal and proper disposal of all access roads, structures, and equipment not required beyond the end-of-mine-life.
- The long-term stabilization of all exposed erodable materials.
- The natural integration of disturbed lands into surrounding landscape, and restoration of the natural appearance of the area after mining ceases, to the greatest possible extent.
- The establishment of a self-sustaining vegetative cover consistent with existing wildlife needs.

The heap will be encapsulated within the ultimate waste dump upon completion of active leaching, detoxification, and determination that the drainage from the heap meets the release criteria, and capped with an engineered cover system that minimizes infiltration.

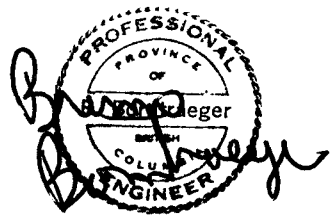
These closure concepts are conceptual only and may change significantly as a result of research programs carried out during mining operations.

SECTION 5.0 - CERTIFICATION

This report was prepared and approved by the undersigned.

Prepared by: _____

Brett Garland, EIT.
Staff Engineer



Sept 15, 2006

Reviewed by: _____

Bruno Borntraeger, P.Eng.
Senior Engineer

Approved by: _____

Ken J. Brouwer, P.Eng.
Managing Director

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TABLE 4.1

IMPERIAL METALS CORPORATION
MOUNT POLLEY MINE

HEAP LEACH PAD AND PONDS
DESIGN CRITERIA SUMMARY

SITE

Location	56 km NE of Williams Lakes
Country	Canada
Province	British Columbia
Nearest Major Metropolitan Center	Kamloops
Elevation	
Processing Facility	1,000 to 1,100 meters
Meteorology	
Temperature	
Daily Maximum	29.0º C
Daily Minimum	-31º C
Annual Daily Mean	1.3º C
Average Pan Evaporation	423 mm/year
Precipitation	
Average Annual	755 mm
Snowfall (WE)	304 mm
Rainfall	451 mm
Electrical Power	
Source	Line Power
Distribution	13,800 V
Medium Voltage	600 V, 3 ph, 60 Hz
Control Voltage	110 V, 1 ph, 60 Hz

MINING

Production Schedule	7 days per week 50 days 10 hrs/day
Production Rate	200,000 tonnes 4,000 tpd, average
Average Grade (Total Cu)	0.322%
Average Grade (Non-sulfide Cu)	0.202%
Ore Size	80% - 4"
Ore % Moisture, range	5 to 7%
Bulk Density of ROM Ore	1.8 tonne/m^3

TABLE 4.1

IMPERIAL METALS CORPORATION
MOUNT POLLEY MINE

HEAP LEACH PAD AND PONDS
DESIGN CRITERIA SUMMARY

STACKING

General

Bulk Density of Ore	1.8 tonne per m^3 (dry basis)
System	Truck Dump from Prepared Access Corridors Dozer Spreading of Ore Dozer Ripping before Leaching

Sulphur Addition

System	Fine Crushed and then added to heap on 3m lift and 6m lift height. Spread with sand truck to a depth of 50mm and blended by cross-ripping with dozer.
Sulphur	10.0 kg/tonne (100% active) 2,000 tonnes sulphur (min) dependant on percentage of active Sulphur content.

LEACHING

General

Process Type	Heap leach
Operating Schedule	12 hours per shift 2 shifts per day 365 days per year
Average Grade (Total Cu)	0.322%
Average Grade (Non-sulfide Cu)	0.202%
Recovery	
Total Copper, 80% - 4"	40%
Nominal Production	
Total Recoverable	257 tonnes Cu 568,000 pounds

TABLE 4.1

IMPERIAL METALS CORPORATION
MOUNT POLLEY MINE

HEAP LEACH PAD AND PONDS
DESIGN CRITERIA SUMMARY

Leach Pad and Heap	
Type	Single lift, single-use pad
Liner	500 mm soil liner with dual 60 mil HDPE geomembrane separated by geonet (with 500 mm overliner)
Heap Characteristics	
Lift Height	8 m
Number of Lifts	1
As-Stacked Bulk Density	1.8 t/m^3
Angle of Repose	37°
Setback	Toe of Heap pile to be kept 1m below top of berm
Overall Heap Slope	2H:1V (toe of first lift to crest of heap)
Solution Application	
Leach Cycle, Total	300 days
Number of Leach Cycles	4
Solution Application Rate	8 to 10 liters/hour/m^2
Recycle Solution Pumping Rate	
Normal	40 m^3/hr
Maximum	50 m^3/hr
Pregnant Solution Pumping Rate	
Normal	10 m^3/hr
Maximum	15 m^3/hr
Solution Application	Emitters, Summer Operation Buried Emitters, Winter Operation
Ore Absorption	4 % average
Heap Draindown	31 liters per tonne of ore under leach
Residual Moisture after Draindown	9 %

TABLE 4.1

IMPERIAL METALS CORPORATION
MOUNT POLLEY MINE

HEAP LEACH PAD AND PONDS
DESIGN CRITERIA SUMMARY

WATER BALANCE

Test Heap Pad Design	Zero discharge facility
Pad Area	18,000 m^2
Volume of Test Heap below Berm	50,400 m^3
Volume Percent Ore	65%
Calculated Pore Volume for Solution	17,640 m^3
Maximum Potential Inflow	
Precipitation (1 in 100 yr 24 Storm)	77 mm x 20,000 m^2 = 1,540 m^3
10 hours working solution	1000 m^3
Solution Drain Down for tonnes under leach	31 L/tonne * 50,000 tonnes = 1,550 m^3
Spring Snowmelt	353 mm * 20,000 m^2 =7,060 m^3
Maximum Allowable Working Solution	4 m above sump bottom

RECOVERY

General

Recovery Plant Type	EMEW
Production Schedule	One 12 hour shift per day 365 days per year
Operating Availability	≥ 25% (dependant on Pregnant Grade)
Design Flow rate	
Normal	10 m^3/hour
Maximum	15 m^3/hour

Solution Characteristics

	PLS	Barren
Copper, g/L	3.0-4.0	0.5-1.0
Total Iron, g/L	0.5-3.0	0.5-3.0
pH	2-3	1-2

Design Operating Conditions	
Flow per cell, m^3/hr	4
Number of cells	1
Current Density	400-500 A/m^2
Cell Voltage	3.5-4.5
Supply Power	
Voltage	575

TABLE 4.1

IMPERIAL METALS CORPORATION
MOUNT POLLEY MINE

HEAP LEACH PAD AND PONDS
DESIGN CRITERIA SUMMARY

REAGENT HANDLING

Sulfur	Bulk, end or belly dump trucks
Sulfuric Acid (initial startup only)	200 litre drums
Bioleachate	To be propagated in 20 litre containers and transferred to larger containers as colony grows.
Bioleachate addition to Barren Tank	Determined from Free Acid balance (require 1.5 kg/tonne of ore)

LAYOUT DESIGN CRITERIA AND ASSUMPTIONS

Leach pad capacity	200,000 tonnes
Maximum heap height	8 m
Perimeter berm	1.5 m high
Fill slope of leach pad	3H:1V
Solution collection	By gravity to solution collection channel and to sump
Diversion ditches	Around perimeter of pad to divert runoff from hill slopes.

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TABLE 4.2

MOUNT POLLEY MINING CORPORATION
MOUNT POLLEY MINE

TEST HEAP LEACH PAD AND IN-PAD POND
ESTIMATED QUANTITIES FOR FEASIBILITY STUDY

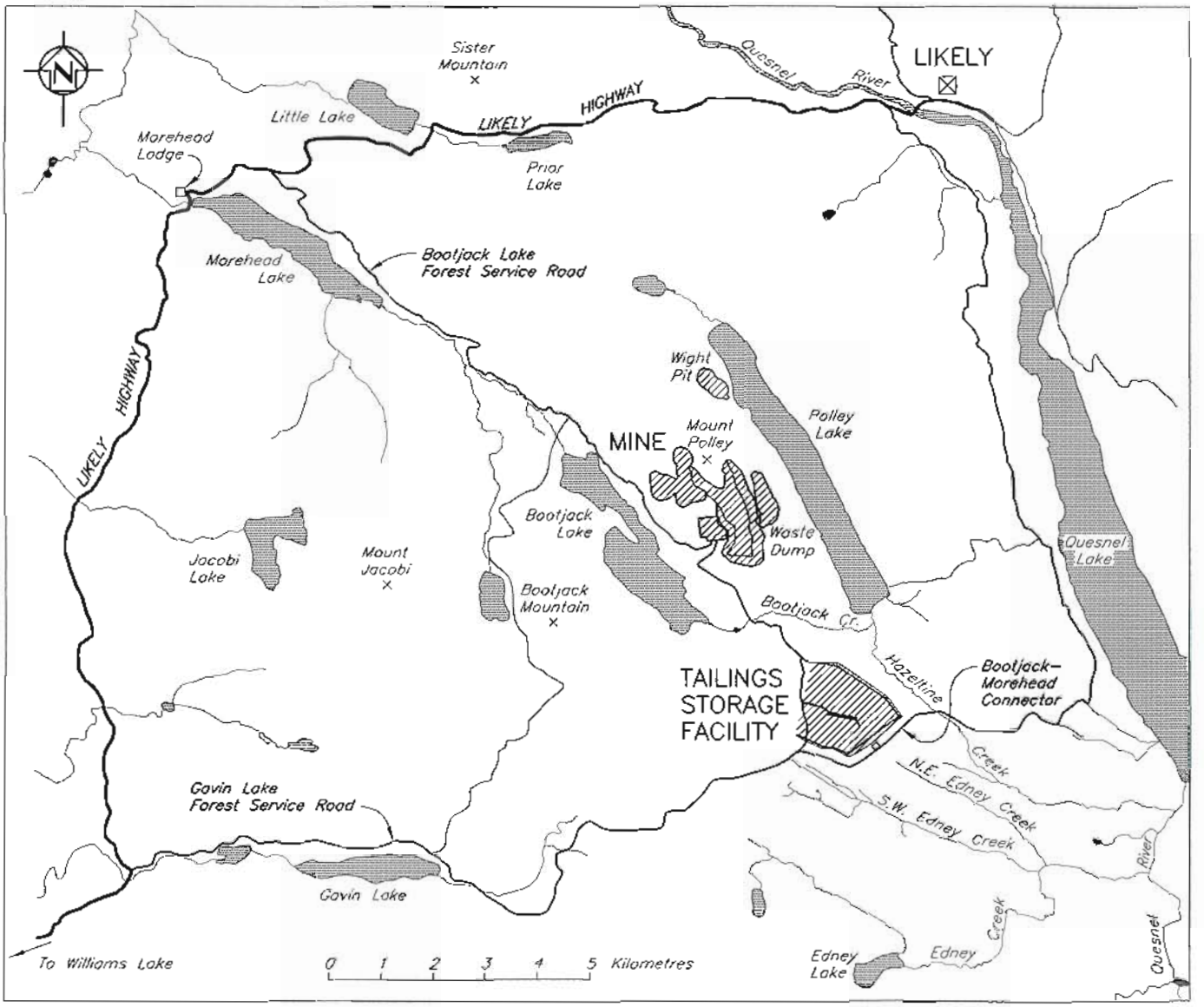
Print Sep-18-06 14:49:28

M:\1\01\00001\15\A\Data\[Table 4.2_R0.xls]Estimated Quantities Rev'd Sep/14/06

Item Number	Description	Units	Quantity
1	**EARTHWORKS**		
a.	Mine waste rock excavation - Leach Pad	m^3	25,500
b.	Mine waste rock excavation - In-Pad Pond	m^3	2,500
c.	Soil excavation - Soil Liner Borrow	m^3	10,000
d.	Load, Haul, Place & Compact Prepared Subgrade (150 mm)	m^3	3,000
e.	Load, Haul, Place & Compact Zone S (500 mm)	m^3	10,000
f.	Load, Haul, Place & Compact Drainage Layer (500 mm)	m^3	9,600
g.	Load, haul, place & compact safety berm	m^3	2,850
h.	Surface preparation for soil liner	m^2	18,300
2	**GEOSYNTHETIC**		
a.	Supply and install 10 oz/yd^2 non-woven geotextile - Foundation Drainage System	m^2	3,200
b.	Supply and install 60 mil HDPE Geomembrane - Leach Pad and In-Pad Pond	m^2	52,000
c.	Supply and install geonet - Pad and In-Pad Pond	m^2	26,000
3	**PIPEWORKS AND APPURTENANCES**		
a.	Supply and install 100 mm dia CPT 'Type SP' Pipe and fittings - Collection Pipe	m	1,100
b.	Supply and install 300 mm dia CPT 'Type SP' Pipe and fittings - Collection Headers	m	160
c.	Supply and install Leak collection sumps at In-Pad Pond	ea	2

Rev 0 - Issued for Report

KEY MAP



LOCATION MAP

MOUNT POLLEY MINING CORPORATION

MOUNT POLLEY MINE

PROJECT LOCATION AND ACCESS PLAN

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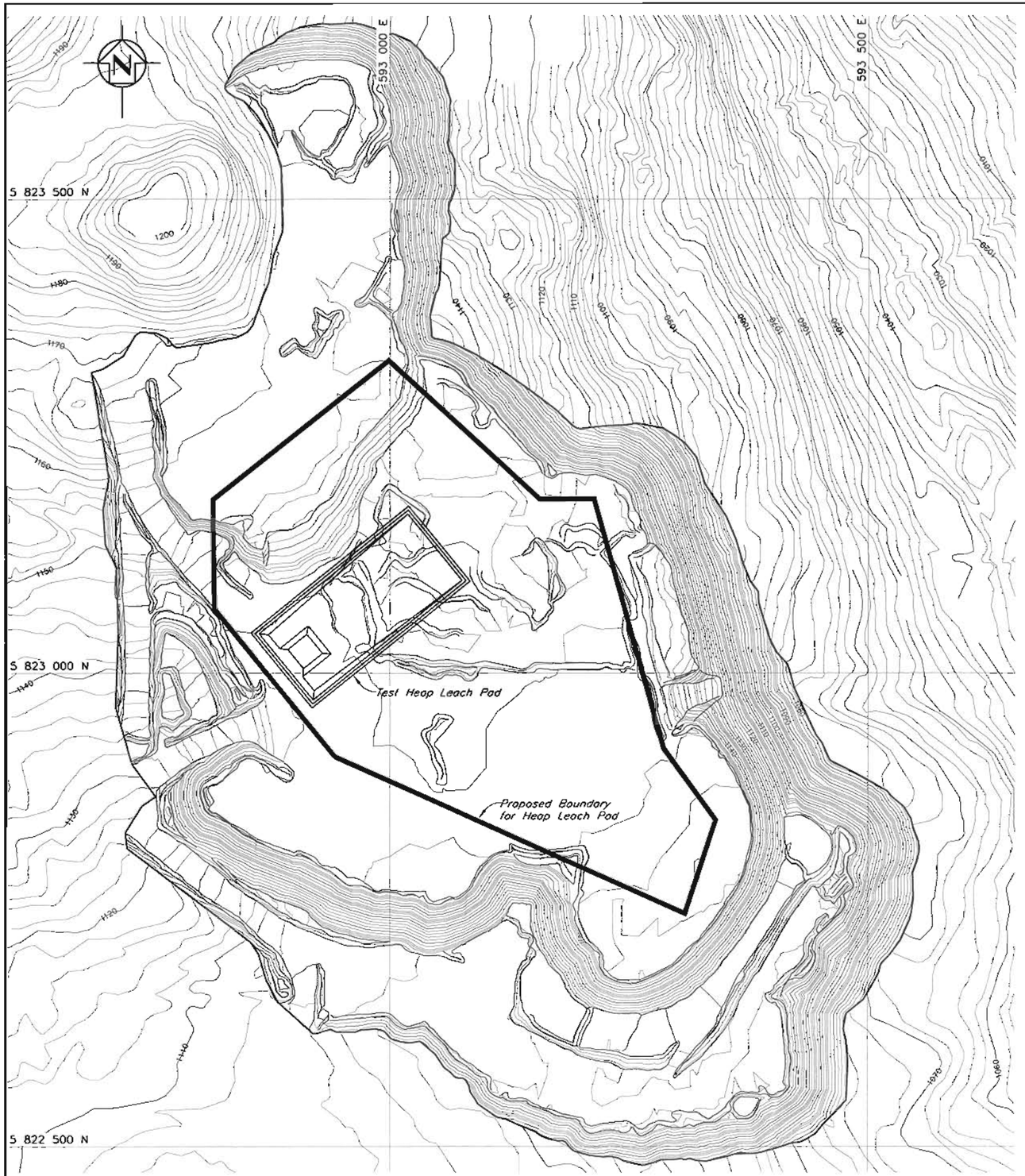
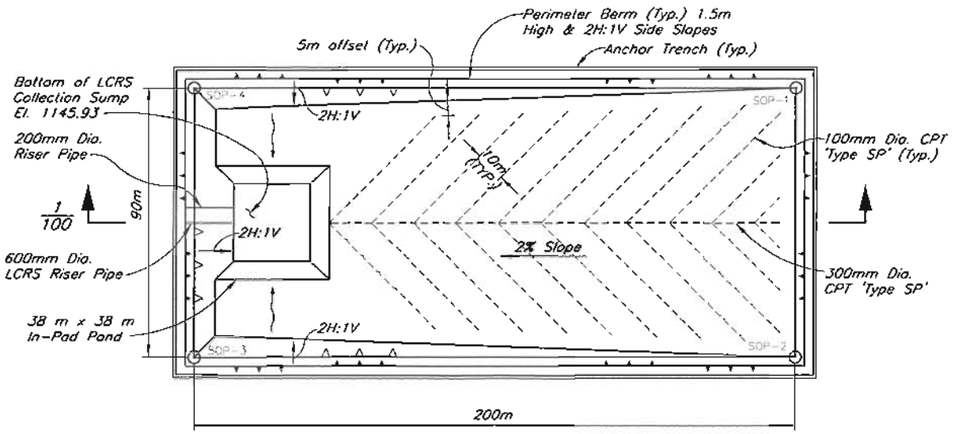
PROJECT/ASSIGNMENT NO.	REF. NO.
VA101-1/15	2

FIGURE 1.1 REV 0

REV. 0 | 15SEP'06 | ISSUED FOR REPORT



PLAN
Scale A



TEST HEAP LEACH PAD
Scale B

SETTING OUT POINTS			
I.D.	NORTHING	EASTING	*ELEVATION*
SOP-1	5 823 167.601	593 018.647	–
SOP-2	5 823 097.668	593 075.299	–
SOP-3	5 822 971.775	592 919.893	–
SOP-4	5 823 041.708	592 863.242	–

NOTES

1. *All contours shown in metres*
2. *Instrumentation shown on Drg. 300.*

A 50 0 50 100 150 200 250 m

B 20 0 20 40 60 80 100 m

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MOUNT POLLEY MINING CORPORATION

MOUNT POLLEY MINE

TEST HEAP LEACH PAD
PLAN

PROJECT/ASSIGNMENT NO.	DRAWING NO.	REVISION
VA101-1/15	100	0

ORIG. NO.	DESCRIPTION
REFERENCE DRAWINGS	

REV	DATE	DESCRIPTION	DESIGN	DRAWN	CHK'D	APP'D
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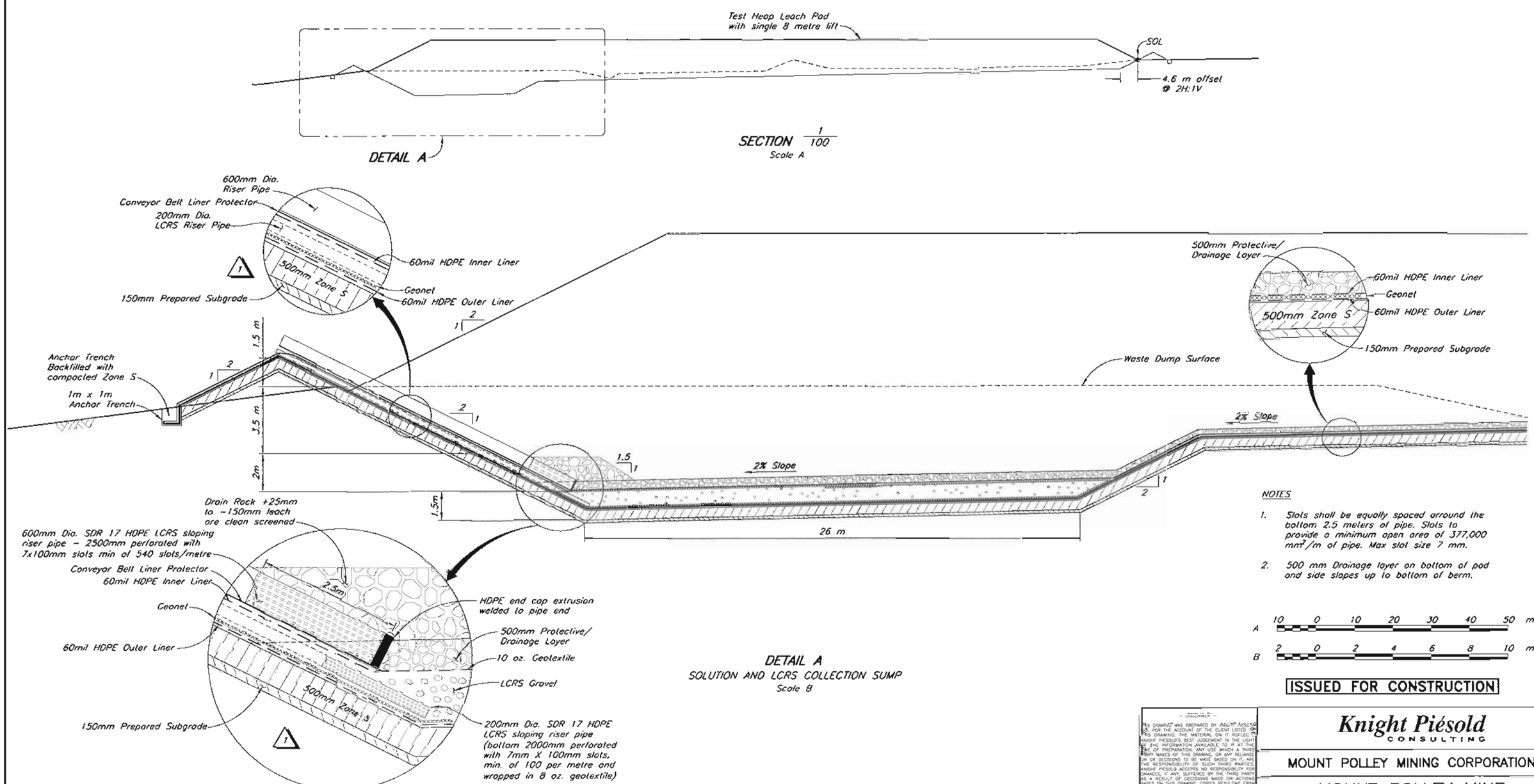

NOTES

1. Slots shall be equally spaced arround the bottom 2.5 meters of pipe. Slots to provide a minimum open area of 377,000 mm²/m of pipe. Max slot size 7 mm.
2. 500 mm Drainage layer on bottom of pad and side slopes up to bottom of berm.

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MOUNT POLLEY MINING CORPORATION

MOUNT POLLEY MINE

TEST HEAP LEACH PAD SECTIONS AND DETAILS

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — E. Borntraeger

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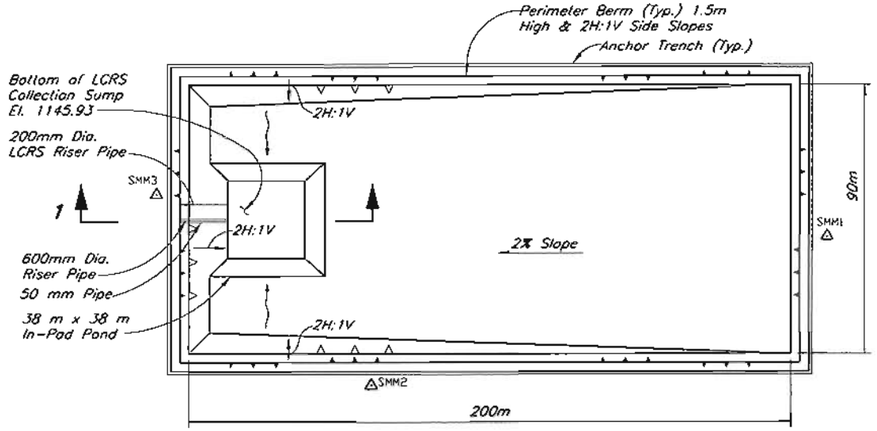
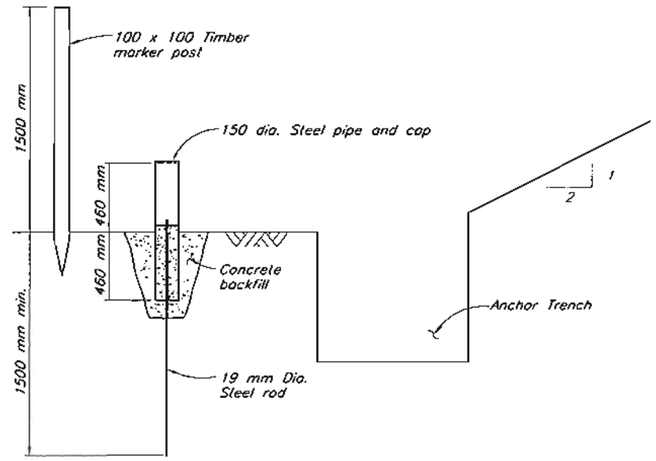
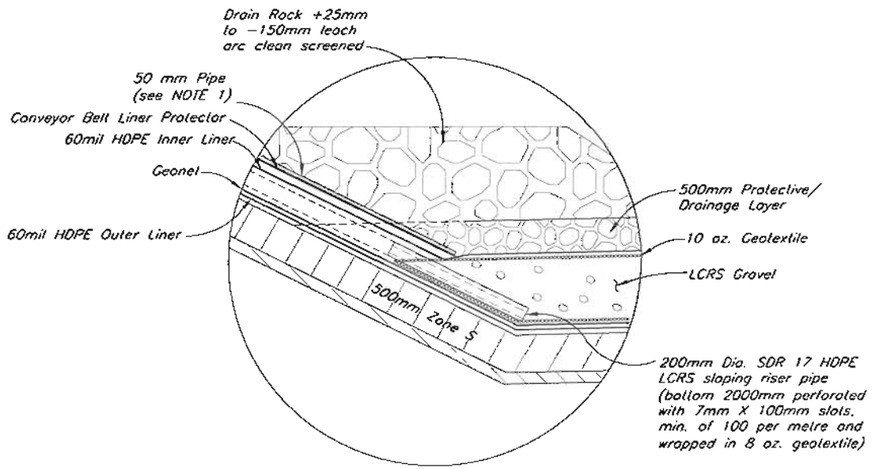


TEST HEAP LEACH PAD
Scale A



TYPICAL DETAIL OF SURFACE MOVEMENT MONUMENT
Scale B



SECTION 1
Scale C

LEGEND

- $\triangle^{SMM1}$ Suface Movement Monument
- V Cut Slope Symbol
- ▼ Fill Slope Symbol

NOTES

1. Solution level monitoring 50 mm pipe with level sensor. Level sensor is pressure transducer type.
2. Surface Movement Monument to be located adjacent to Anchor Trench.

A 20 0 20 40 60 80 100 m

B 0.4 0 0.4 0.8 1.2 1.6 2.0 m

C 0.8 0 0.8 1.6 2.4 3.2 4.0 m

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MOUNT POLLEY MINING CORPORATION

MOUNT POLLEY MINE

TEST HEAP LEACH PAD INSTRUMENTATION DETAILS

PROJECT/ASSIGNMENT NO.	DRAWING NO.	REVISION
VA101-1/15	300	0

DRG. NO.	DESCRIPTION
-	-

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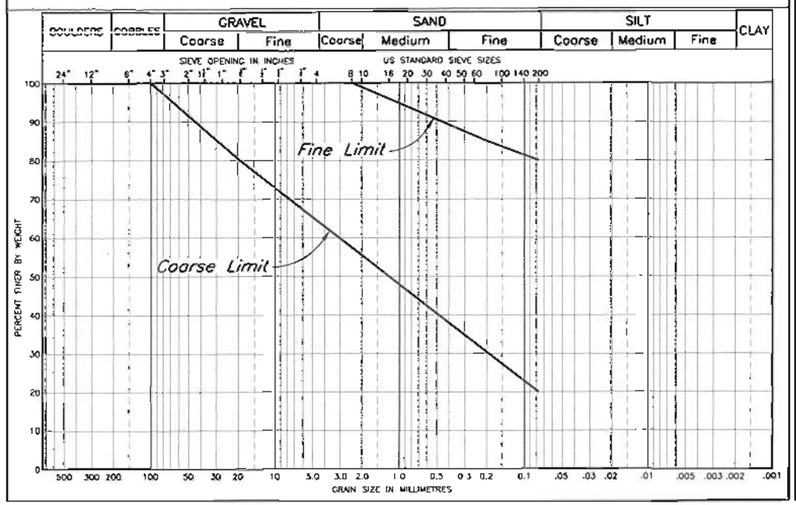
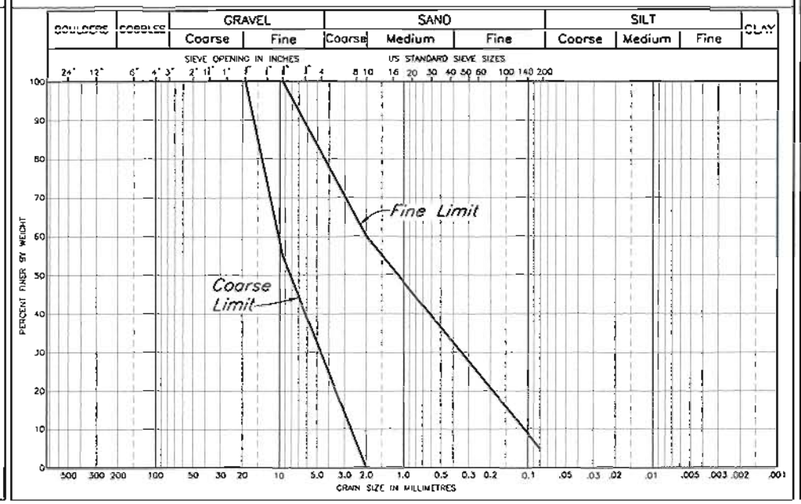
UNIFIED SOIL CLASSIFICATION SYSTEM

ZONE S - SOIL LINER



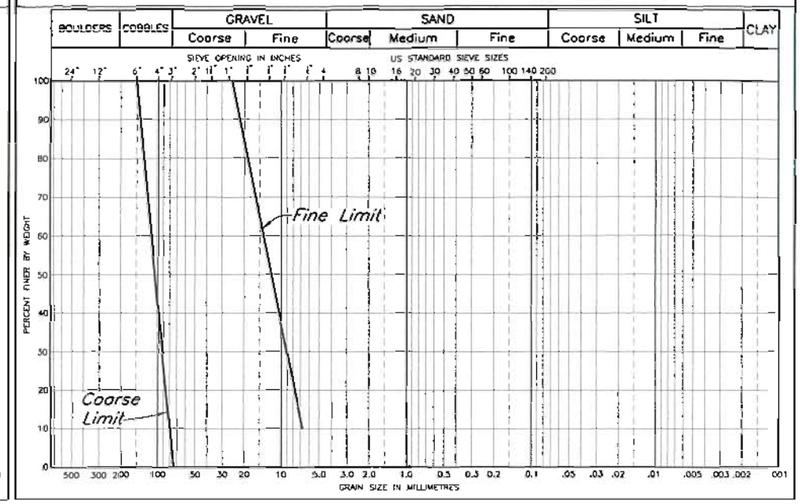
UNIFIED SOIL CLASSIFICATION SYSTEM

LCRS GRAVEL



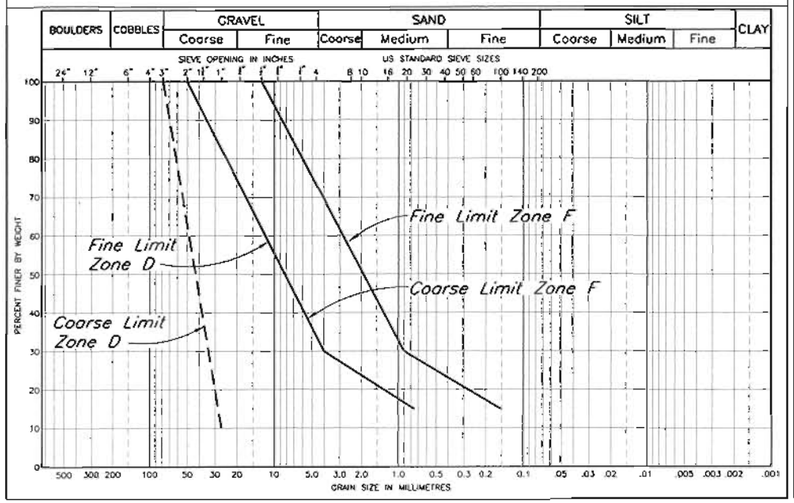
UNIFIED SOIL CLASSIFICATION SYSTEM

DRAIN ROCK



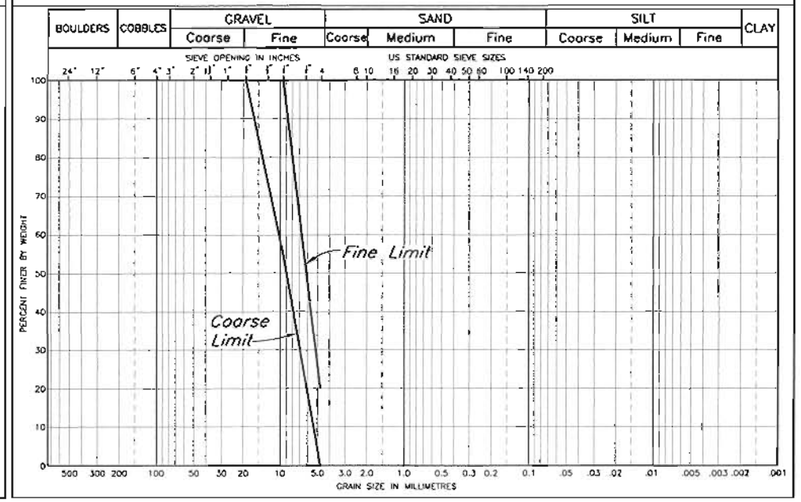
UNIFIED SOIL CLASSIFICATION SYSTEM

ZONE F - Prepared Subgrade



UNIFIED SOIL CLASSIFICATION SYSTEM

PROTECTIVE / DRAINAGE LAYER



ZONE	MATERIAL TYPE	LOCATION	PLACEMENT & COMPACTION REQUIREMENTS
S	Glacial till	Pad Bottom and Side Slopes	Placed, moisture conditioned and spread in maximum 250 mm thick layers (after compaction). Vibratory compaction to 95% of Standard Proctor maximum dry density or as approved by the Engineer.
F	Filter sand	Prepared Subgrade	Placed and spread in maximum 150 mm thick layers and compacted with minimum 4 passes of 10 ton smooth drum vibratory roller, or as approved by the Engineer.
LCRS	Sand and Gravel	LCRS Sump	Placed and spread in maximum 1000 mm thick layer with nominal compaction.
PDL	Processed Ore or Waste Rock	Pad Bottom and Side Slopes	Placed and spread in maximum 500 mm thick layer.
D	Drain Rock	Riser Pipe	Processed from leach ore and placed around the 600 mm Riser Pipe and wrapped with geotextile.

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PROFESSIONAL ENGINEER
B. Borntraeger

Knight Piésold CONSULTING

MOUNT POLLEY MINING CORPORATION

MOUNT POLLEY MINE

TEST HEAP LEACH PAD
MATERIAL SPECIFICATIONS

PROJECT/ASSIGNMENT NO	DRAWING NO	REVISION
VA101-1/15	400	0

ORG. NO.	DESCRIPTION
REFERENCE DRAWINGS	

REV.	DATE	DESCRIPTION	DESIGN	DRAWN	CHK'D	APP'D
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VANCOUVER B.C.

APPENDIX A

TEST HEAP LEACH FACILITY
TECHNICAL SPECIFICATIONS
(Ref. No. VA101-00001/15-1 Rev 0, dated September 15, 2006)

ISO 9001:2000
FS 64925

MOUNT POLLEY MINING CORPORATION
MOUNT POLLEY MINE

TEST HEAP LEACH FACILITY
TECHNICAL SPECIFICATIONS
(REF. NO. VA101-00001/15-1)

Rev. No.	Revision	Date	Approved
0	Issued with Report	September 15, 2006	KJB

PART 7 – TECHNICAL SPECIFICATIONS

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PART 1 - TECHNICAL SPECIFICATIONS

1.1 MOBILIZATION AND DEMOBILIZATION

1.1.1 Scope Of Work

The Work in this section comprises the establishment on the Site of all the temporary accommodation, Plant and equipment necessary for the successful performance and completion of the Work and shall include, but not necessarily be limited to:

a. Assemble all necessary Plant and equipment and transport it to the Site.
b. Establish all the Contractor's maintenance facilities, construction roads, temporary workshops, office accommodation and sanitation facilities on the Site.
c. Provide adequate sediment control measures during the Work.
d. Maintain all Plant and services for the duration of the Work.
e. On completion of the Work, remove all Plant, temporary facilities from the Site and clean up and leave the Site in a clean and tidy condition to the satisfaction of the Owner.

1.1.2 Mobilization

In accordance with the Construction Schedule, or as otherwise agreed in writing with the Owner, following award of the Contract, the Contractor shall mobilize on the Site, sufficient labour, materials, Plant and equipment to enable the Work to commence, and shall bring on to the Site as and when necessary, any additional labour, materials, Plant and equipment which may be required from time to time to complete the Work in accordance with the construction schedule.

1.1.3 Contractor's Laydown Area

The Contractor shall erect, in the area designated by the Owner, adequate workshops, offices, laydown areas and other buildings and structures for the completion of the Work. Such workshops and offices, etc., shall be maintained in a neat and tidy condition throughout the duration of the Work to the satisfaction of the Engineer and Owner.

1.1.4 Sanitation

The Contractor shall provide and maintain adequate sanitary facilities for his personnel at the Site in compliance with local health regulations and to the satisfaction of the Owner.

1.1.5 Construction Roads

All temporary construction roads that the Contractor may require to complete the Work shall be constructed at the Contractor's expense. The location of any temporary roads, or portions thereof, on the Site shall be subject to the Owner's and Engineer's approval.

1.1.6 Sediment Control

The Contractor shall be responsible for erosion protection and prevention of water pollution during the Work.

1.1.7 Demobilization

On completion of the Work the Contractor shall remove all Plant, temporary facilities and equipment from the Site and leave it in a clean and tidy state to the satisfaction of the Owner.

PART 2 - EARTHWORKS

2.1.1 Scope of Work

The portion of Work specified in this Section shall consist of supplying all labour, supervision equipment and materials necessary to construct and protect the earthworks as shown on the Drawings or as required by the Engineer including:

a. Clear, grub and remove topsoil and unsuitable material from the Stage 3C work area as defined on the Drawings.
b. Prepare the foundation areas for construction of the Stage 3C embankments.
c. Construct the raise to the Main, Perimeter and South Embankments using the materials generated from borrow areas and stockpiles, as shown on the Drawings.

2.1.2 Clearing, Grubbing and Removal of Topsoil and/or Unsuitable Material

The Contractor shall clear, grub and remove topsoil and/or unsuitable material from all ground surfaces prior to excavation in any area, in areas which are not excavated but in which fill is to be placed, to the limits as shown on the Drawings.

In order to reduce erosion and contamination of the surface runoff to a minimum at all times, clearing, grubbing and topsoil removal shall be scheduled to be performed only as and when required to enable each portion of the Work to be carried out.

a. Clearing and Grubbing

The Work area will have been logged of merchantable timber prior to the Contractor arriving on site. Clearing the areas of the Site so designated on the Drawings or in the Technical Specifications shall consist of the felling of all non-merchantable trees, shrubs and vegetation to within 0.6 m of the ground surface.

All non-merchantable timber and vegetation shall be disposed of by burning to reduce it to ashes or as otherwise approved by the Owner. Care shall be taken in burning debris to prevent the fire from spreading. Prior to starting any fires the Contractor shall notify the Owner and the governmental authority having jurisdiction with regard to fires and shall obtain their permission to proceed.

At all times during which burning takes place, the Contractor shall have available in working order to control the fire sufficient fire fighting equipment and personnel to operate such equipment.

Any clearing which the Contractor elects to perform for his own purposes, and for which he will not be paid, shall be subject to the approval of the Owner and shall be performed in accordance with the requirements of this Clause. Prior to the clearing of any area, which is not required for the Work, the Contractor shall submit to the Owner for approval, full details of

the clearing it proposes to perform. Clearing in any such area shall not be commenced prior to receipt of written approval by the Owner.

Grubbing of the selected areas of the Site shown on the Drawings shall consist of the complete removal of all vegetation and organic matter and grubbing to remove all roots and stumps. All roots over 50 mm in diameter, protruding from the ground surface, shall be grubbed to a depth of 300 mm below the ground surface. Pieces of wood less than 75 mm in diameter, 1000 mm in length may be scattered within the clearing limits and will be incorporated with the topsoil during topsoil stripping operations by the Contractor.

All vegetable matter, roots and stumps so produced shall be disposed of in the same manner as that specified for non-merchantable debris in (a) above. Muskeg or peats which cannot be burned shall be temporarily stockpiled or windowed within the work area and shall ultimately be disposed of by placing in designated stockpiles or exhausted borrow areas and covering with fill material.

b. Removal of Topsoil and/or Unsuitable Material

After an area has been cleared and grubbed, and the debris removed, the Contractor shall remove the topsoil and/or unsuitable materials and stockpile this material in the designated areas as shown on the Drawings.

Unsuitable material shall be identified by the Engineer and will generally comprise saturated soils, ash, or fill materials which when compacted do not achieve the designated density.

The material is to be stockpiled in a neat workmanlike manner approved by the Engineer such that it shall be stable and protected from erosion. Soil covers shall be required on stockpiles as directed by the Engineer.

After removal of surface soil and/or unsuitable material in an area and before any additional work is undertaken:

(i) the Engineer shall inspect the area to determine whether removal of material has been completed satisfactorily,
(ii) the Engineer shall determine the type of surface treatment to follow, for the particular area, and
(iii) a survey will be taken of the area in order to determine quantities and/or verify lift/layer thickness.

c. Removal of Unsuitable Material from Embankment Slopes

The Contractor shall remove unsuitable materials from the existing embankment slopes and stockpile this material in the designated areas as shown on the Drawings or as otherwise directed by the Owner.

Unsuitable material shall be identified by the Engineer and will generally comprise saturated fill materials, which when compacted do not achieve the designated density.

The material is to be stockpiled in a neat workmanlike manner approved by the Engineer such that it shall be stable and protected from erosion. Soil covers shall be required on stockpiles as directed by the Engineer.

After removal of unsuitable material in an area and before any additional work is undertaken:

(i) the Engineer shall inspect the area to determine whether removal of material has been completed satisfactorily,
(ii) a survey will be taken of the area to determine quantities and/or verify lift/layer thickness.

The fill shall be keyed into the existing embankment slopes by cutting vertical steps into the slope equal in height to the lift thickness of the fill being placed.

2.1.3 Removal of Temporary Cover

The Contractor shall remove any temporary soil cover spread during the previous stage of construction for protection purposes.

Temporary protected areas are those where previous soil cover shall be removed to the required depth for proper connection between the “As Constructed” and “Designed” section according to latest revised drawings or upon the discretion of the Engineer during construction.

2.1.4 Open Excavation

a. General

The Contractor shall develop its excavation methods, techniques and procedures with due consideration of the nature of the materials to be excavated and shall take such precautions as are necessary to preserve in an undisturbed condition all materials outside the lines and grades shown on the Drawings. The Contractor shall be permitted to carry out excavation, shaping, etc. by whatever method it considers most suitable, providing it is consistent with producing an acceptable end result as determined by the Owner or Engineer. The Contractor shall be solely responsible for the safety and adequacy of the methods employed.

The Contractor shall notify the Engineer after clearing, grubbing, and removing topsoil and unsuitable material from an area, and shall obtain the Engineer’s approval of the adequacy of the exposed surface prior to the Contractor excavating below or placing material on the surface.

After the completion of clearing, grubbing and removal of topsoil and unsuitable material from an area, and after excavation of all material, prior to further excavation of any material for which the Contractor expects payment on a unit price basis, the existing ground surfaces shall be established on the basis of surveys to be made by the Contractor for purposes of measurement for payment. Prior to commencement of such surveys of any particular area the Contractor shall notify the Owner, so as to give the Owner the opportunity of participating in, or directing, the carrying out of such surveys. In any event, the Contractor shall not proceed to excavate any material prior to receipt, in writing from the Owner or Engineer of his agreement with the location of the existing ground surface in that area. Failure by the Contractor to comply with the above requirements with respect to excavation in any area shall mean that the location of the existing surface in such an area, for the purpose of measurement, shall be decided solely by the Owner.

The Contractor, in its scheduling of the Work, shall allow sufficient time in its construction schedule for the carrying out of the surveys defined above and for the Owner's or Engineer's proper consideration thereof prior to his authorization to proceed with excavation in any area.

The Contractor shall not excavate beyond the lines and grades shown on the Drawings without the prior written approval of the Engineer. Any additional excavation which is performed by the Contractor for any purpose or reason whatsoever, other than in compliance with a specific request from the Owner or Engineer, shall be carried out at the expense of the Contractor. If such additional excavation, as defined herein, should in the opinion of the Engineer require backfilling in order to satisfactorily complete the Work, such backfilling shall be done by and at the expense of the Contractor, including the supply of fill material, and shall be completed to the satisfaction of the Engineer.

Where pipe, drain or culvert trenches are to be excavated in fill, excavation shall not commence until the elevation of the compacted fill exceeds the nominal crown elevation of the conduit by at least 300 mm.

The Contractor shall provide, maintain and operate any temporary drainage and/or pumping facilities required to control ground and surface water in order to keep the excavations dry and in a stable condition. The Contractor's dewatering operations shall be accomplished in a manner that shall not adversely affect the stability of the excavated slopes and shall not cause erosion and softening of adjacent materials.

The discharge from any dewatering system shall be directed to appropriate sediment control facilities.

When a section of excavation has been completed to the required lines and grades, the Contractor shall notify the Engineer who shall inspect the Work. Excavated surfaces shall not be covered with pipe bedding, fill, geosynthetics or concrete until the surface has been approved in writing by the Engineer. The Contractor shall uncover at its own expense, any excavated surface which has been covered prior to inspection and approval by the Engineer.

The Contractor shall protect and maintain all excavations until completion of the Work or until such time as the adjacent placement of material has been completed.

Material from the excavations, which meets, or can be processed to meet, the requirements for the construction materials specified in the Tender Documents, shall be either stockpiled for later use, or used directly for construction of the Work. In the event that the Contractor elects to stockpile fill material prior to placing it directly into the fill, the cost of double handling shall be at the Contractor's expense.

Excavated materials not suitable for use in construction shall be disposed of in spoil disposal areas approved by the Owner.

b. Revisions to Lines and Grades

In the event that the Owner or Engineer should in his sole discretion require the Contractor to excavate any part of the Work to lines or grades other than specified, previously directed by the Owner or Engineer, or shown on the Drawings then:

(i) If the Contractor is advised of such requirements before excavation to the lines and grades specified, previously directed by the Owner or Engineer, or shown on the Drawings, such required excavation shall be paid for at the applicable price entered for the excavation.

(ii) If the Contractor is advised of such requirements after excavation to the lines and grades specified, previously directed by the Owner or Engineer, or shown on the Drawings, all additional excavation so required shall be paid for by the contractor.

c. Stability and Protection of Excavated Surfaces

The Contractor shall be solely and completely responsible, until completion of the Work, for the safety, stability, maintenance, support and protection of all excavated surfaces, the excavation of which is carried out under the Contract, and for the safety of his work force and the forces of Others while they are in the Contractor's working areas including areas in the immediate vicinity of the excavations. The Contractor shall supply, install and provide all temporary supports, bulkheads, canopies, sheeting and bracing, divert surface water, remove water from the excavations, and shall provide and maintain such drainage and pumping facilities as are necessary to stabilize and protect the excavations. Except as otherwise approved by the Owner or Engineer, such temporary support and facilities shall be removed by the Contractor on completion of the Work.

2.1.5 Foundation Preparation

Foundation preparation of any surface that is to receive fill and from which topsoil, unsuitable material or temporary cover has already been removed shall consist of trimming and levelling to a

consistent surface suitable for fill material and proof rolling with a minimum of 4 passes of the specified compaction equipment.

Prior to placing any fill materials on excavated surfaces, the surfaces shall be prepared as follows:

(i) Surfaces of excavations shall be kept clean of any loose debris and compacted with 4 passes of the specified compaction equipment. In the event that the moisture content of these surfaces is too high to permit 4 passes of a vibratory roller and the surface tends to rut and weave, the compaction shall be reduced to 2 passes of the specified compaction equipment, or as required by the Engineer.

(ii) For excavated surfaces, the fill shall be keyed into the native soil by cutting vertical steps into the slope equal in height to the lift thickness of the fill being placed.

Placing of fill materials on excavated surfaces shall not commence until the preparation of the surfaces has been approved in writing by the Engineer.

2.1.6 Fill Placement

a. General

The words “embankment fill”, “fill materials”, “fill” and “rockfill” shall be regarded as being interchangeable when used in the context of referring to the various zones of material comprising embankments and berms. Similarly the words “backfill” and “bedding” shall be regarded as interchangeable when used in the context of referring to the various zones of materials comprising trench fill.

At least 7 days prior to the scheduled commencement of fill placement the Contractor shall submit to the Owner or Engineer for authorization to proceed with the Work complete details of the various stages, materials, equipment, methods and procedures he proposes to use for such operations and plans for any temporary construction roads. Notwithstanding that the Owner or Engineer has given the Contractor authorization to proceed with such procedures, the Contractor shall be completely responsible for the planning and execution of such procedures.

The Contractor shall be liable for any damage whatsoever to property caused by or resulting from his operations in performing the Work, including dewatering and/or drainage of embankment foundations. Such damage shall be fully repaired by and at the expense of the Contractor.

The Contractor shall prepare the foundations for and shall construct the various zones of fill of embankments and berms and the basin liner to the lines and grades shown on the Drawings and within the tolerances specified herein. Fill materials shall not be placed on any

part of foundations until all required excavation, dewatering and foundation preparation and the Contractor has received written approval by the Engineer.

b. Supply and Production of Fill Materials from Borrow Areas

Fill material for constructing the embankments and berms and for trenches shall be supplied by the Contractor and shall be obtained from excavations required for the Work and supplemented with borrow materials. Borrow areas and other sources may be used to supply specialized materials not available from the required excavations which may be proposed by the Contractor and approved by the Engineer.

The disposition of the material is random and heterogeneous in the excavations and shall require proper planning and operation to obtain suitable materials which meet the specified requirements for the various material types.

The Contractor shall be wholly responsible for supplying materials which conform to the specified requirements for each class of material and shall take whatever measures and precautions considered necessary to achieve this objective. Such measures shall include, but not be limited to, planned operation, drainage and selective excavation in the excavations, sorting, blending, screening, etc.

In the event that the Contractor wishes to obtain any materials from sources other than those stipulated above, then it shall carry out, at it's own expense, investigations to show that the materials contained in the alternate sources are suitable for the intended purpose. Such investigations shall be sufficient to establish that the material is suitable. Details of the investigations and the results thereof shall be submitted to the Engineer at least fourteen(14) days before the Contractor intends to commence production in the alternate area. Approval by the Engineer for the Contractor to obtain construction materials from alternative sources shall not relieve the Contractor of its responsibility to produce materials that conform to the specified requirements.

All borrow areas and excavations shall be cleared, grubbed and all topsoil or unsuitable material shall be removed as required by the Engineer prior to commencement of material production in accordance with the provisions of Clause 7.2.2.

Prior to developing any borrow area other than the borrow areas designated on the Drawings or in the Specifications, the Contractor shall carry out such sub-surface investigation and obtain and submit such samples as are required by the Engineer to enable the Engineer to assess the suitability of the materials in the area for the intended use.

The Contractor shall keep accurate exploration records of a type approved by the Engineer of any test pit, trench or drill hole which is excavated for the purpose of investigating construction materials, and a copy of such records shall be submitted to the Engineer within 7 days of the completion of the test pit, trench or drill hole. Samples recovered from test pits,

test trenches and drill holes, and submitted to the Engineer for approval, will be tested by the Engineer.

The Contractor's borrow area operations shall be such as to avoid waste of any suitable construction material therein. The Contractor shall clear and grub borrow areas, remove all topsoil or unsuitable material. Borrow areas shall be developed with due consideration for drainage and runoff from the excavated surfaces so as not to cause erosion of the adjacent terrain. Borrow areas shall be excavated in such a manner that water will not collect and stand therein. For materials sensitive to overwetting, the borrow areas shall be developed to minimize the exposure of the material to precipitation. All excavated faces in borrow areas shall be vertical. Before being abandoned, the sides of all borrow areas shall be brought to stable slopes with slope intersections rounded and shaped to provide a natural appearance. All rubbish, Contractor's equipment and structures shall be removed from these areas. Waste piles shall be levelled, trimmed and shaped to regular lines to prevent the occurrence of ponding or of concentrations of surface runoff and to provide a neat appearance. All surface water runoff shall be directed to sediment control facilities approved by the Owner.

Waste material from an excavation for the Work or from a processing operation in a borrow area shall be disposed of in a spoil area or in an area approved by the Owner and set aside for this purpose within the borrow area.

c. Supply and Production of Fill Materials from Stockpiles

Some of the fill materials for constructing the embankments and berms shall consist of materials that will be stored in designated stockpiles that will be developed by the Owner. The stockpiles are expected to contain sufficient material to complete the Work.

The Owner shall be wholly responsible for supplying materials from the stockpiles that conform to the specified requirements for each class of material and shall take whatever measures and precautions considered necessary to achieve this objective. Such measures shall include, but not be limited to, planned operation, drainage and selective excavation in the excavations, sorting, blending, screening, etc. The acceptability of such fill materials shall be determined by the Engineer on the basis of quality control tests that will be made frequently on each material. The Contractor's construction schedule must accommodate the Owner's production schedules.

Other sources may be used to supply specialized materials not available from the borrow areas and stockpiles. These sources will be developed by the Owner, after the completion of investigations as described above.

d. Borrow Area Fill Material Requirements

The Contractor shall provide the fill materials required for the Work from the borrow areas and shall ensure that such materials meet the requirements specified herein or shown on the

Drawings. The acceptability of such fill materials shall be determined by the Engineer on the basis of quality control tests that will be made frequently on each material.

Borrow area fill materials shall be durable and shall not, except as otherwise specified, contain more than a small proportion of thin, flat or elongated particles and shall be free from organic and other deleterious material. Except as otherwise specified, the particles shall be hard and resistant to breakdown during handling.

Borrow area fill materials shall be well graded within the specified gradation limits. That is, they shall contain a good distribution of all sizes of particles from the coarsest to the finest. The specified gradation limits shall apply to the materials when they are dumped and spread on embankments and berms or placed in trenches prior to any required compaction.

The required gradation envelopes for the various material types from borrow areas used in the Work are specified on the Drawings.

The Contractor shall provide materials to produce fill materials that meet the requirements specified on the Drawings and described in the Technical Specifications. Such provision shall, where necessary, include, but not be limited to, separating material into various sizes, blending one material with another, scalping off oversize material, screening and/or washing to remove fines, crushing or selective excavation of the materials.

All oversize material shall be removed from the fill material either prior to its being placed in embankments and berms or after it is dumped and spread but before compaction operations are started. Material that is a by-product of the processing of materials for one type of material may be incorporated in the fill for another material provided that it satisfies the specifications for such latter material either by itself or after it has been blended with other material.

In the event that the Contractor chooses to stockpile material from the borrow areas, the stockpile locations shall be as approved by the Owner or Engineer. The Contractor shall stockpile fill material, if required, such that excessive segregation shall not occur. Before any area is used for stockpiling, it shall be cleared and stripped as necessary to prevent contamination of the material. Any stripping and grubbing, removal of topsoil or unsuitable material and temporary soil cover that is required shall be carried out by the Contractor in accordance with the provisions of Clauses 7.2.2 and 7.2.3.

e. Fill Placement

The Contractor's operations and procedures for placing fill shall be subject to the approval of the Engineer in accordance with the provisions of Clause 7.2.6.a. Furthermore, no fill materials shall be placed in embankments, berms or trenches until all foundation preparation in the fill area has been completed by the Contractor and has been approved in writing by the Engineer.

The Contractor shall construct the embankments and berms only with materials meeting the specified requirements as shown on the Drawing or described in the Technical Specifications. The fill material shall be free from lenses, pockets and layers of materials that are substantially different in gradation from the surrounding material in the same zone.

Fill material shall be excavated, transported, placed and spread in such a manner that segregation is avoided. Any material placed which does not meet the specified requirements shall be removed or remixed, blended, disked, or otherwise reworked by and at the expense of the Contractor to produce a material that does satisfy the specified requirements of the zone, whether or not such material has been covered by other fill material. Except as otherwise specified, the Contractor shall construct each zone by placing, spreading and levelling and, where required, compacting the specified fill material in continuous lifts of the specified thickness. The surface of each lift shall be sloped only at such grades as are necessary to ensure at all times that adequate surface drainage is provided.

Fill shall not be placed against concrete until a minimum of seven(7) days have elapsed after concrete placement.

Except as otherwise specified in the Technical Specifications, fill shall be placed and spread in such a manner that no gaps are left between adjacent placed loads of materials. The fill shall be levelled prior to compaction using a motor grader to obtain a smooth surface free from depressions. Except in areas where space is limited or as is otherwise specified, fill shall be placed by routing the hauling and spreading units approximately parallel to the axis of the embankment and, within practical limits, the hauling units shall be so routed that they do not follow in the same paths but spread their tracks evenly over the surface of the fill. The equipment used for placing fill shall be such that it does not cause segregation of the material.

For trench backfill or working around or near pipes, valves, instrumentation or structures, the Contractor shall exercise particular care in fill placement to avoid damage to the Work. Should the Engineer for any reason wish to re-inspect components previously authorized for backfilling, the Contractor shall excavate and re-expose such Work to the satisfaction of the Engineer. If any fault in the Work is uncovered the Contractor shall make the fault good to the satisfaction of the Engineer and replace the backfill. Such excavation, repairs and backfilling shall be done at the expense of the Contractor.

The Contractor shall have available during all working hours, sufficient heavy rubber tired graders or other equipment, approved by the Engineer in accordance with this Clause to level, re-level and otherwise maintain the uncompacted fill surfaces in a smooth and workmanlike manner.

In fills that require moisture conditioning, the Contractor shall condition the material to the moisture content designated by the Engineer prior to placing the material on the fill zone. The Contractor shall adopt all measures necessary to achieve a moisture content within one percent of that designated, distributed uniformly throughout the layer of material being

placed, immediately prior to compaction. The Contractor shall adopt whatever measures necessary to ensure that the designated moisture content is preserved after compaction, until the succeeding layer is placed.

Wherever necessary, after a layer of fill has been placed, the moisture content of the fill material shall be modified to ensure that it is within the range specified. If after placing, spreading and levelling any fill material becomes too wet for proper compaction as determined by the Engineer, it shall be either removed from the embankment or berm or the moisture content reduced to a value acceptable to the Engineer by disking or other approved methods. Suitable disc harrows or other approved equipment shall be available during all working hours for use if required.

Equipment used by the Contractor to apply water to fill material shall be designed to apply water uniformly and at sufficient rates to achieve the designated moisture content. Water tank trucks shall be equipped with positive shut-off valves so that no leakage shall result from the nozzles when the equipment is not operating. In the event that leaks do occur, they shall be repaired immediately.

Moisture conditioning shall be carried out in a manner that will avoid flow of water between zones.

In non-freezing conditions, all zones in the embankments and berms are to be constructed in near horizontal lifts with each lift being completed over the full length and breadth of the zone before material is placed in the next lift. The maximum difference in elevation between adjacent zones in the embankments, permitted at any time during construction, shall be equal to the larger of the two lift thicknesses for the two adjacent zones. Except for this requirement, the Contractor will not be permitted to form any construction joints in the embankments without the approval of the Engineer.

f. Zone S Material

The Zone S material shall be placed to the lines and grades as shown on the drawings and compacted as discussed in the technical specifications and as shown on the drawings.

The surface of any area which will be lined with geosynthetics shall be trimmed and dressed to form a surface which is firm, dry, smooth and free of projections of sharp rock fragments, which could puncture or damage the overlying liners, to the satisfaction of the Engineer. All finished soil liner surfaces on which geomembrane is to be placed shall be rolled with a steel drum roller to bed gravel particles into the soil matrix. Particles not bedded during the rolling process shall be removed by hand and/or brooming the surface. The upper 100 mm of the subgrade shall have a maximum particle size of 50 mm. Objects protruding from the soil liner surface which cannot be rolled into the soil matrix with a smooth drum vibratory roller or other approved means, shall be removed by raking, brooming, or handpicking the surface.

The bottom of excavations shall be proof-rolled with the number of roller passes determined by the Engineer to present a smooth, firm surface, suitable for placement of the overlying fill or liner.

The Contractor may be required by the Engineer to over excavate and/or place compacted and approved fill on areas which, in the opinion of the Engineer, are not suitable for placement of liner materials.

g. Subgrade Material

The subgrade material shall be placed to the lines and grades as shown on the drawings and compacted as discussed in the technical specifications and as shown on the drawings. The subgrade material shall be placed in a manner that minimizes segregation.

h. LCRS Material

The LCRS drainage material shall be placed to the lines and grades as shown on the Drawings. LCRS drainage material shall be placed in a manner that minimizes segregation.

Extreme care shall be taken while placing LCRS drainage material to avoid damaging the underlying geotextile and/or synthetic liner. The material will be spread in one thick lift by advancing it progressively away from the nearest road access. No equipment shall be permitted on the synthetic liner or filter fabric.

Any damage to the HDPE geomembrane resulting from placement techniques shall be immediately reported to the Engineer, who will specify the method of repair. The cost for such repair shall be borne solely by the Earthworks Contractor.

Equipment will be permitted only on access roads and LCRS drainage material after the full thickness of the zone has been achieved. The completed surface of the LCRS drainage material shall be levelled to form a smooth workmanlike surface prior to covering with geotextile.

i. Protective Drainage Layer

The protective drainage material will be hauled and placed on the pad to produce a continuous blanket of material, not less than 500 mm in thickness, placed directly on top of the 60 mil HDPE geomembrane. Incorporated in the protective drainage material is a network of perforated CPT drainage collection pipes.

The protective drainage material shall be dumped from haulage trucks adjacent to the advancing edge of the layer and "feathered" onto the liner with a small low ground pressure crawler type tractor or a blade. At no time shall equipment operate directly on the surface of the geomembrane or within 1.5 metres of the advancing edge.

Once placed, the surface of the material shall be maintained in a moist condition to prevent dusting. If necessary, the Contractor shall sprinkle the area to prevent the surface from drying out.

As the ambient air temperature increases, wrinkles in the HDPE liner will develop due to thermal expansion and physical properties of the HDPE liner. Folding of wrinkles will be considered unacceptable. To minimize the size and the potential of folding wrinkles, the protective drainage material shall be placed in the cooler times of the day or night when the geomembrane lays relatively flat and placed in an uphill direction and/or parallel to the contours.

Repair of any damage to the geomembrane liner due to the placement of the protective drainage layer shall be performed to the satisfaction of the Lining Contractor, the Engineer, and the Owner and at the expense of the Earthworks Contractor.

Because of the thickness of the protective drainage layer material and the potential crushing of the collector pipes, vehicle traffic on the protective drainage layer shall be the minimum possible and shall be restricted to roadways and other areas clearly established in the Contractor's approved method of working and marked on the pad during the construction. If necessary, compacted areas of the final protective drainage layer surface shall be carefully scarified but extreme care must be exercised to avoid damage to the collection piping and geosynthetic liner.

j. Drain Rock

Drain rock shall be placed to the lines and grades as shown on the Drawings. Drain rock shall be placed in a manner that minimizes segregation.

Extreme care shall be taken while placing drain rock to avoid damaging the underlying synthetic liner or the pipework. No equipment shall be permitted directly on the synthetic liner.

Any damage to the HDPE geomembrane resulting from placement techniques shall be immediately reported to the Engineer, who will specify the method of repair. The cost for such repair shall be borne solely by the Earthworks Contractor.

k. Anchor Trenches

All anchor trenches shall be excavated and backfilled by the Earthworks Contractor. Backfill to anchor trenches shall generally consist of imported soil liner material, with a maximum particle size of 75 mm. Subject to the approval of the Engineer, material from the anchor trench excavation may be used if it is determined to be suitable.

Backfill will be carefully placed so as not to damage the liner and shall be compacted in layers not exceeding 150 mm (after compaction). The fill shall be compacted to 92% of maximum
dry density as determined by ASTM D1557, unless otherwise specified.

l. Fill Placement During Freezing Conditions

Construction of embankments, berms and basin liner may take place during freezing conditions. The Contractor will be permitted to place fill materials in freezing conditions only if the materials can be placed and compacted to the specified densities that would normally be achieved if freezing conditions did not prevail. Criteria for placing fill materials during freezing conditions are summarized below.

(i) All ice and snow and loose frozen fill materials must be removed from compacted fill surfaces or prepared foundations prior to placing any new fill materials.
(ii) Fill materials can be placed on previously placed and compacted frozen fill or approved frozen foundations provided that the surfaces are cleaned as per (i) above.
(iii) Only non-frozen fill can be placed on embankments and berms. Frozen soils must be removed from the borrow areas prior to excavation of non-frozen fill materials.
(iv) Fill materials must meet the specified moisture content criteria before excavation in the borrow areas and before placement on embankments or berms.
(v) The fill materials must be immediately spread and compacted after placement to achieve the specified density before freezing.
(vi) Fill placement and compaction should occur rapidly and in relatively small areas. The exposed surfaces shall be kept to a minimum so as to minimize the potential for fill materials to become frozen before they are compacted to the specified densities.
(vii) Any fill materials that become frozen prior to compaction to the specified densities must be removed to spoil.
(viii) Fill materials shall not be placed when it is snowing or when there is any accumulation of snow or ice on surfaces to be covered by the succeeding layers of fill.

Methods proposed by the Contractor for construction during freezing conditions shall be reviewed and approved by the Engineer prior to commencing fill placement.

m. Compaction

All fill material, after placing, spreading and levelling to the appropriate layer thickness, shall be compacted in accordance with the Technical Specifications and as shown on the drawings.

Compaction of each lift of fill shall proceed in a systematic, orderly and continuous manner such as to ensure that all of each lift receives the compaction specified. The compaction shall be carried out by routing the compaction equipment parallel to the axis of the embankment or berm, except that where such routing is impracticable, such as in roller turning areas, in areas adjacent to the foundations or at the lower elevations of the fill, in

areas adjacent to concrete, and in trenches. In such areas the compaction equipment may be routed in any direction provided that all of each lift receives the compaction specified.

Hand guided vibratory compactors shall be used to compact materials which cannot be compacted by the specified vibratory rollers because of locations near pipes, valves, instrumentation, structures, or due to limited accessibility.

The Contractor shall take every precaution when operating compaction equipment to avoid damage to adjacent structures, instrumentation devices and their leads, and to avoid disturbing the foundation. Any such damage or disturbance shall be repaired or remedied by the Contractor at its own expense.

The rolling pattern at all zone boundaries or construction joints shall be such that the full number of roller passes required in one of the adjacent zones or on one side of the construction joint extends completely across the boundary or joint.

Should the surface of the fill become rutted or uneven subsequent to compaction it shall be regraded and recompacted by and at the expense of the Contractor, before the next layer of fill is placed.

All large particles that interfere with compaction shall be removed from the zone in which they were placed, either prior to or during compaction.

The Contractor shall provide sufficient compaction equipment of the types and sizes specified herein as is necessary for compaction of the fill materials. If the Contractor wishes to use alternative equipment, it shall submit to the Engineer for approval complete details of such equipment and the methods proposed for its use. The Engineer's approval of the use of alternative equipment will be dependent upon the Contractor's demonstrating, by constructing suitable test fills to the satisfaction of the Engineer, that such alternative equipment will compact the fill materials to a density not less than that which would be produced by the equipment and number of coverage's specified herein.

Compaction equipment shall have sufficient power to handle the most adverse conditions to be encountered during compaction of the fill and required ballasting to the maximum weight specified for compaction of the fill.

When vibratory rollers are operated in a multiple arrangement, all of the rollers shall be similar and similarly ballasted.

Compaction equipment shall be maintained in good condition at all times to ensure that the amount of compaction obtained is a maximum for the equipment. The Contractor shall immediately make adjustments to the equipment to achieve this end whenever such are necessary.

The Contractor shall, prior to shipping compaction equipment to the Site, submit to the Engineer the manufacturer's data providing all dimensions, weights and complete technical data, including descriptions and calculations of applied forces.

Unless approved under the prior provisions of this clause, all fill material shall be compacted using the following specified equipment:

(i) Smooth Drum and Wedge-Foot Drum Vibratory Rollers

Smooth drum and wedge-foot drum vibratory rollers shall be equipped with a suitable cleaning device to prevent the accumulation of material on the drum during rolling. Each roller shall have a total static weight of not less than 10 tonnes at the drum when the roller is standing on level ground. The drum shall be not less than 1.5 metres in diameter and not more than 2.2 metres in width. The vibration frequency of the roller drum during operations shall be between 1100 and 1500 vibrations per minute and the centrifugal force developed by the roller at 1250 vibrations per minute shall not be less than 18 tonnes.

The power of the motor driving the vibrator shall be sufficient to maintain the specified frequency and centrifugal force under the most adverse conditions that may be encountered during compaction of the fill. Propulsion equipment for the roller shall be adequate to propel the roller at speeds up to 6 km/hr.

For compaction by the vibratory roller, 1 coverage shall consist of 1 pass of the roller. A minimum overlap of 300 mm shall be maintained between the surfaces traversed by adjacent passes of the roller drum. During compaction the roller shall be propelled at 3 km/hr.

(ii) Hand-Guided Vibratory Compactors

The Contractor shall adopt special compaction measures consisting of hand guided vibratory compactors to compact fill in trenches, around structures and in other confined areas which are not accessible to the larger vibratory roller. Such compaction shall be capable of compacting the material to the same density as that achieved by the larger vibratory roller.

n. Quality Control

The Engineer will take samples of fill materials and perform gradation and moisture content tests and will carry out field density tests on the compacted fill and any other tests considered necessary to ascertain that the fill being placed or already placed meets the Contract requirements. The results of the tests carried out by the Engineer will be final and conclusive in determining compliance with the Technical Specifications.

Samples for quality control will be excavated by the Engineer. Sample pits by the Engineer shall be backfilled by the Contractor using fill material similar to that excavated and compacted, at no extra charge to the Owner or the Engineer.

The Contractor shall give the Engineer full co-operation in sample taking or testing and shall render such assistance as is necessary to enable such sampling and testing to be carried out expeditiously. Each lift of embankment fill shall be approved by the Engineer prior to placement of further fill. The Contractor shall allow sufficient time for the Engineer to conduct the required test work in order to determine the acceptability of each lift. The making of such tests by the Engineer or the time taken to interpret their results shall not constitute grounds for a claim by the Contractor for additional compensation or an extension of time.

Tests carried out by the Engineer will be performed in accordance with the principles and methods prescribed by the American Society for Testing and Materials (ASTM) and other such recognized authorities with such methods being modified, if necessary, to take into account local conditions and materials containing large particle sizes.

Notwithstanding any quality control testing carried out by the Engineer, the Contractor shall be responsible for performing such tests as are necessary to control the quality of the materials prior to delivery to, and after incorporation in, embankments and berms.

Quality control testing by the Engineer for the purposes defined above will be as follows:

(i) Control Tests on Fill Materials Prior to Compaction

Tests for gradation, and for moisture content, where applicable, will be made on samples of fill materials taken from the borrow areas and stockpiles or from the fill after spreading and prior to compaction, at frequencies sufficient to ensure that the fill materials adopted for use are in full compliance with the Technical Specifications and the Drawings.

The results of these tests will be made available to the Contractor on request as soon as the necessary computations have been completed and checked.

(ii) Record Tests on Fill after Compaction

Tests for gradation, moisture content and density will be made on the fill compacted in place and samples of the fill will be obtained for related laboratory testing, at such frequency as the Engineer considers necessary for the proper evaluation of the properties of the fill materials after compaction.

o. Suspension and Resumption of Operations

In planning and implementing suspension and resumption of fill placement operations, the Contractor shall take into account the requirements for foundation preparation.

The Contractor shall not place fill materials at such times that conditions for such operations are unsatisfactory due to excess rain, extreme low temperatures or any other reason. The Contractor will be permitted to place fill during freezing conditions only if it can be placed and compacted to densities equal to those that would be achieved in the same material if freezing conditions did not prevail. Fill materials may be placed during freezing weather and on frozen fill surfaces provided that the materials in such surfaces were compacted as required by the Engineer before they became frozen and that the surface is free of snow and ice. The requirements for construction during freezing conditions are discussed in detail in Clause 7.2.6.g.

If placement of fill is suspended because of precipitation or impending precipitation or for any other reason, the surface shall be graded and rolled smooth to seal the surface to avoid unnecessary absorption of moisture. In order to achieve this, the Contractor may at his option, provide cross or crown slopes of up to 5 percent for drainage control. The runoff from fills in progress shall be directed to sediment control facilities to the satisfaction of the Engineer.

Where operations have been suspended, the effects of rain or other adverse conditions will be assessed by the Engineer before approval is given to resume placing. Equipment shall not be allowed to travel on the fill until the fill has dried sufficiently to prevent excessive rutting and to allow the equipment to be operated satisfactorily.

p. Protection and Maintenance

The Contractor shall maintain any placed fill in a neat and workmanlike condition until completion of the Work. The Contractor shall take such steps as are necessary to avoid ponding of water on the fill or contamination of the fill by traffic or other causes, and it shall at all times keep the surface and slopes of the embankment free from rubbish, rejected or unsuitable fill, or waste materials.

The Contractor shall do whatever is necessary to prevent surface runoff or water from any other source from eroding fill materials placed for the Work, and shall, at its own expense, immediately repair any damage resulting from such erosion. Any repairs shall be carried out using the same standards for quality and workmanship as defined in the Contract Documents for the portion of the Work being repaired.

Should any slide, including all movements of earth, rock, debris, or other material occur within or onto any part of the embankments or berms, the Contractor shall remove such materials and all other materials affected as directed by the Owner, and any portions of the embankments or berms so removed shall be rebuilt in accordance with the Contract Documents.

Unless shown otherwise on the Drawings, buried pipework shall not be crossed by motorized vehicles until the specified backfill has been compacted to a depth of at least 300 mm above the crown of the pipe. In embankments or roadways subject to compacting equipment or

high wheel loads the depth of cover shall be at least 600 mm above the crown of the pipe. Temporary crossings shall be adequately flagged.

2.1.7 Construction Tolerances

The Contractor shall construct the various embankment fill zones to the lines and grades as shown on the Drawings, within the tolerances specified below:

Description	Maximum Permissible Deviation	
	Line	Grade[Note 1]
Excavation slopes	± 300 mm	± 150 mm
Fill slopes	± 300 mm	± 150 mm
Embankment crest	± 300 mm	+ 150 mm - 0mm
Construction access roads	± 300 mm	+ 150 mm - 0 mm

1. No work will be accepted if the grade is other than specified.

The location of the embankment foundation will depend on the conditions encountered and shall be determined by the Engineer. Any deviation from the foundation elevations shown on the Drawings shall be subject to the provisions of Clause 7.2.3 and Clause 7.2.4.

2.1.8 As-Built Survey

An as-built survey is required to accompany all interim and final monthly progress estimates to show the progress of the Work. The as-built survey shall be presented on as-built drawings which shall be made available to the Owner on computer diskette in AutoCAD.dwg file format, complete with X, Y, and Z co-ordinates (northing, easting and elevation). The as-built drawing shall contain at a minimum:

- Fill levels at 25 metre chainage points shown on the Drawings (toes and crests).
- Fill zone boundaries at 25 metre chainage points shown on the Drawings.
- Final excavated surfaces, including shoulders and toes.
- Final clearing and stripping and grubbing limits.
- Top of pipe surveys for all installed pipes.
- All buried services, instrumentation, etc.
- Investigation locations.
- Haul road locations.

No separate measurement or payment will be made for the as-built survey.

PART 3 - GEOSYNTHETICS

3.1.1 Scope of Work

The portion of Work specified in this Section shall consist of supplying all labour, supervision, equipment and materials necessary to install and protect the geosynthetic materials as shown on the Drawings, or as required by the Engineer.

3.1.2 Submittals

Any alternatives or exceptions to this section shall be submitted in writing to the Engineer as part of the Tender.

A copy of the geogrid, geomembrane and geotextile Manufacturer's Quality Control Manual, and Installation Quality Control Manual shall be submitted to the Engineer as part of the Tender.

The Geosynthetic Supplier/Installer shall confirm as part of the Tender that the guarantees covering materials and all workmanship, as well as degradation due to ultraviolet light, listed in this Section.

Weld test data for HDPE (both extrusion and wedge welds) shall be supplied to the Engineer as part of the Tender.

Upon award of the bid, the Geosynthetics Supplier/Installer shall supply the Engineer with panel layouts of the HDPE geomembrane which must be approved prior to commencing the Work.

3.1.3 Co-Ordination Between Owner, Engineer, Contractor and Geosynthetics Supplier/ Installer

After the Contractor has completed preparing the subgrade surface which will lie directly below geosynthetics, the Geosynthetics Supplier/Installer, Engineer and Owner will verify acceptance by signing a form which describes the extent of the area. At that time, the Contractor assumes responsibility of protecting the approved surface, through the use of barriers or other means to eliminate vehicle traffic on approved surfaces until it is covered with geosynthetics.

Any damage by mechanical means caused by the Geosynthetics Supplier/Installer to approved subgrade areas shall be repaired to the satisfaction of the Engineer at the expense of the Contractor. Any damage caused by weather to approved subgrade areas shall be repaired to the satisfaction of the Engineer at the expense of the Owner. Any damage caused by weather to approved subgrade areas resulting from poor surface runoff control (e.g. allowing surface runoff onto approved areas) as a result of operations of the Contractor shall be repaired to the satisfaction of the Engineer at the expense of the Contractor

After installation of the geomembrane and final quality control measures are completed by the Geosynthetics Supplier/Installer, areas receiving cover material shall be clearly identified and the

Engineer shall be notified for geomembrane inspection. Upon signed acceptance by the Engineer that the geomembrane has been installed in accordance with the Specifications, it will be available to the Contractor for placing the geotextile and cover material. At that time the Contractor will assume responsibility for maintaining the condition of the portion of the geomembrane until it is covered.

Any damage to previously accepted geomembrane as a result of the Contractor's operation will be repaired to the satisfaction of the Engineer at the Contractor's expense.

In the event of contradiction or conflict between parties mentioned above, questions will be taken to the Engineer for final decision.

3.1.4 Delivery, Handling and Storage of Geosynthetics

Delivery handling and storage of geosynthetics shall be in accordance with the manufacturer's printed instructions. All people walking or working on the geomembrane shall wear soft-sole shoes.

Geosynthetics shall be packaged and shipped in standard roll lengths and widths. The geotextile shall be kept dry and wrapped such that it is protected from the elements during shipping and storage. At no time shall the geotextile filter fabric be exposed to ultraviolet light for a period exceeding fourteen (14) days. The geotextile filter fabric shall be labelled as per ASTM D4873.

3.1.5 HDPE Geomembrane

(i) Manufacturer's Quality Control

The geomembrane liner shall be of high quality formulation, containing approximately 97% polymer and 3% carbon black with anti-oxidants and heat stabilizers. It shall be resistant to ultraviolet rays.

The geomembrane shall be HDPE material manufactured of new, first-quality products designed and manufactured specifically for the purpose of liquid containment in hydraulic structures. The finished material shall be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter.

The manufacturer of the geomembrane shall take random samples of the geomembrane material from each fabricated roll during manufacture. Samples shall be tested by a qualified laboratory by methods specified within this Section, or applicable ASTM standards, for thickness, strength, tear resistance, low temperature impact, density and dimensional stability. The test results shall be supplied to the Engineer and the rolls of material shall be clearly identified and correlate to the test results provided.

(ii) Material Properties

The material provided as smooth high density polyethylene (HDPE) geomembrane shall conform to the following standards:

Smooth 60 mil HDPE Geomembrane Specifications Minimum Typical Material Properties				
	Property	**Test Method**	**Value**	**Units**
a.	Thickness	ASTM D5199	54	mil
b.	Density	ASTM D1505	0.94	g/cm^3
c.	Tensile Properties	ASTM D638[1] Type IV		
	Tensile @ Yield		126	lb/in of width
	Tensile @ Break		228	lb/in of width
	Elongation @ Yield		12	%
	Elongation @ Break		700	%
d.	Tear Resistance Initiation	ASTM D1004 Die C	42	lbs
e.	Puncture Resistance	ASTM D4833	108	lbs
f.	Environmental Stress Crack	ASTM D5397, Appendix, Single Point[2] (30% yield, 20% notch)	300	Hours
g.	Carbon Black (Range)	ASTM D1603 modified	2.0 to 3.0	%
h.	Carbon Black Dispersion	ASTM D5596	See note 3	
i.	Seam Strengths[5]	ASTM D4437, NSF		
	Peel	54, Annex A	1. ≥65-80% of PM[4] material yield strength 2. FTB[4] 3. ≤10% linear length of peel	
	Shear		1. ≥90% of PM[4] material yield strength 2. FTB[4] 3. ≥50% strain at break	

Notes:

1. Yield elongation is calculated using a gage length of 33 mm. Break elongation is calculated using a gage length of 50 mm.
2. Full curve to quality new resin.
3. Carbon Black Dispersion for 10 different views:
   - minimum 8 of 10 in Categories 1 or 2
   - all 10 in Categories 1, 2 or 3
4. Film Tear Bond = FTB, Parent Material = PM

5. Seam tensile strength testing shall be performed at the same strain rate as the parent material tensile strength testwork. (2 ipm)

The Geosynthetics Supplier/Installer shall provide a written guarantee covering materials and all workmanship as well as degradation due to ultraviolet light for exposed areas. The material shall be warranted against manufacturer's defects for a period of 5 years from the date of installation. The installation shall be warranted against defects in workmanship for a period of 2 years from the date of installation.

(iii) Installation Quality Control

The geomembrane shall be installed on the area shown on the Drawings or as directed by the Engineer.

Prior to deployment of geomembrane, the Geosynthetics Supplier/Installer shall inspect, certify and accept, with the Engineer, all surfaces on which the geomembrane is to be placed to ensure conformance with the specifications. Surfaces not in compliance with the specifications shall be rectified by the Contractor.

The amount of geomembrane deployed without final quality control and final repairs being completed shall not exceed 200,000 square feet but may be extended at the discretion of the Engineer. In addition, no seams shall be left unwelded and no openings in the liner shall be left at the end of a shift.

The geomembrane will be placed using methods and procedures that ensure a minimum of handling. The installer shall provide adequate temporary anchoring devices to prevent damage due to winds.

The liner shall be installed in a relaxed condition and shall be free of tension or stress upon completion of the installation. All necessary precautions, including provisions for installing extra material, shall be taken to avoid trampolining of liner which will remain exposed.

Horizontal field seams on slopes should be kept to a minimum. Seams shall be made by lapping the uphill material over the downhill material with sufficient overlap. A minimum of three feet is required from the toe of the slope to any horizontal seam on flat areas.

Installation shall be performed under the direction of a Superintendent who has installed a minimum of 10,000,000 square feet of HDPE flexible lining material. The Superintendent shall be provided by the Geosynthetics Supplier/Installer and shall be in charge of the installation.

Extreme care shall be taken by the Geosynthetics Supplier/Installer in the preparation of the areas to be welded. The area to be welded shall be cleaned and prepared according

to standard industry procedures, and all sheeting shall be welded together by thermal methods.

The welding equipment used shall be capable of continuously monitoring and controlling the temperatures in the zone of contact where the machine is actually fusing the lining material, to ensure changes in weather conditions will not affect the integrity of the weld.

No “fish mouths” shall be allowed within the seam area. Where “fish mouths” occur, the material shall be cut, overlapped, and extrusion welded. All welds on completion of the Work shall be tightly bonded. Any membrane area showing distress due to excessive scuffing or puncture from any cause shall be replaced or repaired.

The Geosynthetics Supplier/Installer shall take into account that rapid weather changes are very possible, resulting in delays in construction of field seams. Jointing of panels and repairs will only be permitted under weather conditions allowing such work within the warranty limits imposed by the liner manufacturer.

(iv) Field Seam Inspection and Testing

A maximum effort shall be made to install a perfect liner. This means that all seams completed in the field, patches and extrusions shall be inspected, tested and recorded.

The Engineer shall inspect each seam. Any area showing a defect shall be marked and repaired in accordance with HDPE repair procedures.

All field sampling and testing shall be done by the Geosynthetics Supplier/ Installer as approved by the Engineer.

The field installation testing program shall consist of periodic visual observations, continuity, and strength tests. These inspections and tests are to be made routinely and are automatic regardless of other types of testing required. The program shall include:

1) Visual Observations

Visual observations are to be made routinely and shall include the following:

- Visually check field seams for squeeze out, foot print, melt and overlap.
- Check machines for cleanness, temperature and speed.
- Any area of the seam or panel showing a defect shall be marked and repaired in accordance with the applicable repair procedures.

2) Continuity testing is required for all field seams and repaired areas. Inter-seam pressure or "air testing" and testing using vacuum box are considered acceptable methods for continuity testing. The Engineer shall inspect all continuity tests and initial them as they are each completed.

The test procedures for interseam pressure or air testing is the following:

- Seal both ends of the seam to be tested by applying heat to the end of the seam until flow temperature is achieved. Clamp off the ends and let cool.
- Insert a pressure gauge/needle assembly into the end of the seam and seal.
- Apply air pressure to the void between the two seams according to the following schedule:

HDPE INITIAL PRESSURE SCHEDULE			
Material HDPE Thickness	Pressure Range		Allowable leak down after 5 minutes (psi)
	Minimum (psi)	Maximum (psi)	
60 mil	28	30	3

- The initial start pressure is read after a 2-minute relaxing period, which allows the air to reach ambient liner temperature; the ending pressures is read after 5 minutes.
- The results of the leak test shall be marked at the test location and shall be recorded by the Geosynthetics Supplier/Installer. If the test fails, the location of the leak shall be found and repaired or the entire seam shall be repaired and retested.

The test procedure for vacuum box testing is as follows:

- Mix a solution of liquid detergent and water and apply an ample amount to the area to be tested. If a seam contains excess overlap or loose edges it is to be trimmed before testing.
- Place a translucent vacuum box over the area and apply a slight amount of downward pressure to the box to the seal strip to the liner.
- Apply a vacuum (3 psi to 5 psi) to the area. Any leaks will become visible by large bubbles and shall be repaired.

Spark Testing

Spark testing shall be completed on all extrusion welded seams that cannot be tested by vacuum box methods and the proposed test procedure is as follows:

- Install copper wire at location of overlap prior to extrusion welding and leave adequate wire for connection to electrode
- Check spark test equipment for proper operation and connect electrode to wire.
- Test the weld by running the copper brush over the weld and check for arcing.

3). Strength Testing Strength Testing

For trial seams the following is to be completed by the Liner Contractor:

A test specimen 1 metre long by 0.3 metres wide for each welding machine shall be run as follows:

- At the beginning of seaming operations.
- After breaks from the seaming operation (i.e. lunch).
- After repairs have been made to the seaming equipment.
- By each technician using the seaming equipment.
- Under the same conditions and using the same materials, preseaming and seaming techniques as used to fabricate field seams.
- As required by the Engineer.

The test weld shall be marked with date, ambient temperature and welding machine number. Coupons from the test weld shall be tested in shear and peel in accordance with the applicable ASTM standards. Random weld samples may be removed from the installed, welded sheeting.

For field seams the following procedure is to be used:

Coupon sampling of all field seams, including patches and repair areas, shall be taken by cutting perpendicular to the seams a sample approximately 1 metre long by 0.3 metre wide. This sample shall be cut into three samples of 0.3 metre by 0.3 metre and labelled with welder's identification, welding machine speed and temperature, date and location. The location of the test samples shall be determined by the Engineer, and the testing frequency shall not be less than one sample per 150 metres of welded seams. Heat welded seams shall be allowed to cool or warm to about 70°F prior to testing.

10 coupons measuring 25 mm x 100 mm shall be cut from each field seam sample. 5 coupons shall be tested for peel strength and the remaining 5 coupons tested for shear

strength. A field seam is considered acceptable if 4 of 5 peel tests and 4 of 5 shear tests meet or exceed the following minimum strength values:

GEOMEMBRANE STRENGTH VALUES		
Test Description	**Minimum Strength Values**	
	60 mil (1.5 mm HDPE)	**80 mil (2.0 mm HDPE)**
Peel Test, wedge weld	min 90 ppi	NA
Peel Test, extrusion weld	min 78 ppi	NA
Shear Test	min 120 ppi	NA

In addition to the specified minimum seam strength requirements, the seams shall break by a Film Tear Bond (FTB). A film tear bond is the condition where one of the welded sheets fails in the parent material, in other words the seam may not delaminate.

If conflict between the Engineer's and Liner Contractor's test values occurs, the third test sample shall be sent to an independent laboratory for confirmation testing. Should the laboratory and field tests conflict, installation shall halt until the conflict is resolved to the satisfaction of the Engineer.

A Liner Contractor quality control technician or field engineer shall inspect each seam, marking his initials and date inspected at the end of each panel. Any area showing a defect shall be marked and repaired in accordance with the applicable repair procedures.

The manufacturer shall provide a written guarantee that the liner will not fail for a minimum of 15 years. The guarantee will cover materials, workmanship and resistance to ultraviolet light. This guarantee shall cover the cost of material, labour, and equipment to replace the failed material.

In addition to providing the Owner and the Engineer with copies of all the fabrication and installation test logs and conformance data, the Liner Contractor shall submit as-built drawings showing the installed panel layout with each panel or portion of panel identified by the manufacturer's identification number. Locations of all tests shall be identified along with locations of any repairs. As a minimum, as-built drawings shall be submitted at the end of each week as the work progresses, showing work completed that week and to date.

3.2 GEOTEXTILE

3.2.1 Material Requirements

The geotextile specified on the Drawings and within the Specifications shall be a non-woven, needle-punched polypropylene fabric, or equal approved by the Engineer, conforming to the following specification:

GEOTEXTILE SPECIFICATIONS MINIMUM MATERIAL PROPERTIES		
Fabric Property	**ASTM Test Method**	**Value**
Unit Weight	D3776	10 oz/sq.yd.
Grab Strength *MD	D4632	250 lbs
Grab Elongation (MD/CD)	D4632	>50%
Burst Strength (Mullen)	D3786	460 psi
Trapezoidal Tear	D4533	100 lbs
Permeability (k)	D4491	0.30cm/sec
Permittivity	D4491	1.2 sec^{-1}
Apparent Opening Size	D4751	100 US Sieve
UV Resistance (500 hr)	D4355	not required

*MD = Machine Direction

3.2.2 Installation

The filter fabric sheets shall be placed to the limits as shown on the Drawings or as directed by the Engineer.

All joints shall have a six (6) inch lap and shall be heat fused. A grab strength as defined in Section 3.3.1 shall be achieved for the sample before the fusion machine shall be used in the work.

Any seams that are flawed shall be repaired by the Contractor at its expense.

3.3 GEONET (DRAINAGE NET)

3.3.1 Material Requirements

The geonet (drainage net) shall be non-deformed three-dimensional net (geogrid) constructed of extruded and/or polyethylene rods. The supplier shall provide certification that the proposed geonet has a transmissivity of not less than 1 x 10-3 m2/s when tested in accordance with ASTM D4716 at a confining pressure of 24,000 psf. The supplier shall provide certification that the angle of friction between the proposed 60 mil smooth HDPE geomembrane and proposed geonet under saturated conditions as tested in accordance with ASTM test methods, will be at least 12°. The geonet shall contain stabilizers to prevent ultra-violet light degradation. The drainage net shall be Poly-Net PN3000, as manufactured by Fluid Systems, Inc., or approved equal, conforming to the following specifications:

GEONET SPECIFICATIONS MINIMUM MATERIAL PROPERTIES		
Net Property	**ASTM Test Method**	**Value**
Polymer S.G.	D792	.935 g/cm^3
Polymer Melt Index	D1238	<1.10 g/10 min
Carbon Black	D1603	2% (min)
Nominal Thickness	D1777	.20 in.
Nominal Mass/Unit Area	D3776	.18 psf
Transmissivity at 24000 psf	D4716	>1x10^{-3} m^2/sec
Nominal Conductivity	-	>0.1 m/sec
Angle of Friction with 60 mil HDPE liner	-	>12°
Tensile Strength	D1682	50 lb./in.

3.3.2 Installation

The geonet sheets shall be placed to the limits shown on the Drawings or as directed by the Engineer. Installation is to be completed in accordance with the manufacturer's specifications for installation.

3.4 AS-BUILT DOCUMENTATION

The Geosynthetic Supplier/Installer shall provide the Engineer with copies of all the fabrication and installation test logs and conformance data including:

- Geomembrane, geonet, and geofabric certification,
- Daily panel placement logs,
- Seam control logs,
- Field destruction test results,
- Construction repair report.

In addition, the Geosynthetic Supplier/Installer shall submit as-built drawings showing the installed panel layout with each panel or portion of panel identified by the manufacturer's identification number. Locations of all tests shall be identified along with locations of any repairs. The as-built drawings shall be made available to the Owner and Engineer in a timely fashion after the work is completed.

PART 4 - PIPEWORKS AND APPURTENANCES

4.1.1 Scope of Work

The portion of the Work specified in this Section shall consist of the supply of all labour, supervision, equipment and materials necessary to install the pipeworks and appurtenances as shown on the Drawings or as required by the Engineer including:

a. Supply and install all perforated CPT pipeworks and fittings associated with the drain pipes.
b. Supply and install all HDPE pipeworks and fittings associated with the sump.

4.1.2 Applicable Specifications and Regulations

All materials furnished by the Contractor shall be new, suitable and the best of their respective kind and shall be subject to approval by the Engineer. They shall comply with the latest applicable standards for:

- Canadian Standards Association (CSA)
- American National Standard Institute (ANSI)
- American Society of Mechanical Engineers (ASME)
- American Society for Testing and Materials (ASTM)
- American Water Works Association (AWWA)
- American Association of State Highway and Transportation Officials (AASHTO).

Any contradictions between standards shall be submitted to the Engineer for decision.

4.1.3 Submittals

The Contractor shall submit to the Engineer one copy of manufacturer's catalogues at least 14 days prior to installation of the pipework. For pipe fittings and related pipework components, catalogues shall include detailed information on material specifications, dimensions and pressure ratings, storage and handling requirements, installation and joining procedures, name and location of manufacturer's representative.

4.1.4 Delivery, Handling and Storage of Pipe

Pipe, fittings, valves and other appurtenances shall be loaded and unloaded by lifting with hoists in such a manner as to avoid damage or hazard. Under no circumstances shall the pipe or pipe fittings be dropped to the ground or into trenches. Pipe shall not be skidded or rolled against pipe already on the ground. The interior of all pipes, fittings and valves shall be kept free from dirt and foreign material at all times.

4.1.5 High Density Polyethylene (HDPE) Pipe

Materials used for the manufacture of polyethylene pipe and fittings shall be very high molecular weight, high density ethylene/hexane copolymer polyethylene resin, having a material designation of PE 3408. The material classification (per ASTM D1248) shall be Type II C P 34 and cell classification (per ASTM D3350) 345434C.

Dimensions and workmanship for HDPE pipe shall be as specified by ASTM F714, D2513, D3035. Pipe diameters shall be as specified on the Drawings.

Stub ends and pipe fittings for butt fusion shall be of at least the same wall thickness and pressure rating and the same resin type, grade, and cell classification and manufacturer as the pipe to be joined, unless otherwise recommended by the manufacturer.

Back-up rings for flanged joints shall be the convoluted type of ductile iron material (ASTM 536 Grade Range from 60/40/18 to 64/45/12), drilled to ANSI bolt circle, and have pressure rating of 150 psi, unless otherwise specified. Back-up flanges and bolts shall be as approved or supplied by the pipe manufacturer.

Flange gaskets shall conform to ANSI B16.21 and shall be used with all flanged joints unless specified otherwise by the supplier of valves, fittings, or pipework, and as approved by the Engineer.

4.1.6 Corrugated Polyethylene Tubing (CPT) With Smooth Interior

Pipe and fittings shall be made of virgin polyethylene compounds, which shall conform to the requirements for Type III, Category 4 or 5, Grade P33 or P34, Class C polyethylene plastics, as defined in ASTM D1248 and D3350. All sizes shall conform to AASHTO classification “Type SP” for perforated. Sealed couplers shall conform to ASTM D3212.

The 4 inch (100 mm) diameter CPT shall have a minimum pipe stiffness at 5 percent deflection in accordance with ASTM D2412 of 50 psi. Diameter refers to the inside pipe diameter.

Where perforations are specified, they shall be slots cut circumferentially unless specified otherwise and shall conform to the requirements as follows:

- AASHTO M252 “Class 2” for 4 inch pipe

4.1.7 Pipe Installation

The pipe shall be installed to the lines and grades and generally in the manner shown on the Drawings. Where specific lines and grades are not indicated on the Drawings, the lines and grades will be determined by the Engineer in the field to suit the existing ground conditions. The Contractor shall use equipment and methods acceptable to the Engineer

and in accordance with the pipe manufacturer's recommendations for handling and placing of pipe, fittings and valves.

The Contractor shall provide and install all piping required to complete the piping installation in accordance with good piping practices, whether such piping is specifically detailed on the Drawings or not. The general layout as shown on the Drawings will be maintained. Where field adjustments are required during installation, or relocation of pipelines is deemed necessary, the Engineer shall be consulted before any changes are made.

All pipelines shall be installed to preserve accurate alignment. Care shall be taken in the installation of pipeline runs where drainage is required to ensure that the pipeline has a continuous slope to the point of drainage.

Prior to installation, each segment of pipe, all fittings, and valves shall be inspected for defects and/or damage. Foreign material shall be prevented from entering the pipe while it is being installed. Open ends of the pipe shall be covered by temporary end caps or other approved means when installation is not in progress.

Pipe bends to form curves in either a horizontal or vertical plane shall not exceed that diameter recommended by the manufacturer or approved by the Engineer. The cutting of pipe for the inserting of fittings or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe and so as to leave a smooth end at right angles to the axis of the pipe.

a. HDPE Pipework

Joining of HDPE pipe lengths shall be by thermal butt fusion or by flanges as shown on the Drawings or where otherwise required.

Thermal butt fusion of HDPE shall be carried out by experienced technicians supplied by, or approved by, the pipe supplier or manufacturer and in general accordance with ASTM D2657 and the recommended procedures provided with the manufacturer's catalogue information. The Engineer may require fusion technicians to perform test welds for destructive testing prior to commencing work on any permanent component of the facility.

Butt fusion equipment shall be in good repair and of appropriate size for the job, complete with all necessary clamps, controls, gauges, supports, ancillary equipment and operation and maintenance manuals. The Engineer reserves the right to have non-destructive testing of all thermally butt fused HDPE pipe welds carried out at any time during the Work and to reject those that are unsatisfactory for any reason. Such joints shall be cut out and repaired at the Contractor's expense.

If the Contractor elects to drag HDPE pipework into place, all stub ends, flanges and other components must be supported above ground on suitable skids or as otherwise necessary to avoid damage. The Contractor shall provide at his own expense all necessary temporary guide posts and equipment to ensure pipework is not dragged across areas of completed earthworks susceptible to damage. If damage occurs to pipeline components or to completed earthworks during pipeline installation, the damage shall be made good at the expense of the Contractor. Gouges, holes or abrasion of HDPE pipework such that the wall thickness is reduced to less than 90 percent of its manufactured thickness shall be sufficient grounds for rejecting the pipe. Damaged sections of HDPE must be cut out and the pipe rejoined by butt fusion, all at the expense of the Contractor.

Natural bends in HDPE pipelines shall not exceed 50 pipe diameters in radius unless otherwise approved by the Engineer. Pipelines shall not be bent to such radius until at least 6 hours after completion of any fused joints in the section of pipeline to be bent.

b. Corrugated Polyethylene Tubing (CPT)

Installation of corrugated polyethylene pipework shall be in general accordance with ASTM D2321 and the manufacturer's instructions, with specific requirements as shown on the Drawings. Pipework shall be laid to the maximum extent, in long lengths as to minimize the number of couplings required. Joining of corrugated polyethylene pipework to other pipework shall be carried out as shown on the Drawings.

The Contractor's method for the placement of the CPT within the basin area of the pond shall be reviewed by the Engineer prior to the start of installation. The Contractor shall develop methods which will ensure the CPT is not damaged during installation or backfilling. The Contractor shall sequence the placement of the CPT in the basin to protect all pipework from damage due to vehicle and equipment traffic.

4.1.8 Construction Tolerances

The Contractor shall construct the pipework to the lines and grades as shown on the Drawings, within the tolerances specified below:

Description	Maximum Permissible Deviation	
	Line	Grade[Note 1]
300 mm perforated CPT “Type SP” drain pipes	± 150 mm	± 25 mm
100 mm perforated CPT “Type SP” drain pipes	± 150 mm	± 25 mm
600 mm SDR 17 HDPE with perforated end	± 150 mm	± 25 mm
200 mm LCRS riser pipe with perforated end	± 150 mm	± 25 mm

Note:

1. No work will be accepted if the grade is other than specified.

PART 5 - INSTRUMENTATION

5.1.1 Scope of Work

The portion of the Work specified in this Section shall consist of supplying all labor, equipment and materials necessary to install the instrumentation as shown on the Drawings, or as required by the Engineer including:

a. Installation of surface movement monuments at the locations as shown on the Drawings.

b. Installation of solution monitoring equipment at the location as shown on the Drawings.