Technical Memorandum P

Design of the Processed Kimberlite Containment Area

Jericho Project, Nunavut

Report Prepared for

Tahera Diamond Corporation

Report Prepared by

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Technical Memorandum P

Design of the Processed Kimberlite Containment Area

Jericho Project, Nunavut

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1 Introduction

This document presents the design of the processed kimberlite containment area (PKCA) for the Jericho Diamond Project owned by Tahera Diamond Corporation (Tahera). The document provides the PKCA design and a detailed operating plan for fine processed kimberlite (PK) disposal and related water management. It also provides a conceptual closure plan that may be altered during the life of the facility as further data becomes available.

This document has been prepared as part of the Water Licence application to the Nunavut Water Board (NWB).

2 Project Area Description

2.1 Location and Access

The Jericho Diamond Project is located in Nunavut, approximately 420 km northeast of Yellowknife and 27 km northwest of the Lupin Mine. The project location is shown on Drawing 1CT004.06 – G1.

Access to the mine is currently by winter road or air to the mine landing strip.

2.2 Regional Geology

The Jericho Diamond Project is located within the Canadian Shield. The oldest rocks in the project area comprise Archean tonalities or granodiorites, which outcrop in the immediate vicinity of the PKCA. The region is regarded as being geologically very stable and not subject to active tectonics. The last tectonic event is believed to have been emplacement of the Proterozoic dykes approximately 1.3 billion years ago.

The project site was glaciated several times during the Pleistocene era. The last deglaciation, which began approximately 9,300 years ago, was accompanied by deposition of a discontinuous, but locally thick blanket of gravely, silty sand till with a high percentage of cobbles and boulders in the matrix. Glaciofluvial and glaciolacustrine deposition was also part of deglaciation. Glaciofluvial deposits include eskers, outwash deltas, kame deltas and supra-glacial deltas. These sediments range from clean sand and gravel to very coarse, thick boulder and block accumulations. Glaciolacustrine sediments consist mainly of silt and sand, while periglacial processes caused mechanical breakdown and mass wasting of near-surface rock. Organic soils have often developed in poorly drained areas.

2.3 Seismicity

The project area lies in a region of low seismicity, but magnitude 4+ earthquakes have recently occurred within a similar part of the shield. As there are no active faults in the region, Natural Resources Canada indicated that the deterministic approach to estimate peak ground accelerations (PGA) does not provide a representative estimate (NRCan 2003a and NRCan 2003b). NRCan recommends that the probabilistic approach should be adopted; particularly the new proposed National Building Code of Canada (NBCC) PGA values (scheduled for formal adoption in January 2005).

Further details related to site seismicity are provided in Technical Memorandum A (SRK 2003a).

2.4 Climate

The Jericho Diamond Project is situated 60 km south of the Artic Circle, at 65^{o} 47' north latitude. Daylight is, therefore, almost continuous at the beginning of the summer and virtually absent at the beginning of winter. The area is marked by relatively cool summers and very cold winters. The temperatures range between summer and winter means is 40^{o} C. Precipitation is limited and averages about 330 mm per annum, approximately half rain and half snow (rainfall equivalent). Evaporation occurs almost entirely during the four snow-free months. The average annual lake evaporation is estimated to be 270 mm while average annual evapotranspiration is estimated at approximately 200 mm per annum, or 75 % of lake evaporation.

Wind speed data collected at the project site are somewhat consistent with the Lupin mine site, some 27 km southeast of the Jericho site. The data from Lupin indicates mean monthly speeds ranging from 11 to 20 km/hour, with December having the lowest and October the highest wind speed. Wind directions measured at Carat Lake were predominantly from the west and southwest. Further information regarding the permafrost conditions at the Jericho site is available in Technical Memorandum C (SRK 2003c).

2.5 Permafrost

The Jericho Diamond Project lies within a region of continuous permafrost. Permafrost is present everywhere except beneath large lakes and rivers and, at the Jericho pipe, is estimated to extend to a depth of approximately 540m (BGC 1996). In the surficial soils, the active layer typically ranges in thickness from less than one meter in organic soil to slightly more than three meters where well drained granular soils are present. The active layer thickness in exposed rock locally exceeds three meters.

Ground temperature data from the site indicates the average ground temperature is about -5° to -6°C. Further information regarding the permafrost conditions at the Jericho site is available in Technical Memorandum B (SRK 2003b).

2.6 Hydrology

Long Lake, the location of the PKCA, drains to the west via Stream C3 to Lake C3 and then north by northeast to Carat Lake. Discharges from Carat Lake are via the Jericho River (local name), Kathawachaga Lake and the Burnside River and ultimately discharges into the Artic Ocean.

The catchment of the PKCA is approximately 53.5 ha, while the potential total contributing catchment area for the rest of the project site is 142.5 ha.

2.7 Hydrogeology

The hydrogeologic regime is strongly influenced by the presence of permafrost. Groundwater within the permafrost occurs as ice. Groundwater movement is, therefore, limited primarily to the active layer during the period of each year when it thaws.

3 Design Criteria and Assumptions

3.1 Design Basis

3.1.1 Processed Kimberlite Characteristics

The ore will be processed by conventional diamond processing techniques and the main steps are as follows:

- Crushing – breakage of ore to liberate the diamonds;
- Scrubbing – breakage of soft conglomerates;
- Dense medium separation (DMS) – gravity concentration to separate heavy and light particles;
- Interparticle crushing – reduction of large particles without diamond breakage;
- X-ray sorting; and
- Cleaning and sorting.

Processing of the 2.6 million tonnes of kimberlite reserves will produce the following three processed kimberlite (PK) products:

- Coarse PK, comprised of a gravely sand made up of about 50 to 93% sand and 7 to 50% fine gravel, will make up about 81% of the total PK product by weight. A description of the geochemistry of the coarse PK is provided in Section 3.2.4 of SRK Technical Memorandum M. Approximately 2,118,000 tonnes of coarse PK will be produced, essentially all of which will be stored in a stockpile northeast of the PKCA.
- Recovery plant rejects, comprised of medium sand to fine gravel with particle sizes from 1 to 6 mm, will make up about 4% of the total PK product by weight. Recovery plant rejects were not characterized in the original geochemical studies for this project. Approximately 105,000 tonnes of fine PK will be produced. Following evaluation of diamond recovery and geochemical characterization of the solids, the recovery plant rejects will, on a staged basis, be either moved to the coarse PK stockpile (if testing indicates there are no ARD/ML concerns) or blended thoroughly with the coarse PK using conveyors and plant equipment (if testing indicates blending with coarse PK is required to minimize ARD/ML concerns).
- Fine PK (less than 0.1 mm grain size) comprised of 70 to 85% silt and 15 to 30% clay size will make up about 15% of the total PK product by weight. Approximately 380,000 tonnes of fine PK will be produced, all of which will be deposited in the PKCA.

The test results from six settling tests performed on fine PK samples from the Jericho bulk-processing plant in 1997 indicate that the fine PK achieved settled densities 0.99 t/m^3. This was achieved in laboratory conditions, i.e. no ice entrainment. Data from diamond operations in Northern Canada indicate that the likely range of achieved densities is 0.5 t/m^3 to 1.0 t/m^3 with an overall effective settled density of 0.7 t/m^3. The wide variations in densities are indicative of fine PK deposition management and related climatic conditions, variations in ore sources and supernatant pool management.

An effective settled density of 0.5 t/m^3 was conservatively assumed to calculate the capacity of the PKCA, which corresponds to a settled PK volume of 760,000 m^3. However, the actual overall densities are likely to be higher based on the relatively thin layers of fine PK deposited per annum (approximately 1 m except for year 1) and expected thawing each summer of a substantial portion of the layer deposited over the previous winter.

3.1.2 Geochemistry and Water Quality

3.1.2.1 Fine PK

Geochemical characterizations of the fine PK and PK supernatant were presented in Appendix D.1.5 of the EIS (Tahera 2003). The results indicated that the fine PK was similar in composition to kimberlite ore. The solids were characterized by a serpentine/carbonate matrix. In general, the heavy metal concentrations were low, although levels of chromium, copper, nickel and zinc were slightly elevated. No acid-base accounting (ABA) tests were done, but the general absence of sulphides in the kimberlite, the presence of carbonates, and the high neutralization potential of the ore indicate that the fine PK will be non-acid generating.

3.1.2.2 PK Supernatant

The chemistry of fresh PK supernatant was characterized by alkaline pH (8.3 to 9.5) and moderate to elevated concentrations of alkalinity (21 to 84 mg $CaCO_3$ eq/L), chloride (191 to 1300 mg/L), calcium (16 to 148 mg/L), magnesium (50 to 113 mg/L), potassium (23 to 77 mg/L) and sodium (17 to 81 mg/L). Heavy metal concentrations were generally very low. However, barium, copper, manganese, molybdenum and zinc were slightly elevated in some of the samples, and aluminum and nickel exceeded the criteria for freshwater aquatic life in more than one of the samples. It should be noted that the elevated chloride and calcium concentrations may be due to use of calcium chloride during underground mining. Therefore, the actual hardness may be significantly lower than that indicated by these tests. There were only minor differences between the aged PK supernatant and the fresh sample supernatant.

Ammonia concentrations were relatively high in the test samples (10.2 to 23.7 mg/L as N), likely due to high rates of ANFO loss during the underground mining. Significantly lower rates of loss (<1 mg/L) are expected in ore recovered during both the open pit and underground mining phases because the proposed mining methods use less ANFO and experience lower rates of cutoffs than the methods used to extract the bulk samples.

The chemical and biological test results indicate that the water quality of the PK supernatant would not be suitable for direct discharge to the environment, largely due to the ammonia concentrations in the leachate. However, the ammonia concentrations will decrease because ammonia volatizes under alkaline conditions (something that could not occur during the laboratory testing, as the PK samples and supernatant were stored in sealed pails).

3.1.2.3 Other Inflows to the PKCA

In addition to the fine PK and PK supernatant, the PKCA will be used to manage water from the pit sump(s), treated sewage, runoff from other disturbed areas, and local runoff during operations. As well, depending on the water quality, seepage and runoff from the waste rock dumps, ore stockpiles and coarse PK stockpile will be directed to the PKCA.

The geochemical characteristics of the kimberlite, coarse PK and waste rock were provided in Appendices D.1.3 to D.1.6 of the Final EIS (Tahera 2003) and Technical Memorandum H of the supplemental EIS (SRK 2003g). A summary of the geochemical characteristics of these materials is provided in Technical Memorandum M, entitled “Waste Rock, Overburden, Low Grade Ore, and Coarse Processed Kimberlite Management Plan” (SRK 2004a). In brief, the results of the testing programs indicated that these materials had a low potential for acid rock drainage and metal leaching, but that concentrations of some metals could exceed CCME guidelines for freshwater aquatic life or drinking water.

Estimates of source concentrations for each of the above facilities were provided in Technical Memorandum I of the supplemental EIS (SRK 2003h). The source concentrations have not been changed as a result of recent refinements to the project design. The source concentration estimates indicated that concentrations of aluminum, copper and uranium concentrations in seepage from the waste rock, and concentrations of molybdenum and nickel in seepage from the kimberlite could exceed receiving water quality guidelines. Based on nutrient loss calculations and experience from other sites, ammonia and suspended sediments in the seepage and runoff, and nutrients in the treated sewage were also identified as parameters that could exceed receiving water guidelines during mining operations. Due to the proximity of fish habitat in Carat Lake near Stream C1, the open pit and the waste rock dumps, Tahera plans to collect this water and pump it to the PKCA unless monitoring data indicates that it could be discharged without significantly impacting those areas.

Estimates of flows and water quality in the combined discharges to and from the PKCA were provided in Technical Memorandum F of the supplemental EIS (SRK 2003e). Slight modifications to the footprint have resulted in minor changes to some flows. Therefore, an updated water and load balance is presented in Technical Memorandum W, entitled “Site Water Management” (SRK and Clearwater 2004). The results indicate that the combined inflows from all areas of the site would likely meet discharge limits used at other northern diamond mines, and site-specific discharge limits proposed for this site.

The discharges will be released to Lake C3 on a seasonal basis, with flows paced to those in the receiving environment. Stream C3 will be the conduit for this water. Concentrations are expected to meet CCME criteria for freshwater aquatic life beyond a 200 m mixing zone near the mouth of Stream C3.

3.2 Design Criteria

The design criteria at the PKCA and the ancillary facilities follow the guidelines provided in Dam Safety Guidelines (Canadian Dam Association, 1999).

3.2.1 Dam Classification

The dam classification system recommended in the Canadian Dam Association (CDA) guidelines is shown in Table 3.1.

Table 3.1: CDA Dam Classification in Terms of Consequences of Failure

Consequence Category	Potential Incremental Consequences of Failure [a]	
	Life Safety[b]	Socioeconomic, Financial & Environmental[c]
Very High	Large number of fatalities	Extreme damages
High	Some fatalities	Large damages
Low	No fatalities anticipated	Moderate damages
Very Low	No fatalities	Minor damages beyond owner's property

Notes to Table 3.1

a) Incremental to the impacts which would occur under the same natural conditions (flood, earthquake or other event) but without the failure of the dam. The consequence (i.e. loss of life or economic loses) with the higher rating determines which category is assigned to the structure. In the case of tailings dams, consequence categories should be assigned for each stage in the life cycle of the dam.

b) The criteria which define the Consequence Categories should be established between the Owner and the regulatory authorities, consistent with societal expectations. Where regulatory authorities do not exist, or do not provide guidance, the criteria should be set by the owner to be consistent with societal expectations. The criteria may be based on levels of risk which are acceptable or tolerable to society.

c) The owner may wish to establish separate corporate financial criteria which reflect their ability to absorb or otherwise manage the direct financial loss to their business and their ability to pay for damages to others.

There will be up to four dams associated with the PKCA (Drawing 1CT004.06-P1). The potential incremental consequences of failure of any of the four dams with regard to life safety factors are classified as "no fatalities", corresponding to a consequence category of "very low". This selection is based upon the remote nature of the site, the low seismic hazard, the climate, the type of dam and the foundation conditions.

The potential incremental consequence of failure with regard to socioeconomic, financial and environmental factors is classified as "moderate damages", corresponding to a "low" consequence category. Selection of this classification is primarily based upon the financial impacts associated with a dam failure. The socioeconomic and environmental impacts associated with a dam failure at the PKCA are very low due to the lack of downstream human habitation and the relatively low level of potential contamination. Based upon these factors, the PKCA dams are classified as "low" in terms of consequences of failure. However, for all practical purposes, there are no significant differences between design criteria based on a "low" versus a "very low" consequence rating.

3.2.2 Design Earthquake

The CDA indicates that the usual minimum criterion for the design earthquake for a dam which coincides with the "low" consequence category would be an earthquake with an annual exceedance probability of 0.01 to 0.001. These probabilities represent return periods of 100 and 1,000 years, respectively. NRCan (2003a and 2003b) has indicated that the 1,000 year event has a peak ground acceleration of 0.016g. However, in conjunction with proposed changes to the National Building Code of Canada, NRCan indicated it would be prudent to evaluate the performance of the dams during the earthquake with a 2,475-year return period and its peak ground acceleration of 0.06g.

3.2.3 Design Flood

The CDA indicates that the usual minimum criterion for the inflow design flood (IDF) for a dam which coincides with the "low" consequence category would be a flood with an annual exceedance probability of 0.01 (100 year return period) to 0.001 (1,000 year return period). However, due to the relatively small local catchment at the PKCA (53.5 ha), the spillway will be designed to pass a 24 hour PMP flow. This flood event is significantly larger than the 1,000 year event.

The spillway at the settling pond will be designed to pass a PMP inflow, including outflows from the PKCA.

3.2.4 Stability

Slope Stability

The current slope stability requirements for earth and rock fill dams, advocated by the International Committee on Large Dams (ICOLD) and the Canadian Dam Association (CDA 1999), were adopted for design of the PKCA dams. These requirements are summarized in Table 3.2. As indicated in this table, the case of rapid drawdown conditions was not examined. Rapid drawdown conditions were considered inappropriate for these dams because the material on the upstream face of each dam is relatively coarse. The drawdown rates are therefore modest relative to the dam materials, i.e. about 2 to 4 m over a period of about 4 months.

Table 3.2: Minimum Factors of Safety

Loading Condition	Minimum Factor of Safety	Slope
Steady state seepage with maximum storage pool	1.5	Downstream
Full or partial rapid drawdown	1.3 (Note: Not applicable to PKCA)	Upstream
End of construction before reservoir filling	1.3	Downstream and Upstream
Earthquake (pseudo-static)	1.1	Downstream

Thermal Stability

As will be discussed later, the most critical of the dams at the PKCA has been designed as a frozen core dam. The thermal criterion for this structure has been set at -0°C but very conservative input parameters have been assumed for purposes of the thermal analyses (Section 6.5).

4 Site Selection

4.1 Site Selection Criteria

A site selection study was undertaken in 1999 in order to identify the most appropriate location for the PKCA. The key criteria used to select potential sites were as follows:

- Fine PK storage capacity should be about 900,000 cubic metres, which corresponds to a total ore reserve of 3.0 million tonnes (pilot test results indicated that 15% of the total mill feed, or about 450,000 tonnes, will end up as fine PK, the settled density of which has been conservatively taken to be 0.5 tonnes per cubic metre);
- Water storage based on a slurry density of about 28% by weight and the expectation that excess pond water will be discharged from the PKCA each spring/summer;
- Potential sites should be within about 3 km of the kimberlite pipe to minimize haul distances; and
- Potential sites should occupy depressions or lakes in order to minimize embankment construction.

4.2 Identified Sites

Based on these criteria, eight sites were identified, as shown in Figure 3.1. Each of the sites coincides with one or more lakes. A reconnaissance-level inspection was completed at each site and fish studies were undertaken in those lakes that do not freeze to the bottom (Lake C4, Lynne and Key lakes, Long Lake and Lake C1). A brief description of each of these sites is provided below.

The Lake C4 site is about one kilometre northeast of the kimberlite pipe. Bedrock dominates the site except on the east lake shore where colluvial soils are present. The site is not particularly well suited to PK storage due to its somewhat unfavourable topography. Furthermore, Lake C4 has a significant catchment to the east. Lake C4 is approximately 0.5 km from Carat Lake, into which it drains. The lake freezes to the bottom, or nearly to the bottom in winter and has no fish.

The Key Lake and Lynne Lake sites are actually two sites that were identified in a previous study by Bruce Geotechnical Consultants (BGC 1997). Key and Lynne Lakes are situated about one kilometre southeast and two kilometres east, respectively, of the kimberlite pipe. Bedrock dominates the north sides of these two lakes whereas colluvial soils and/or till deposits occupy their south sides. The topography at Key Lake is not well suited to efficient dam construction. However, Lynne Lake has lots of capacity and has topography that is well suited to efficient dam construction. These lakes, which in a regional context have relatively large catchments, drain into Contwoyto Lake, which is situated approximately one kilometre east of Lynne Lake. Arctic char, lake trout and slimy sculpin are found in these two lakes.

The East site occupies a lake situated approximately 2.5 km southeast of the kimberlite pipe. Bedrock dominates the site except on its north end where morainal soils are present. The site is well suited to PK storage due to its favourable topography. The East site has a very small catchment and drains into Contwoyto Lake, which is situated approximately 0.7 km to the east. No fish studies were completed in this lake as it freezes to the bottom in winter.

The South site coincides with two small lakes and was also identified by BGC in 1997. The site is situated approximately two kilometres southeast of the kimberlite pipe. Bedrock and morainal soils dominate this site. The site is well suited to PK storage due to its favourable topography, although it is at a relatively high elevation. This site has a relatively small catchment. It drains west and then north to Key Lake, which then drains to Lynne Lake and then to Contwoyto Lake. No fish studies were completed in these lakes as they freeze to the bottom in winter.

The unnamed lake site is situated about one kilometre south of the kimberlite pipe. Bedrock dominates the north sides of the lake whereas colluvial soils and/or till deposits occupy its south side. The site is not particularly well suited to PK storage due to its shallow topography. This lake drains east into Key Lake, which then drains to Lynne Lake and then to Contwoyto Lake. No fish studies were completed in this lake as it freezes to the bottom in winter.

The Long Lake site is situated about 1.2 km southwest of the kimberlite pipe. Colluvial soils and/or till deposits occupy the soils in the valley and along most of its the south shore. Bedrock is present along the north side of the lake. The site is relatively well suited to PK storage due to its favourable topography. Long Lake has a very small catchment. It drains into Lake C3, about 1.2 km to the west, and then into Carat Lake. Long Lake contains small populations of slimy sculpin and burbot.

The Lake C1 site is situated about 0.5 km west of the open pit. Bedrock dominates the site except for minor soil deposits on its south and east shores. The site is moderately well suited to PK storage due to its topography. Lake C1 has a relatively large catchment and drains into Carat Lake, about 0.7 km to the northeast. Small populations of lake trout and, slimy sculpin occur in Lake C1.

4.3 Evaluation Factors and Results

The key factors that were used to evaluate the sites were as follows:

- Drainage basin;
- Proximity to the kimberlite pipe;
- Storage capacity and/or suitability for efficient dam construction;
- Catchment size; and
- Fish populations and habitat.

Due to the proximity of the mine activities to Carat Lake and the fish populations and productivity of Contwoyto Lake, it was concluded that it would be unacceptable to impact a second drainage, particularly one as productive as the Contwoyto Lake system. As a result, the five sites which drain to Contwoyto Lake were rejected from further consideration. That left the North site, the Long Lake site and the C1 site, which are compared in the Table 4.1, below.

Table 4.1: Comparative Assessment of Remaining Three Sites

Property	Lake C4	Long Lake	Lake C1
Proximity to pipe	1 km	1.2 km	0.5 km
Storage capacity and/or dam efficiency	Limited capacity; relatively inefficient dam	Ample capacity; relatively efficient dam	Adequate capacity; relatively efficient dam
Catchment size	moderate	Very small	Relatively large
Fish populations & habitat	No fish	Slimy sculpin and burbot (no salmonids)	Lake trout and slimy sculpin

The Long Lake site is judged to be the most appropriate for PKCA disposal for the following reasons:

- Although it is not the site closest to the kimberlite pipe, the Long Lake site, at 1.2 km, is well situated to provide cost-effective fine PK disposal. The Lake C1 site is closer but the resultant difference in cost is minor since both sites are relatively close.

- The Long Lake site offers an ample volume of storage. This means that there is flexibility with the storage that can be adapted to store water, if necessary, or to provide incremental fine PK storage. The Lake C1 site also has adequate capacity but the dam construction required to store fine PK at the Lake C1 site is less efficient that at the Long Lake site. The Lake C4 site is the least efficient and has marginal capacity compared to the other sites. These factors significantly compromise its flexibility in terms of flood storage and water treatment.

- The minimal catchment at the Long Lake site means inflows is preferred in terms of water management. Diversions will not be needed at this site. The catchment at the Lake C1 site is significantly larger and would require either diversions or larger dam to provide the incremental storage capacity for floods. The catchment at the Lake C4 site is intermediate to the other two sites.

- The Lake C4 site is the best of the three sites site in terms of fish, since no fish were encountered in this lake. The Long Lake site has burbot and slimy sculpin, whereas the Lake C1 site has lake trout and slimy sculpin. The Long Lake site is therefore preferred over Lake C1.

Considering the factors described above, the Long Lake site was selected for the storage of fine processed kimberlite.

5 Processed Kimberlite Containment Area

5.1 Overview of PKCA

The selected PKCA site is located south of the proposed process plant and pit locations, and consists of the following:

- Four main earthen containment structures (West, East, Southeast and North);
- Minor containment dykes at various locations around the perimeter of the PKCA;
- One internal divider dyke;
- Spillway (at the West Dam)
- PK deposition infrastructure;
- Process return water reclaim infrastructure; and
- Operational discharge infrastructure.

Depending on the results of water quality monitoring, the following additional elements could be constructed as a contingency to provide incremental settling time prior to the release of excess water from the PKCA:

- Downstream polishing pond with associated dam;
- Spillway (at the Settling Pond Dam)

In the event that the PKCA does not allow sufficient time for suspended sediment to adequately settle out, the Settling Pond Dam is a contingency option that could be developed. The dam and spillway construction would occur during winter over a period of several months. If necessary, water would be stored in the PKCA until the Settling Pond Dam has been constructed and the use of the settling pond lowers the suspended solids to levels suitable for discharge. The location and general layout of the Settling Pond Dam and spillway are provided in SRK Technical Memorandum E (SRK 2003d).

5.2 PKCA Storage Characteristics

Long Lake, with its current water level of about elevation 515.4 mamsl, occupies approximately 9.8 ha of a narrow basin north of the plant site. There are several localized pockets in the lake, as illustrated by the series of three sections through the lake on Figure 5.1. The deepest of these pockets has a depth of about 8 m.

Using available topographic and bathymetric data, elevation-capacity curves for the site were developed. The elevation-capacity curves are provided on Drawing 1CT004.06-P1. The plot on the left of that drawing shows the storage capacity of the entire PKCA assuming that the stored volume of fine PK and/or water is struck level, i.e. a horizontal slope over the entire PKCA. The plot also includes the following:

- Annual production rate of 47,500 tpa at an effective dry density with ice entrainment of 0.5 t/m^3 (Note: the density is a conservative assumption for volume calculations only);
- Annual supernatant solution volume as ice based on a 30:70 solids to water ratio;
- Annual precipitation of 330 mm, stored as ice, falling within the 53.5 ha PKCA catchment and reporting to the impoundment; and
- Discharge of approximately 405,000 to 490,000 m^3 of excess water in the summer months (refer to Technical Memorandum W, Table W4).

The maximum operating water elevation is 523 metres above mean seal level (mamsl), which corresponds to the invert elevation of the PKCA spillway. The storage capacity of the entire PKCA at elevation 523 m is about 1.9 million m^3, compared to a fine PK volume requirement of 760,000 m^3. There is an additional 1 m of freeboard, to elevation 524 mamsl, that represents the maximum storage or containment elevation for the facility, i.e. emergency situation. However, since the West Dam relies, in part, on a frozen core, the West Dam crest elevation is 527 mamsl in order to provide thermal insulation above the frozen core.

In practice, the fine PK will be deposited from the east end of the PKCA. It is expected that the deposited PK will form a beach that slopes away from the point of deposition. A beach slope of 0.5% has been assumed for developing the operational requirements. The actual beach slope will depend on supernatant pool size, fine PK particle size, ice entrainment and operational management. The divider dyke will be used to hold most of the fine PK in the east end of the PKCA. The two plots on the right side of Drawing 1CT004.06-P1 show the storage capacity on either side of the divider dyke, again assuming struck level storage. The capacity east of the divider dyke is approximately 700,000 m^3, slightly less than the fine PK volume requirement. However, with deposition of the fine PK occurring from the east end of the PKCA, it is possible to use space above elevation 523 m in the eastern end of the PKCA by lengthening and raising the East and Southeast embankments and using subaerial deposition to beach the fine PK. Alternatively, an additional divider dyke constructed to the west of the divider dyke shown on Drawing 1CT004.06-P1 could be used to provide the incremental fine PK storage.

Drawing 1CT004.06-P9 shows what the fine PK might look like in 2013 assuming the fine PK is confined mainly to the area east of the divider dyke. The area of the fine PK in this case would be about 12 ha. The pond west of the divider dyke, as illustrated in Drawing 1CT004.06-P9, would be about 5.2 ha.

5.3 Foundation Conditions

The surficial geology and terrain in the vicinity of the PKCA are provided, along with the locations of the various earthen containment structures, on Drawing 1CT004.06-P2. The locations of boreholes completed in the vicinity of the PKCA are provided on Drawings 1CT004.06 – P3 through 1CT004.06 – P6. The logs of boreholes shown on these latter four drawings are provided in Technical Memorandum A (SRK 2003a). A series of site photographs illustrating site conditions are provided in Technical Memorandum S (SRK 2004b).

5.3.1 West Dam

The west dam will be situated at the west limit of the PKCA, as shown on Drawing No 1CT004.06 – P2. The west dam will span a narrow, relatively shallow valley. A series of five boreholes (BH-03-07, BH-03-08, 00SRKGeotech2, 00SRKGeotech3 and 00SRKGeotech8) were completed between 2000 and 2003 at the locations shown on Drawing 1CT004.06 – P3. Bedrock is exposed on the north valley slope and a thin mantle of organics covers most of the south valley slope. A boulder field, developed as a result of frost action and with very shallow standing water between the boulders, dominates the valley floor. The material beneath the surficial soils on the valley floor and south side of the valley comprise a bouldery till with a silty, sandy matrix. Observations from BH-03-07 and BH-03-08 indicate the till has, in some locations, stratified ice layers up to 6 mm thick. Elsewhere the till is well bonded with no excess ice. By extrapolation, the till is up to about 10 m thick in the vicinity of the dam. The till is underlain by bedrock comprised primarily of granite with no visible ice. The rock quality designation (RQD) of the bedrock core was typically greater than 85%. Two packer tests were undertaken in the bedrock in two boreholes (BH-03-07 and BH-03-08). The permeability value calculated from a single packer test was 3×10^{-10} cm/s, which suggests there were probably few, if any open voids in the bedrock. No flow was observed during the other packer test. The packer test results are summarized on the borehole logs.

Available data indicates that the site of the proposed West Dam is underlain by permafrost at temperatures which typically range between -4° C and -7°C.

5.3.2 North Dam

The North Dam will be situated on a saddle between two bedrock ridges on the north side of the PKCA. The ground north of the saddle drains to the north, into Lakes C2 and C1. The ground south of the saddle drains into a small lake perched above Long Lake. There are no boreholes at the North Dam site, but aerial photographic mapping indicates there is a colluvial layer at this site (Drawing 1CT004.06 – P2). Subsequent field observations and geologic mapping indicate that the colluvial layer is very thin and that the saddle is dominated by bedrock, as shown on Drawing 1CT004.06 – P4.

No temperature data was collected at this site but the thermal conditions are likely to be similar to other dam sites at the PKCA, i.e. permafrost temperatures which typically range between -4° C and approximately -7°C.

5.3.3 East Dam

The East Dam will be situated at the east limit of the PKCA and immediately south of the mine process and stockpile locations, as shown on Drawing No 1CT004.06 – P2. The East Dam will span a relatively narrow saddle between two bedrock ridges. Two boreholes (00SRKGeotech1 and BH-03-10) were drilled at this site in 2001 and 2003, respectively (Drawing 1CT004.06 – P5). The logs indicate, that between the bedrock ridges, the dam site is occupied by a thin mantle of organics that is underlain by a bouldery till with a silty, sandy matrix. The log of BH-03-10 indicates the till is well bonded with no excess ice. The till, which is up to about 23 m thick at the dam, is underlain by bedrock comprised primarily of granite. The average RQD of the bedrock core was about 65%. One packer test was undertaken in BH-03-10, but no flow was recorded.

Available data indicates that the site of the proposed East Dam is underlain by permafrost at temperatures which typically range between -4° C and -7°C.

5.3.4 Southeast Dam

The Southeast Dam will be situated south of the East Dam, at the southeast limit of the PKCA, as shown on Drawing No 1CT004.06 – P2. The topography and setting at the southeast dam are similar to the East Dam. One borehole (01-Geotech5) was drilled at this site in 2001. It indicated the site is underlain by about 4 m of overburden (presumably till), as indicated by Drawing 1CT004.06 – P6. No data regarding the ice content was recorded. The bedrock is primarily granite.

No temperature data was collected at this site but the thermal conditions are likely to be similar to the conditions at the East Dam, i.e. permafrost temperatures which typically range between -4° C and -7°C.

5.3.5 Dykes

The divider dyke will be situated in a particularly narrow part of the Long Lake basin, between two bedrock outcrops, as shown on Drawing No 1CT004.06 – P2. There is no subsurface information at this site but Figure 5.1 indicates that the depth of water is less than 2 m along the approximate dyke location. Bedrock is present at the abutments and local data would suggest that either till or colluvium of indeterminate depth are likely the dominant soils types on the valley floor. Within the lake, talik is likely present under the proposed dam footprint.

A series of four dykes will occupy shallow depressions around the perimeter of the PKCA. Two will be located on the north side of the PKCA and two will be located on the south side. The surficial geological mapping indicates that the foundation conditions at the dyke locations consist primarily of bedrock, although localized deposits of colluvium and till may also be present, as shown on Drawing No 1CT004.06 – P3. Local permafrost data indicates these sites are underlain by permafrost.

5.3.6 Settling Pond Dam (contingency option only)

As noted in Section 5.1, the Settling Pond Dam is a contingency option that could be constructed in the event that the PKCA does not allow sufficient time for suspended sediment to adequately settle out.

The Settling Pond Dam would be located west of the West Dam in a narrow, relatively shallow valley, as shown on Drawing No 1CT004.06 – P2. A series of boreholes completed in the vicinity of the dam between 2000 and 2003 (Boreholes BH-03-03B, BH-03-05, BH-03-06, BH-04, 01-Geotech1, 01-Geotech4, 01-Geotech6 and 01-Geotech7) describe the foundation conditions at the locations shown on Drawing 1CT004.06 – P3. Like the West Dam, bedrock is exposed on the north valley slope and a thin mantle of organics covers most of the south valley slope. A boulder field, developed as a result of frost action and with very shallow standing water between the boulders, dominates the valley floor. The material beneath the surficial soils on the valley floor and south side of the valley comprise a bouldery till with a silty, sandy matrix. The logs indicate the till is generally well bonded with no excess ice. The till, which is up to about 20 m thick in the vicinity of the dam, is underlain by bedrock comprised primarily of granite with the occasional mafic dike. The bedrock core had a relatively high RQD, i.e. typically greater than 75%. The permeability values calculated from packer tests in two boreholes were 1×10^{-8} cm/s and 7×10^{-9} cm/s. No flow was observed during the packer tests in the other two boreholes.

Available data indicates that the site of the Settling Pond Dam is underlain by permafrost at temperatures which typically range between -4° C and -6°C. Talik may be present in the pond area immediately east of the dam site, but its extent is likely limited by the very shallow depth of the lake.

6 Embankments Design

Operation of the PKCA will be based on storage of fine PK deposited from its east and decanting of water from its west end. Based on this mode of operation, the West and North Dams have been designed as lined, frozen core structures, while the East and Southeast Dam have been designed solely as frozen core structures. Design details for these structures are provided below.

6.1 Embankment Design (West and North Dams)

6.1.1 West Dam

Based on the proposed operating methodology, fine PK will be deposited from the eastern end of the PKCA and only water will be in contact with the West Dam. The West Dam has therefore been designed as a water retaining structure utilizing a central frozen core backed by a geosynthetic clay liner (GCL) as shown Drawing 1CT004.06 – P7. The frozen core and GCL are required to an elevation of 524 mamsl to provide engineering and environmental containment under extreme operating conditions. The embankment will be constructed in a single construction sequence because of the ice core requirements related to quality control and construction mobilization.

The core material would be composed of esker sand borrow material (material A). The frozen core would be keyed and frozen into the central key trench utilizing thermosyphon evaporators (Drawing 1CT004.06 – P8). A transition layer consisting of gravel produced from waste rock (material B) will be placed against the frozen core to protect it from the run-of-mine waste rock shell (material C).

Although the frozen core is intended to limit seepage, the GCL liner will provide the water retaining capability in case the core develops cracking due to thermal expansion and contraction. The core (and GCL) would extend 1 m above the maximum operating water level (elevation 523 m at the spillway invert) and the outer shell would be at least 3 m thick to provide insulation to the frozen soil.

The dam construction would be undertaken in winter and it is expected that the key excavation would be drilled and blasted. The slopes of the key cut are shown at 0.5 to 1 (horizontal to vertical) to illustrate this, but they may be steeper in the field.

6.1.2 North Dam

The depression at the east end of Long Lake (the east cross section on Figure 5.1) has sufficient storage for the most of the fine PK production in the first year of operation. The PKCA has sufficient capacity to store excess water, both process and run-off, from the first freshet if required due to water quality reasons, i.e. no discharge during 2006. The required containment elevation under this scenario would be 520 mamsl. The current ground elevation at the North Dam alignment is 518m. An access road causeway is required at the North Dam location to provide access to the West Dam. Based on the operating scenario of depositing fine PK from the east end of the PKCA and decanting all excess water during the summer months(except potentially in 2006), the construction of the North Dam to its full containment height of 524 m would not be required. Thus, the design calls for lining the upstream face of the road access causeway with GCL that would be keyed into the causeway fill as shown on Drawing 1CT004.06 – P7. The current exposed bedrock at the site would be cleaned off and bentonite spread on the rock surface to provide sealing between the GCL and the bedrock. A layer of select waste rock (minus 150 mm) will be placed on either side of the GCL liner for protective purposes (this detail is not noted on Drawing 1CT004.06 – P7).

The storage requirement situation at the North Dam would be evaluated annually. Should an embankment be required to 524 mamsl, the design would be very similar to the West Dam, i.e. central frozen core with a GCL, but without thermosyphon evaporators.

6.1.3 Settling Pond Dam (contingency option only)

The Settling Pond Dam, if needed as a contingency to in relation to suspended solids in the PK supernatant, would have a design cross section very similar to the West Dam section shown on Drawing 1CT004.06 – P7. The main difference would be that the crest of the Settling Pond Dam would be at elevation 521 mamsl, i.e. 6 m lower than what is shown for the West Dam on Drawing 1CT004.06 – P7. Further details regarding the Settling Pond Dam are provided in Technical Memorandum E (SRK 2003d).

6.2 Embankment Design (East and Southeast Dams)

The design for the East and Southeast Dams will include a frozen core to an elevation of 520 mamsl while the shell material would be coarse PK and/or waste rock. The 520 m elevation coincides with the expected water elevation in the summer of 2007 in the unlikely event that no discharge occurs during the summer of 2006. The crest elevation of the shell material, allowing for thermal insulation, would be 524 mamsl. There would be no requirement for a GCL since it is only during the initial years of operation that water is likely to impound against the structure for a limited time. Fine PK would be deposited from the embankments and these will form a rising and ever-widening zone of low permeability material against the face of these dams. The shell portion of the dams could be further raised on a regular basis using coarse PK and/or mine waste using downstream construction methods and raising the elevation of the subaerial deposition points. The outer shell of the dams will be lined with waste rock to prevent wind and water erosion.

The initial construction of the East and Southeast Dams is expected to occur in the winter prior to the first freshet, i.e. the winter of 2005/2006. This is to retain the contingency of not releasing any excess water during the summer of 2006.

A contingency to raise the core of the East and Southeast Dams using GCL is shown on Drawing 1CT004.06 – P7.

6.3 Dyke Design

6.3.1 Divider Dyke

The sole purpose of the divider dyke is to limit the extent to which fine PK solids move into the west half of the PKCA. The dyke is, therefore, not intended to be a water retaining structure. The design section will consist primarily of coarse PK and/or waste rock (material D) with an upstream layer of esker sand (material A), as shown on Drawing No 1CT004.06 – P7. If most of the core is constructed exclusively of waste rock, a filter zone of coarse PK will be placed between the waste rock and the esker sand.

The divider dyke crest elevation shown in Drawing No 1CT004.06 – P7 is 520 mamsl, but the dam would probably be built to a lower elevation initially. As the fine PK levels behind the divider dyke approach the crest of the divider dyke, the dyke will be raised using the downstream construction method. In the event there are minor accumulations of fine PK on the downstream side of the divider dyke, it is highly unlikely that they will lead to stability issues

The initial divider dyke construction would be undertaken in the summer or fall of 2007 or, possibly 2008, when the esker deposits are free of frost. Raises will typically occur in the summer or fall, but could also be undertaken in winter.

6.3.2 Perimeter Dykes

The dykes that are required at four locations around the PKCA will be very low structures. The available topographic mapping indicates that the low point in the bedrock at each of these dykes is approximately elevation 523 mamsl, which corresponds to the invert elevation of the PKCA spillway. The need for these structures to hold water is therefore limited to short-term emergency situations when the water level is flowing through the PKCA spillway.

The basic design of each of the perimeter dykes would be similar to what is shown for the North Dam road access causeway on Drawing No 1CT004.06 – P7. The main differences are that the dykes will have a crest elevation of about 524 mamsl and will typically be only about 1 m high. The crest width will be established based on the minimum access widths associated with the construction equipment.

6.4 Seepage Control

The control of seepage at the PKCA system is dependent on the integrity of its perimeter dams, principally the West Dam.

The valley occupied by Long Lake and the PKCA is intersected by a fault as shown on Drawing No 1CT004.06 – P2. However, the available thermistor data confirms that the West and East dams are underlain by permafrost. It is reasonable to assume that the other dam sites (North, Southeast) are also underlain by permafrost. Experience with properly constructed frozen core dams has shown that seepage is effectively zero. Typical examples include the dams at Ekati Diamond Mine™ with similar design, i.e. frozen core dams, which are well constructed. Therefore, to the extent that the frozen cores of the various dams are thermally contiguous with the natural permafrost, the seepage losses should be non-existent.

Conventional seepage analyses are not well suited to the estimation of seepage through frozen core dams. However, for water balance purposes only, it is assumed that seepage from the PKCA system will be 0.1 L/sec. This amount of seepage might be attributable to slight imperfections in the seepage control system as a result of, for example, minor construction flaws or imperfect freezing at select locations.

The fine PK will be deposited via sub-aerial beaching from the East and Southeast embankments. This beached PK will prevent ponded water from directly contacting the adjacent embankments. Thus, no significant head of water is expected against the East or Southeast embankments, except under the contingency scenario where no discharge occurs during the first freshet due to unexpected water quality issues.

Consideration has been given to the potential need for a sump immediately east of the East dam and the Southeast dam, i.e. a possible sump is noted in Technical Memorandum G, Figure G.1 (SRK 2003f). The toe areas at all dams will be monitored. To the extent that seepage any seepage is observed, and depending on the amount and water quality of any such seepage, consideration will be given to collecting this seepage in a sump or sumps and pumping it back into the PKCA.

6.5 Thermal Analyses

6.5.1 General

Thermal analyses were performed for the West Dam because it is the main water retention structure for the PKCA and because the retained water will transport additional heat towards the West Dam, which could significantly influence the thermal stability of the frozen core in the West Dam. The thermal analyses assumed that the water level in the PKCA was relatively high and constant. In addition, to account for the contingency scenario that might lead to the construction of the Settling Pond Dam, the thermal analyses also assumed that the Settling Pond was continuously in place at a relatively high level.

A summary of the thermal analyses are provided here. Appendix B provides further details on the thermal modeling.

The thermal modelling presented herein was carried out using the finite element thermal model SVHEAT version 3.09 developed by SoilVision Systems Ltd. SVHEAT models heat transport for both steady-state or time-dependent analyses. It incorporates the latent heat associated with phase changes of water. The geometry is treated as a 2D vertical cross-section. Further details are available in the User's Manual of SVHEAT (SoilVision Systems 2004).

6.5.2 Method of Analysis

The thermal model was used to simulate the thermal regime at the West Dam under seasonal fluctuations over a period of 10 years. A "warm" climate based on the warmest three years from the Lupin Mine 30 year climatic dataset was used for the climatic data in the model. The "warm" average climate resulted in a mean annual ambient temperature of -8.9 °C with an annual amplitude of 21.0 °C. Given the relatively short period of mine operation (8 years), the impact of global warming was not incorporated into the thermal simulations, although the "warm" average was used.

The interpretation is based on the position of the 0 °C isotherm during the 10th year of simulation.

6.5.3 Geometry and Input Parameters

The geometry was set to 275 m wide and 116 m high along the existing ground surface, plus another 11 m for the West Dam, for a maximum height of 127 m at the crest of the dam (assumed crest elevation of 527 mamsl). The stratigraphy is represented by 23 m of glacial till over 93 m of bedrock. The entire finite element domain was constructed using 9164 elements: 828 for the bedrock layer, 5820 for the overburden and 2516 for the dam.

The boundary conditions were as follow:

- Bottom boundary: geothermal heat flux of 2.02 kJ day-1 m-1, based on a geothermal gradient of 9 °C km-1 and a thermal conductivity of 2.25 kJ m-1 day-1 °C-1 (frozen bedrock).
- Left and right vertical boundaries: no heat flux conditions.
- Original ground surface and the submerged portions of the dam (assumptions of submergence are elevation 525 mamsl on the upstream side and elevation 520 mamsl on the downstream side): time-dependent surface temperature but limited to 5 °C or warmer.
- Portion of the dam not submerged: time-dependent surface temperature with no temperature restriction.

The boundary condition that simulated the surface temperature along the ground surface and the dam is based on the daily ambient air temperature and the use of coefficients that represent the type of surface. The daily ambient air temperature was approximated by a time-dependent sinusoidal function using the “warm” mean annual ambient temperature and the corresponding annual amplitude.

The daily ambient temperatures were then converted to surface temperatures by using freezing and thawing surface indices whether the ambient temperature was above or below freezing. The freezing surface index was set to 0.33 for all the surfaces except for the crest of the dam, where it was increase to 0.5. The difference is to compensate for the lower snow accumulation that is expected along the cress of the dam. The thawing surface index was set to 1.0 where the surface was submerged and 2.0 elsewhere.

The initial condition for the time-dependent simulation is based on a steady-state simulation where the upper boundaries were all set to a constant temperature of -4 °C. The left, right and bottom boundaries were set identical to time-dependent simulations described above.

6.5.4 Results and Interpretation

The time-dependent thermal simulation shows that the central core of the West Dam will remain frozen after 10 years of operation (Figure 6.1). It shows that the 0 °C isotherm barely penetrates the central frozen core. This temperature distribution is consistent with observations reported in the literature (Biyanov, 1976; Holubec and Dufour, 1986; Holubec and Hu, 2003).

The time dependent simulation also indicates that the active zone does not penetrate the core below the location of the liner. This indicates that the 2.5 m thick granular cover is sufficient to protect the core from reaching temperature in excess of 0°C.

The simulations described herein assumed that both sides of the dam will have very high water levels on a continuous basis for a period of 10 years. In fact, the mine life is 8 years and the expected water level in the PKCA will only approach the level used in the analyses for short periods under extreme conditions. Similarly, the water level on the Settling Pond side would be less than indicated except for very brief periods, if it is present at all. The Settling Pond Dam is, after all, only a contingency.

n summary, the boundary conditions used in the thermal model simulate thermal conditions that are more severe than what will occur in the field. The analyses are, therefore, very conservative and, as such, justify the use of a thermal criterion of 0°C. Based on this criterion, the central core portion of the West Dam will remain frozen over the 8-year period of operation.

Potential degradation of the frozen core over the long term time, with or without the impact of global warming, is not a concern because of the elimination of the PKCA pond at closure. As is noted in Section 13, the West Dam will be breached or the spillway will be lowered. In either case, a frozen core dam will not be needed to control seepage post closure.

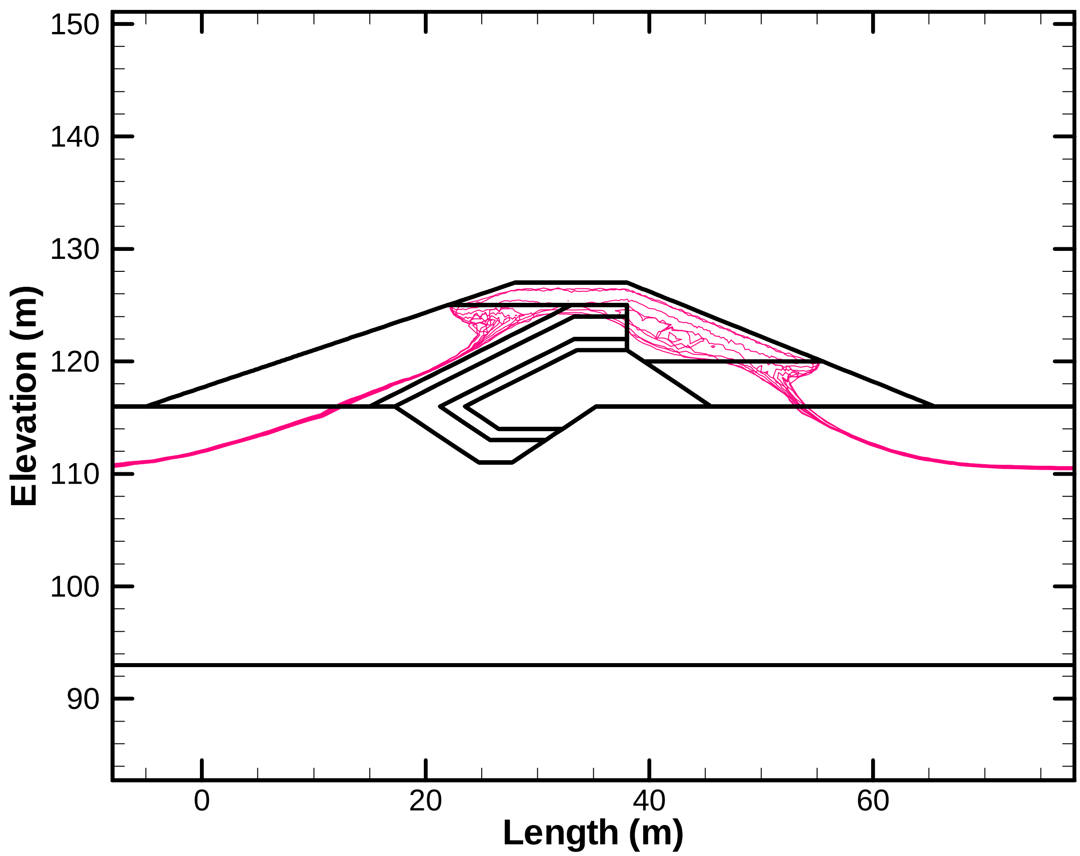

Figure 6.1: Time-dependent simulation showing the annual variation of the 0 °C isotherm during 10 yrs of mine operation. The lowest red line is the 0 °C isotherm after 10 yrs.

6.6 Stability Analyses

The stability of the West Dam has been assessed using a conventional stability analyses. The West Dam is the highest dam at the PKCA and will operate under the most severe operating conditions of all the dams. The results from this dam are therefore, conservative, relative to the other PKCA dams. A summary of the analyses is presented below. The detailed results are contained in Appendix B.

6.6.1 Failure Modes

The dams, including the West Dam, will have relatively moderate slopes. The dams and their foundations are generally granular and frozen. Data from the geotechnical investigations (SRK

Technical Memorandum A) suggest that, in general, there is relatively little excess ice in the foundation soils. The most likely failure modes therefore comprise:

- A failure surface which is relatively shallow and sub-parallel to the slope face,
- A failure of the internal slope of the dam due to rapid drawdown coupled with failure along the GCL interface.

The analyses assume that, in the event there is thawing of the dam or its foundation, the materials are sufficiently granular to prevent the build-up of pore pressures to levels which would significantly affect dam stability.

6.6.2 Method of Analysis

The slope stability analyses were performed using 2-dimensional limit equilibrium analyses and the computer program SLOPE/W, which was developed by GEO-SLOPE International. Factors of safety for the various stability cases were determined using the Bishop method.

6.6.3 Geometry and Input Parameters

The highest slope at the West Dam has been used for analysis. Input parameters have been selected based on judgment and are believed to be at or below typical mean values for the materials considered (Table 6.1). The fact that the core of the dam will be frozen has been ignored.

Table 6.1: Input Parameters used in the Stability Analyses

Parameter	Moist Unit Weight (kN/m^3)	Effective Strength Parameters		Earthquake for Pseudo-Static Assessment
		c (kPa)	phi (degrees)	
Shell	20	0	35	0.013 and 0.06
GCL	19.6	0	11	
Core - fine	22	0	30	
Fine PK	17.8	0	28	
Foundation Till	22	0	32	
Bedrock	Failure surface prevented from intersecting the bedrock			

Note 1: The water table is assumed to run through the upstream shell at the PKCA at elevation 525 m, across the top of the frozen core, and then down slowly to the downstream face of the dam at elevation 520 m. The water level on the downstream side of the dam assumes that the settling pond is in place.

The earthquakes with 475 and 2,475-year return periods coincide with peak ground accelerations of 0.013g and 0.06g, respectively. Further details regarding the earthquake hazard and peak ground acceleration are provided in Technical Memorandum A (SRK 2003a).

6.6.4 Results of Analyses

The results of the analyses are summarized in Table 6.2.

Table 6.2: Summary of Critical Factors of Safety for West Dam

Stability Condition	Suggested Minimum FOS	Calculated Factor of Safety (FOS)	Comments
Dam Surface			
End of Construction	1.3	2.2	Dam shell, infinite slope analysis
Steady State	1.5	2.2	Dam shell, infinite slope analysis
Deep Seated			
End of Construction	1.3	1.4	Circular, upstream (u/s) no water
Steady State	1.5	2.0	Circular, u/s (with water on slope)
Steady State	1.5	1.6	Circular, d/s (with water table)
Pseudo-static	1.1	1.6	Circular, d/s, acceleration = 0.013g
Pseudo-static	1.1	1.3	Circular, d/s, acceleration = 0.06g
Along Liner			
End of Construction	1.3	1.4	HDPE liner (no water on slope)
Pond Full	1.5	1.4	HDPE liner (with water on slope)
Pseudo-static	1.1	1.3	HDPE liner, acceleration = 0.013g
Pseudo-static	1.1	1.1	HDPE liner, acceleration = 0.06g

6.6.5 Conclusions

Table 6.2 demonstrates that the calculated factors of safety for the West Dam generally meet or exceed the minimum allowable values. The only exception is the steady state seepage scenario for a failure along the liner (highlighted in grey in Table 6.2). In this case, the differential is relatively small. The actual friction angle between the rock fill and the liner will be assessed in more detail as part of final design for construction, and downstream slopes will be adjusted or buttressed, if necessary.

7 Water Balance

7.1 General

The water balance for the PKCA is provided in Technical Memorandum W (SRK and Clearwater 2004). An overview discussion of the PKCA water balance is provided below.

Long Lake is shallow with a maximum water depth of approximately 7 m and a volume of approximately 100,000 m^3. This water will be pumped out and discharged to stream C3 prior to the start of PK disposal.

The PKCA, in addition to storing fine PK, will also be a key element in the overall site water management. The site-wide sources that could impact the PKCA water balance are as follows:

- Run-off water from the waste dump areas. The volume related to this source is a contingent on the areas of disturbance and the water quality;
- Run–off water from the plant and process areas;
- Pit dewatering (from meteoric sources);
- Direct precipitation and snow falling within the PKCA;
- Water from the sewage treatment plant, accommodation complex and surrounding area; and
- Process water associated with the fine PK deposition.

As part of the site water management, the water balance for the PKCA was analysed. The balance represents a continuous simulation to model the water and solids quantities within the PKCA over the life of the facility. The spreadsheet model used monthly time steps to simulate inflows and outflows from the various project components or sources.

Water quantities are calculated monthly in the model based on input values for process-related flows including fine PK slurry flow, void losses in deposited fine PK, other process inflows, sewage, and seepage flows. Net runoff volumes are calculated for each catchment and each type of ground cover (disturbed and undisturbed ground and pond areas) based on monthly precipitation and evaporative losses appropriate for the ground type. The annual snowmelt runoff is distributed over May, June and July with the bulk of the runoff occurring during June, similar to flows in the natural environment. Snowmelt is generated from the cumulative snowfall from September through May each year.

7.2 Input Parameters

The “base case” scenario included the following assumptions for modeling purposes:

- Eight years of ore processing starting in the first quarter of 2006. The model timeframe was extended beyond eight years to cover the expected time required to fill the pit after the completion of mining activities.
- Average precipitation and evaporation conditions. Dry and wet precipitation years were also evaluated to assess the impact on water quality and quantity.
- Average expected source concentrations for the modeled parameters.
- If runoff/seepage water quality from a project component area is acceptable for direct release, water would be directed to the receiving environment. The Base Case model assumed that, over the entire operating period, all water, runoff and seepage from all site components will be collected and directed to the PKCA for temporary storage until released from the system.
- Water will be reclaimed from the PKCA to the processing plant from June to September.
- The PKCA pond level will be limited to a maximum elevation of 523 m, corresponding to a total storage volume of 1,790,000 m3. The minimum allowable operating PKCA pond volume was assumed to be 100,000 m3.
- The elevation of solids stored within the PKCA and the elevation of the total of water plus solids each year were estimated from the PKCA elevation-storage relation conservatively assuming flat line or horizontal storage. Solids will be encouraged to deposit above water around the eastern end of the impoundment using an internal splitter dike and perimeter spigotting.
- Releases of excess water will be allowed from the PKCA starting in the first summer of operation: the model indicates that water quality in the PKCA will be acceptable for release. Releases will occur in June, July, August and September. Release rates will be varied to follow the pattern of flow rates in the receiving environment.
- After the completion of active mining operations and starting in Year 9 (2014 in the model), all site area flows will be directed into the open pit.

7.3 Modeling Results

The modeling results show that, of approximately 487,000 m^3 total net inflow to the PKCA each year (average precipitation conditions), about 140,000 m^3/year (29%) originate from local runoff and process inflows (including about 16,000 m^3 from the sewage treatment plant). The remaining net inflow volume is pumped either from the open pit or from the collection ponds (if constructed) minus the volume reclaimed to the processing plant.

In order to maintain the water balance within the PKCA, the net inflow of excess water must be released each year. Typical monthly release volumes (June to September) would range from about 300,000 m^3 in June (60% of the annual total) to about 36,000 m^3 in September (7% of the annual total).

Contingency allowances included in the system include the following:

- The PKCA has more than ample storage to, if necessary due to water quality concerns, store all site area runoff (all component area runoff plus pit inflows plus PKCA area runoff) for the first two years of operations without any releases.
- If processed kimberlite settling characteristics within the PKCA are less efficient than expected, additional flocculants could be used and the Settling Pond could be constructed to serve as a final settling and polishing pond for PKCA releases; and
- Depending on actual PKCA water quality during the first one or two years of operation, pilot testing of a spray irrigation scheme would be carried out. The removal of water from the PKCA for possible spray irrigation trials has not been included in the water balance.

8 Design of the Water and Fine PK Management Facilities

This section deals with the design of the facilities required to perform the PK disposal and manage the supernatant and excess water within the PKCA.

8.1 Reclaim and Decant System

Water management facilities within the PKCA include reclaim and decant facilities. Under operational conditions, water will be decanted from the PKCA via a pump to a position downstream of the West Dam each summer and fall to remove excess water that meets discharge criteria. The amount of water to be removed will vary depending on inflow inputs and water management criteria. A normal operating basis would be to maintain the level of free standing water in the PKCA at the West Dam near the natural existing level (elevation 515.4 mamsl) to maintain seasonal flows in stream C3.

Under operational conditions, water will be reclaimed to the process plant and/or decanted to Stream C3 via a pumped system. The pumping system will be installed on a floating barge located at the western end of the PKCA. The layout and details of the pipeline and pumps are shown on Drawing No 1CT004.06 – P11.

The ability to reclaim water from the PKCA has been included in the water balance, but the actual implementation of the water reclaim system will be staged. This will afford Tahera the opportunity to evaluate whether year-round reclaim is feasible. To the extent that the pond and ice conditions allow, reclaim will be carried out throughout the year. However, in the event that reclaim to the process plant and decanting of excess water to Stream C3 is only occur during the summer months, the pump barge will be removed from the pond and stored during the winter. In addition, the decant and reclaim pipelines will be winterized.

8.2 Operational Emergency Discharge System

An emergency spillway will be cut into the bedrock outside the right abutment of the West Dam to protect the West Dam from overtopping. Similarly, in the event the Settling Pond Dam is constructed, an emergency spillway will be cut into the bedrock at the right abutment of the Settling Pond Dam. Further discussion of each of these spillways is provided below.

West Dam Spillway

During operations, the inlet elevation of the West Dam spillway will be 523 mamsl. The spillway bottom has been designed with a nominal width of 3 m and 1 to 1 (horizontal to vertical) side slopes. The alignment and sections through the spillway are shown on Drawing 1CT004.06 – P8.

The spillway is to be cleared of snow and ice should water elevations be within several meters of the spillway inlet elevation prior to the annual snowmelt to minimize the potential for channel blockage.

Settling Pond Spillway – Contingency Design Only

The Settling Pond Dam has been designed as a contingency only and will only be constructed should operational conditions dictate, specifically that the TSS content of the discharge water requires further treatment. Under this contingency scenario, water in the PKCA would be directed to the Settling Pond to facilitate a reduction of the TSS to discharge limits prior to release to Stream C3. It should be noted that this is considered the third or fourth level of contingency as the PKCA has the capability to store up to two years of total site water without releasing water to the environment. This two year surge capacity includes conservative figures for settled density of solids, no subaerial deposition, maximum disturbance of surface areas and all runoff reporting to the PKCA.

If constructed, the Settling Pond spillway would have a concrete stoplog structure, founded on bedrock. The minimum inlet elevation of the stoplog will be 516 mamsl to facilitate a sediment storage volume of approximately 20,000 m^3. The operating elevation during the summer months when water is being released to Stream C3, will be 519.5 mamsl. This will provide a pool volume of approximately 85,000 m^3 of settling and retention capacity.

8.3 PK Hydraulics/Piping

Three pipelines have been designed in relation to the PKCA. These are the fine PK disposal pipeline, the reclaim pipeline and the supernatant discharge pipeline. The fine PK disposal pipeline and the reclaim pipeline are shown on Drawing No 1CT004.06 – P11. The supernatant discharge pipeline will be a short pipeline that will run from the barge mounted reclaim pump adjacent to the upstream face of the West Dam, to a logical point in the spillway (exact location of the end point of this pipeline will be determined in the field once the spillway has been constructed).

The following information and design criteria were used to design the fine PK disposal pipeline under normal operating conditions:

- Design production: 47,500 tonnes per annum or 130 tonnes per day
- Fine PK slurry solids concentration by mass: 30%
- Solids specific gravity: 2.65 t/m^3
- Fine PK grading curve: from Figure 1 in Appendix C
- Thickener underflow tie-in elevation: 518 mamsl

- East and southeast embankment elevation at the end of mine life: 527 mamsl
- Length of initial fine PK pipeline: 665 m
- Length of final PK pipeline: 945 m
- Maximum design slurry velocity: 2 m/s
- Insulated HDPE pipes to be used for slurry transport.

Water will be reclaimed and discharged from the PKCA every summer over the life of the facility. For pipeline design purposes, the percent reclaim has been assumed at 80% of the process plant water requirements. The discharge will directly to Stream C3 when water meets discharge criteria. No discharge will be made from the PKCA unless discharge criteria are met. The following was used to design the reclaim and discharge pipelines:

- Reclaim design flow: 2.81 l/s (243 m^3/day) (note: only in the summer months)
- Discharge design flow: 117 L/s
- Decant inlet elevation varies from a maximum of 523mamsl to a minimum of the existing lake level at elevation 515.4 mamsl
- Reclaim discharge elevation: 520 m
- Stream C3 discharge elevation (at the end of the spillway): 516 mamsl

The details of the pump arrangements, and the pipeline plan and long section are shown on Drawing 1CT004.006 – P11. The detailed hydraulic calculations are provided in Appendix C.

9 PKCA Construction

9.1 Embankment Construction Sequence

The PKCA and its various components will be constructed over multiple seasons. The specific construction steps for the West Dam are as follows:

- Ice-rich and deleterious materials (boulders, organics, low density, etc) will be removed from the dam footprint;
- The key-cut will be excavated as shown on Drawing 1CT004.006 – P7. During the key-cut excavation, should areas of talik be identified, the bottom width of the key-cut will remain as shown, but the overall key-cut depth dimension will increase based on cut slope requirements (0.5 to 1 m – horizontal to vertical);
- Esker sand (material A) and GCL liner will be installed within the key-cut and core. The esker sand should be dried, moisture conditioned to ensure saturation and placed in thin lifts. Each lift will be allowed to freeze prior to placement of the next lift.
- The transition material (material B) will be placed over frozen core material (material A);
- The run-of-mine (material C) will be placed over the transitional material to provide the bulk fill and thermal insulation needed for the frozen core. The thickness and final slopes of the run-of-mine materials will be as shown on Drawing No 1CT004.006 – P7.

In practise, the overall sequence of raising the core, transition and shell materials would likely be performed simultaneously.

The construction sequence for the North Dam will be essentially the same as for the West Dam except that the key-cut for the North Dam will be very thin due to the fact that the bedrock is at or very close to the ground surface.

The construction sequence for the East and Southeast Dams will be the same as for the West Dam except that there will be no GCL within the section and the shell material may be comprised of run-of-mine (material C) and/or coarse PK (material D). The thickness and final slopes of these materials will be as shown on Drawing 1CT004.006 – P7. In the event that a low permeability element must subsequently be added to the East and Southeast Dams, part of the shell material overlying the frozen core will be excavated so that a GCL can be added to the section (see the contingency core raise section on Drawing 1CT004.006 – P7).

9.2 Construction Staging

Long Lake will be substantially dewatered prior to commencement of plant operation, resulting in a natural weir that will help contain the solids in the eastern end of the PKCA basin during the initiation of fine PK deposition (see the profile on Figure 5.1). This would make it possible to start up the processing plant while the dams at higher elevations in the Long Lake basin (North, East and Southeast) are still under construction or are yet to be built. The perimeter dykes would be constructed last, as required.

The PKCA dams will be constructed in a sequential fashion that takes into account the basal elevation at each dam site, the required construction season (i.e. the frozen core dams will be constructed in winter) and the likely elevation of water in the PKCA each spring. Details are provided below.

The PKCA will be commissioned and the dams and related infrastructure will be built in the following stages:

- 2nd and 3rd Quarter 2005. Access road to West, North, East and Southeast Dams to be constructed. The North Dam road access causeway will be built as part of the road construction. The core material will be moved to West, East and Southeast Dam areas. After the natural freshet has passed, most of the water will be pumped from Long Lake. In conjunction with this operation, the fish will also be removed. The water level will be lowered to the 513.5 m level or lower, exposing several natural ridges in the lake bottom (Figure 5.1).
- 4th Quarter 2005. Plant commissioning begins with initial fine PK deposition into the depressions at the east end of Long Lake.
- 1st Quarter 2006 (winter). The West Dam will be constructed to elevation 527 mamsl. This will be followed by the construction of the East and Southeast Dams to elevation 524 mamsl.
- 3rd Quarter 2006 (summer). The decant system will be installed at the PKCA so that excess water can be discharged (pump will be removed every winter unless water can be reclaimed to the plant site over the winter period).
- 1st Quarter 2007 (winter). Depending on the actual water management requirements, the North Dam will be constructed. However, if the water management does not require the construction of these dams in 2007, the construction of the North Dam and the contingency raises on the East and Southeast Dams can be deferred until later (to be reviewed annually).
- 3rd Quarter 2007 (summer). The reclaim pipeline will be installed between the PKCA and the processing plant.
- Regular operations over the mine life. Internal dykes, including the divider dyke, will be constructed at the PKCA as required to retain the tailings at the east end of the PKCA and to enhance the quality of the water that reports to the decant system at the west end. Also, depending on the beach slope, coarse PK and/or mine waste rock will be used to increase heights of the East and Southeast Dams, thereby providing higher discharge elevation points for subaerial deposition.

9.3 Construction Materials

The fill materials for the dams, as determined by preliminary engineering, will comprise the following:

Frozen Core (material A): The frozen cores and the material under the frozen cores will be constructed of esker sand, with a minus 10 mm maximum particle size, obtained from the esker deposits north of Carat Lake. The esker sand will be selected so that it is well graded with some fines to retain water. The in-place degree of saturation must be greater than 85%. Lift thicknesses will be approximately 150 to 300 mm (field trials are required to confirm the minimum fines content and optimum lift thickness – some mixing or processing of materials may be required).

Liner: The liner consists of a geosynthetic clay liner (GCL).

Transition Zone (material B): The transition zone includes the material placed above and below the protective sand cover that overlies the GCL liner. This material is expected to comprise the finer “tail” of the rock produced for the shells and, to the extent possible, will comprise crushed rock fill with a maximum particle size of approximately 150 mm. The source of the crushed rock is expected to be granitic waste rock from the development of the open pit.

Upstream and Downstream Shells (material C): The upstream and downstream shells overlying the transition zone at the West and North Dams will be comprised of run-of-mine rock fill (material C). The source of the run-of mine rock is expected to be granitic waste rock from the development of the open pit.

Upstream and Downstream Shells (material D): For the East and Southeast Dams, the upstream and downstream shells can consist of either run-of-mine rock fill (as for material C) and/or coarse PK.

9.4 Construction Quality Assurance, Control and Monitoring

During the dewatering of Long Lake, water quality in the lake and at the pipe discharge will be monitored to ensure that it meets discharge guidelines for total suspended sediments. The water will be examined on a frequent basis for clarity, and samples will be collected and submitted for testing of routine parameters. The pump suction will be designed to pull water from the lake surface to avoid disturbance of the lake bottom to the maximum extent possible. Once water turbidity becomes apparent from the disturbance of lake bottom sediments, the pumping will cease. The pump system will be removed and winterized and kept for seasonal lake water discharges.

Quality assurance and quality control measures appropriate to the construction of frozen core dams will be implemented during the construction of the dams.

9.5 Quantities

The construction quantities for the dams are listed in Appendix D. These quantities are based on the design drawings that accompany this report and have been prepared for purposes of the Water Licence application.

10 PKCA Operation

10.1 PK Disposal

10.1.1 Disposal Concepts

The proposed development of the PKCA over the operational life is depicted on Drawing No 1CT004.006 – P9. Fine PK slurry will be pumped from the thicker underflow location to the eastern end of the PKCA. The fine PK slurry will be discharged from the East Dam and, later, the Southeast Dam from single discharge points on a subaerial deposition basis during periods of open water. During the winter months, the discharge point will be moved closer to the water's edge to avoid major ice entrainment within the deposited PK. This deposition methodology will place a bias on the beach slope to the west, i.e. the position of the spillway and decant facilities. The western portion of the PKCA will remain primarily as a pond for final settling of TSS.

To limit ice entrainment and create as much sub-aerial beach as possible, there will be a seasonal deposition plans for winter and summer conditions. The two seasonal plans are summarized below.

Summer

Summer PK deposition will be undertaken concurrently from a number of deposition points (discharge location will be regularly moved) located on the East and Southeast embankments such that a beach is established and maintained between the impounded supernatant solution and the east and southeast dams. Due to the general valley gradient and the high fines content of the fine PK, the beach will limit seepage towards the East and Southeast Dams.

Winter

Winter deposition will be discharged closer to the water level to limit ice entrainments from single deposition points that are including point located on the northern eastern side of the facility. This will shorten the beach length and assist in limiting ice entrainment. The specific deposition location will be periodically rotated dependant on the build-up of fine PK and ice at the deposition points.

10.1.2 Beach Slopes

It is expected that the fine PK, as it is deposited, will form a beach that slopes away from the point of deposition. At Ekati Diamond Mine™, the average slope on beaches comprised of fine PK is 1.2% but the PK fines at Ekati Diamond Mine™ are finer than the PK fines at Jericho (D. Hayley, pers. comm.). It is likely, therefore, that the slope on the beaches at Jericho will be flatter than 1.2%. For design purposes, a slope of 0.5% has been assumed. The actual beach slope will depend on the supernatant pool size, fine PK particle size (it will vary as a function of distance from the deposition point), ice entrainment and operational management. The intention during operation is to maximize the beach slope to provide a beach between the supernatant pool and the non water retaining embankments, i.e. the fine PK will limit the movement of seepage towards the dams at the east end of the PKCA. In addition, the beach surface will facilitate proper drainage on the surface of the fine PK at closure.

10.1.3 Initial Deposition

Long Lake will be substantially dewatered prior to commencement of fine PK deposition in the PKCA. This will expose a topographical low at the east end of the lake (see the profile on Figure 5.1). The high ground at the west end of this topographical low will form a natural weir that will contain the initial discharge of fine PK and related supernatant solids in the eastern end of the PKCA basin while the West Dam is under construction.

As the fine PK fills the depression, an internal dyke will be constructed at the location of the natural weir or at the location of the divider dyke shown on Figure 5.1. The location will be selected based on factors such as access, the PKCA water level and the beach angle of the fine PK. The dyke will be raised periodically with mine waste rock to help contain the fine PK in the eastern third of the PKCA, thereby allowing the height of the east and southeast embankment structures to be increased using subaerial deposition procedures.

10.2 Operational Water Management

10.2.1 General

Supernatant water volumes will accumulate in the PKCA from diamond processing, spring watershed runoff and from direct precipitation within the PKCA. In addition, run-off water from the open pit, plant site, waste dump sites and possibly other areas will be pumped to the PKCA in the event that any of these waters do not meet discharge criteria. Excess water which accumulates in the PKCA will be managed by controlled release each summer to stream C3 depending on water quality.

Depending on total water inflows from other sources (pit and waste rock areas), the management of the water quantity within the PKCA will be adjusted accordingly. The intention is to maintain a PKCA water level which is approximately consistent with the current level in Long Lake. Water at this level will meet water reclaim needs and provide maximum flexibility to address extreme precipitation events and, potentially, any unexpected changes in water quality that would necessitate storage of the supernatant for a period of months.

The amount of water required to create a fine PK slurry will be minimized by the use of thickeners prior to discharge into the PKCA. Flocculant will be added in small doses to the thickeners, with thorough mixing occurring prior to discharge to the PKCA. As in the thickener operation, solids will rapidly settle in the PKCA upon discharge.

The results of freeze/thaw tests performed on the fine PK indicate that the suspended colloidal size particles provide accelerated solids settling characteristics. In addition, test results where flocculant was added also produced rapid settling of the fine PK. Therefore, we do not expect to have turbid water in the supernatant pool, apart from that caused by wind action, i.e. close to the eastern edge. It is expected that the wind turbidity would be controlled by the limiting the fetch with the fill structure of the mid-point in the PKCA.

The primary contingency, should the PKCA supernatant water not meet discharge criteria, would be to retain the water and not discharge for a season. This would allow natural factors such as dilutive precipitation and freeze/thaw effects to improve water quality for discharge in the following year. This would also allow Tahera to evaluate and test potential action plans that would be implemented the following season. The current design allows for the safe storage of 2 years of water inflows to the PKCA without discharging to the environment in the event that water quality becomes an issue preventing the regular discharge or water each year. Two years is expected to be ample time for Tahera to test, procure and install alternative treatment plans such as spray irrigation or water treatment (or further flocculation can be achieved on an in-line basis prior to discharge into the PKCA and/or the Settling Pond can be developed downstream of the West Dam, if necessary). Geochemical modeling indicates that while, under certain assumptions, water quality could become an issue, it is expected that operations will quickly demonstrate that water quality issues over an extended time period are unlikely to occur during the operational phase of the PKCA.

Further details on the site wide water management are provided in Technical Memorandum W (SRK and Clearwater 2004).

10.2.2 Reclaim

The water balance "base case" assumes that water will be recycled to the processing plant during the summer months and that excess water will be discharged from the PKCA. It should be noted that the PKCA has the capacity to maintain zero discharge for a two-year period, should the water quality not be acceptable for discharge.

The ability to recycle water depends primarily on the following two factors:

- Establishment of the actual plant operational water balance requirements
- The ability to maintain a pool that is deep enough to enable a pumping system to work through the winter when the much of the available water is "locked up" as ice.

It is expected that maintenance of the supernatant pool position on the western side of the PKCA, relatively free from settled PK material, will provide a clean and usable water source for reclaim operations and will provide additional storage time to assist in settling of any residual fine PK. However, in the event that TSS levels are too high, another option would be to construct an additional dyke between the divider dyke and the West Dam to help control TSS levels.

Discharge to Stream C3

The water balance "base case" assumes that excess water will be discharged from the PKCA annually during the summer months to Stream C3. Geochemistry data suggests that the PKCA water supernatant chemistry will be suitable for discharge to Lake C3 during operations and, as such, discharges are planned to commence in the first summer that the mine is in operation. All discharges will be in a controlled manner via a pump/pipe system, which will allow flow volumes to be monitored and chemistry to be sampled.

Release rates from the PKCA will follow the approximate shape of the natural hydrograph in the creek as shown in Table 10.1. The actual release rates will be slightly higher in July and August than indicated by the regional analysis.

Table 10.1: Annual Water Monthly Percentages Release Rates

	Monthly % of Annual Flow			
	Regional Analysis	Water Balance Model	Releases at	
			Point Where PKCA Discharges to Stream C3 (Downstream toe of West Dam)	Mouth of Stream C3
May	3%	4%	0%	1%
June	65%	56%	62%	61%
July	11%	15%	15%	15%
August	8%	17%	15%	16%
Sept	13%	8%	8%	7%

Flows out of the PKCA and associated lake systems have been evaluated to establish the baseline flows, i.e. pre-mining and then the likely operational flows, as shown in Table 10.2. These flows are based on the following scenarios that consider monthly averages and average precipitation conditions:

- Case A - Monthly flows, pre-mining, Stream C3 downstream of West Dam (55 ha area);
- Case B - Monthly flows, pre-mining, Stream C3 at the mouth (outlet to Lake C3) (100 ha);
- Case C - Monthly flows at the point where the PKCA discharges to Stream C3 (downstream toe of the West Dam), during operations (includes flows from Ponds A/B/C, PKCA, open pit, plant area, etc);
- Case D - Monthly flows at the mouth of Steam C3, during operations; and

- Case E - Monthly flows at the West Dam assuming no releases for two years, all excess water released in one year immediately following the second year of "no release" conditions (similar to case presented at NIRB Hearings but all excess releases over one year instead of two).

Table 10.2: Monthly Flows for Modeled Scenarios

	Monthly Flows (L/s)				
Scenarios	**A**	**B**	**C**	**D**	**E**
May	1.4	2.8	0.0	1.4	0.0
June	23.5	44.1	117.0	137.1	241.6
July	5.6	11.7	28.0	33.9	247.5
August	6.6	12.9	28.0	34.0	148.8
September	3.4	6.5	14.0	17.1	22.3

10.3 Extreme Event Management

It is expected that, during routine operation of the PKCA, the actual water level within the PKCA is likely to be significantly lower than the maximum operating elevation. Under these circumstances, water from peak storm events will be stored and then discharged via pumping and/or siphoning as part of routine discharge to Stream C3 during the summer.

Under extreme circumstances, the water level in the PKCA could be at or close to the spillway invert for a short period. The spillway invert elevation at 523 mamsl provides a passive system to discharge flows from the PKCA. During an extreme flood event, it is expected there will be sufficient dilution within the entire system to allow the supernatant water to be discharged directly through the spillway. The impoundment has a storage capacity of approximately 300,000 m^3 between the maximum operating elevation of 523 mamsl and the maximum storage elevation of 524 mamsl. The facility would therefore be able to store and attenuate the PMF event.

10.4 Monitoring

10.4.1 Dam Safety Monitoring

Inspections

During the operation of the PKCA, site staff will carry out daily inspections in relation to the performance and condition of the dams. Particular attention during these inspections will be given to the West Dam. Site staff will also inspect the spillway channel in advance of the freshet, so that any blockages or substantial ice accumulations in the spillway inlet area can be removed prior to the freshet.

A geotechnical or civil engineer registered in Nunavut will make an annual inspection of the PKCA facilities each summer. His report will summarize the results of his inspection and his review of the available monitoring data (described below). The report will be filed in a timely manner so that, if required, construction activity or modifications to these structures can be implemented prior to the next freshet.

Monitoring Stations

The monitoring stations for each of the dams are shown on Drawings 1CT004.006 – G14 and 1CT004.006 – 10. They include the following:

- East, Southeast and North Dams – Survey monuments to measure settlement and lateral movement; and

- West Dam – Thermistors and survey monuments.

Survey data from the survey monuments can be completed once every two months for the first year, unless there are signs of stress on the dams that would lead to more frequent surveys. The thermistors should be monitored monthly.

In addition, the volume occupation of the deposited fine PK should be evaluated on an annual basis to determine the dry density of the stored PK and the amount of ice entrainment. This is probably best done in late winter when access onto the PK surface is possible.

Data Recording and Analysis

Tahera will develop a system for recording and analysing their visual observations and monitoring data, and will assign the responsibility to appropriate personnel. This person will be responsible for completing and analysing the data, for maintaining written records and, where appropriate, for implementing corrective actions. The monitoring data will be reviewed as part of the annual inspection by the geotechnical or civil engineer.

10.4.2 Water Quality Monitoring

All inflows to and discharges from the PKCA will be monitored on a regular basis during mining operations to detect any significant deviations from the conditions assumed in the current water and load balance. Key locations in the internal site water monitoring network include:

- Temporary or permanent collection ditches or ponds A, B and C, which will be used as control structures to direct water to the pit sump or PKCA during operations
- The pit sump
- The process plant supernatant
- Treated sewage effluent

- PKCA pond water
- PKCA discharge water (this will be the controlling quality data to establish whether water is suitable for discharge from the PKCA)

During the first two years of operations, each of the above locations would be established as “routine monitoring stations” for measurement of flow and water quality. Sampling of the PKCA inflows would be on a monthly basis during the open water season (generally June to September). The PKCA pond and any inflows that continue through the winter months (i.e. the supernatant and the treated sewage) would continue to be monitored on a monthly basis during the winter. The PKCA discharge would be monitored on a weekly basis during the discharge period from June through September.

Samples would be submitted for a comprehensive suite of parameters, including pH, conductivity, ORP, temperature, major ions, acidity, alkalinity, metals and nutrients. Standard QA/QC procedures for water sampling including collection of field, travel and method blanks as well as duplicate samples will be included in the program.

The results of the routine monitoring results would be provided in an annual monitoring report.

Further details on the site monitoring program are provided in the Site Water Management (SRK Consulting and Clearwater Consulting, 2004).

11 Operations Manual

An Operations Manual will be prepared prior to the start of operations at the PKCA. The intent of the Operations Manual is to provide mine personnel with descriptions of the equipment, fine PK disposal, water management, equipment operation and maintenance and monitoring procedures for the PKCA. The following will comprise the main sections of the manual:

- Facility Description
- Fine PK Disposal Management Plan
- Supernatant Fluids Management Plan
- Pipeline Operation and Maintenance
  - Fine PK pipeline
  - Reclaim and discharge water pipeline
- Monitoring
  - Inspections
  - Volume Occupation
  - Water Balance
  - Freeboard
  - Seepage
  - Precipitation
  - Instrumentation
  - Discharges (Chemistry, volumes and TSS)
  - Monitoring Management Action
- Emergency Procedures

12 Failure Modes and Effects Analysis

12.1 General

A failure modes and effects analysis (FMEA) was completed for the PKCA. It involved a systematic evaluation of the scenarios that could lead to damage or, in an extreme case, failure of the West or North Dams at the PKCA. The analysis identified the potential failure modes, related trigger mechanisms, associated consequences and remedial and mitigative measures.

Remedial measures are defined as the actions taken in the event of observation of signs that the failure mode could be unfolding. Mitigative measures are the elements which have been incorporated of the design with the intention of minimizing or eliminating the possibility of such failures.

12.2 Results

The failure modes are presented for two phases of the PKCA life, namely operation and closure. The FMEA is summarized in Table 12.1.

It is not the intent of Table 12.1 to present details of the remedial or mitigative measures, but to signal that these have been considered in the design and/or will be covered in the Operations Manual and the Final Closure Design.

The FMEA results in Table 12.1 are directly applicable to the West Dam, since it is the main seepage control structure for the PKCA and is built with a frozen core and GCL. It is expected that water will be impounded against the West Dam over the entire life of mine, albeit at relatively low levels most of the time, except possibly for brief intervals during the spring or summer.

In the case of the North Dam, assuming that the water balance during the early stages of the PKCA operation requires the North Dam be constructed as a replacement to the initially constructed North Dam road access causeway, it is expected that water will be ponded against the North Dam for only relatively brief periods during extreme events. Furthermore, since the North Dam will be founded on bedrock, significant settlement of the foundation and slope failure related to either pore pressures or a weak foundation layer are not possible. There are, therefore, fewer failure modes associated with the North Dam than are listed in Table 12.1.

Table 12.1: Failure Modes and Effects Analysis

Potential Failure Mode	Trigger Event	Consequences	Remedial Measures	Mitigative Measures	Comments
Failure of the frozen core to perform from the outset	Inadequate saturation of ice core	Potential seepage	Install additional thermosyphons	Esker sand geotechnical specifications, handling and placement requirements, QA/QC and monitoring	Embankment has GCL for second level of seepage control.
Thawing of the frozen core	Presence of a talik that leads to heat transfer to the core	Settlement of the core and potential seepage	Install additional thermosyphons	Key-cut preparation and thermosyphon requirements, monitoring	Ice core is massive and should settlement occur, additional material could used to raise crest. Embankment has GCL for additional seepage control.
Thawing of the permafrost in the foundation or abutments	Seepage or an unexpected change in climate	Settlement and/or seepage	Install additional thermosyphons	Thermosyphons, monitoring	Would likely occur gradually over time
Failure of the GCL	Settlement	Potential seepage	Depends on the rate of seepage, but could lead to dam reconstruction	Monitoring	Based on ice content in the foundation, any settlement will be small. GCL is second level of containment
Slope failure (circular failure)	Inadequate strength along GCL/ice core interface	Dam breach	Toe buttress & raise or reconstruct the crest	Monitoring	Displacements will likely occur prior to failure
Slope failure (sliding/block failure)	Pore pressure and/or weak layer in the foundation	Dam breach	Toe buttress & raise or reconstruct the crest	Monitoring	Displacements will likely occur prior to failure
Overtopping failure	Water retained coupled with major storm event or freshet	Dam breach	Re-construct	Spillway and additional freeboard provided by 3 m ice core insulation material	Freeboard additional to 1 m designed operational freeboard
Erosion of West Dam upstream slope	Wave action	Dam breach	Re-construct	Material specification, i.e. run-of mine waste rock for shell	Construction material available at all times

The East and Southeast Dams will be used as discharge points for the deposition of the fine PK. Except possibly during extreme conditions that would persist for a very short time, the supernatant will be situated well away from these dams. As is the case with all tailings dams, the risk of failure in relation to both seepage and dam breaches is significantly reduced when the ponded supernatant is situated away from the dam. Based on location of the supernatant pond and the differences in the design of these two dams compared to the West Dam, much of Table 12.1 is not directly applicable to the East and Southeast Dams.

13 PKCA Closure Methodology

The PKCA closure plan is described in the Abandonment and Restoration Plan (AMEC 2004). A summary of that plan is provided below.

The main closure components include:

- Developing the final fine PK surface to provide natural drainage;
- Dewatering of the residual western portion of the PKCA;
- Developing a low level outlet through or adjacent to the West Dam;
- Placing a cover to prevent dusting and major erosion; and
- Revegetating, to the extent practical.

13.1 Final PK Surface

During the PKCA operation, deposition will proceed generally from east to west. The PK surface will drain to the western portion of the PKCA and, at closure, an exposed beach will exist at the eastern portion of the PKCA. The expected final surface of the PK is shown as a series of contour lines on Drawing 1CT004.06 – G15.

In addition, a relatively small quantity of fine PK will be present on the floor and sides of the western portion of the PKCA, downstream of the divider dyke. The distribution and thickness of the fine PK will depend on the actual operating history of the facility, particularly in relation to water management. At a minimum, however, a coating of fine PK associated with settling of the suspended solids will be present over the vast majority of the western portion of the PKCA.

13.2 Dewatering

At closure, the ponded supernatant in the western end of the PKCA will be pumped and/or siphoned to Stream C3. To the extent that this water does not meet discharge criteria, it will be treated prior to discharge.

In order to minimise or eliminate the subsequent water storage capacity of the PKCA, the discharge elevation will be lowered by either breaching the West Dam or deepening the spillway. The final discharge elevation will be determined as part of the preparation of the final closure design based on the expectation that a shallow body of water will remain at the western end of the PKCA. The West Dam will, therefore, no longer perform or be classified as a dam. The discharge elevation will be set so that fine PK present on the floor and sides of the western portion of the PKCA, and any sediment associated with the cover, do not wash downstream. Thereafter, the natural watershed volumes are expected to once again flow into Stream C3.

13.3 Cover

The final surface of the fine PK will be covered by a layer of coarse PK to reduce the dusting and erosion potential of the fine PK. The coarse PK will be taken from the stockpile adjacent to the east end of the PKCA. The proposed cover methodology at this time is based on the following:

- A 0.3 to 0.5 m layer of coarse PK from the coarse PK stockpile will be spread over the surface of the fine PK (geotextile is unlikely to be needed as a separator between the fine PK and the cover material); and
- The coarse kimberlite may be top dressed with up to 0.3 m of overburden from the overburden stockpile or run-of-mine waste rock from one of the waste rock dumps.

These activities will occur in either winter or summer, depending on the driving conditions on the PKCA surface, but current expectations are that most of this work will have to be done in winter when the fine PK is sufficiently frozen to permit vehicle access. There may be opportunities to attempt trafficability trials over select areas of the impoundment during operations.

13.4 Revegetation

Once the coarse kimberlite buffer has been placed over the fine PK, one of three revegetation scenarios will follow:

- If vegetation trials indicate vegetation can be successfully established on the coarse kimberlite, finished areas will be revegetated. Ekati Diamond Mine™ has had some success at planting directly onto dried fine kimberlite in the mine’s PKC and, pursuant to further favourable results, PKCA beaches at Jericho will be treated the same way, i.e., by direct planting on the dry beaches. In 2004 there was some question about the long-term suitability of PK as a growth medium.
- If vegetation trials indicate overburden promotes successful revegetation, areas will be top dressed with up to 0.3 m of overburden from the overburden stockpile. This will occur in either winter or summer, depending on the driving conditions on the cell.
- If vegetation cannot be demonstrated to establish successfully, PKCA finished areas will be covered with coarse kimberlite and run-of-mine rock to retard erosion and to provide perching areas for rodents and birds.
- Revegetation, as indicated from reclamation trials, will take place either in the spring or fall, depending on timing of completion of the overburden placement.

13.5 Monitoring

The PKCA and its spillway will be inspected at closure by a qualified geotechnical engineer in order to assess physical stability in the context of the closure requirements. Recommendations as regards for further inspections, if warranted, would be identified at that time.

Runoff from the reclaimed PKCA will continue to be monitored on a regular basis for the first few years following closure, or until it can be demonstrated that the runoff meets appropriate criteria.

It is anticipated that, since the fine PK will be deposited using primarily the subaerial method, much of the fine PK (perhaps most of it) will be frozen at closure. Over time, given the local climate, permafrost will likely aggrade within any unfrozen zones, although an active layer will be present within the cover and top of the fine PK deposit. During this period, the possibility exists that freeze-back from the top of the deposit could trap unfrozen pore water, raising pore water pressure to the point where it is expelled to the surface. A better understanding of the probable porewater quality can be obtained during operations. However, based on the fine gradation of the fine PK, the expulsion of porewater, should it occur, is likely to involve very small volumes of water. The impact on the quality of water leaving the PKCA, based on natural dilution, is likely to be negligible. Regardless, this potential issue will addressed by the monitoring of runoff from the PK, as noted above.

Further details of the post-closure monitoring plan for the PKCA will be provided in the final closure plan for the site.

Post abandonment monitoring will be continued until Nunavut Water Board agrees to cessation.

14 References

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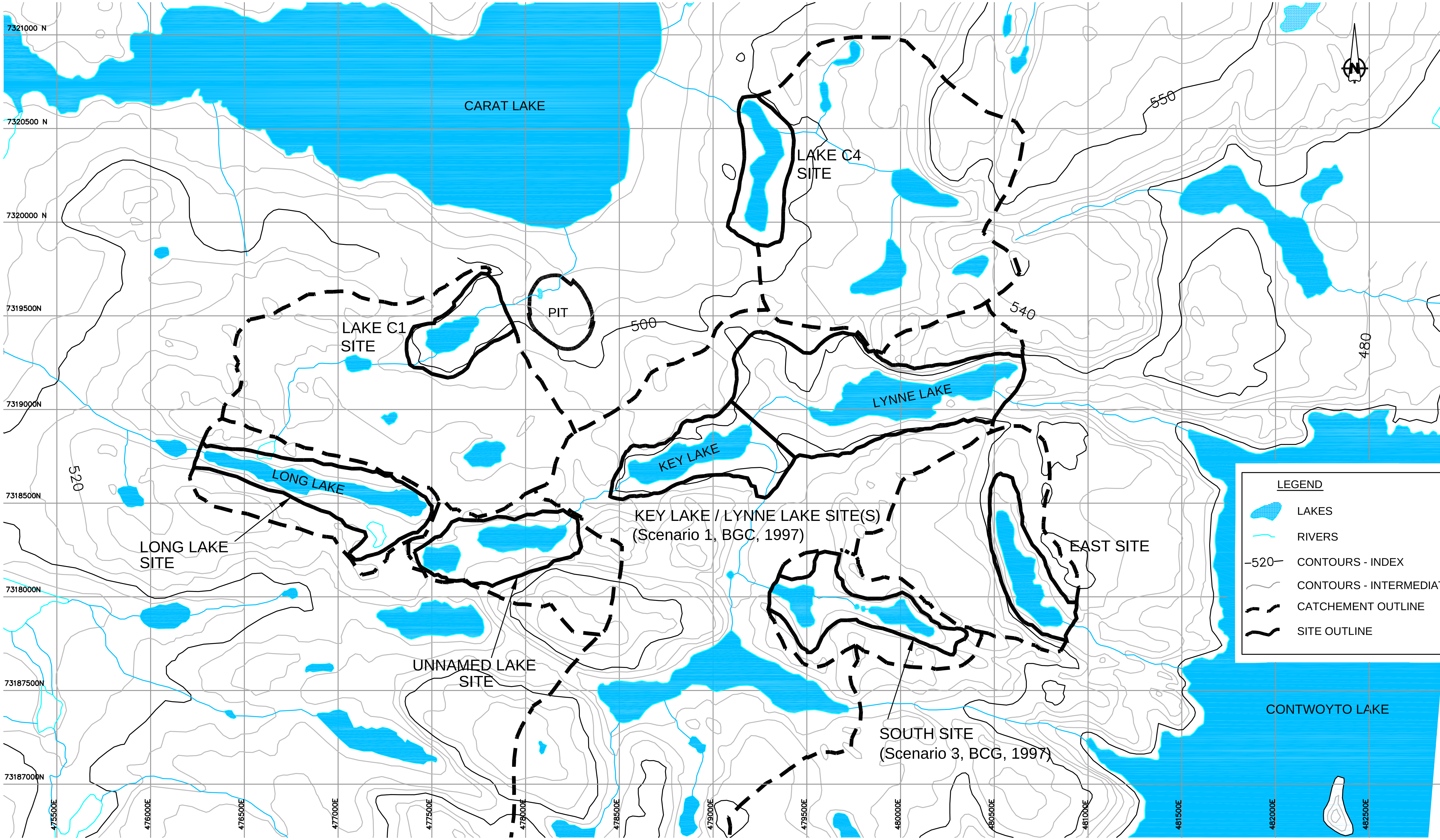
Figures



TAHERA CORPORATION
JERICHO LAKE PROJECT

Date of Photography: August 5, 1995.
Scale of Photography: 1:10 000

Survey control based on: UTM Projection, NAD 27, Zone 12
Compiled by The ORTHOSHOP, Calgary, October 1995.

0 100 200 300 400 500 METRES
1:10,000

SRK Consulting
Engineers and Scientists

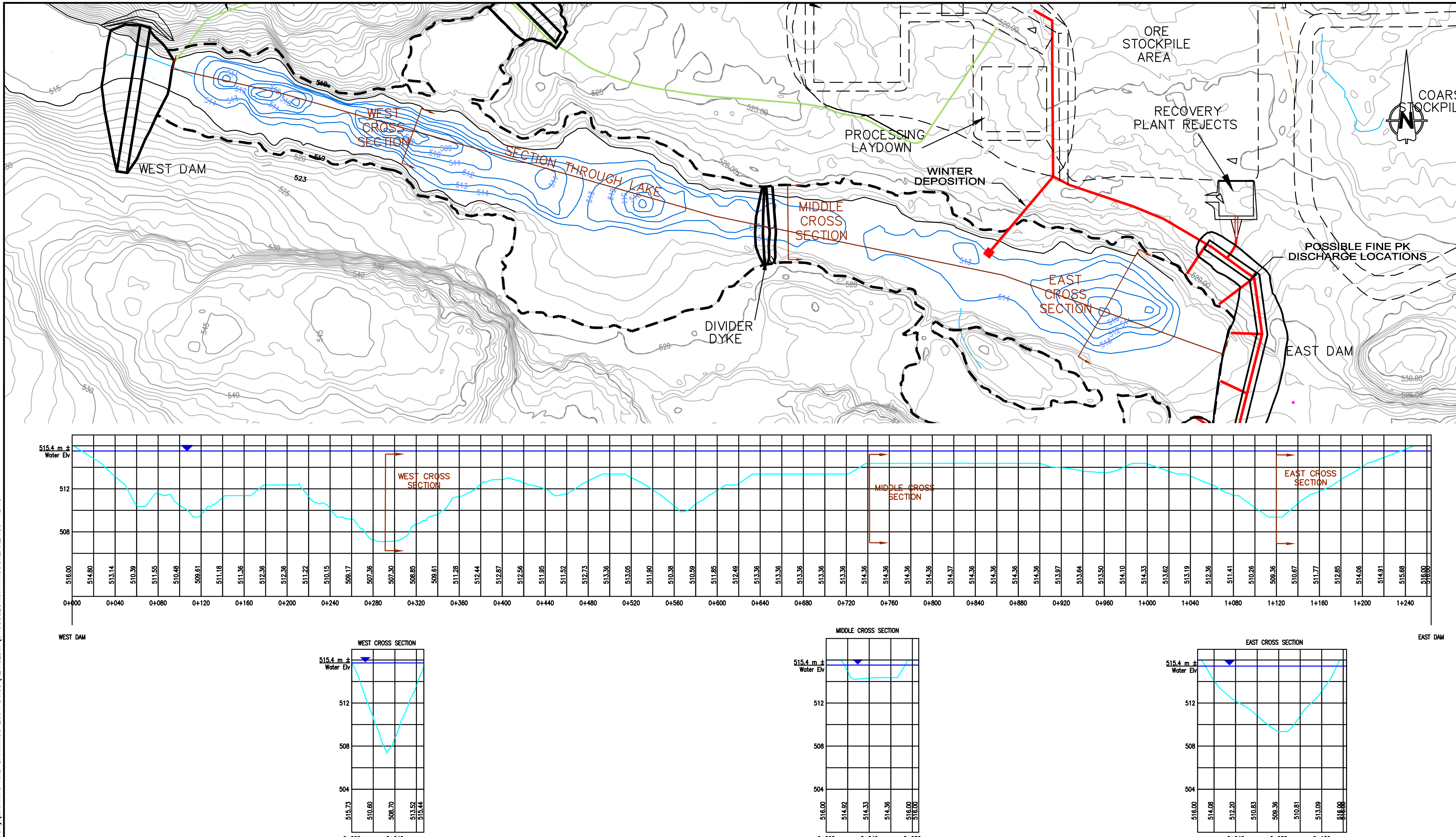
Tahera
Diamond Corporation

JERICHO PROJECT

ALTERNATIVE SITES FOR FINE DISPOSAL

PROJECT NO.	DATE	APPROVED	FIGURE
1CT004.06	AUG 2004	CCS	4.1

File Ref: F:\TAHERA CORP (LYTTON)\MAPPING AND DRAWINGS 2004 DWGS\REVISED...\FIGURE4-1.DWG



NOTE: 10x VERTICAL EXAGGERATION ON ALL SECTIONS

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Tahera Diamond Corporation

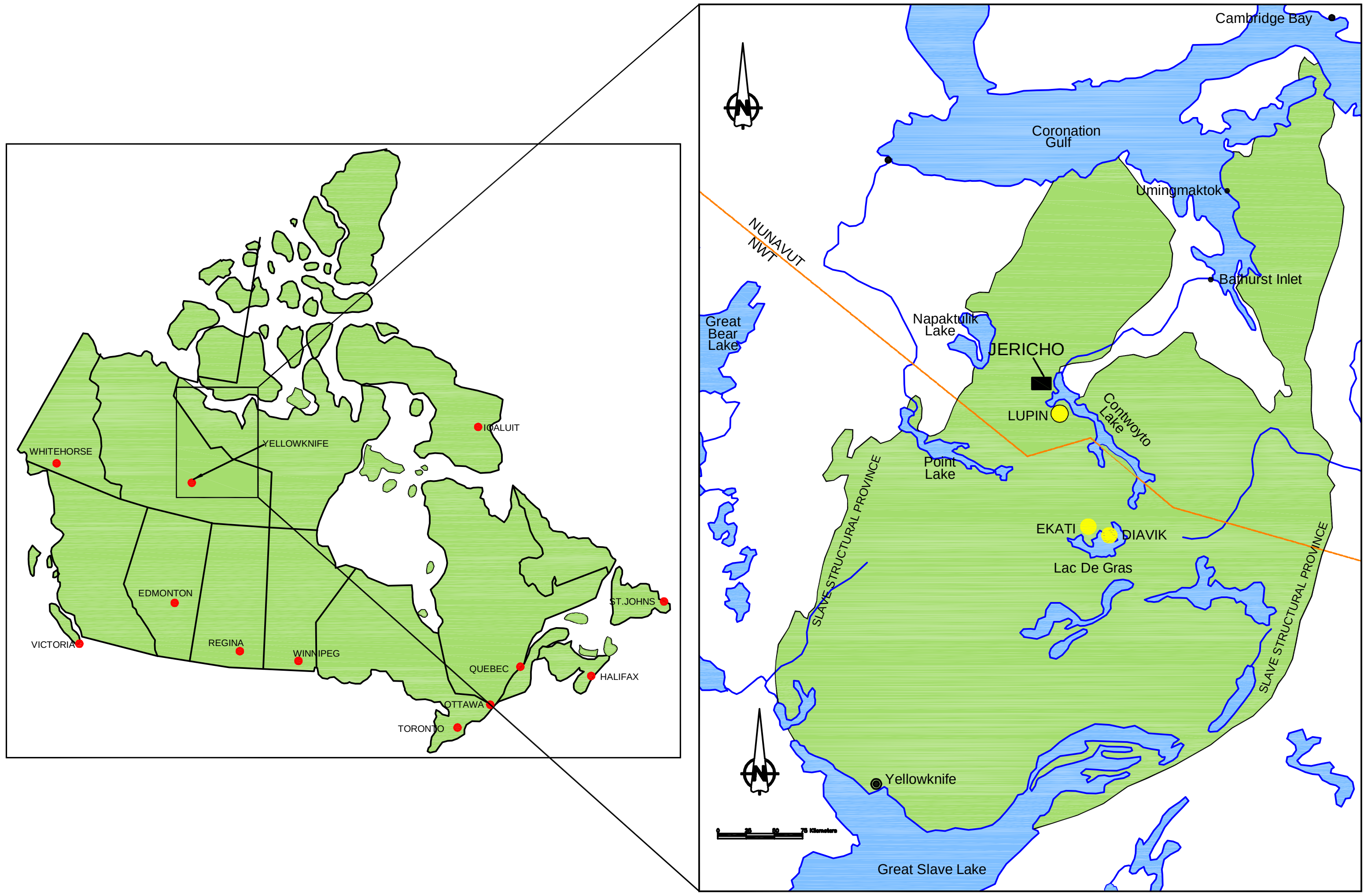
JERICHO PROJECT

CROSS SECTIONS THROUGH LONG LAKE

PROJECT NO.	DATE	APPROVED	FIGURE
1CT004.06	AUG 2004	CCS	5.1

File Ref: F:\TAHERA CORP (LYTTON)\MAPPING AND DRAWINGS 2004 DWGS\REVISED...\CROSSSECTIONTHROUGHLAKEFIG5-1.DWG

Drawings



REGIONAL LOCATION

DRAWING INDEX:

GENERAL

1CT004.06-G-1:	PROJECT LOCATION AND DRAWING INDEX
1CT004.06-G-2:	SITE VICINITY MAP
1CT004.06-G-3:	SITE INVESTIGATION MAP
1CT004.06-G-4:	EXISTING THERMISTOR INSTALLATIONS
1CT004.06-G-5:	QUATERNARY GEOLOGY OF THE JERICHO PROJECT AREA
1CT004.06-G-6:	BEDROCK GEOLOGY OF THE JERICHO PROJECT AREA
1CT004.06-G-7:	TERRAIN EVALUATION MAP
1CT004.06-G-8:	BORROW AREAS - PLAN AND TYPICAL SECTION
1CT004.06-G-9:	AMMONIUM NITRATE STORAGE AND EMULSION PLANT LAYOUTS
1CT004.06-G-10:	GENERAL ARRANGEMENT AT END OF APRIL 2006
1CT004.06-G-11:	GENERAL ARRANGEMENT AT END OF APRIL 2007
1CT004.06-G-12:	GENERAL ARRANGEMENT AT END OF APRIL 2008
1CT004.06-G-13:	GENERAL ARRANGEMENT AT END OF DECEMBER 2014
1CT004.06-G-14:	SITE MONITORING STATION LOCATIONS
1CT004.06-G-15:	CLOSURE CONCEPTS

MINE WASTE DUMPS AND STOCKPILES

1CT004.06-M-1:	LAYOUT OF WASTE DUMPS AND STOCKPILES
1CT004.06-M-2:	SITE INVESTIGATION AND TERRAIN MAP
1CT004.06-M-3	WASTE DUMPS 1 AND 2, LOW GRADE STOCKPILE AND COARSE PK STOCKPILE CROSS SECTIONS AND DETAILS
1CT004.06-M-4:	RECOVERY PLANT REJECTS PLAN AND SECTIONS
1CT004.06-M-5:	SCHEMATIC OF WASTE DUMP 1 CONSTRUCTION SEQUENCE

PKCA

1CT004.06-P-1:	LAYOUT OF THE PKCA INCLUDING HEIGHT CAPACITY CURVES
1CT004.06-P-2:	SITE INVESTIGATION AND TERRAIN MAP
1CT004.06-P-3:	WEST DAM PLAN AND GEOLOGIC SECTIONS
1CT004.06-P-4:	NORTH DAM PLAN AND GEOLOGIC SECTIONS
1CT004.06-P-5:	EAST DAM PLAN AND GEOLOGIC SECTIONS
1CT004.06-P-6:	SOUTHEAST DAM PLAN AND GEOLOGIC SECTIONS
1CT004.06-P-7:	TYPICAL DAM CROSS SECTIONS AND DETAILS
1CT004.06-P-8:	WEST DAM SPILLWAY AND THERMOSYPHON SECTIONS AND DETAILS
1CT004.06-P-9:	PKCA CONSTRUCTION SEQUENCE
1CT004.06-P-10:	PKCA MONITORING PLAN SECTIONS AND DETAILS
1CT004.06-P-11:	PIPELINE PLAN AND PROFILES

WATER MANAGEMENT FACILITIES

1CT004.06-W-1:	LAYOUT OF WATER MANAGEMENT FACILITIES
1CT004.06-W-2:	C1 DIVERSION PLAN AND CROSS SECTIONS
1CT004.06-W-3:	C1 DIVERSION DETAILS
1CT004.06-W4:	PRELIMINARY LAYOUT OF POND A CROSS SECTIONS AND DETAILS
1CT004.06-W-5:	PRELIMINARY LAYOUTS OF PONDS B AND C CROSS SECTIONS AND DETAILS
1CT004.06-W6:	PRELIMINARY LAYOUT OF CAUSEWAY SECTIONS AND DETAILS

DRAWING NO.	DRAWING TITLE	NO.	DESCRIPTION	CHK'D	APP'D	DATE	REV.	ISSUE PURPOSE	AUTH. BY	DATE
							A	WATER LICENSE APPLICATION	CSS	JULY 2004

REFERENCE DRAWINGS | REVISIONS | ISSUE AUTHORIZATION

WATER LICENSE APPLICATION

SRK Consulting
Engineers and Scientists

DESIGNED BY: DL	DRAWN BY: JM
DATE: JULY 2004	DATE: JULY 2004
CHECKED BY: CCS	DISCIP. ENGR.
DATE: JULY 2004	DATE:
PROJ. MGR:	PROJ. ENGR.
DATE	DATE

SRK PROJECT NUMBER: 1CT004.06

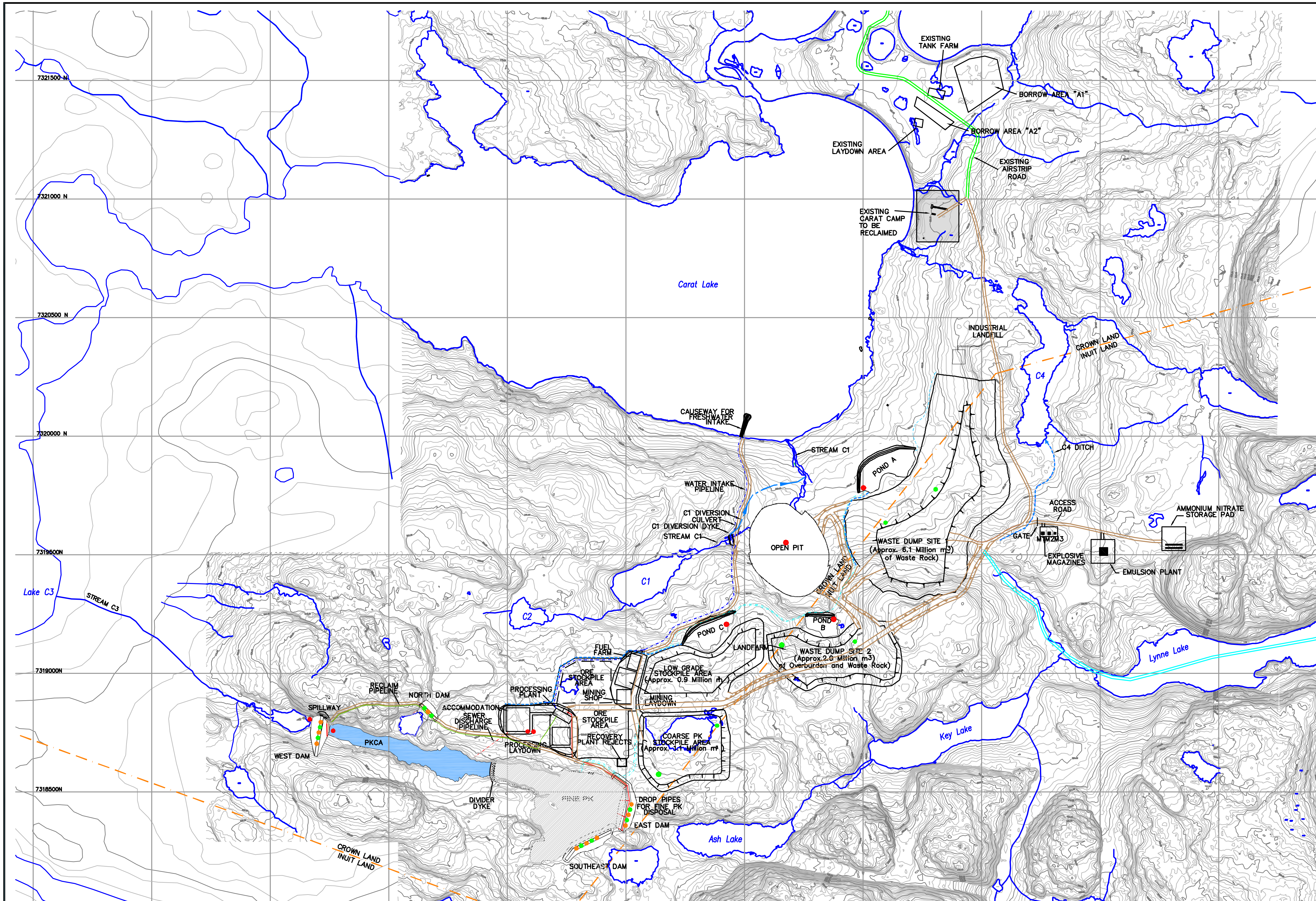
Tahera Diamond Corporation

JERICHO PROJECT

PROJECT LOCATION AND DRAWING INDEX

DRAWING NUMBER: 1CT004.06–G1

REV.: A



LEGEND

- EXISTING ROAD
- EXISTING ROAD (APPROXIMATE LOCATION)
- ROAD REQUIRED BY YEAR 7
- WINTER ROAD
- FRESH WATER PIPELINE
- MINE WATER PIPELINE
- FINE PK DISCHARGE PIPELINE
- RECLAIM PIPELINE
- SEWER PIPELINE
- PKCA DISCHARGE PIPELINE
- DITCH
- WATER QUALITY MONITORING STATION
- THERMISTOR STATION (EXACT LOCATION YET TO BE DETERMINED)
- SURVEY MONUMENT

NOTES:

1. LAYOUTS ARE APPROXIMATE AND MAY NOT REFLECT ACTUAL SIZE AND FOOTPRINT LOCATIONS

TAHERA CORPORATION
JERICHO LAKE SOUTHWEST EXTENSION

Date of Photography: August 5, 1995.
Scale of Photography: 1:10 000
Survey control supplied by: Canamera Geological Ltd.
Survey control based on: UTM Projection, NAD 27, Zone 12
Compiled by The ORTHOSHOP, Calgary, October 1995.
WO 7423

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1:8000

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
DRAWING G-9	AMMONIUM NITRATE STORAGE LAYOUT		
DRAWING G-8	BORROW AREAS PLAN & SECTION		
DRAWING G-7	TERRAIN EVALUATION MAP		
DRAWING G-6	BEDROCK GEOLOGY MAP		
DRAWING G-5	QUATERNARY GEOLOGY MAP	DRAWING G-15	CLOSURE CONCEPTS
DRAWING G-4	EXISTING THERMISTOR INSTALLATION PLAN	DRAWING G-13	GENERAL ARRANGEMENTS DEC 2014
DRAWING G-3	SITE INVESTIGATION MAP	DRAWING G-12	GENERAL ARRANGEMENT APRIL 2008
DRAWING G-2	SITE VICINITY MAP	DRAWING G-11	GENERAL ARRANGEMENT APRIL 2007
DRAWING G-1	PROJECT LOCATION AND DRAWING INDEX	DRAWING G-10	GENERAL ARRANGEMENT APRIL 2006

REFERENCE DRAWINGS

No.	DESCRIPTION	CHK'D	APP'D	DATE

REVISIONS

REV.	ISSUE PURPOSE	AUTH.	BY	DATE
A	WATER LICENSE APPLICATION	CCS		JULY 2004

ISSUE AUTHORIZATION

WATER LICENSE APPLICATION

SRK Consulting
Engineers and Scientists

DESIGNED BY: CCS DATE: JULY 2004	DRAWN BY: JM DATE: JULY 2004
CHECKED BY: CCS DATE: JULY 2004	DISCIP. ENGR. DATE:
PROJ. MGR: DATE	PROJ. ENGR. DATE
SRK PROJECT NUMBER: 1CT004.06	

Tahera Diamond Corporation

JERICHO PROJECT

SITE MONITORING STATION LOCATIONS

DRAWING NUMBER
1CT004.06 – G14

REV.
A

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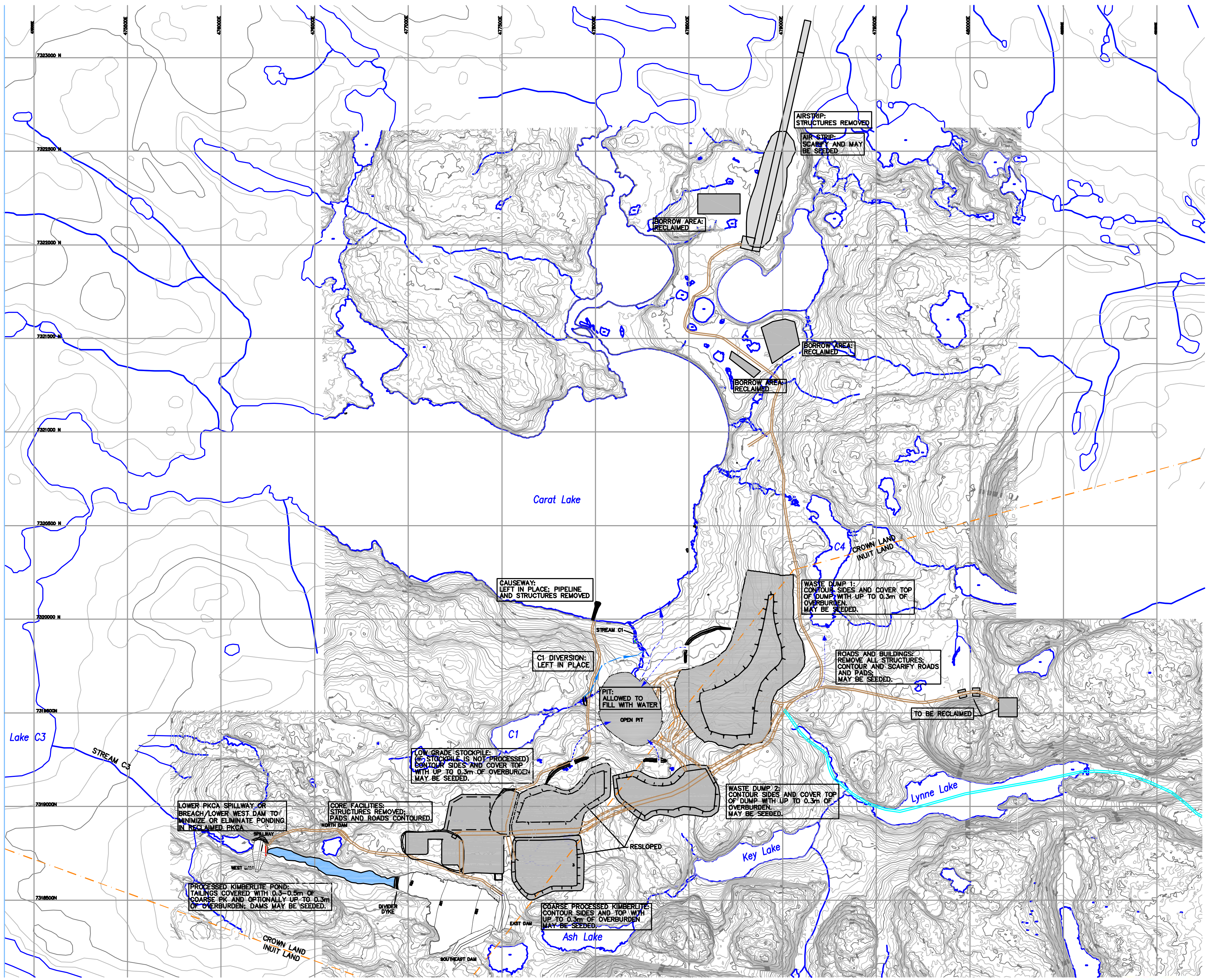

N

LEGEND

- ROAD AT CLOSURE
- WINTER ROAD
- FRESH WATER PIPELINE

NOTES ON CLOSURE ACTIVITIES:

1. BREACH DYKES AT PONDS A, B AND C. DIVERT RUNOFF TO OPEN PIT.
2. OPEN PIT TO TAKE UP TO 19 YEARS TO FILL, BUT OPTIONS EXIST TO FILL IT QUICKER.
3. AFTER OPEN PIT FILLS: OVERFLOW TO DISCHARGE INTO STREAM C1 OR INTO CONSTRUCTED CHANNEL DISCHARGING ALONG EAST SHORE OF CARAT LAKE. (LOCATION SHOWN IS CONCEPTUAL ONLY)
4. LOWER PKCA SPILLWAY OR BREACH/LOWER WEST DAM TO MINIMIZE OR ELIMINATE PONDING IN RECLAIMED PKCA.

TAHERA CORPORATION
JERICHO LAKE SOUTHWEST EXTENSION

Date of Photography: August 5, 1995.
Scale of Photography: 1:10 000
Survey control supplied by: Canamera Geological Ltd.
Survey control based on: UTM Projection, NAD 27, Zone 12
Compiled by The ORTHOSHOP, Calgary, October 1995.
WO 7423

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DRAWING NO.	DRAWING TITLE	DRAWING NO.	
DRAWING G-9	AMMONIUM NITRATE STORAGE LAYOUT		
DRAWING G-8	BORROW AREAS PLAN & SECTION		
DRAWING G-7	TERRAIN EVALUATION MAP		
DRAWING G-6	BEDROCK GEOLOGY MAP		
DRAWING G-5	QUATERNARY GEOLOGY MAP		
DRAWING G-4	EXISTING THERMISTOR INSTALLATION PLAN	DRAWING G-13	GENERAL ARRANGEMENT APRIL 2013
DRAWING G-3	SITE INVESTIGATION MAP	DRAWING G-12	GENERAL ARRANGEMENT APRIL 2008
DRAWING G-2	SITE VICINITY MAP	DRAWING G-11	GENERAL ARRANGEMENT APRIL 2007
DRAWING G-1	PROJECT LOCATION AND DRAWING INDEX	DRAWING G-10	GENERAL ARRANGEMENT APRIL 2006

REFERENCE DRAWINGS

No.	DESCRIPTION	CHK'D	APP'D	DATE

REVISIONS

REV.	ISSUE PURPOSE	AUTH. BY	DATE
A	WATER LICENSE APPLICATION	CCS	JULY 2004

ISSUE AUTHORIZATION

WATER LICENSE APPLICATION

SRK Consulting
Engineers and Scientists

DESIGNED BY: CCS	DRAWN BY: JM
DATE: JULY 2004	DATE: JULY. 2004
CHECKED BY: CCS	DISCIP. ENGR.
DATE: JULY 2004	DATE:
PROJ. MGR:	PROJ. ENGR.
DATE	DATE

SRK PROJECT NUMBER: 1CT004.06

Tahera Diamond Corporation

JERICHO PROJECT

CLOSURE CONCEPTS

DRAWING NUMBER: 1CT004.06 – G15

REV. A

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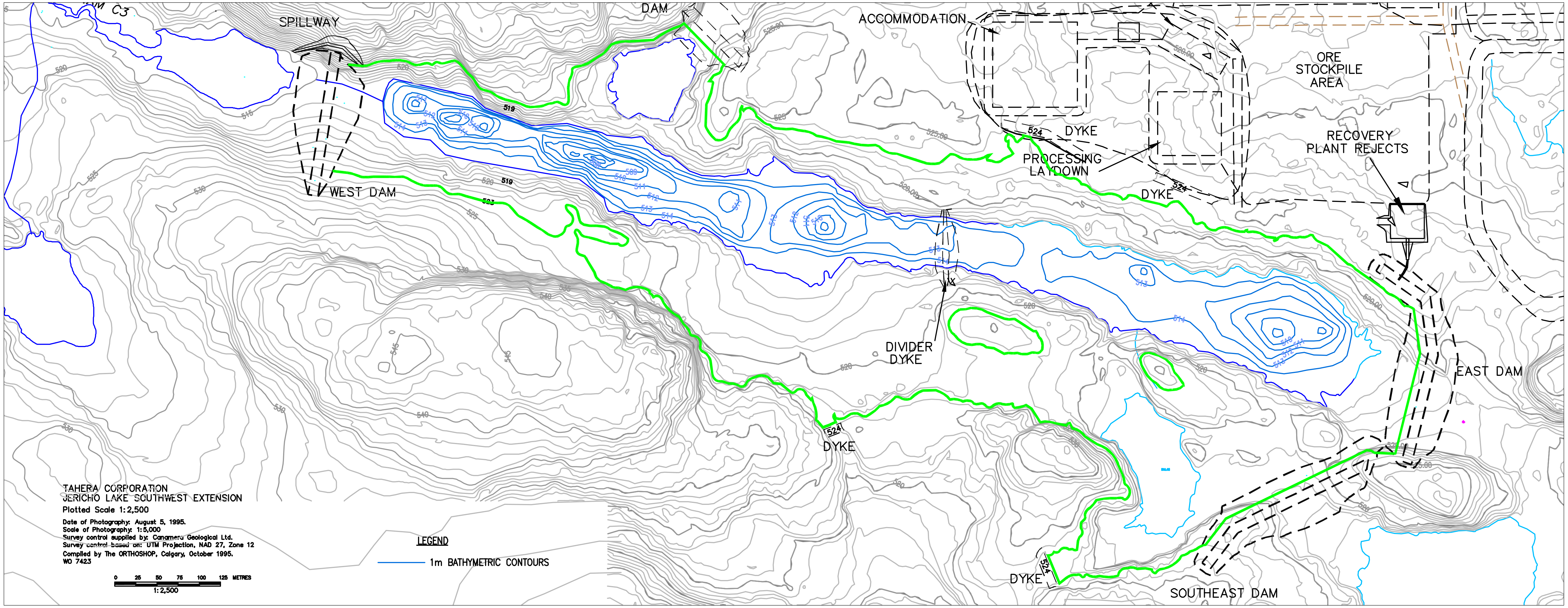
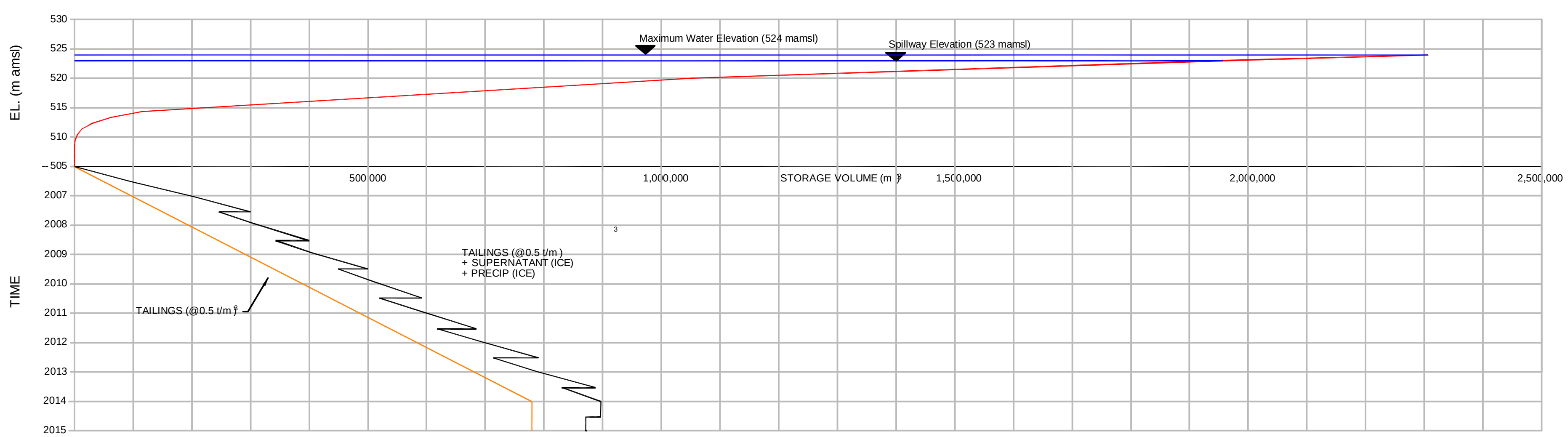
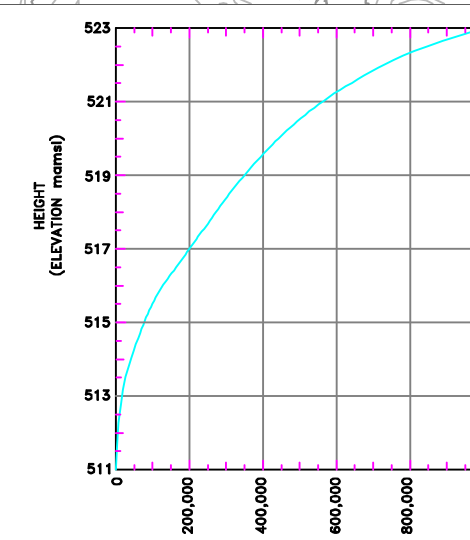
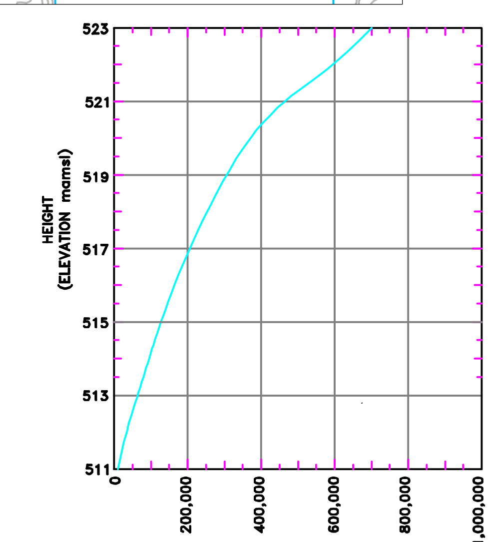




HEIGHT – CAPACITY CURVE FOR ENTIRE PKCA.



HEIGHT – CAPACITY CURVE
(POND AREA – WEST OF DIVIDER DYKE)



HEIGHT – CAPACITY CURVE
(FINE PK – EAST OF DIVIDER DYKE)

NOTE: THE HEIGHT – CAPACITY CURVES SHOWN HERE ASSUME THE TAILINGS ARE "STRUCK-LEVEL".

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
DRAWING P-8	PKCA SPILLWAY AND THERMOSYPHON SECTIONS AND DETAILS		
DRAWING P-7	TYPICAL DAM CROSS SECTION AND DETAILS		
DRAWING P-6	SOUTHEAST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-5	EAST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-4	NORTH DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-3	WEST DAM GEOLOGIC CROSS SECTIONS	DRAWING P-11	PIPLINE PLAN AND LONG SECTION
DRAWING P-2	SITE INVESTIGATION AND TERRAIN MAP	DRAWING P-10	PKCA MONITORING PLAN AND SECTIONS
		DRAWING P-9	CONSTRUCTION SEQUENCE

REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE

REVISIONS

REV.	ISSUE PURPOSE	AUTH. BY		DATE
A	WATER LICENSE APPLICATION	DL		JUNE 2004

ISSUE AUTHORIZATION

WATER LICENSE APPLICATION

SRK Consulting
Engineers and Scientists

DESIGNED BY: DL	DRAWN BY: JM
DATE: APRIL 2004	DATE: MAR. 2004
CHECKED BY: CCS	DISCIP. ENGR.
DATE: APRIL 2004	DATE:
PROJ. MGR:	PROJ. ENGR.
DATE	DATE

SRK PROJECT NUMBER:
1CT004.06

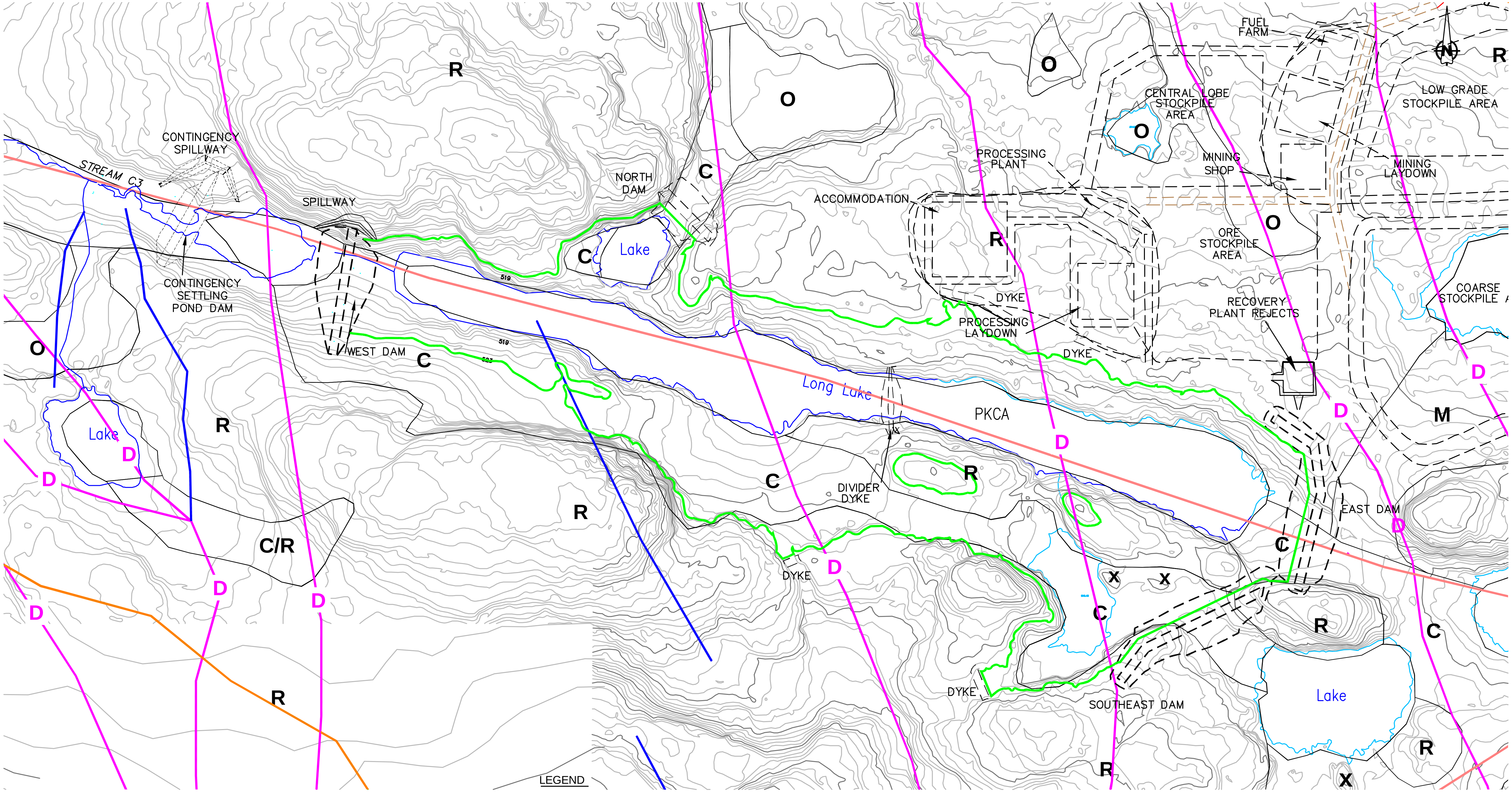
Tahera
Diamond Corporation

JERICHO PROJECT

LAYOUT OF THE PKCA INCLUDING HEIGHT–CAPACITY CURVES

DRAWING NUMBER
1CT004.06 – P1

REV.
A



LEGEND

Quaternary Holocene Deposits
- A River and creek deposits.
- C Colluvium.
- O Organic deposits.

Quaternary Pleistocene Deposits
- F^G Fluvioglacial sediment.
- M Till. Silt, sand, gravel, cobbles and boulders.

Pre-Cambrian Bedrock
- R Undifferentiated metamorphic and volcanic bedrock.

- Major Linear Fault
- EW Oriented Amphibolite Dykes
- -D- NNW Oriented Diabase Dykes (Mackenzie)
- Less Magnetic Dykes with Variable Orientation

TAHERA CORPORATION
JERICHO LAKE SOUTHWEST EXTENSION
Plotted Scale 1:2,500

Date of Photography: August 5, 1995.
Scale of Photography: 1:5,000
Survey control supplied by: Canamera Geological Ltd.
Survey control based on: UTM Projection, NAD 27, Zone 12
Compiled by The ORTHOSHOP, Calgary, October 1995.
WO 7423

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1:2,500

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
DRAWING P-9	CONSTRUCTION SEQUENCE		
DRAWING P-8	PKCA SPILLWAY AND THERMOSYPHON SECTIONS AND DETAILS		
DRAWING P-7	TYPICAL DAM CROSS SECTION AND DETAILS		
DRAWING P-6	SOUTHEAST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-5	EAST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-4	NORTH DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-3	WEST DAM GEOLOGIC CROSS SECTIONS	DRAWING P-11	PIPELINE PLAN AND LONG SECTION
DRAWING P-1	LAYOUT OF THE PKCA	DRAWING P-10	PKCA MONITORING PLAN AND SECTIONS

REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE

REVISIONS

REV.	ISSUE PURPOSE	AUTH. BY	DATE
A	WATER LICENSE APPLICATION	DL	JULY 2003

ISSUE AUTHORIZATION

WATER LICENSE APPLICATION

SRK Consulting
Engineers and Scientists

DESIGNED BY: DL	DRAWN BY: JM
DATE: JULY 2004	DATE: JULY 2004
CHECKED BY: CCS	DISCIP. ENGR.
DATE: JULY 2004	DATE:
PROJ. MGR:	PROJ. ENGR.
DATE	DATE
SRK PROJECT NUMBER: 1CT004.06	

Tahera Diamond Corporation

JERICHO PROJECT

SURFICIAL GEOLOGY AND TERRAIN MAP

DRAWING NUMBER
1CT004.06 – P2

REV.
A

FILE NAME: F:\Tahera Corp (Lytton minerals)\Mapping and Drawings-2004 dwgs\REVISED...\figure-P1,P2,P9.DWG

TAHERA CORPORATION
JERICHO LAKE SOUTHWEST EXTENSION
Plotted Scale 1:2000

Date of Photography: August 5, 1995.
Scale of Photography: 1:2000
Survey control supplied by: Canamera Geological Ltd.
Survey control based on: UTM Projection, NAD 27, Zone 12
Compiled by The ORTHOSHOP, Calgary, October 1995.
WO 7423

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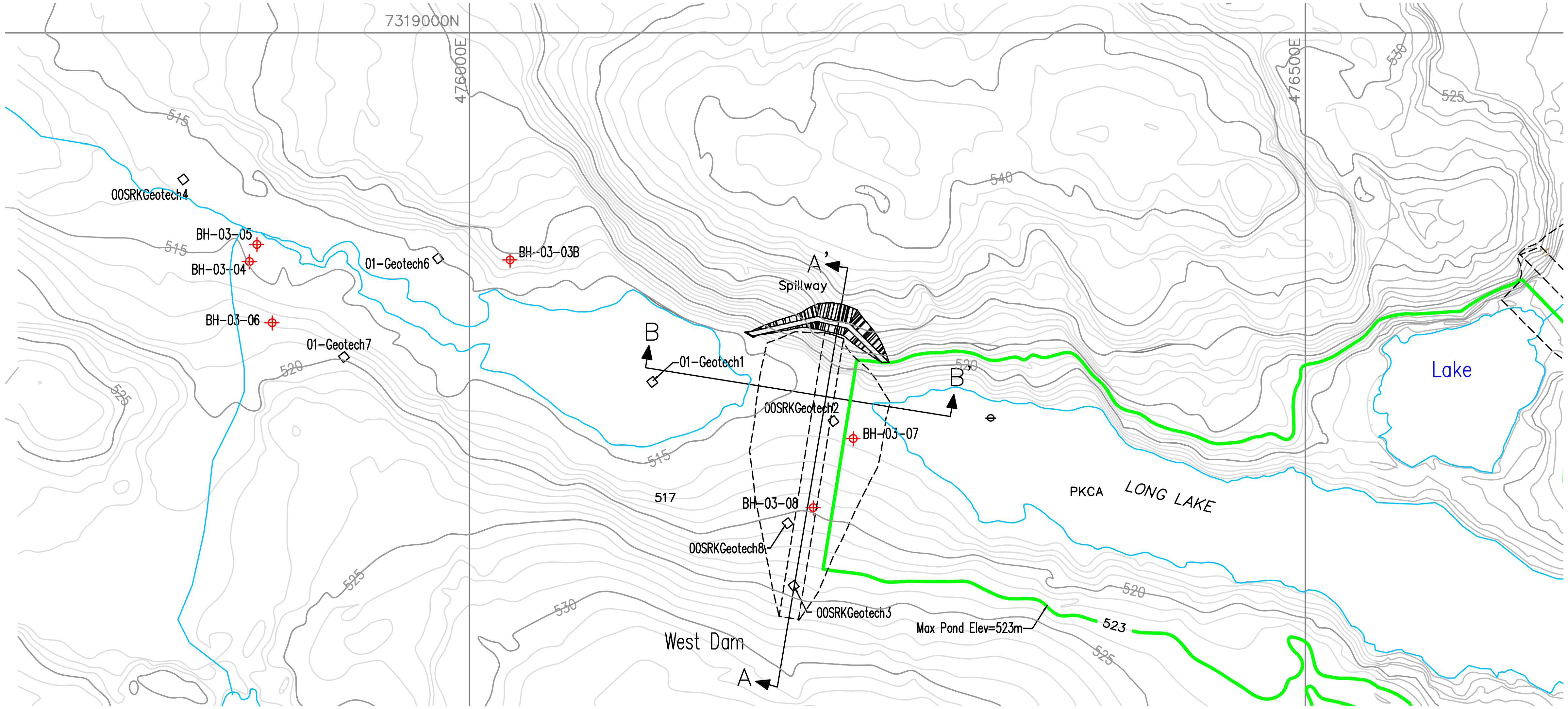

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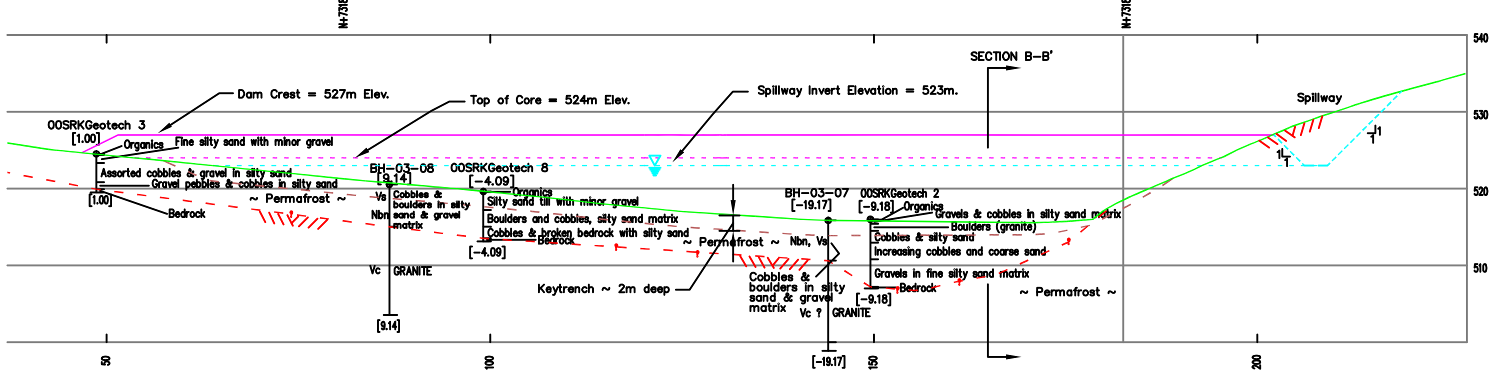

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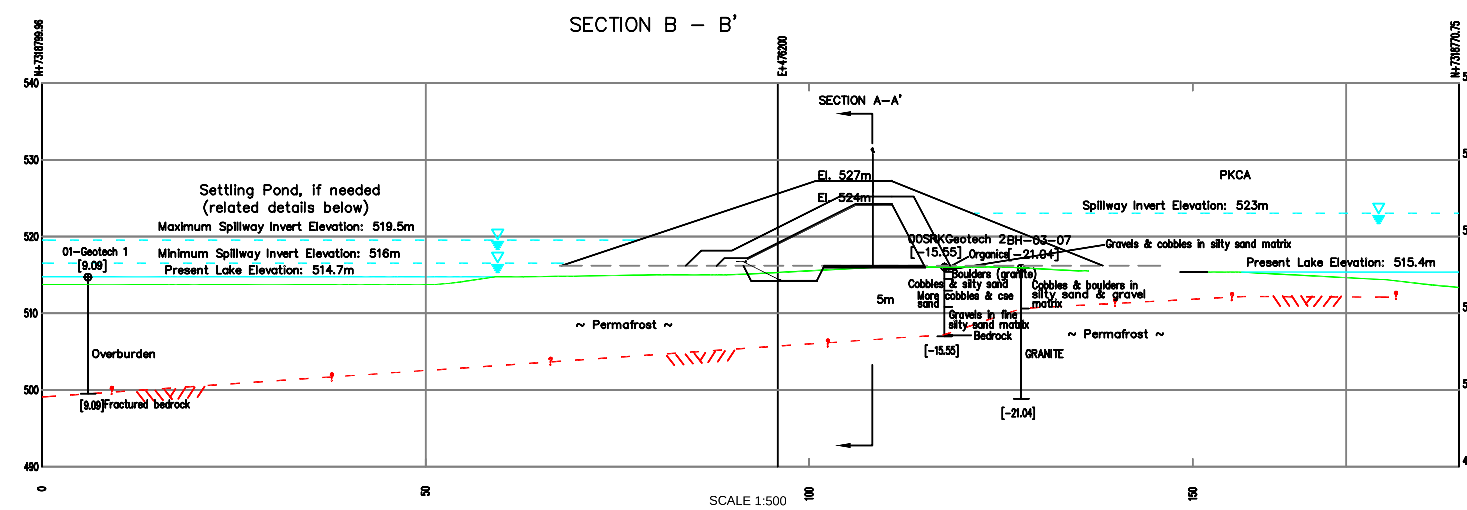

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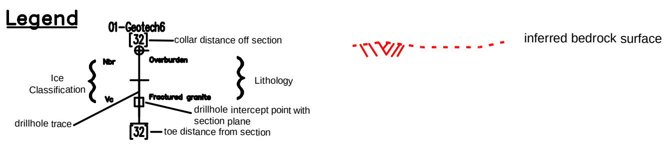


NOTE: REFER TO TECHNICAL MEMORANDUM A, SRK 2003, FOR BOREHOLE LOG

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
DRAWING P-9	CONSTRUCTION SEQUENCE		
DRAWING P-8	PKCA SPILLWAY AND THERMOSYPHON SECTIONS AND DETAILS		
DRAWING P-7	TYPICAL DAM CROSS SECTION AND DETAILS		
DRAWING P-6	SOUTHEAST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-5	EAST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-4	NORTH DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-2	SITE INVESTIGATION AND TERRAIN MAP	DRAWING P-11	PIPELINE PLAN AND LONG SECTION
DRAWING P-1	LAYOUT OF THE PKCA	DRAWING P-10	PKCA MONITORING PLAN AND SECTIONS

REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE

REVISIONS

REV.	ISSUE PURPOSE	AUTH. BY	DATE
A	WATER LICENSE APPLICATION	DL	JULY 2004

ISSUE AUTHORIZATION

WATER LICENSE APPLICATION

SRK Consulting
Engineers and Scientists

DESIGNED BY: DL	DRAWN BY: JM
DATE: JULY 2004	DATE: JULY 2004
CHECKED BY: CCS	DISCIP. ENGR.
DATE: JULY 2004	DATE:
PROJ. MGR:	PROJ. ENGR.
DATE	DATE

SRK PROJECT NUMBER: 1CT004.06

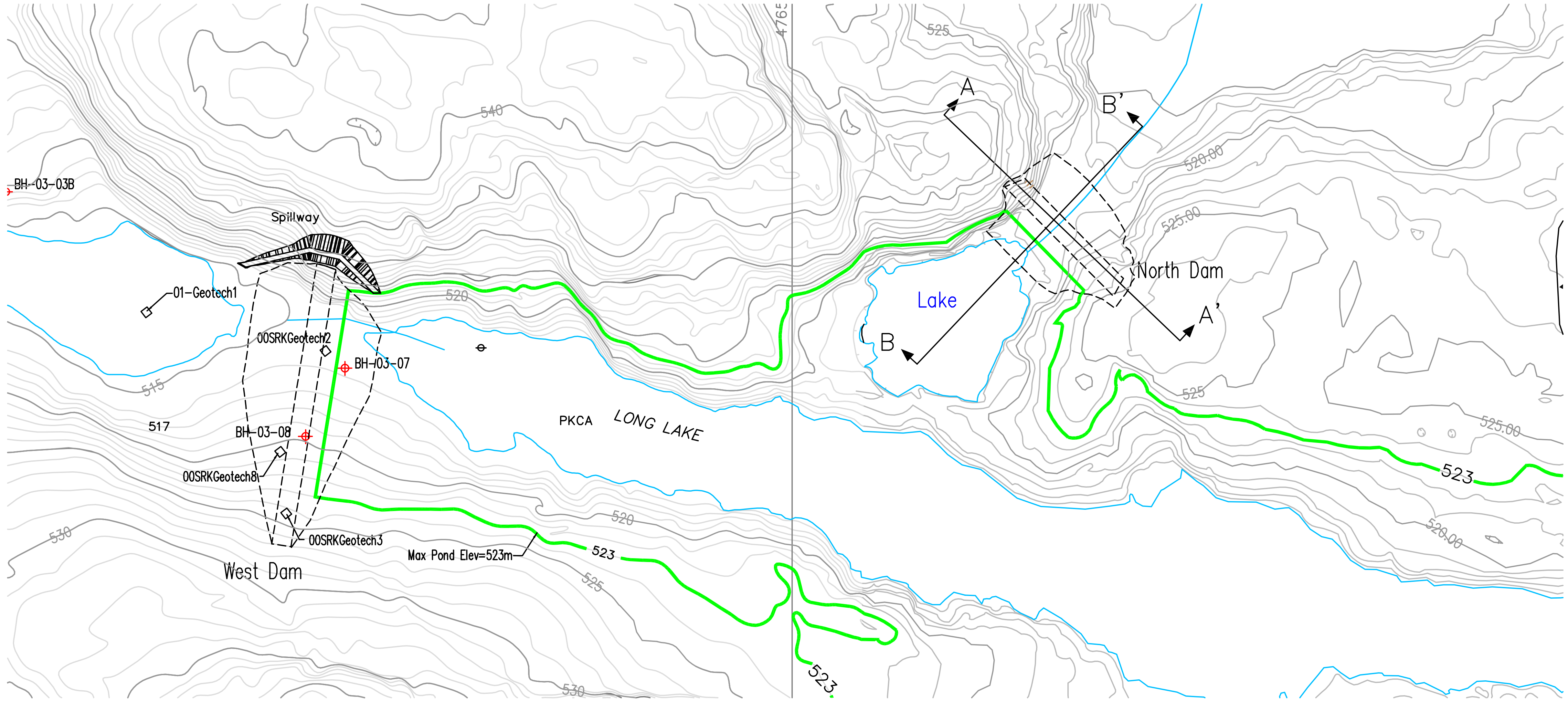
Tahera Diamond Corporation

JERICHO PROJECT

WEST DAM PLAN AND GEOLOGIC SECTIONS

DRAWING NUMBER: ICT004.06 – P3

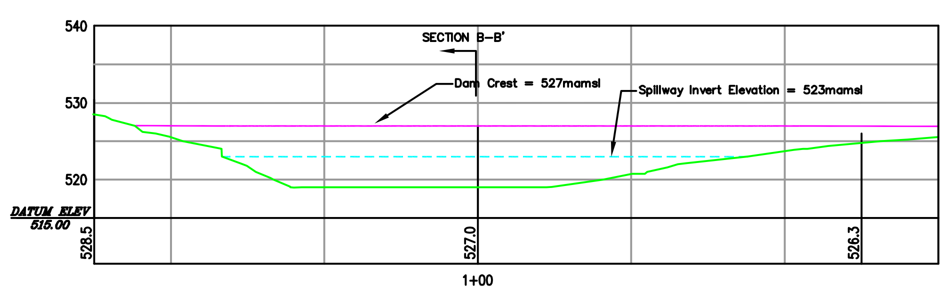
REV. A



TAHERA CORPORATION
JERICHO LAKE SOUTHWEST EXTENSION
Plotted Scale 1:2000
Date of Photography: August 5, 1995.
Scale of Photography: 1:2000
Survey control supplied by: Canamera Geological Ltd.
Survey control based on: UTM Projection, NAD 27, Zone 12
Compiled by The ORTHOSHOP, Calgary, October 1995.
WO 7423

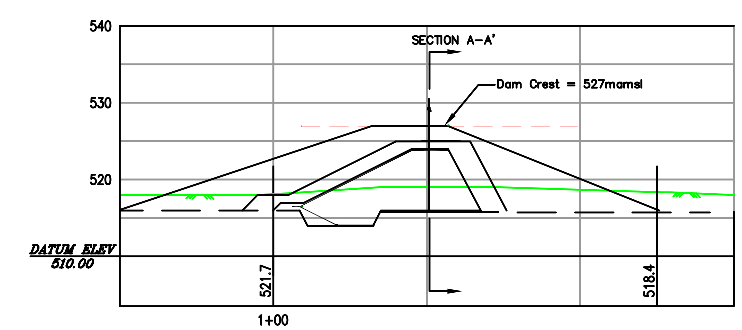
0 25 50 75 100 METRES
1:1500

SECTION A – A'



SCALE 1:500

SECTION B – B'



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NOTE: REFER TO TECHNICAL MEMORANDUM A, SRK 2003, FOR BOREHOLE LOG

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
DRAWING P-9	CONSTRUCTION SEQUENCE		
DRAWING P-8	PKCA SPILLWAY AND THERMOSYPHON SECTIONS AND DETAILS		
DRAWING P-7	TYPICAL DAM CROSS SECTION AND DETAILS		
DRAWING P-6	SOUTHEAST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-5	EAST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-3	WEST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-2	SITE INVESTIGATION AND TERRAIN MAP	DRAWING P-11	PIPELINE PLAN AND LONG SECTION
DRAWING P-1	LAYOUT OF THE PKCA	DRAWING P-10	PKCA MONITORING PLAN AND SECTIONS

REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE

REVISIONS

REV.	ISSUE PURPOSE	AUTH.	BY	DATE
A	WATER LICENSE APPLICATION	DL		JULY 2004

ISSUE AUTHORIZATION

WATER LICENSE APPLICATION

SRK Consulting
Engineers and Scientists

DESIGNED BY: DL	DRAWN BY: JM
DATE: JULY 2004	DATE: JULY 2004
CHECKED BY: CCS	DISCIP. ENGR.
DATE: JULY 2004	DATE:
PROJ. MGR:	PROJ. ENGR.
DATE	DATE

SRK PROJECT NUMBER:
1CT004.06

Tahera Diamond Corporation

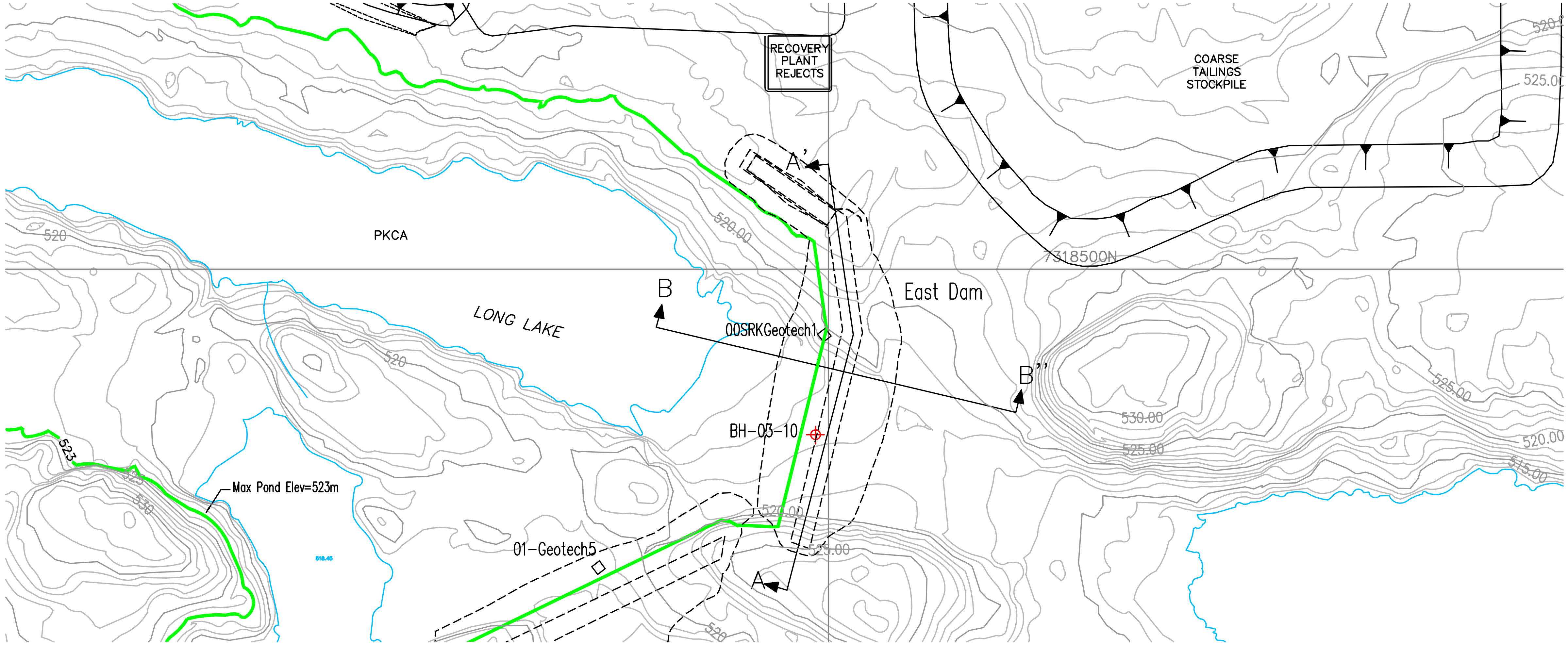
JERICHO PROJECT

NORTH DAM PLAN AND GEOLOGIC SECTIONS

DRAWING NUMBER
1CT004.06 – P4

REV.
A

FILE NAME: F:\Tahera Corp (Lytton minerals)\Mapping and Drawings-2004 dwgs\REVISED...\PKCA DRAWINGS P3-P6,P8.DWG

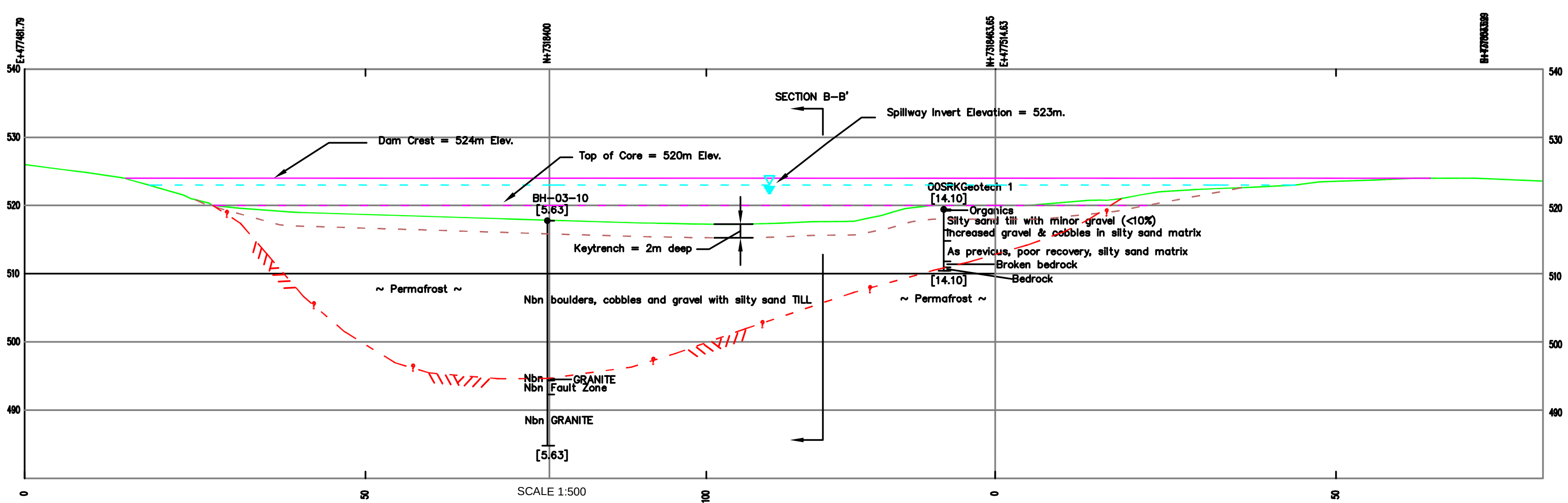


TAHERA CORPORATION
JERICHO LAKE SOUTHWEST EXTENSION
Plotted Scale 1:2000

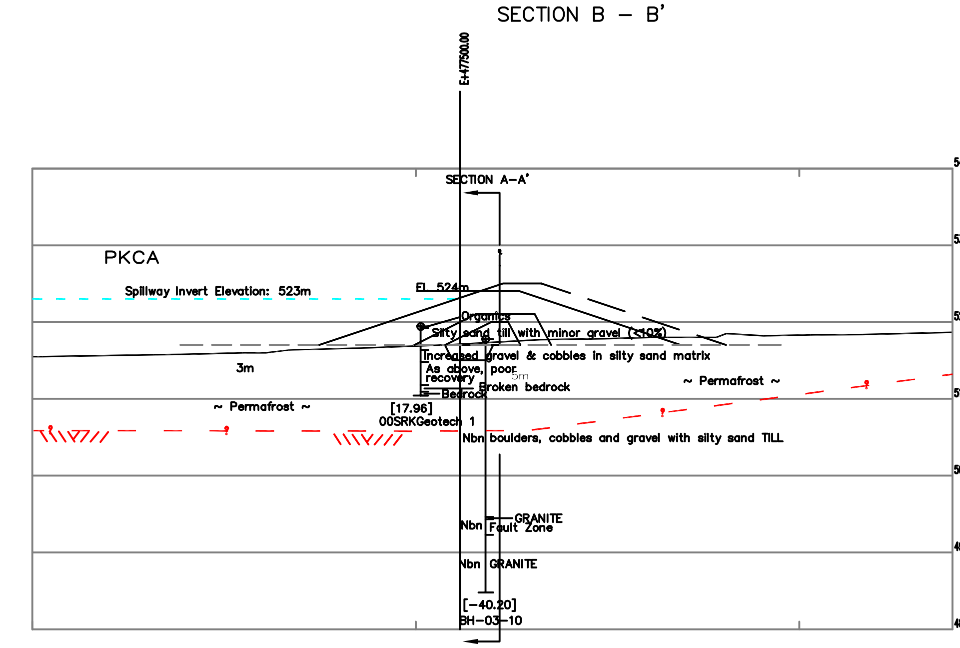
Date of Photography: August 5, 1995.
Scale of Photography: 1:2000
Survey control supplied by: Canamera Geological Ltd.
Survey control based on: UTM Projection, NAD 27, Zone 12
Compiled by The ORTHOSHOP, Calgary, October 1995.
WO 7423

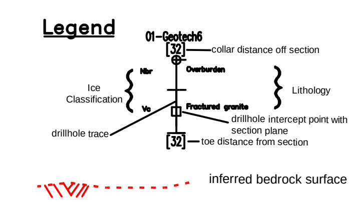
0 25 50 75 100 METRES
1:1500

SECTION A – A'



SECTION B – B'





NOTE: REFER TO TECHNICAL MEMORANDUM A, SRK 2003, FOR BOREHOLE LOG

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
DRAWING P-9	CONSTRUCTION SEQUENCE		
DRAWING P-8	PKCA SPILLWAY AND THERMOSYPHON SECTIONS AND DETAILS		
DRAWING P-7	TYPICAL DAM CROSS SECTION AND DETAILS		
DRAWING P-6	SOUTHEAST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-4	NORTH DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-3	WEST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-2	SITE INVESTIGATION AND TERRAIN MAP	DRAWING P-11	PIPELINE PLAN AND LONG SECTION
DRAWING P-1	LAYOUT OF THE PKCA	DRAWING P-10	PKCA MONITORING PLAN AND SECTIONS

REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE	REV.	ISSUE PURPOSE	AUTH. BY	DATE
					A	WATER LICENSE APPLICATION	DL	JULY 2004

REVISIONS — ISSUE AUTHORIZATION

WATER LICENSE APPLICATION

SRK Consulting
Engineers and Scientists

DESIGNED BY: DL	DRAWN BY: JM
DATE: JULY 2004	DATE: JULY 2004
CHECKED BY: CCS	DISCIP. ENGR.
DATE: JULY 2004	DATE:
PROJ. MGR:	PROJ. ENGR.
DATE	DATE

SRK PROJECT NUMBER: 1CT004.06

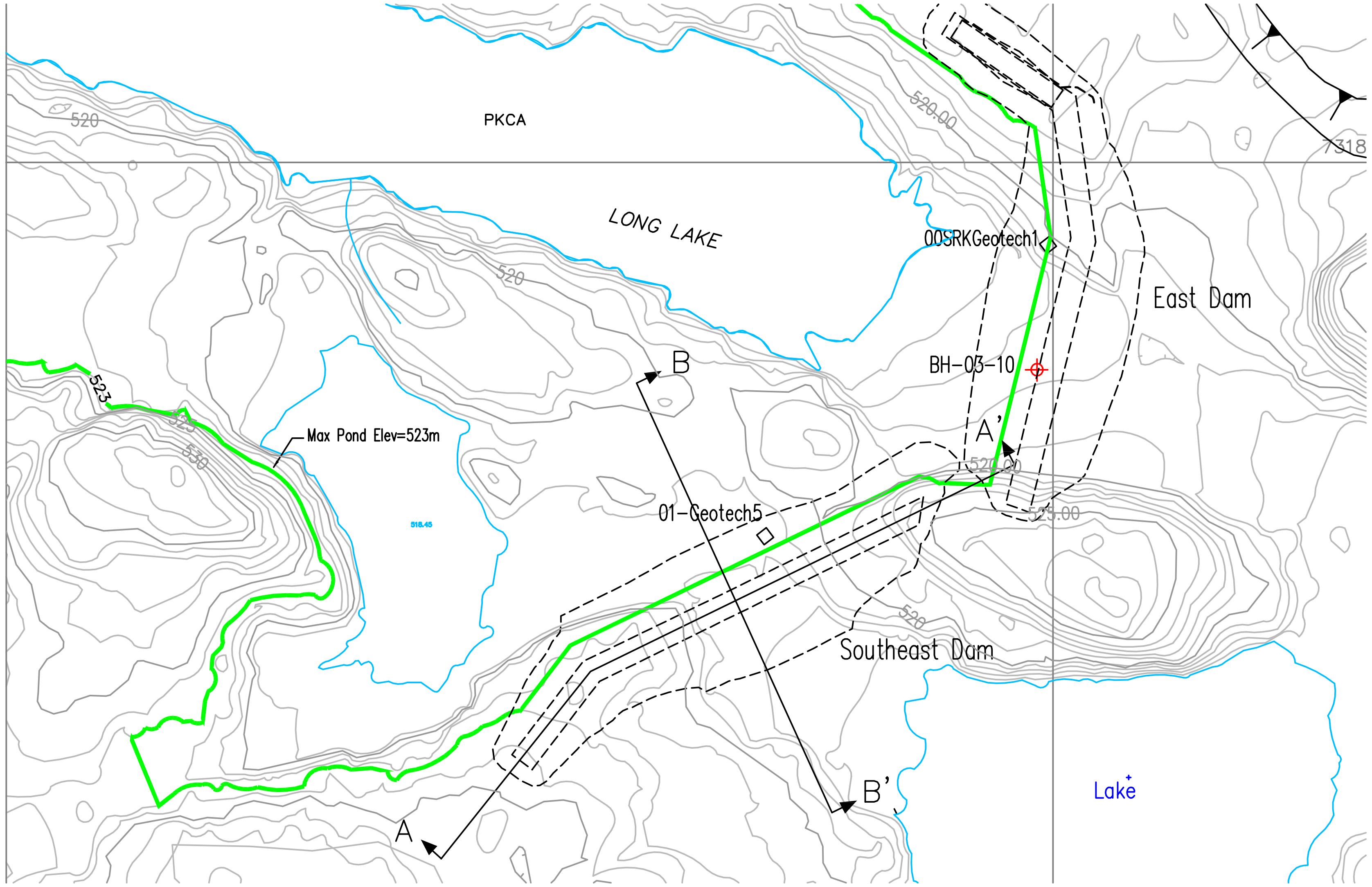
Tahera Diamond Corporation

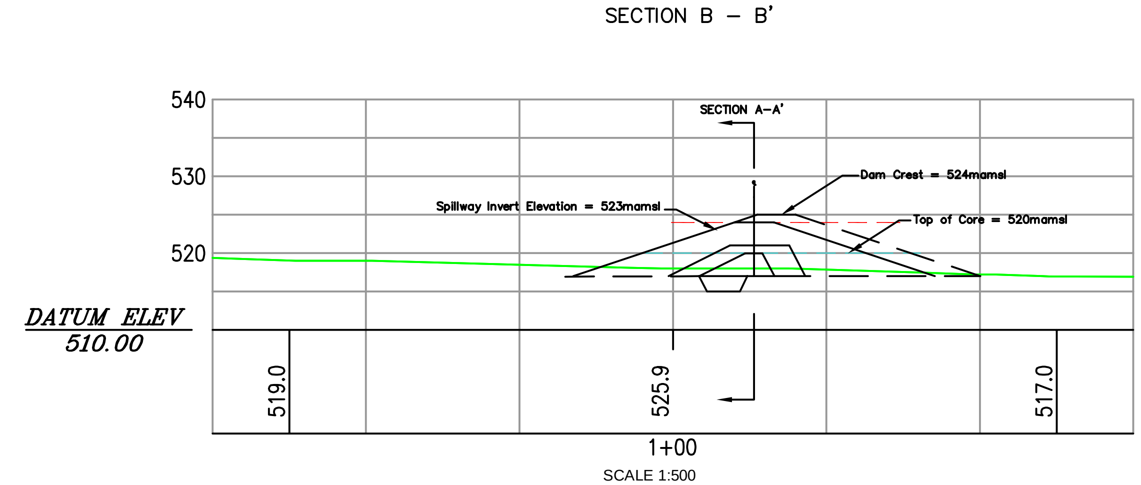
JERICHO PROJECT

EAST DAM PLAN AND GEOLOGIC SECTIONS

DRAWING NUMBER: 1CT004.06 – P5

REV.: A

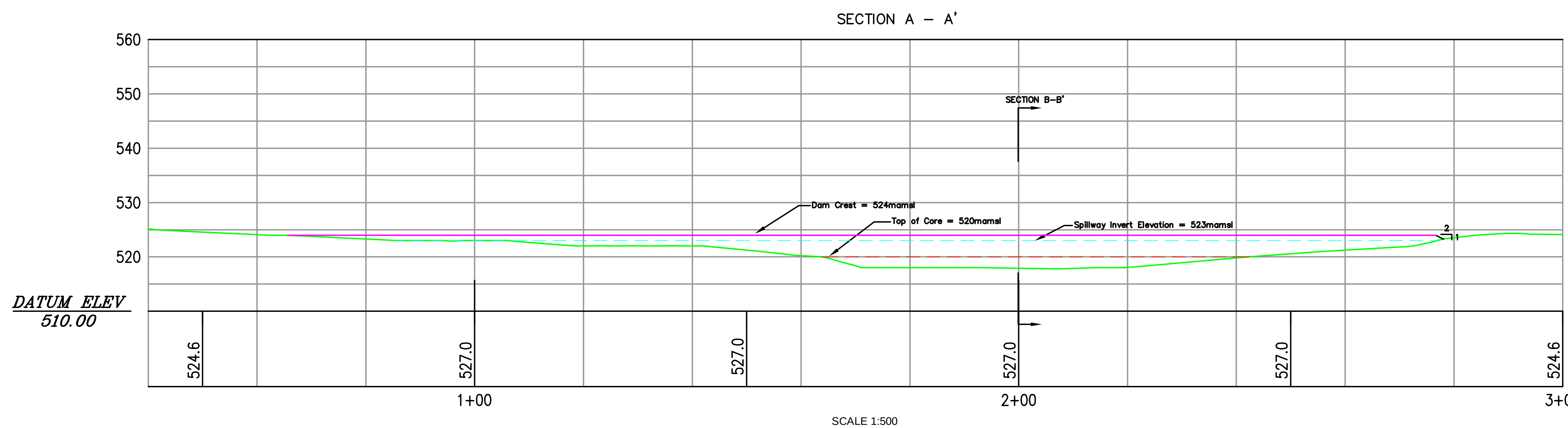




TAHERA CORPORATION
JERICHO LAKE SOUTHWEST EXTENSION
Plotted Scale 1:2000

Date of Photography: August 5, 1995.
Scale of Photography: 1:2000
Survey control supplied by: Canamera Geological Ltd.
Survey control based on: UTM Projection, NAD 27, Zone 12
Compiled by The ORTHOSHOP, Calgary, October 1995.
WO 7423

0 25 50 75 100 METRES
1:1500



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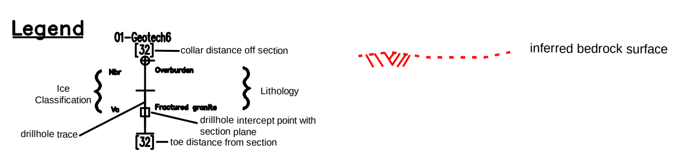


DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
DRAWING P-9	CONSTRUCTION SEQUENCE		
DRAWING P-8	PKCA SPILLWAY AND THERMOSYPHON SECTIONS AND DETAILS		
DRAWING P-7	TYPICAL DAM CROSS SECTION AND DETAILS		
DRAWING P-5	EAST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-4	NORTH DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-3	WEST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-2	SITE INVESTIGATION AND TERRAIN MAP	DRAWING P-11	PIPELINE PLAN AND LONG SECTION
DRAWING P-1	LAYOUT OF THE PKCA	DRAWING P-10	PKCA MONITORING PLAN AND SECTIONS

REFERENCE DRAWINGS

No.	DESCRIPTION	CHK'D	APP'D	DATE

REVISIONS

REV.	ISSUE PURPOSE	AUTH.	BY	DATE
A	WATER LICENSE APPLICATION	DL		JULY 2004

ISSUE AUTHORIZATION

WATER LICENSE APPLICATION

SRK Consulting
Engineers and Scientists

DESIGNED BY: DL
DATE: JULY 2004
DRAWN BY: JM
DATE: JULY 2004
CHECKED BY: CCS
DATE: JULY 2004
DISCIP. ENGR.
DATE:
PROJ. MGR:
DATE
PROJ. ENGR.
DATE
SRK PROJECT NUMBER:
1CT004.06

Tahera Diamond Corporation

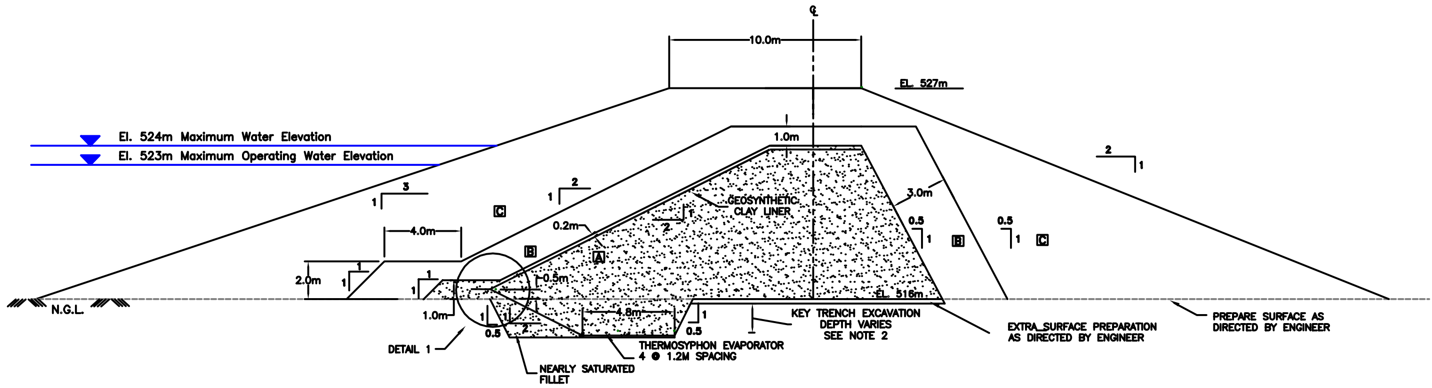
JERICHO PROJECT

SOUTHEAST DAM PLAN AND GEOLOGIC SECTIONS

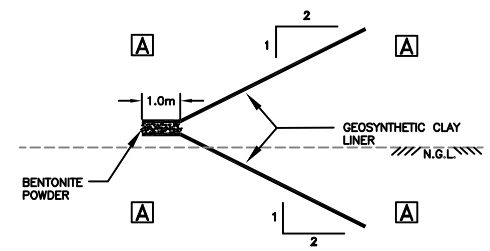
DRAWING NUMBER
1CT004.06 – P6

REV.
A

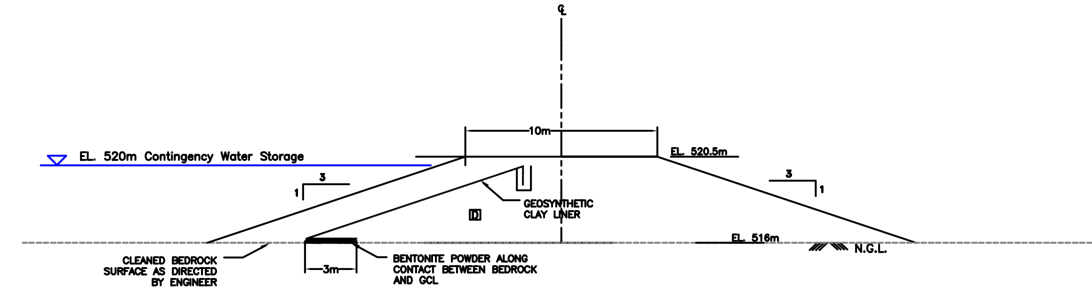
FILE NAME: F:\Tahera Corp (Lytton minerals)\Mapping and Drawings-2004 dwgs\REVISED...\PKCA DRAWINGS P3-P6,P8.DWG



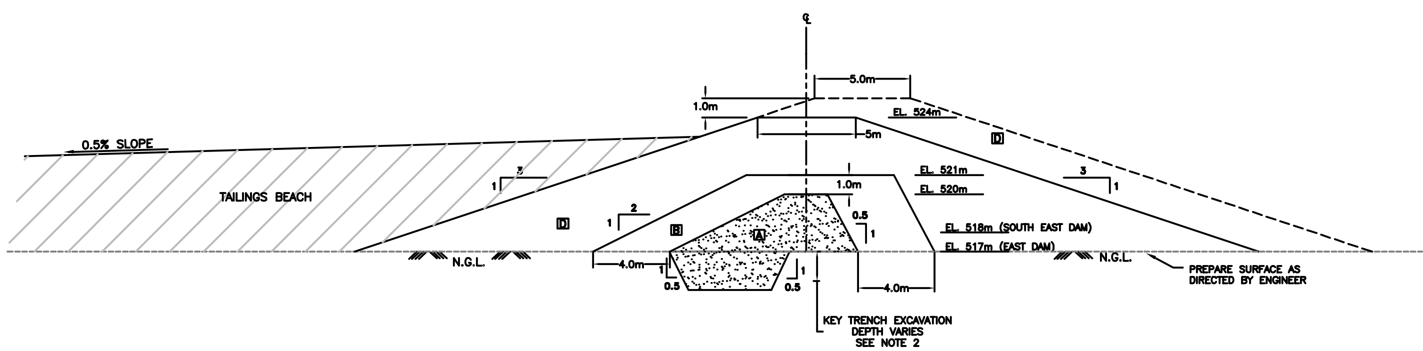
WEST AND NORTH DAM SECTION



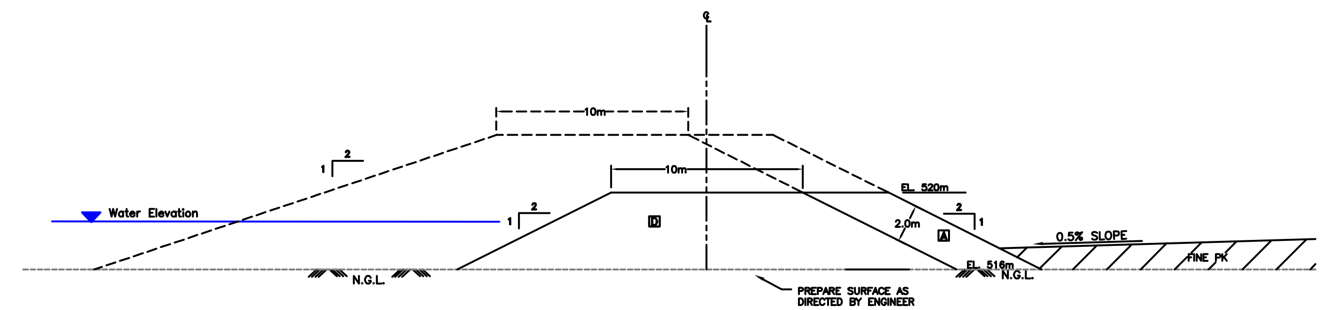
DETAIL 1
GEOSYNTHETIC CLAY LINER OVERLAP
N.T.S.



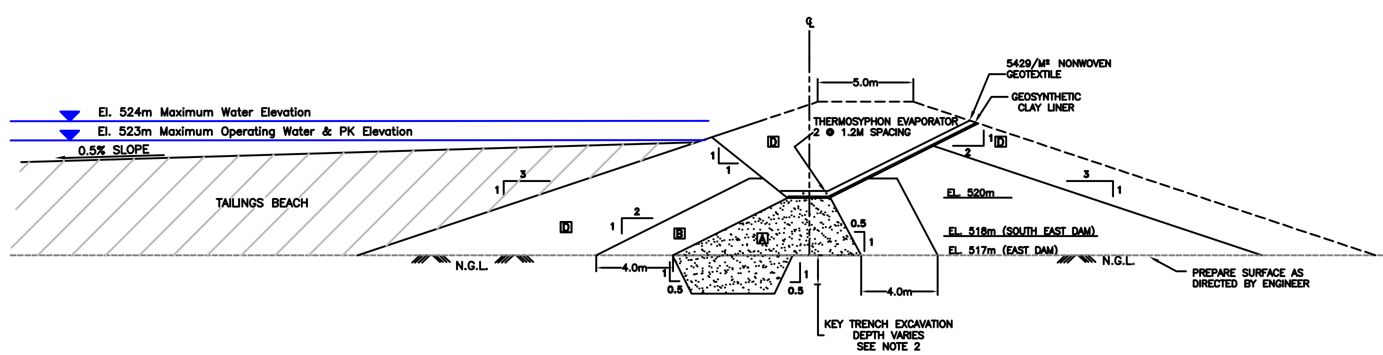
NORTH DAM ROAD ACCESS CAUSEWAY
(SEE NOTE 3)



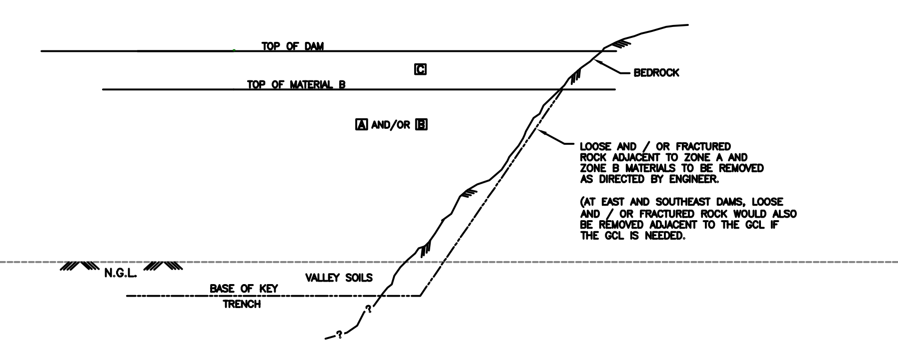
EAST AND SOUTHEAST DAM SECTION
(WITHOUT THE INCLUSION OF THE CONTINGENCY CORE RAISE SECTION DETAILED BELOW)



INTERNAL DIVIDER DYKE
(SEE NOTE 4)



CONTINGENCY CORE RAISE SECTION FOR EAST AND SOUTHEAST DAMS
(SEE NOTE 6)



ABUTMENT DETAILS
N.T.S. (SEE NOTE 5)

MATERIALS:

- A MINUS 10mm MATERIAL
- B MINUS 150mm MATERIAL
- C RUN-OF-MINE SHELL MATERIAL
- D COARSE PK AND/OR RUN-OF-MINE SHELL MATERIAL

0 2 4 6 8 10 METERS
1:200
ALL FIGURES SHOWN AT 1:200 SCALE UNLESS OTHERWISE NOTED

NOTES:

1. OVER-EXCAVATION TO BE BACKFILLED WITH MATERIAL B.
2. ACTUAL DEPTH OF KEY-CUT MAY BE LESS THAN THOSE DIMENSIONED ACTUAL DEPTH TO BE DETERMINED BY INSUTY CONDITIONS.
3. NORTH DAM ROAD ACCESS CAUSEWAY WILL BE INTEGRATED INTO THE NORTH DAM AS NEEDED.
4. IF THE INTERNAL DIVIDER DYKE MUST BE RAISED, THE DOWNSTREAM CONSTRUCTION METHOD WILL BE USED.
5. ABUTMENT DETAIL APPLIES TO THE NORTH ABUTMENT OF THE WEST DAM, BOTH ABUTMENTS OF THE NORTH DAM, SOUTH ABUTMENT OF THE EAST DAM AND NORTH ABUTMENT OF THE SOUTHEAST DAM.
6. THE NEED FOR THE CORE RAISE SECTION AT THE EAST AND SOUTHEAST DAMES WILL BE EVALUATED IN THE FIRST YEAR OF OPERATION, I.E. DUE TO ACTUAL DATA.

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
DRAWING P-9	CONSTRUCTION SEQUENCE		
DRAWING P-8	PKCA SPILLWAY AND THERMOSYPHON SECTIONS AND DETAILS		
DRAWING P-6	SOUTHEAST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-5	EAST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-4	NORTH DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-3	WEST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-2	SITE INVESTIGATION AND TERRAIN MAP	DRAWING P-11	PIPELINE PLAN AND LONG SECTION
DRAWING P-1	LAYOUT OF THE PKCA	DRAWING P-10	PKCA MONITORING PLAN AND SECTIONS

REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE

REVISIONS

REV.	ISSUE PURPOSE	AUTH. BY	DATE
A	WATER LICENSE APPLICATION	DL	JULY 2004

ISSUE AUTHORIZATION

WATER LICENSE APPLICATION

SRK Consulting
Engineers and Scientists

DESIGNED BY: DL	DRAWN BY: JM
DATE: JULY 2004	DATE: JULY 2004
CHECKED BY: CCS	DISCIP. ENGR.
DATE: JULY 2004	DATE:
PROJ. MGR:	PROJ. ENGR.
DATE	DATE

SRK PROJECT NUMBER: 1CT004.06

Tahera
Diamond Corporation

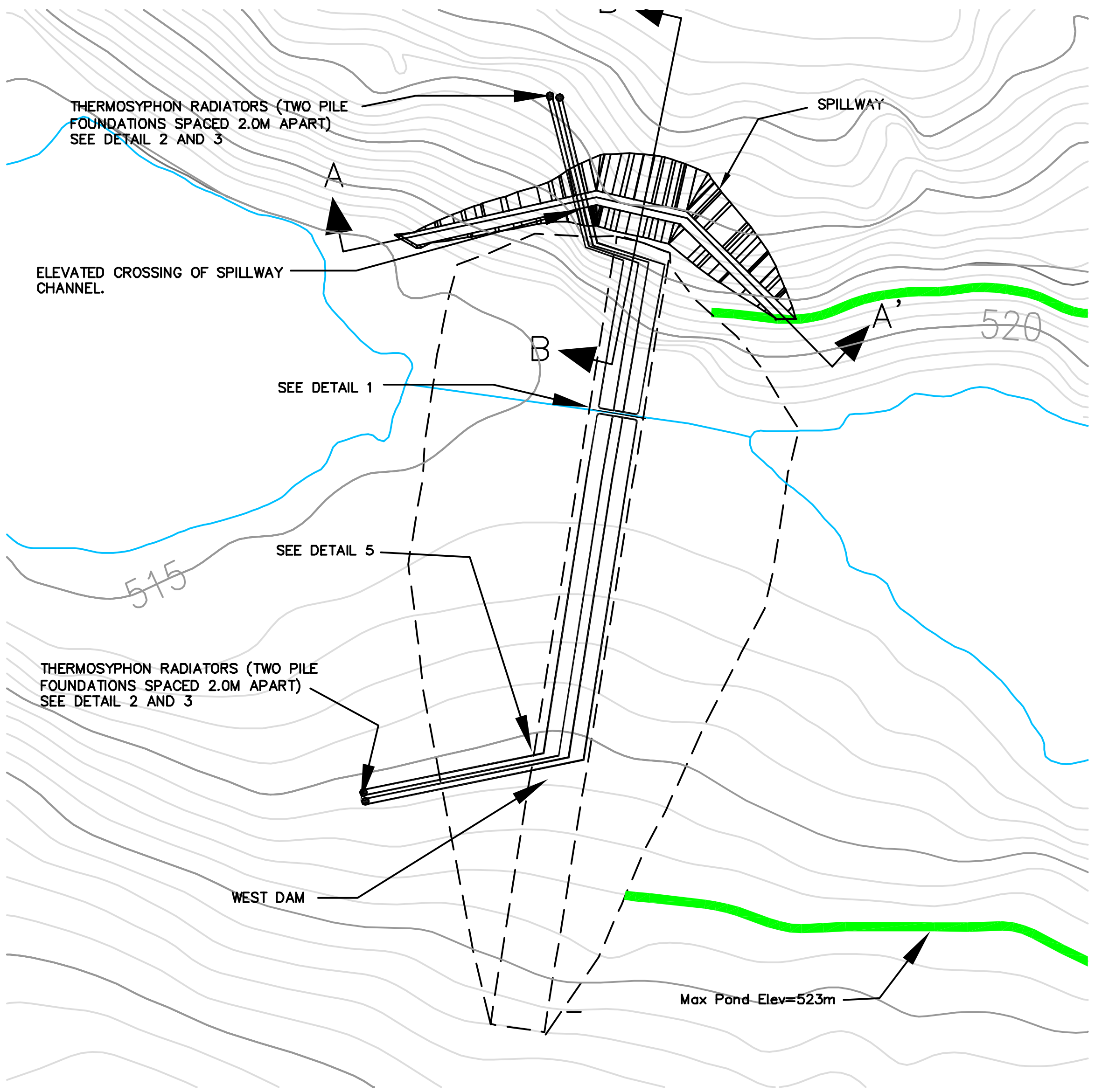
JERICHO PROJECT

TYPICAL DAM CROSS SECTIONS & DETAILS

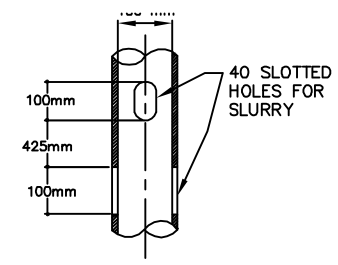
DRAWING NUMBER: 1CT004.06 – P7

REV. A

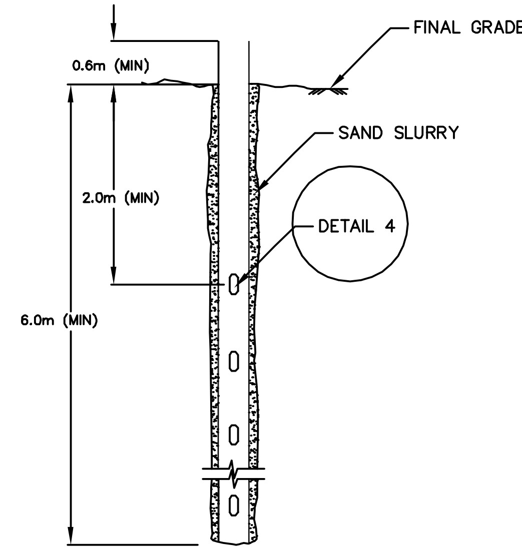
FILE NAME: P:\Tahera Corp (Lytton minerals)\Mapping and Drawings-2004 dwgs\REVISED...\PKCA DRAWINGS P7,P10.DWG



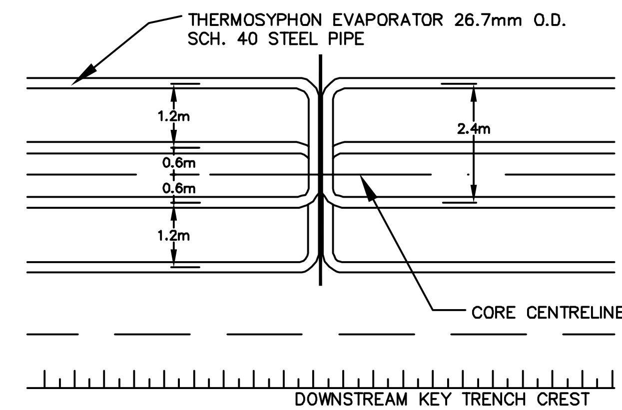
SCALE 1:750



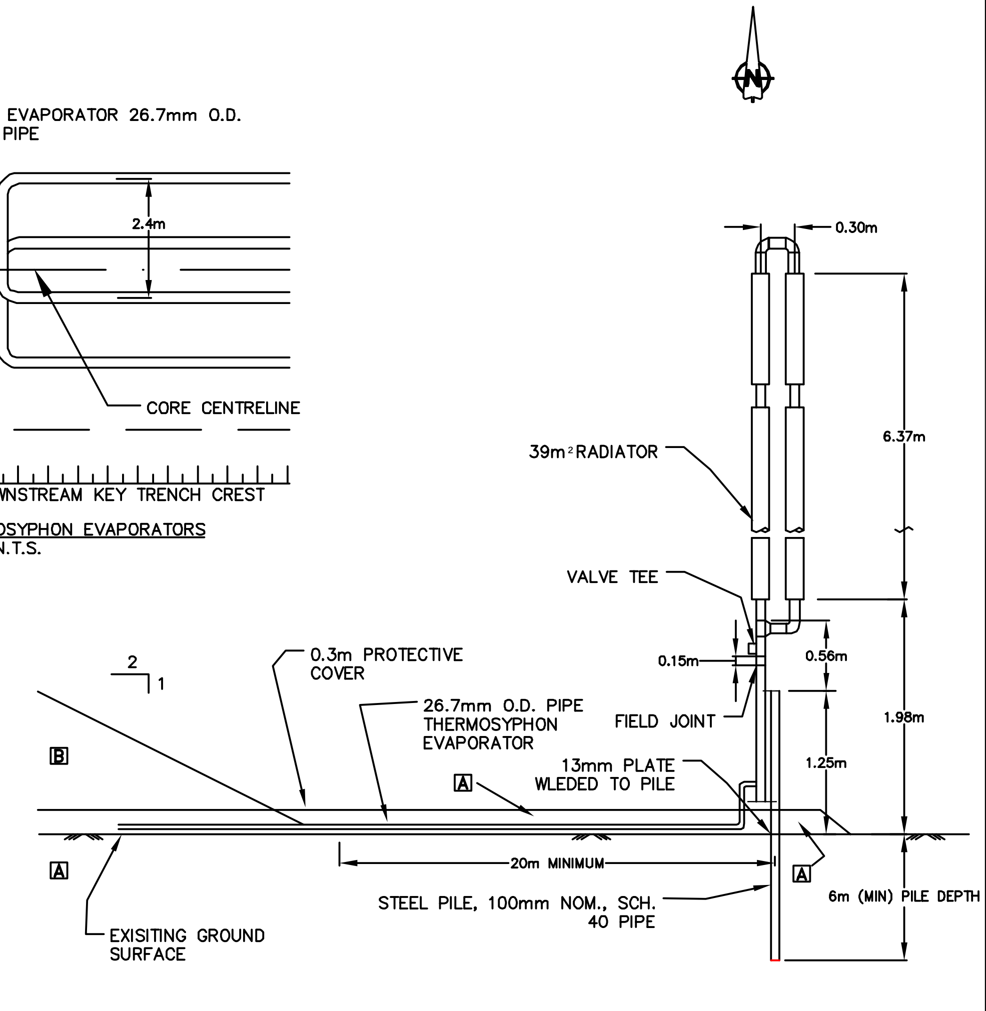
DETAIL 4 – SLURRY HOLES
N.T.S.



DETAIL 3 – RADIATOR PILE SUPPORT AND SLURRY HOLES
N.T.S.



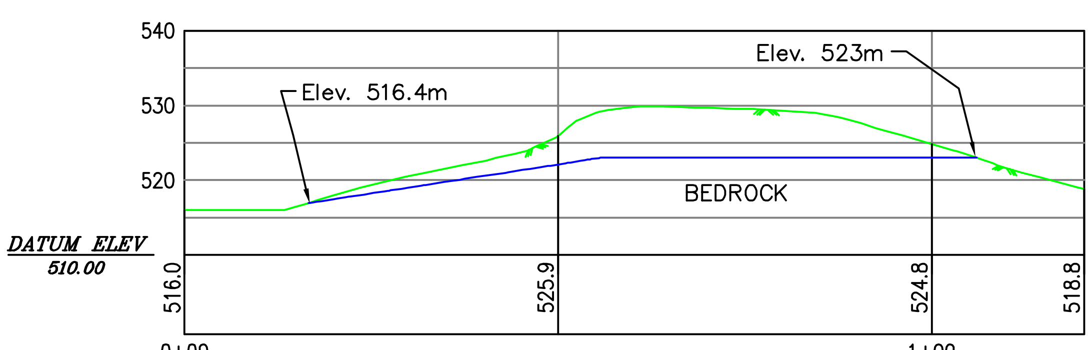
DETAIL 1 – THERMOSYPHON EVAPORATORS
N.T.S.



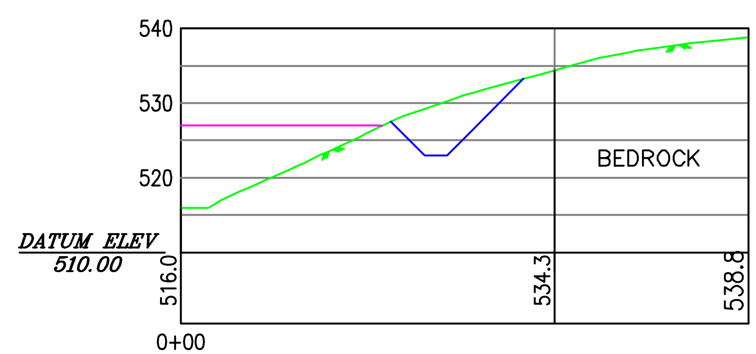
DETAIL 2 – DOWNSTREAM TOE
N.T.S.

MATERIALS:

- [A] MINUS 10mm MATERIAL
- [B] MINUS 150mm MATERIAL
- [C] RUN–OF–MINE SHELL MATERIAL
- [D] COARSE PK AND/OR RUN–OF–MINE SHELL MATERIAL

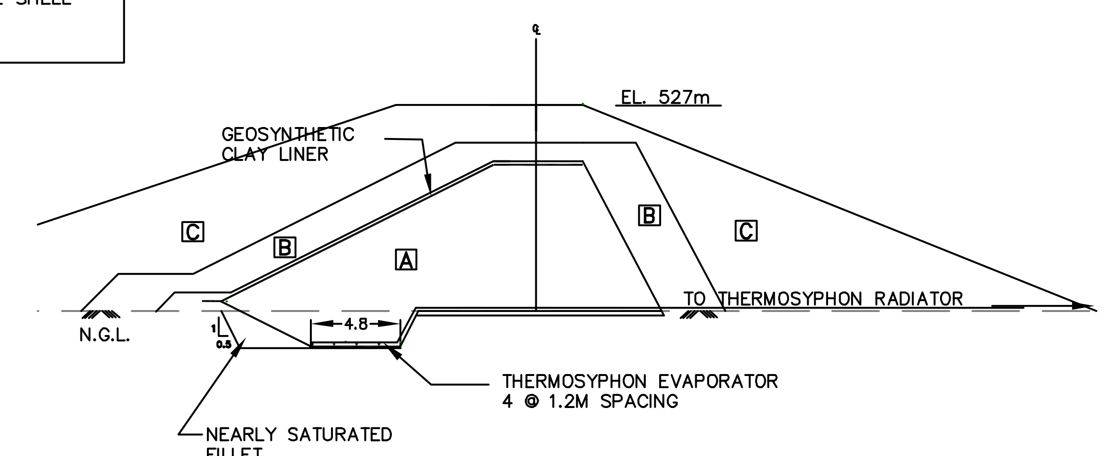


WEST DAM SPILLWAY
SECTION–A



SCALE 1:500

WEST DAM SPILLWAY
SECTION–B



DETAIL 5 – WEST DAM SECTION
SCALE 1:200

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
DRAWING P–10	PKCA MONITORING PLAN AND SECTIONS		
DRAWING P–9	CONSTRUCTION SEQUENCE		
DRAWING P–7	TYPICAL DAM CROSS SECTION AND DETAILS		
DRAWING P–6	SOUTHEAST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P–5	EAST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P–4	NORTH DAM GEOLOGIC CROSS SECTIONS		
DRAWING P–3	WEST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P–2	SITE INVESTIGATION AND TERRAIN MAP		
DRAWING P–1	LAYOUT OF THE PKCA	DRAWING P–11	PIPELINE PLAN AND LONG SECTION

REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE

REVISIONS

REV.	ISSUE PURPOSE	AUTH. BY	DATE
A	WATER LICENSE APPLICATION	DL	JULY 2004

ISSUE AUTHORIZATION

WATER LICENSE APPLICATION

SRK Consulting

DESIGNED BY: DL — DATE: JULY 2004
DRAWN BY: JM — DATE: JULY 2004
CHECKED BY: CCS — DATE: JULY 2004
DISCIP. ENGR. — DATE:
PROJ. MGR: — DATE
PROJ. ENGR. — DATE
SRK PROJECT NUMBER: 1CT004.06

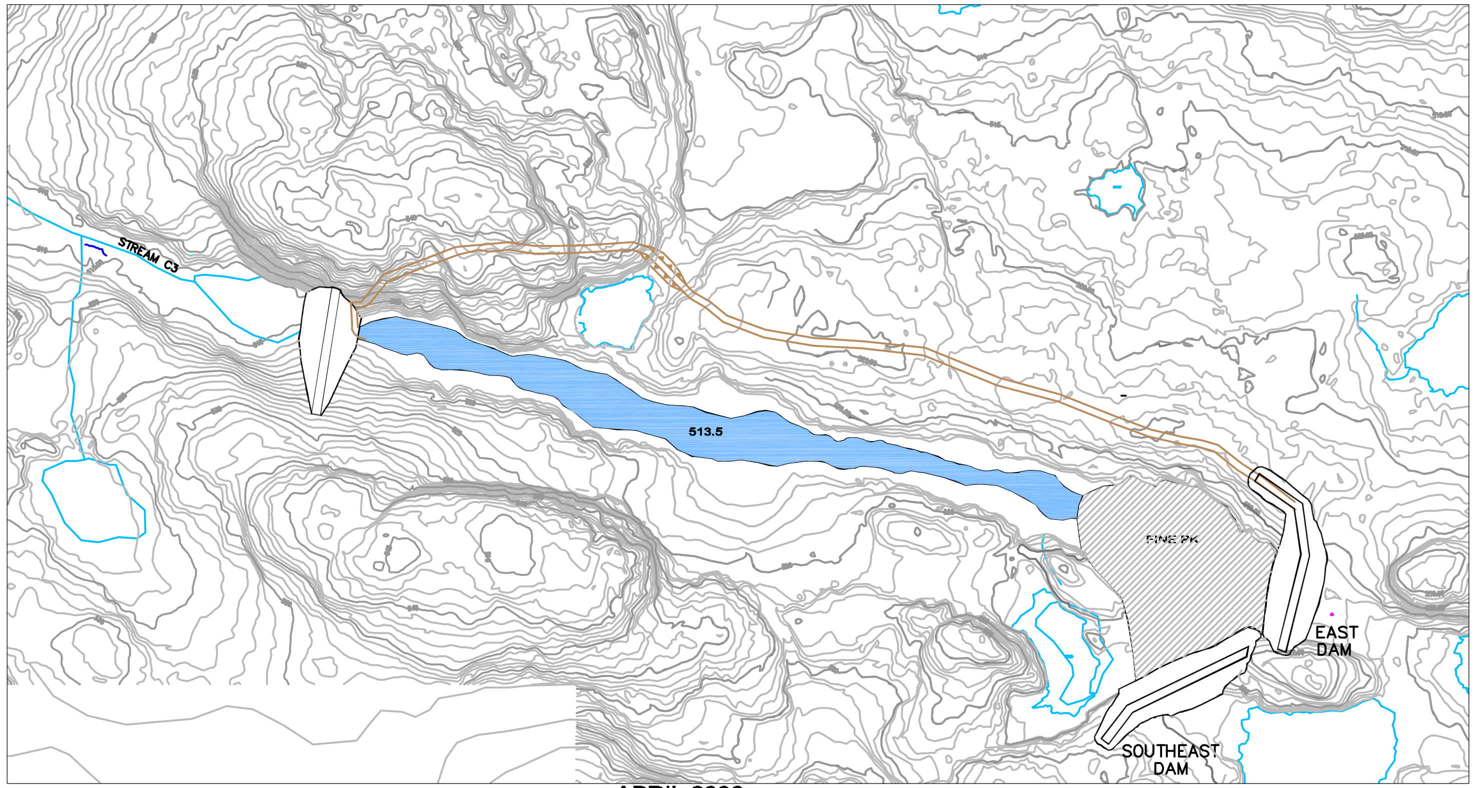
Tahera Diamond Corporation

JERICHO PROJECT

WEST DAM SPILLWAY AND THERMOSYPHON SECTIONS & DETAILS

DRAWING NUMBER: 1CT004.06 – P8

REV. A



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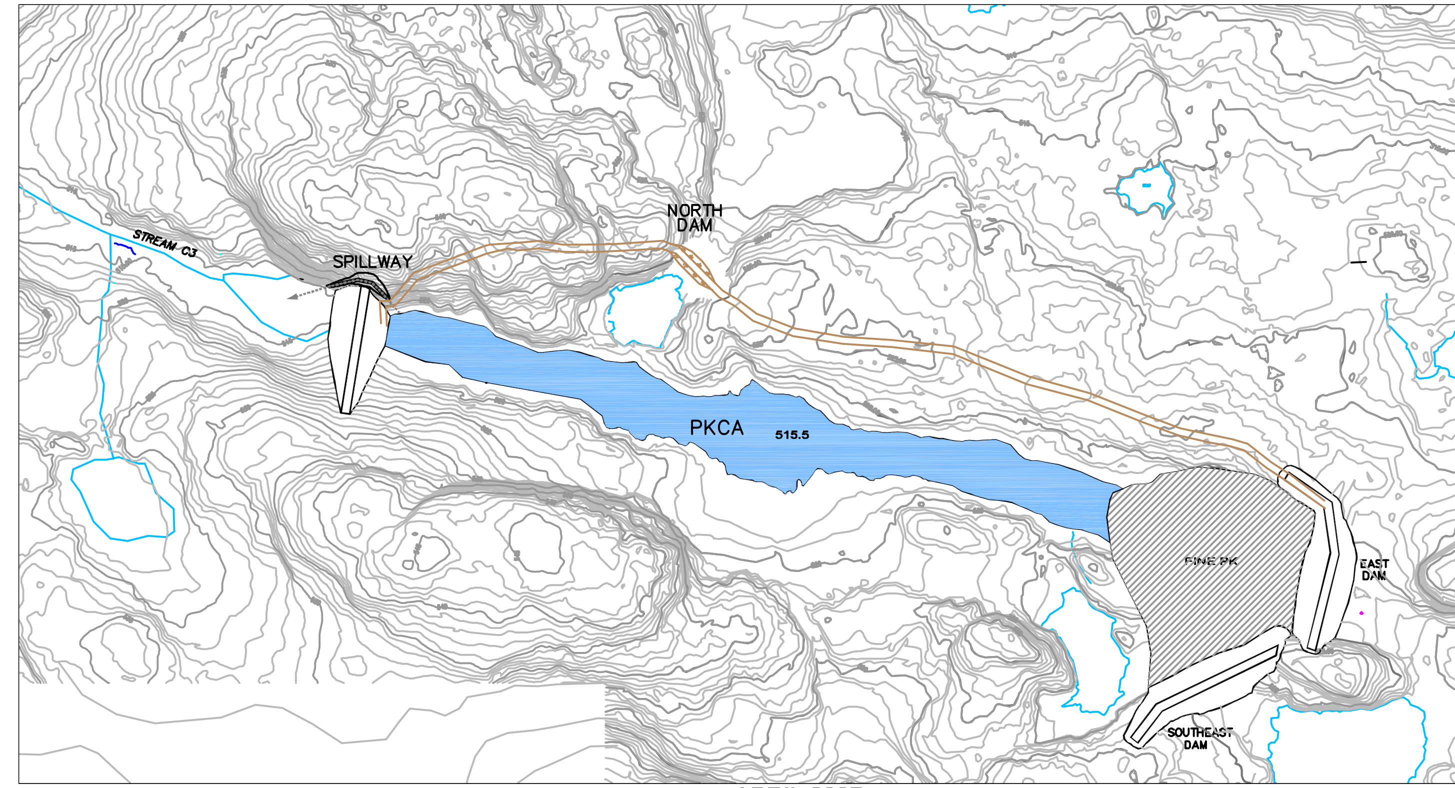

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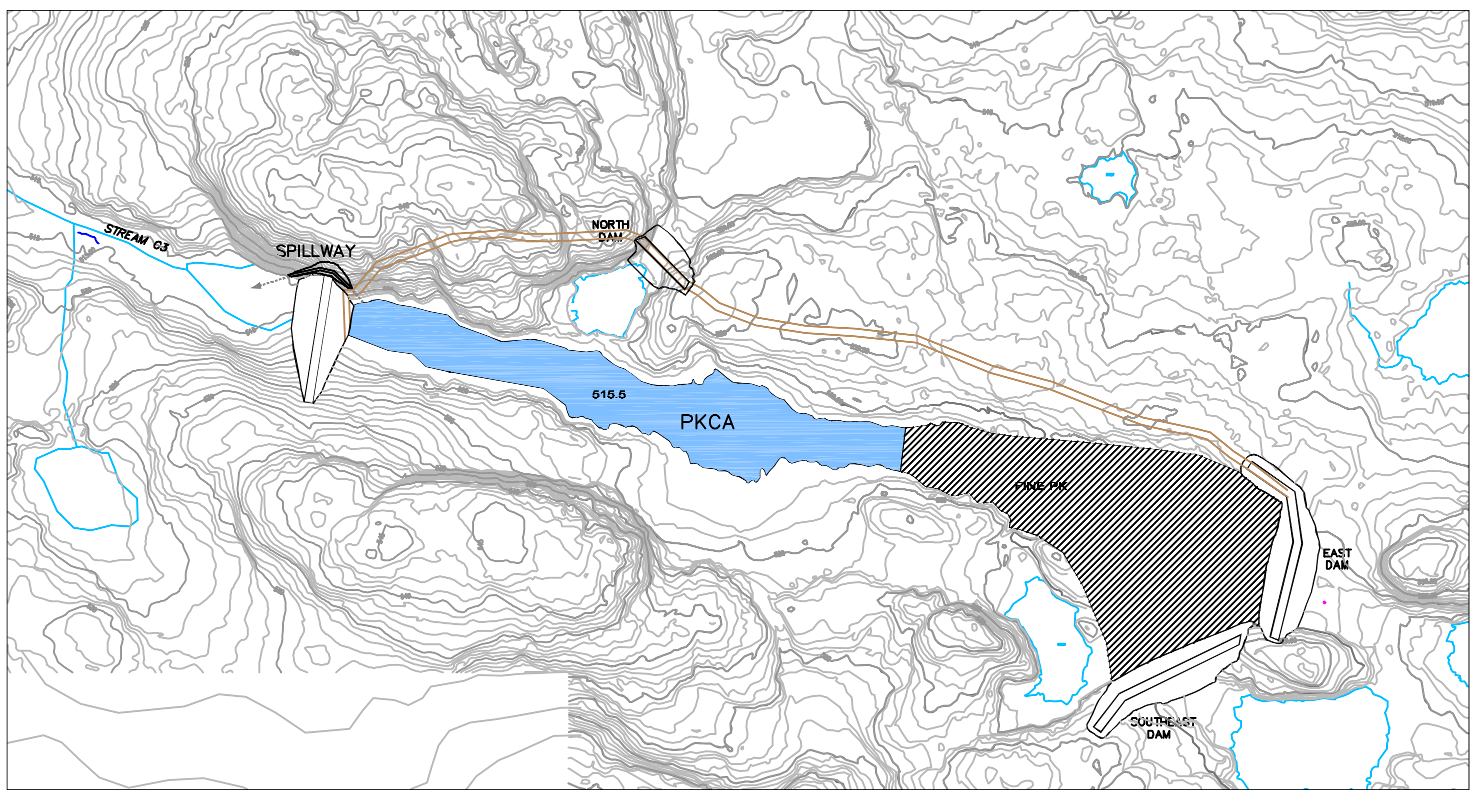

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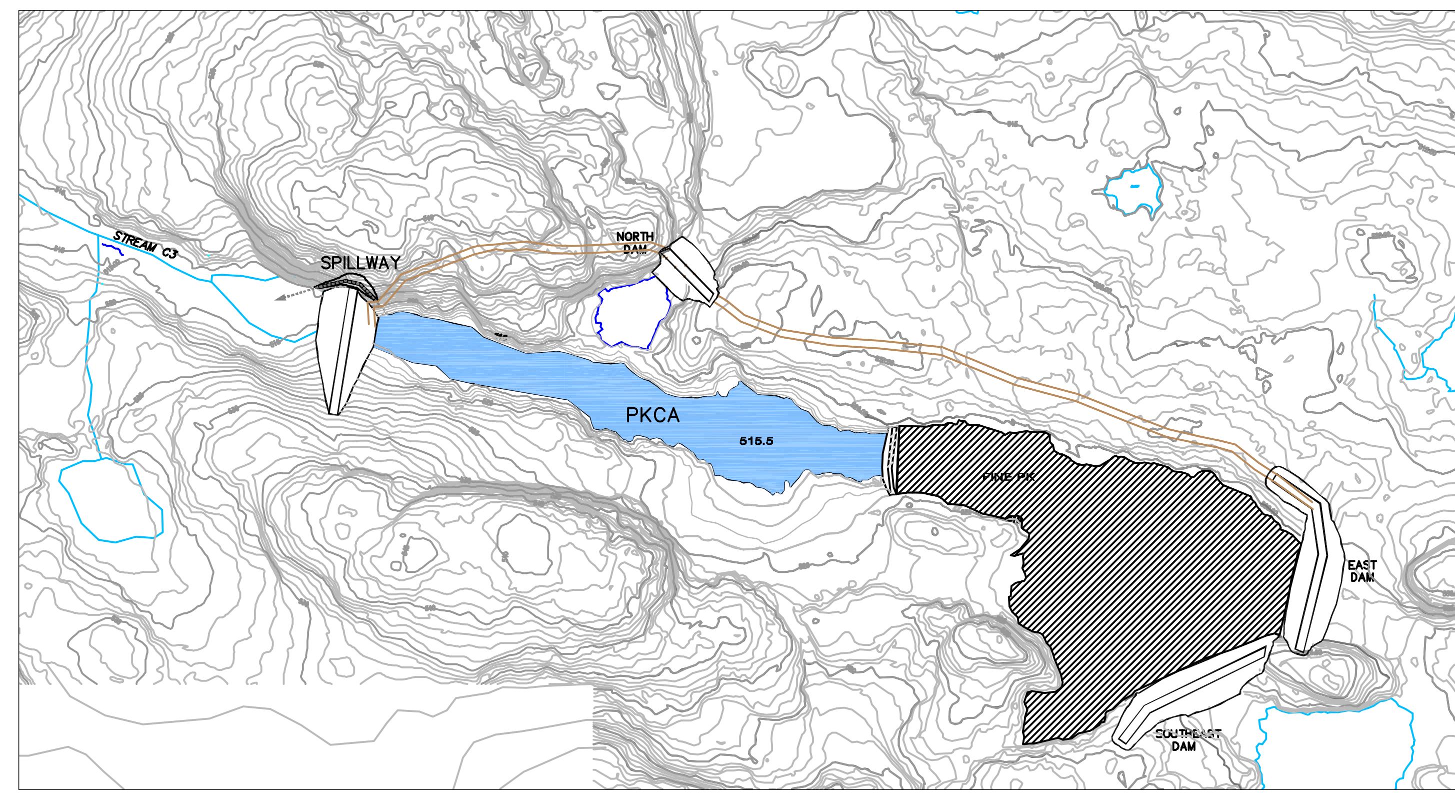


DECEMBER 2013

TAHERA CORPORATION
JERICHO LAKE SOUTHWEST EXTENSION
Plotted Scale 1:5,000

0 50 100 150 200 250 METRES
1:5,000

NOTES:
1. EXTENT OF FINE PK IS APPROXIMATE AND MAY NOT REFLECT ACTUAL CONDITIONS AT EACH PERIOD
2. INTERNAL DIVIDER DYKE WILL BE CONSTRUCTED WHEN CONDITIONS IN THE PKCA INDICATE IT IS APPROPRIATE
3. ADDITIONAL INTERNAL DIVIDER DYKES COULD BE ADDED DEPENDING ON WATER QUALITY DATA NEAR THE WEST DA

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
DRAWING P-8	PKCA SPILLWAY AND THERMOSYPHON SECTIONS AND DETAILS		
DRAWING P-7	TYPICAL DAM CROSS SECTION AND DETAILS		
DRAWING P-6	SOUTHEAST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-5	EAST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-4	NORTH DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-3	WEST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-2	SITE INVESTIGATION AND TERRAIN MAP	DRAWING P-11	PIPELINE PLAN AND LONG SECTION
DRAWING P-1	LAYOUT OF THE PKCA	DRAWING P-10	PKCA MONITORING PLAN AND SECTIONS

REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE

REVISIONS

REV.	ISSUE PURPOSE	AUTH. BY		DATE
A	WATER LICENSE APPLICATION	DL		JUNE 2004

ISSUE AUTHORIZATION

WATER LICENSE APPLICATION

SRK Consulting
Engineers and Scientists

DESIGNED BY: DL DATE: JUNE 2004	DRAWN BY: JM DATE: MAR. 2004
CHECKED BY: CCS DATE: JUNE 2004	DISCIP. ENGR. DATE:
PROJ. MGR: DATE	PROJ. ENGR. DATE
SRK PROJECT NUMBER: 1CT004.06	

Tahera Diamond Corporation

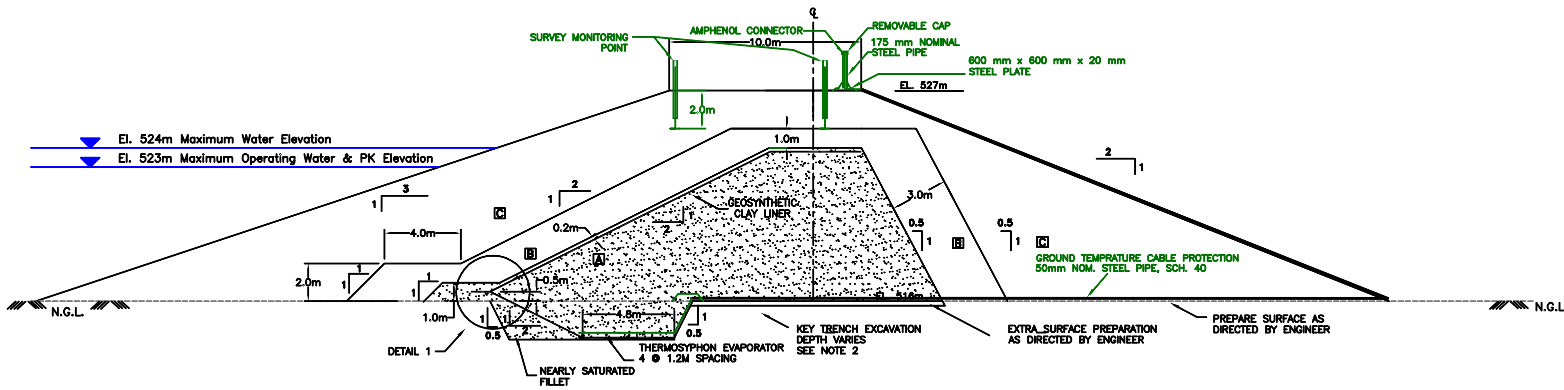
JERICHO PROJECT

PKCA CONSTRUCTION SEQUENCE

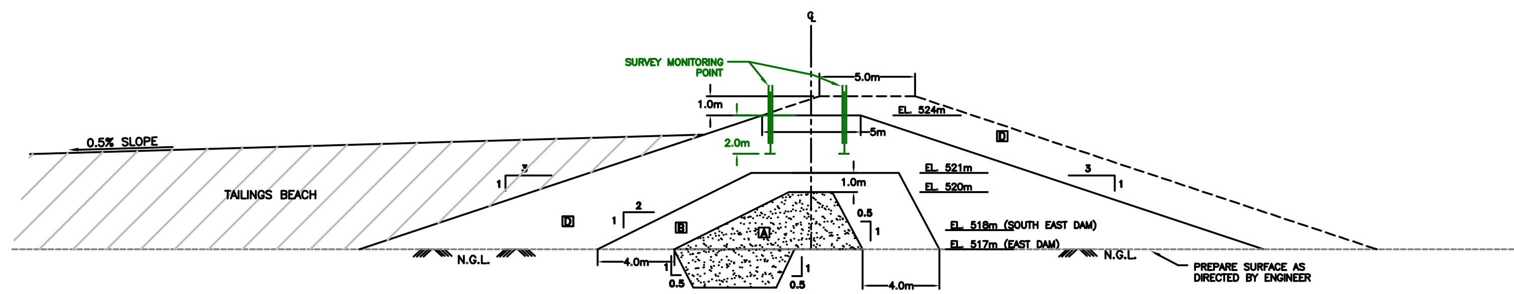
DRAWING NUMBER: 1CT004.06–P9

REV. A

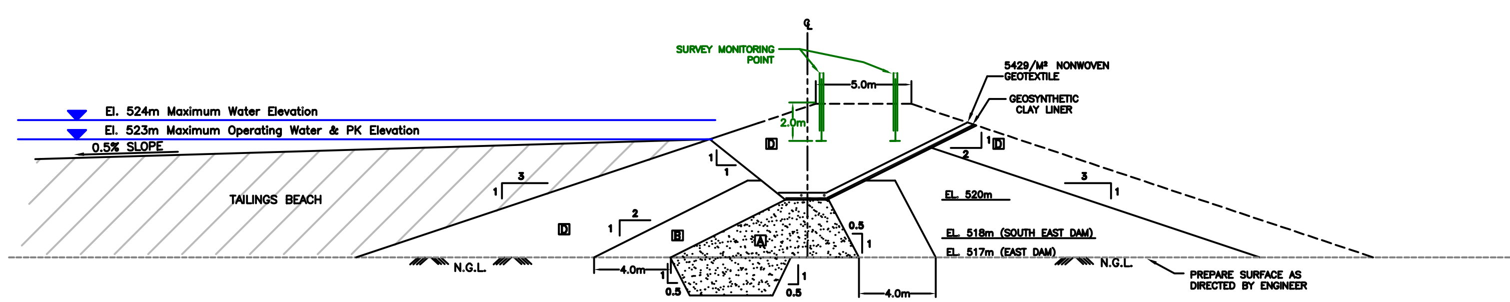
FILE NAME: F:\Tahera Corp (Lytton minerals)\Mapping and Drawings–2004 dwgs\REVISED...\FIGURE–P1,P2,P9.DWG



WEST AND NORTH DAM SECTION



EAST AND SOUTH EAST DAM SECTION



CONTINGENCY CORE RAISE SECTION FOR EAST AND SOUTHEAST DAMS

Summary of Monitoring Details at the PKCA Dams

Dam	Survey Monitoring Points	Thermistor Stations	Water Quality Monitoring Stations
West	3 pair	2 cables	1 in PKCA pond and 1 at downstream end of the spillway
North	1 pair	2 cables	
East	3 pair	2 cables	
Southeast	3 pair	2 cables	

Note: The locations of the monitoring points will be finalized on the design drawings issued for construction.

MATERIALS:
- A MINUS 10mm MATERIAL
- B MINUS 150mm MATERIAL
- C RUN-OF-MINE SHELL MATERIAL
- D COARSE PK AND/OR RUN-OF-MINE SHELL MATERIAL

0 2 4 6 8 10 METERS
1:200
ALL FIGURES SHOWN AT 1:200 SCALE UNLESS OTHERWISE NOTED

REFERENCE DRAWINGS

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
DRAWING P-8	PKCA SPILLWAY AND THERMOSYPHON SECTIONS AND DETAILS		
DRAWING P-7	TYPICAL DAM CROSS SECTION AND DETAILS		
DRAWING P-6	SOUTHEAST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-5	EAST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-4	NORTH DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-3	WEST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-2	SITE INVESTIGATION AND TERRAIN MAP	DRAWING P-11	PIPELINE PLAN AND LONG SECTION
DRAWING P-1	LAYOUT OF THE PKCA	DRAWING P-9	CONSTRUCTION SEQUENCE

REVISIONS

NO.	DESCRIPTION	CHK'D	APP'D	DATE

ISSUE AUTHORIZATION

REV.	ISSUE PURPOSE	AUTH. BY	DATE
A	WATER LICENSE APPLICATION	DL	JULY 2004

WATER LICENSE APPLICATION

SRK Consulting — Engineers and Scientists

DESIGNED BY: DL	DRAWN BY: JM
DATE: JULY 2004	DATE: JULY 2004
CHECKED BY: CCS	DISCIP. ENGR.
DATE: JULY 2004	DATE:
PROJ. MGR:	PROJ. ENGR.
DATE	DATE

SRK PROJECT NUMBER: 1CT004.06

Tahera Diamond Corporation

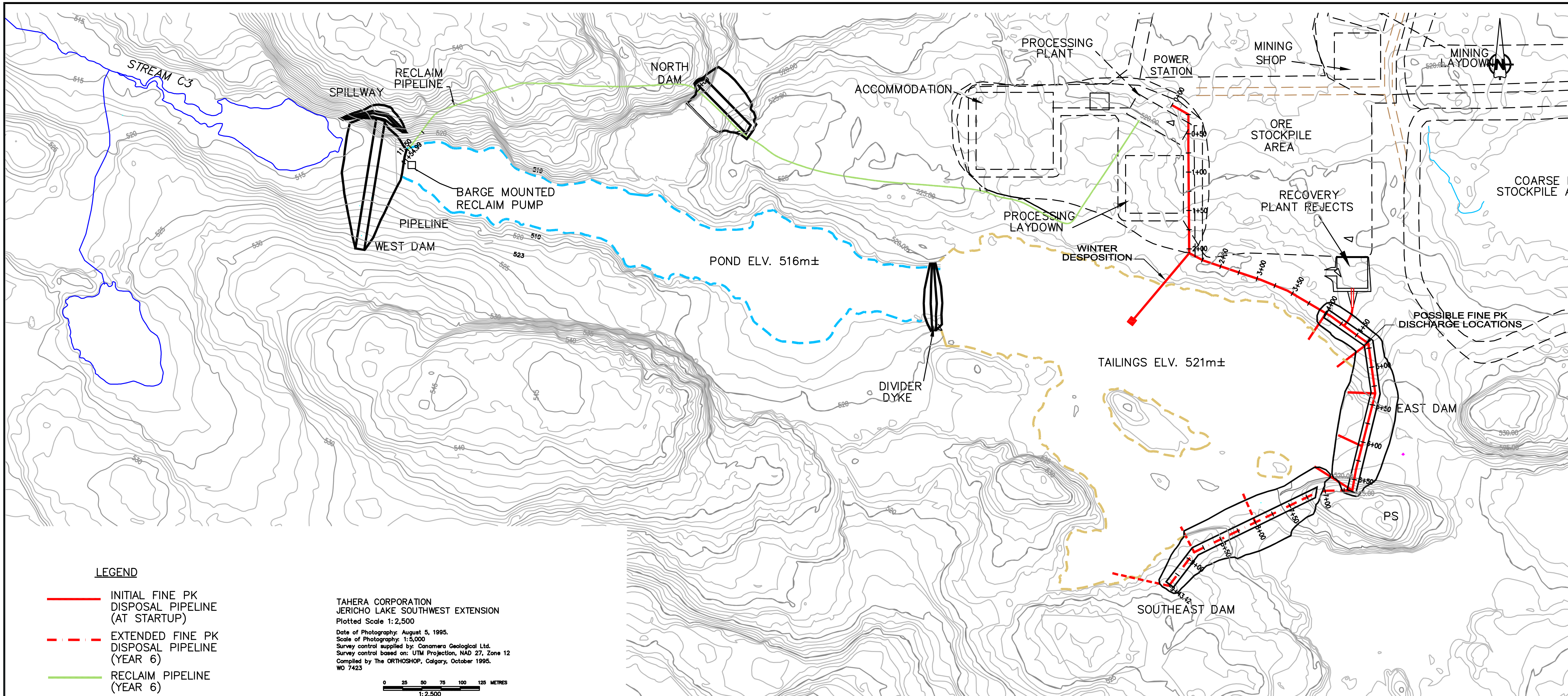
JERICHO PROJECT

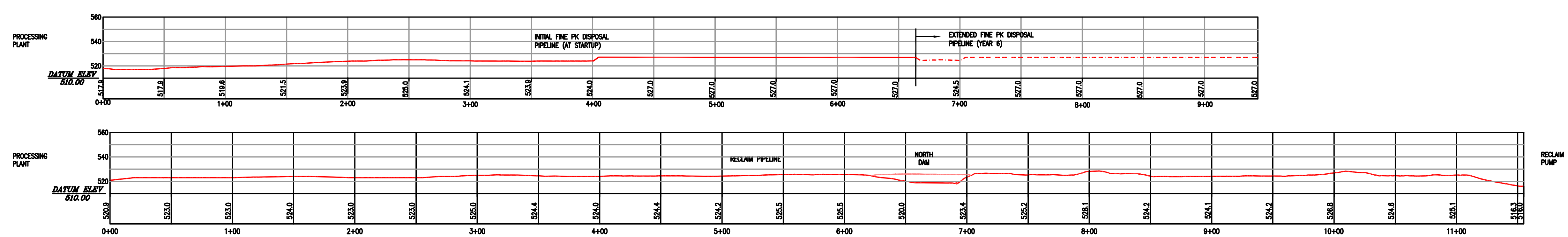
PKCA MONITORING PLAN SECTION & DETAILS

DRAWING NUMBER: 1CT004.06 – P10

REV. A

FILE NAME: F:\Tahera Corp (Lytton minerals)\Mapping and Drawings-2004 dwgs\REVISED...\PKCA DRAWINGS P7,P10.DWG





DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
DRAWING P-8	PKCA SPILLWAY AND THERMOSYPHON SECTIONS AND DETAILS		
DRAWING P-7	TYPICAL DAM CROSS SECTION AND DETAILS		
DRAWING P-6	SOUTHEAST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-5	EAST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-4	NORTH DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-3	WEST DAM GEOLOGIC CROSS SECTIONS		
DRAWING P-2	SITE INVESTIGATION AND TERRAIN MAP	DRAWING P-10	PKCA MONITORING PLAN AND SECTIONS
DRAWING P-1	LAYOUT OF THE PKCA	DRAWING P-9	CONSTRUCTION SEQUENCE

REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE

REVISIONS

REV.	ISSUE PURPOSE	AUTH. BY		DATE
A	WATER LICENSE APPLICATION	DL		JUNE 2004

ISSUE AUTHORIZATION

WATER LICENSE APPLICATION

SRK Consulting
Engineers and Scientists

DESIGNED BY: DL	DRAWN BY: JM
DATE: JUNE 2004	DATE: MAR. 2004
CHECKED BY: CCS	DISCIP. ENGR.
DATE: JUNE 2004	DATE:
PROJ. MGR:	PROJ. ENGR.
DATE	DATE

SRK PROJECT NUMBER: 1CT004.06

Tahera Diamond Corporation

JERICHO PROJECT

PIPELINE PLAN AND PROFILES

DRAWING NUMBER 1CT004.06 – P11

REV. A

FILE NAME: F:\Tahera Corp (Lytton minerals)\Mapping and Drawings-2004 dwgs\REVISED...\FIGUREP11.DWG

Appendix A

Thermal Analyses

SRK Consulting
Engineers and Scientists

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Vancouver, B.C. V6E 3X2
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Fax: 604.687.5532

Memo

To:	File	**Date:**	2004-05-05
cc:		**From:**	Michel Noël
Subject:	Jericho PKCA – Updated thermal calculations & modelling	**Project #:**	1CT004.06

1 INTRODUCTION

The PKCA containment dam cross sections were revised as part of further design work subsequent to the hearing with the Nunavut Impact Review Board in January 2004. This memo describes the thermal modelling that was carried out to assess the thermal regime at the West Dam, which is considered to be the most important of the revised PKCA dam sections. The purpose of the thermal modelling is to confirm that the core of the dam will remain sufficiently frozen for the required 8 years of operation.

2 INPUT PARAMETERS

2.1 Ground Properties

The ground properties used in the thermal analyses is represented by three material types, namely granite bedrock, glacial till and granular material (rockfill/crushed rock, filter material and esker sand). The granular material was also subdivided into saturated and unsaturated conditions.

The relationship between the unfrozen water content and the ground temperature, which is shown in Figure 1, is represented by two curves: one for the glacial till and one for the other materials (bedrock and the granular materials).

2.1.1 Bedrock

The thermal properties of the granitic bedrock were taken from Brown (1973) for pink granodiorite. The estimated values are:

- Bulk dry density: 2500 kg m^{-3}
- Porosity: 0.07
- Degree of saturation: 100%
- Thermal conductivity: Unfrozen: 203 kJ m^{-1} day^{-1} $°C^{-1}$; Frozen: 225 kJ m^{-1} day^{-1} $°C^{-1}$
- Volumetric heat capacity: Unfrozen: 2070 kJ m^{-3} °C; Frozen: 1926 kJ m^{-3} °C

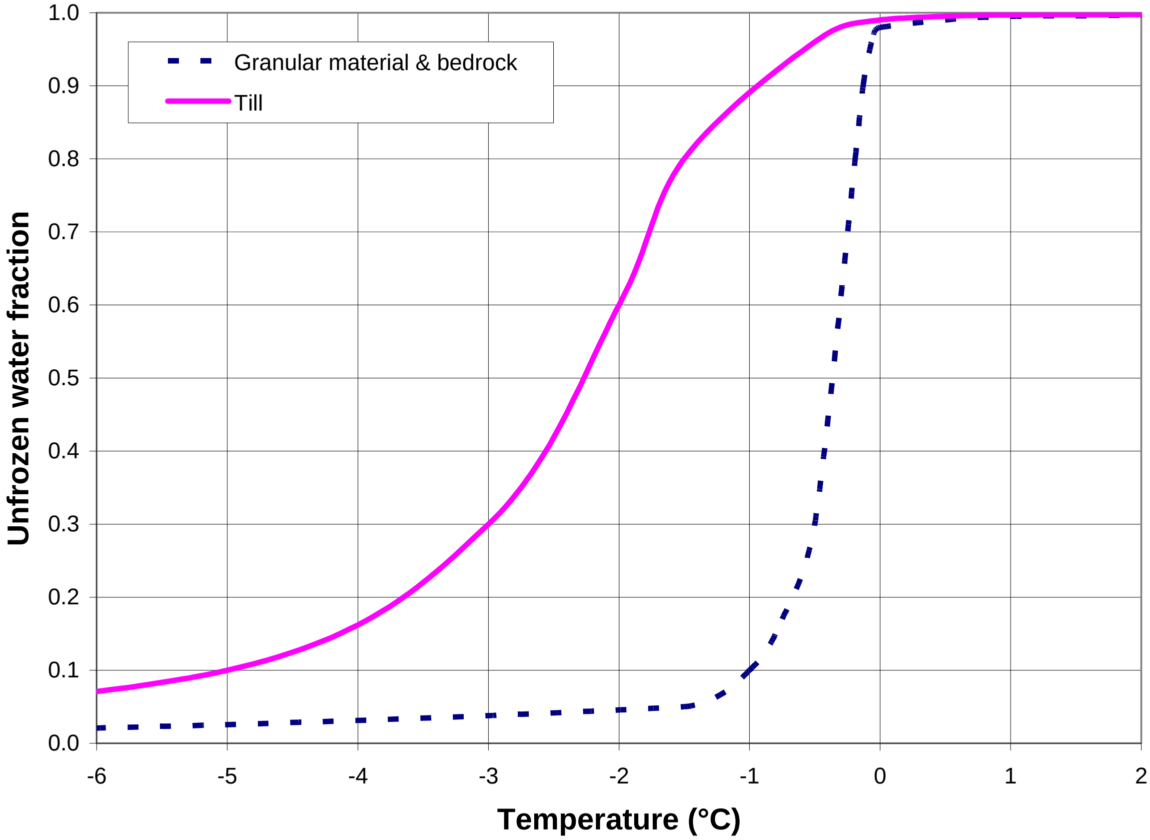

Figure 1: Unfrozen water fraction versus temperature

2.1.2 Overburden (glacial till)

The overburden is primarily a till with numerous cobbles and boulders. It was assumed that the till matrix controls the thermal properties of the overburden. The thermal conductivity was estimated using the method developed by Johansen (1975), assuming a quartz content of 10% and saturated conditions. The estimated thermal properties values are:

- Porosity: 0.30
- Degree of saturation: 100%
- Quartz content: 10%
- Bulk dry density: 2160 kg m^{-3}
- Thermal conductivity unfrozen: 150 kJ m^{-1} day^{-1} $°C^{-1}$
  frozen: 195 kJ m^{-1} day^{-1} $°C^{-1}$
- Volumetric heat capacity: Unfrozen: 2375 kJ m^{-3} °C
  Frozen: 1956 kJ m^{-3} °C

2.1.3 Granular material (rockfill, crushed rock, filter and transition materials)

For the purpose of this modelling, the thermal properties of the crushed rock/rockfill and the esker sand were considered similar. The thermal conductivity was also estimated based on Johansen (1975). The quartz content was also assumed to be at 10% and thermal properties were determined for saturated and unsaturated conditions. The values for the saturated granular soils are:

- Porosity: 0.30
- Degree of saturation: 100%
- Quartz content: 10%
- Bulk dry density: 2160 kg m^{-3}

•	Thermal conductivity	unfrozen:	168 kJ m^{-1} day^{-1} °C^{-1}
		frozen:	252 kJ m^{-1} day^{-1} °C^{-1}
•	Volumetric heat capacity:	Unfrozen:	2601 kJ m^{-3} °C
		Frozen:	1973 kJ m^{-3} °C

The values for the unsaturated granular material are:

- Porosity: 0.30
- Degree of saturation: 20%
- Quartz content: 10%
- Bulk dry density: 2160 kg m^{-3}

•	Thermal conductivity	unfrozen:	101 kJ m^{-1} day^{-1} °C^{-1}
		frozen:	75 kJ m^{-1} day^{-1} °C^{-1}
•	Volumetric heat capacity:	Unfrozen:	1597 kJ m^{-3} °C
		Frozen:	1471 kJ m^{-3} °C

2.2 Climatic Data

Climatic data at the Jericho site is limited and not sufficient to calculate proper climatic averages. The data from the Lupin Mine weather station was therefore used to develop the climatic input required by the thermal model. The following key parameters were calculated from a 30 year dataset, from 1972 to 2001 inclusive.

- mean annual ambient temperature: -11.1 °C
- mean annual amplitude of ambient temperature: 20.6 °C
- "warm" mean annual ambient temperature: -8.9 °C
- "warm" annual amplitude of ambient temperature: 21.0 °C

The "warm" values were calculated from the three warmest mean annual ambient temperatures over the 30 year dataset. Given the relatively short period of mine operation (8 years), the impact from global warming was not incorporated into the thermal simulations, although the "warm" average was used to simulate the daily ambient temperatures.

2.3 Ground Temperature

The Jericho site is underlain by continuous permafrost, which was confirmed by ground temperatures measured at various locations at the site. The measurements show:

- ground temperatures usually colder than -4 °C
- an active zone about 2.5 to 3.0 m thick
- depths of zero annual amplitude between 15 and 20 m

The geothermal gradient measured in the Jericho kimberlite pipe was estimated at 1 °C km^{-1} using the temperature data reported by BGC (1996). Such low geothermal gradient would correspond to a permafrost depth of about 4000 m, thus unrealistic. The geothermal gradient of 9 °C km^{-1} was used in the thermal model, which would correspond to a permafrost depth of about 450 m and is consistent with published data from the Jericho Area (Canamera Geological, 1996).

2.4 Freezing Temperature

There is no indication of saline pore water at the Jericho site, thus suggesting that the pore water will freeze at or near 0 °C. A freezing temperature of 0 °C was used for water in the model.

3 THERMAL MODELLING

3.1 Model Description

The thermal modelling presented herein was carried out using the finite element thermal model SVHEAT version 3.09 developed by SoilVision Systems Ltd. SVHEAT models heat transport for both steady-state or time-dependent analyses. It incorporates the latent heat associated with phase changes of water. The geometry is treated as a 2D vertical cross-section. SVHEAT supports multiple boundary conditions as well as transient boundary conditions. The size and density of the finite elements are determined by the model and are based on numerical convergence and error criteria. Further details are available in the User's Manual of SVHEAT (SoilVision Systems, 2004).

3.2 Scenario

The thermal model was used to simulate the thermal regime at the West Dam under seasonal fluctuations over a period of 10 years. The "warm" dataset (see Section 2.2) was used for the climatic data in the model. The interpretation is based on the position of the 0 °C isotherm over the 10^{th} year of simulation.

3.3 Setup

Geometry

The geometry was set to 275 m wide and 116 m high along the existing ground surface, plus another 11 m for the West Dam, for a maximum height of 127 m at the crest of the dam (assumed crest elevation of 527 mamsl). The stratigraphy is represented by 23 m of glacial till over 93 m of bedrock. Figures 2 and 3 show the finite element mesh that was used for the simulations. The vertical scale is offset by 400 m with the geodesic elevation; for instance, elevation 127 m in the model is equivalent to geodetic elevation 527 m. The entire model domain is constructed using about 5064 nodes (bedrock 468; overburden 3110; dam 1486) and 9164 elements (bedrock 828; overburden 5820; dam 2516).

The material of the dam, for the purpose of the thermal modelling, is considered as a granular soil that is either saturated or unsaturated. The saturated zone is defined by the maximum water level on both sides of the dam: elevation 525 m on the upstream side and 520 m on the downstream side. The only material that is not considered saturated is the block of soil located above the central core and above the downstream and upstream water levels (see Figure 3). In reality, the operation of the PKCA will limit the water elevation to 523 m (except when the spillway is passing water) and, if constructed, the settling pond will be limited to 519.5 m (or less). The difference between the expected maximum water levels and the ones used in the thermal model is to compensate for settlements and increase the magnitude of the heat source introduced by the stored water.

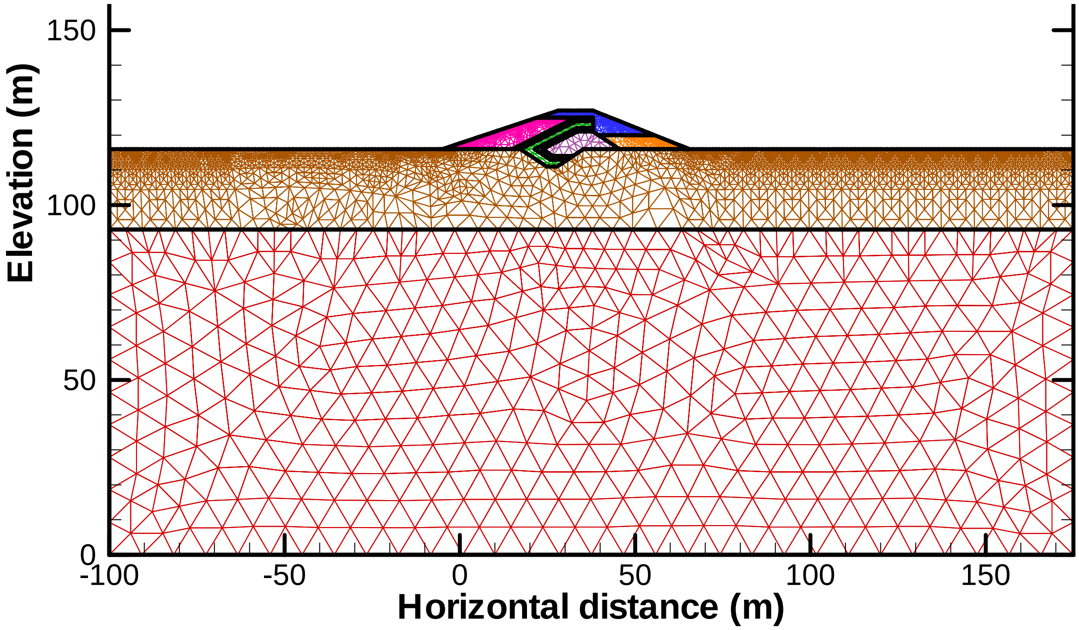

Figure 2: West Dam, finite element mesh used by thermal model.

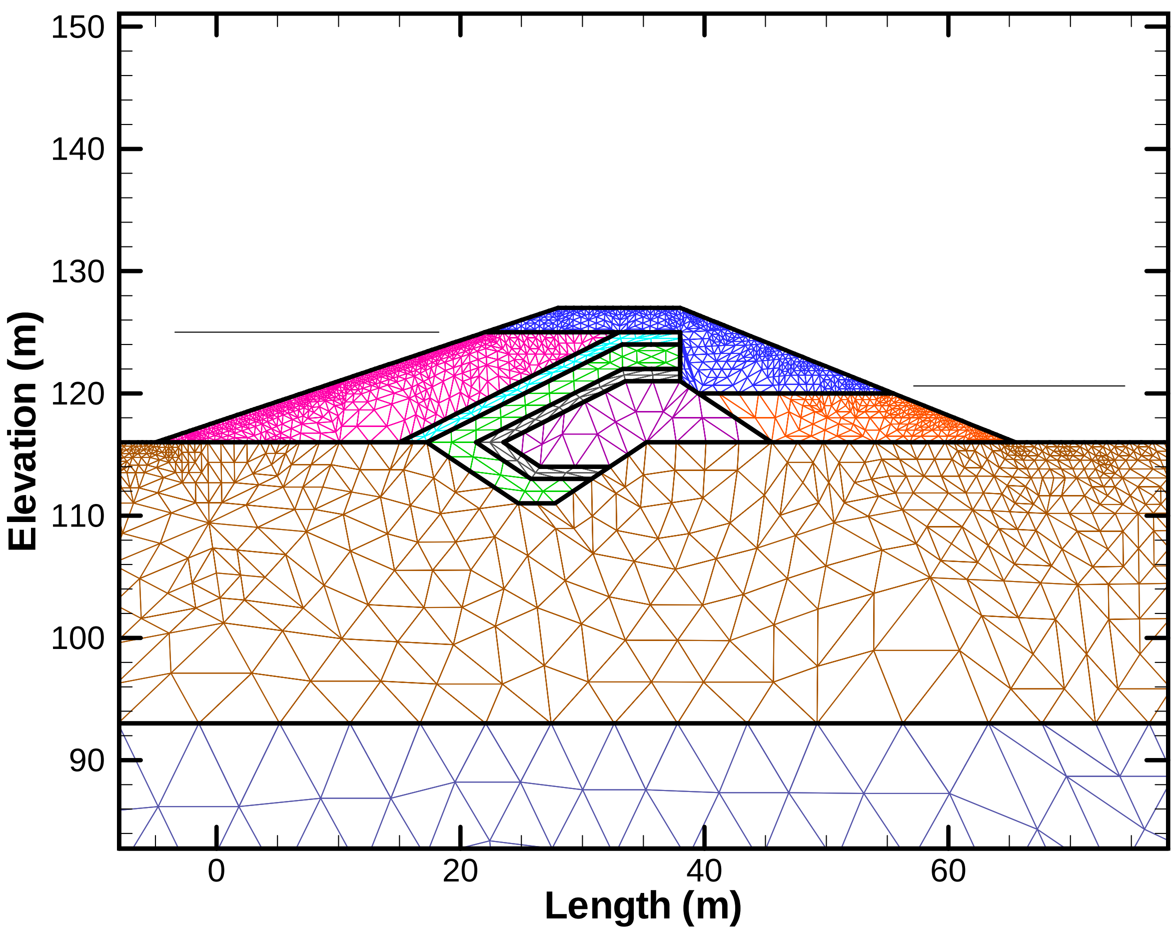

Figure 3: West Dam, finite element mesh used by thermal model, detail of dam

Boundary Conditions and Initial Conditions

The boundary conditions were as follow:

- Bottom boundary: geothermal heat flux of 2.02 kJ day^{-1} m^{-1}, based on a geothermal gradient of 9 °C km^{-1} and a thermal conductivity of 2.25 kJ m^{-1} day^{-1} $°C^{-1}$ (frozen bedrock).
- Left and right vertical boundaries: no heat flux conditions.
- Original ground surface and the submerged portions of the dam (assumptions of submergence are elevation 525 mamsl on the upstream side and elevation 520 mamsl on the downstream side): time-dependent surface temperature but limited to 5 °C or warmer.
- Portion of the dam not submerged: time-dependent surface temperature with no temperature restriction.

The boundary condition that simulated the surface temperature along the ground surface and the dam is based on the daily ambient air temperature and the use of coefficients that represent the type of surface. The daily ambient air temperature was approximated by a time-dependent sinusoidal function in the form of:

$$T_A(t) = T_{MAAT} + A\sin(2\pi \frac{t}{P}) \qquad (1)$$

where T_A = ambient temperature (°C)
t = time (days)
T_{MAAT} = mean annual ambient temperature = -8.9 °C
A = annual amplitude of the ambient temperature = 21.0 °C
P = period of the oscillation = 365 days

The climatic data is based on the "warm" average mentioned Section 2.2.

The daily ambient temperatures were then converted to surface temperatures by using freezing and thawing surface indices whether the ambient temperature was above or below freezing. The daily surface temperatures were calculated as:

$$T_S(t) = n_i T_A(t) \qquad (2)$$

where T_s = Surface temperature
n_i = Surface index
n_t if $T_A(t) > 0$ °C (thawing surface index, summer conditions)
n_f if $T_A(t) < 0$ °C (freezing surface index, winter conditions)

The winter condition is represented by a snow cover for both the submerged and exposed surfaces, with n_f set to 0.33 or 0.5. The freezing surface index was set to 0.5 along the crest of the dam where snow accumulations will be less; the other surfaces were set to 0.33 where the snow accumulation will likely be larger (ground surface and sloped surfaces of the dam). The thawing surface index (summer conditions) was different between the submerged and exposed surfaces. The index n_t was set to 1.0 for the submerged zone (follows the ambient air temperature) while the exposed portion of the dam was assigned a n_t value of 2.0, which is representative of an exposed granular soil surface (Andersland and Ladanyi, 2004). The submerged zones were assigned a restriction: the surface temperature along that submerged portion could not go below +5 °C to simulate the presence of water against the dam. Figure 4 shows the estimated annual surface temperatures used for boundary conditions. The red curve corresponds to the submerged boundary sections and the blue curve, the expose area of the dam above the water.

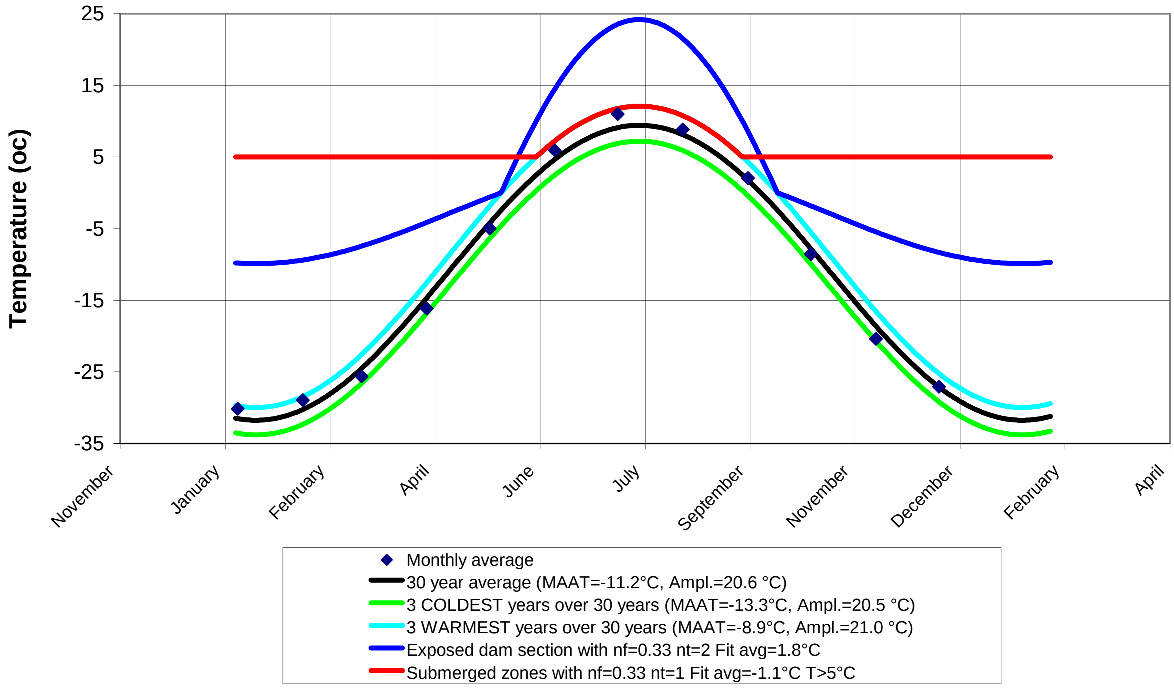

Figure 4: Annual ambient air temperature and surface temperatures.

The initial condition for the time-dependent simulation is based on a steady-state simulation where the upper boundaries were all set to a constant temperature of -4 °C. The left, right and bottom boundaries were set identical to time-dependent simulations described above.

3.4 Results and Interpretation

The time-dependent thermal simulation shows that the central core of the dam will remain frozen after 10 years of operation (see Figure 5), which is 2 years longer than the currently expected mine life. It shows that the 0 °C isotherm barely penetrates the central frozen core. Such temperature distribution is consistent with observations reported in the literature (Biyanov, 1976; Holubec and Dufour, 1986; Holubec and Hu, 2003).

The time dependent simulation also indicates that the active zone does not penetrate core below the location of the liner. This confirms that the 2.5 m thick granular cover is sufficient to protect the core from reaching temperature in excess of 0°C.

The simulations described herein assumed that both sides of the dam will have the maximum water level during the entire period of operation. The expected water level in the PKCA will only reach those maximum levels under extreme conditions and for short periods. The boundary conditions used in the thermal model simulate thermal conditions that are worst than what is expected, thus further supporting the conclusion that the central core portion of the dam will remain frozen over the expected 8 years of operation.

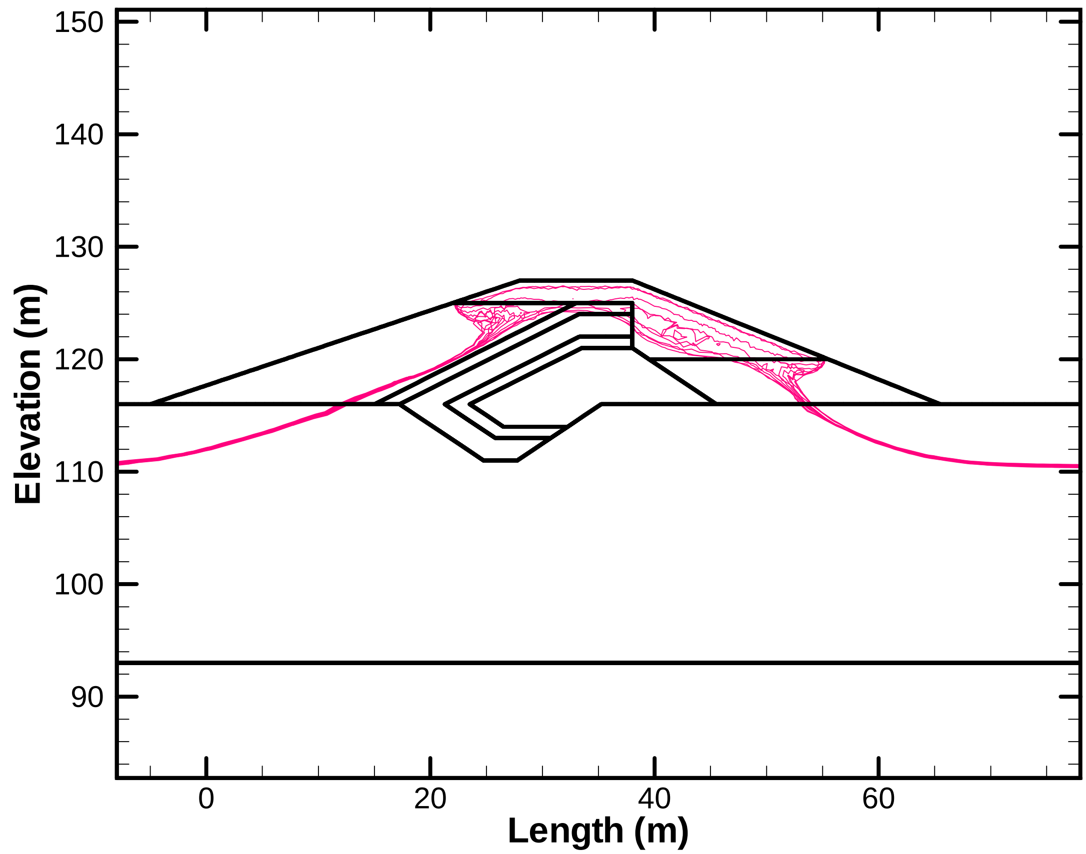

Figure 5: West Dam, time-dependent simulation, annual variation of the 0 °C isotherm assuming the operational life of the mine is 10 years. The lowest red line is the 0 °C isotherm after 10 years.

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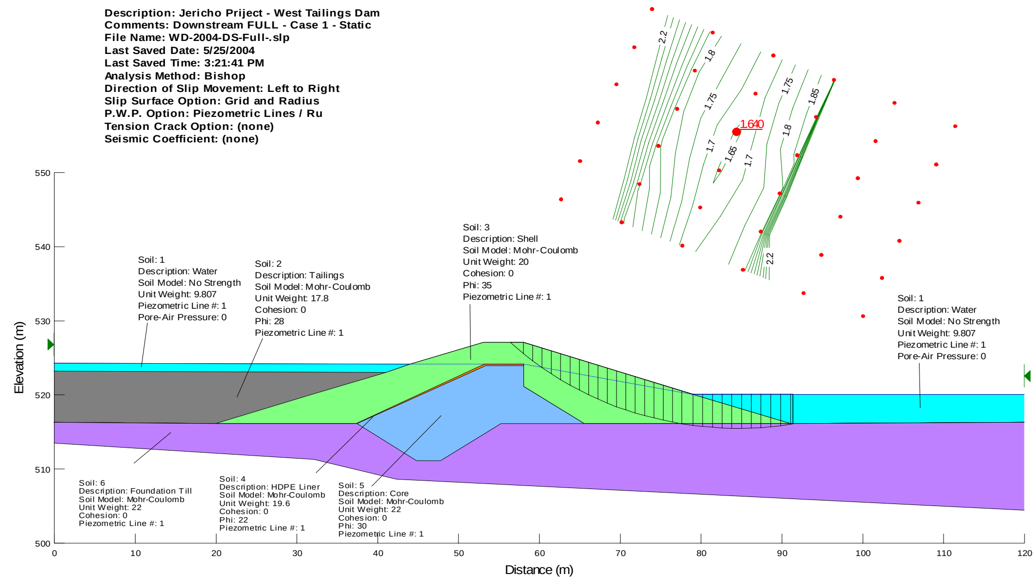
Appendix B

Stability Analyses

Jericho West Tailings Stability Analysis - 2004

Material Properties

Material	Phi (degrees)	C (kPa)	Unit Weight (kN/cu.m.)
Shell	35	0	20
GCL Liner	11	0	19.6
Core	30	0	22
Tailings	28	0	17.8
Foundation Till	32	0	22



Geometry

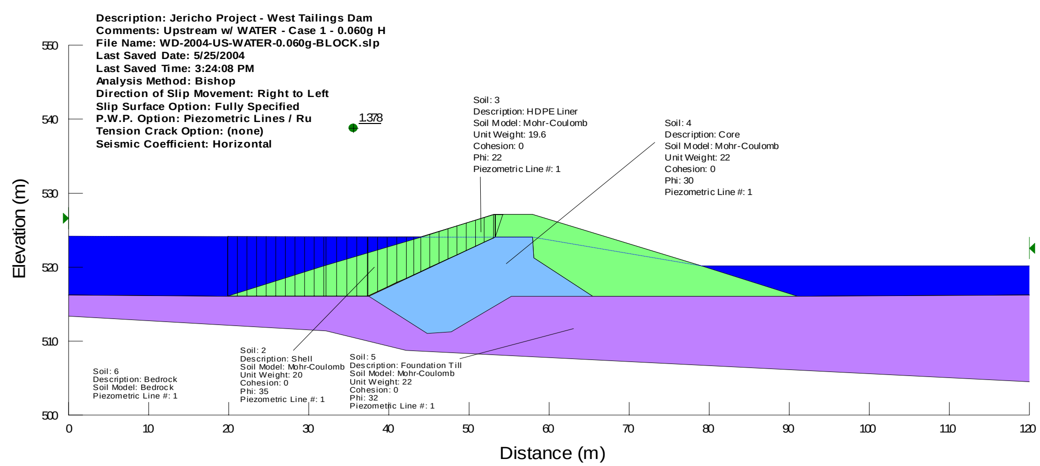
Dam Height (m) 11.0

Slope 18 deg (3H:1V)

Results

Case	FOS	g	Comments
Downstream, Full tails & Water	1.640	0	Circular thru toe
Downstream, Full tails & Water	1.558	0.013	Circular thru toe
Downstream, Full tails & Water	1.312	0.060	Circular thru toe

Case	FOS	g	Comments
Upstream, No Tails & Full Water	1.955	0	Circular thru toe
Upstream, No Tails & Full Water	1.825	0.013	Circular thru toe
Upstream, No Tails & Full Water	1.460	0.060	Circular thru toe
Upstream, No Tails & No Water	1.447	0	Circular thru toe
Upstream, No Tails & No Water	1.383	0.013	Circular thru toe
Upstream, No Tails & No Water	1.189	0.060	Circular thru toe
Upstream, No Tails & Full Water	1.409	0	Block thru liner
Upstream, No Tails & Full Water	1.318	0.013	Block thru liner
Upstream, No Tails & Full Water	1.066	0.060	Block thru liner



Manual Infinite Slope Case Analysis

Slope angle = 18 deg

Waste rock phi = 35 deg

Fs = Tan(35)/Tan(18)

Infinite Slope Fs = 2.16

Appendix C

PK Hydraulics/Piping Design

1 Introduction

Hydraulic calculations and detailed design were carried out for the three PKCA pipelines, namely the fine PK disposal pipeline, the reclaim pipeline and the discharge pipeline. Pipe routes and sections for these pipelines are shown on Drawing No 1CT004.06 – P-11.

Fine PK will be pumped from the thicker underflow location to the eastern side of the PKCA. Deposition of the fine PK will only be from the east dam during the first three years. In year 4 the fine PK deposition pipeline will be extended southwards to the end of the southeast dam embankment. The slurry deposition will be sub-aerial and the slurry will be discharged from a single deposition point. During winter months the deposition point will be moved closer to the edge of the pool to avoid potential major ice entrapment.

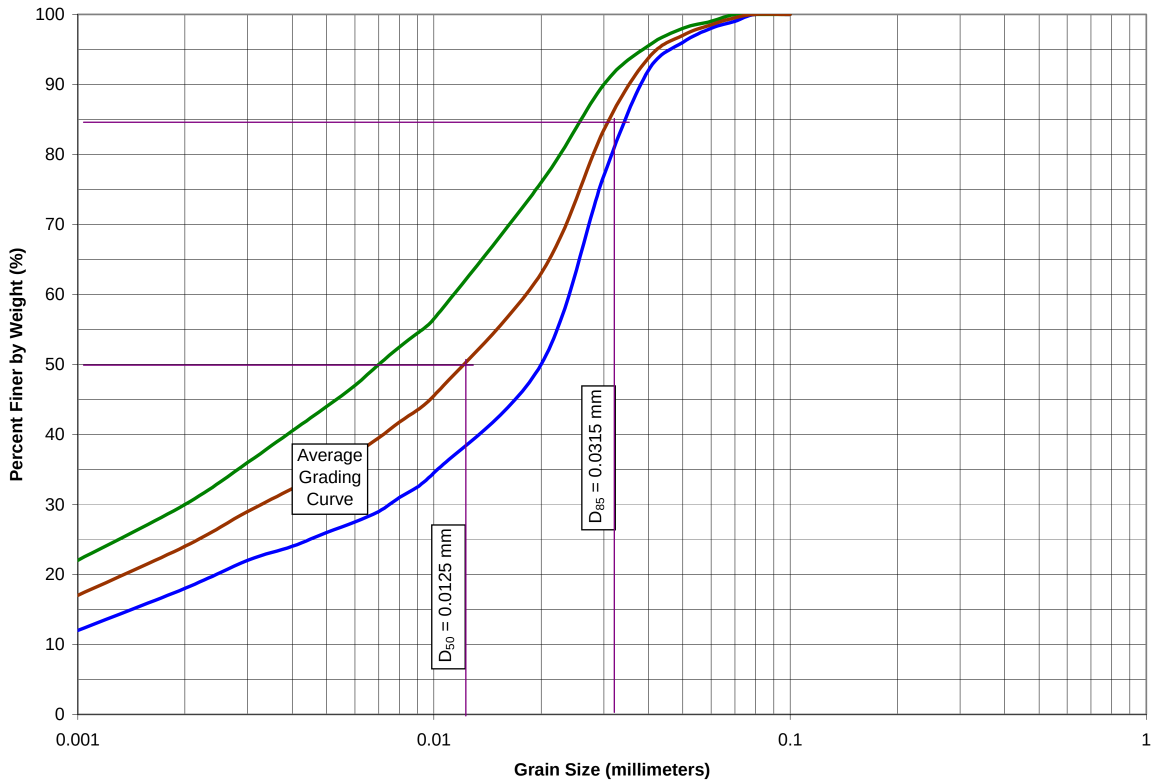
2 Available Information

The following information was used to design PK slurry delivery and deposition pipeline:

- Design production: 47,500 tonnes per annum or 130 tonnes per day
- PK slurry solids concentration by mass: 30%
- PK solids specific gravity: 2.65 t/m^3
- Maximum design slurry velocity: 2 m/s
- Thickener underflow tie-in elevation: 518 mamsl
- East Dam embankment elevation: 527 mamsl
- Southeast Dam embankment elevation: 527 mamsl
- Length of initial fine PK pipeline : 750 m
- Length of final PK pipeline: 950 m
- Insulated HDPE pipes are be used for slurry transport
- No heat tracing is required for the PK slurry pipes
- Slurry deposition is a 365 days, 24 hours operation

An envelope of the fine PK solids grading was obtained from DRA. The average grading values were calculated and both the envelope and the average grading are presented on Figure 1.

Figure 1: Gradation Envelope for Fine PK Solids



3 Hydraulic Calculations for Slurry Pipeline

Based on the above information the following total slurry parameters were calculated:

- The slurry specific gravity : 1.23 t/m^3
- The solids concentration by volume : 14 %
- The slurry design flow : 4.1 l/s

Preliminary calculations indicated that using a 75mm diameter HDEP SDR11 pipe will result in the slurry velocity of just below 1 m/s (0.98 m/s), while the slurry velocity through a 50 mm diameter HDEP SDR11 pipe will be 2.13 m/s which is in excess of the 2 m/s proposed maximum design slurry velocity. Since the slurry velocity in the 50 mm HDPE pipe is slightly exceeding the maximum design velocity, the transition velocities were calculated for both 75 mm and 50 mm diameter pipes.

Transition velocities from part stationary bed to fully moving bed and from fully moving bed to fully suspended flow were calculated for the fine PK slurry conveyed in both 50 mm and 75 mm diameter HDPE pipes using the following formulae.

Transition velocity from part stationary bed to fully moving bed was calculated using Wasp's[1] formulae:

$$V_{dep} = F_L \sqrt{2gD(S_S - S_W)} \left(\frac{d}{D}\right)^{\frac{1}{6}}$$

where:

V_{dep} - slurry deposition velocity (m/s)
F_L - function of solids concentration by volume
g - gravitational constant (9.81 m/s^2)
d - representative particle diameter d_{50} (m)
D - pipeline diameter (m)
S_s - solids relative density (t/m^3)
S_w - water relative density (t/m^3)

This transition velocity was calculated to be 0.76 m/s for a 50 mm diameter pipe and 0.92 m/s for a 75 mm diameter pipe.

In addition, transition velocity from fully moving bed to fully suspended flow was calculated using Durand's[2] correlation:

$$V_{susp} = F_L \sqrt{2gD(S_S - S_W)}$$

where:

V_{susp} - slurry suspension velocity (m/s)
F_L - Durand's limiting settling velocity parameter as a function of particle size and solids concentration for solids of closely graded sizing
g - gravitational constant (9.81 m/s^2)
D - pipeline diameter (m)
S_s - solids relative density (t/m^3)
S_w - water relative density (t/m^3)

This transition velocity was calculated to be 2.8 m/s for a 50 mm diameter and 3.7 m/s for a 75 mm diameter HDPE pipe.

The operational velocity in the pipeline should be maintained between the two transitional velocities in order to maintain blockage free operation and avoid excessive friction losses. Corresponding velocities for both pipe diameters are summarized in Table 1.

Table 1: Slurry Transition and Operating Velocities

Pipe nominal diameter (mm) and pressure rating	Transition velocity from part stationary bed to fully moving bed (m/s)	Transition velocity from fully moving bed to fully suspended flow (m/s)	Operational velocity (m/s)
50 mm SDR11	0.76	2.8	2.13
75 mm SDR11	0.92	3.7	0.98

Both 50 mm and 75 mm diameter pipes can be used to convey slurry. Velocity of the slurry in the 75 mm diameter pipe is very close to the transition velocity from part stationary bed to fully moving bed, i.e., the minimal slurry velocity. Any potential decrease in slurry flow will result in a decrease in slurry velocity. Since the operational velocity is very close to the minimal design velocity, the decrease in velocity may result in settling of solids and subsequent blockage of the pipeline. Therefore, the 50 mm diameter HDPE pipe is recommended for the fine PK slurry conveyance.

Hydraulic calculations were carried out for the winter deposition pipeline, pipeline for deposition during years 1-4 and the final pipeline length (after year 4).

Modified Durand's correlation was used in the hydraulic calculations:

$$\frac{\Delta P}{\Delta L} = \frac{\Delta P}{\Delta L_W}\left[1 + 85 C_{vd}\left(\frac{gD\left(S_s - S_w\right)}{V_m^{\ 2}}\frac{1}{\sqrt{C_D}}\right)^{\frac{3}{2}}\right]$$

where:

$\frac{\Delta P}{\Delta L}$ - slurry pressure gradient (m/m)

$\frac{\Delta P}{\Delta L_W}$ - clear water pressure gradient (m/m)

C_{vd} - delivered volumetric solids concentration

g - gravitational constant (9.81 m/s^2)

D - pipeline diameter (m)

S_s - solids relative density (t/m^3)

S_w - water relative density (t/m^3)

V_m - mean slurry velocity (m/s)

C_D - drag coefficient

The clear water pressure gradient was obtained by applying the Darcy-Weisbach formulation:

$$\frac{\Delta P}{\Delta L_w} = \frac{2\rho f V^2}{D}$$

Swamee and Jain[3] correlation was adopted for the friction factor calculation:

$$f = \frac{0.33125}{\left[\ln\left(\frac{k}{3.7D} + \frac{5.74}{\mathrm{Re}^{0.9}}\right)\right]^2}$$

where:

$\frac{\Delta P}{\Delta L}$ - clear water pressure gradient (m/m)

ρ_w - fluid density (kg/m3)

f - friction factor

V - fluid velocity (m/s)

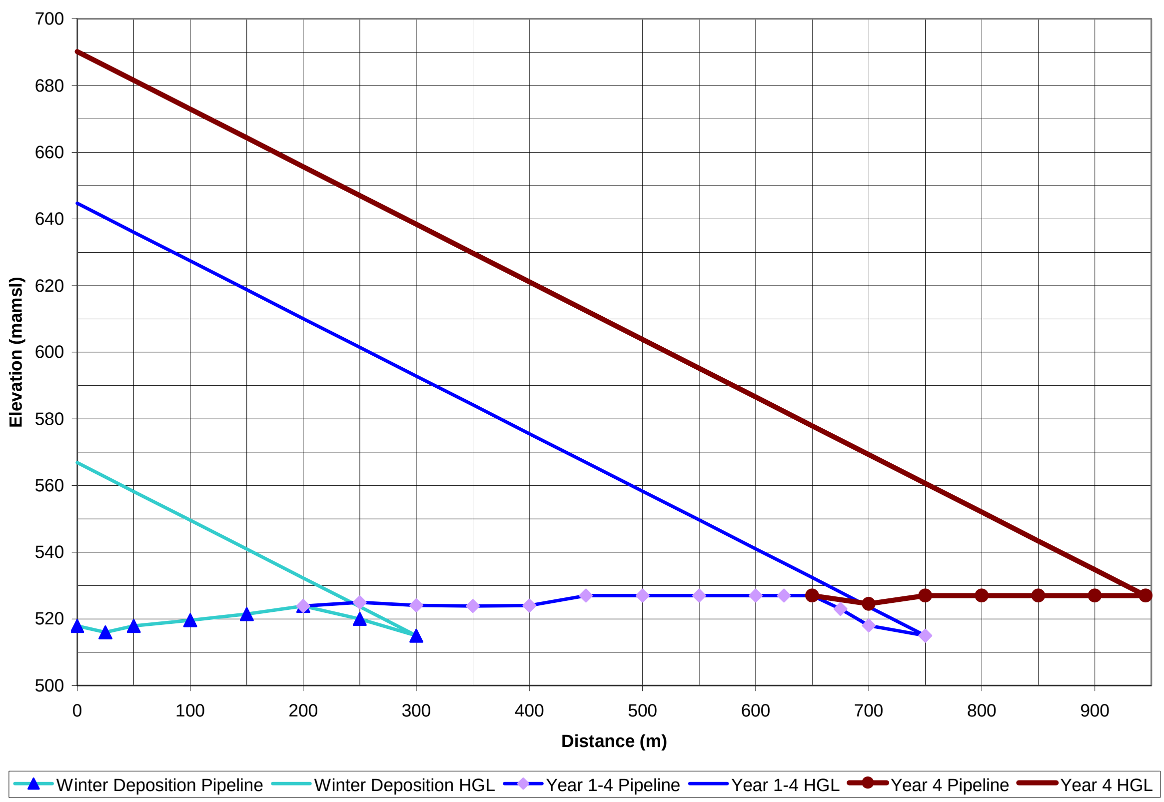
D - pipeline diameter (m)

k - hydraulic pipe roughness (m)

Re - Reynolds number

Hydraulic calculations were carried out for the slurry flow from the PK thickener to the slurry discharge points at PKCA. Three deposition scenarios were evaluated and the results are presented on Figure 2.

Figure 2: PK Fine Slurry - Long Sections and Hydraulic Grade Lines



During winter months the fine PK slurry will be conveyed through a 300 m long pipeline (including a 100 m long spigot drop pipe) and deposited via a spigot pipe along the northern slope of the PKCA. With the 50 mm diameter HDPE SDR11 slurry pipe, the total head required for this deposition is 520 kPa.

Hydraulic calculations for the Year 1-4 fine PK pipeline were carried out for the 750 m long pipe and include the furthest spigot drop pipe located at the end of the East Dam embankment. The calculations indicate that a 1,300 kPa head will have to be generated by the PK pump in order to convey the design flow of 4.1 l/s to the deposition point.

Hydraulic calculations for the Year 4 PK pipeline extension were carried out for the 950 m long pipe and include the furthest spigot drop pipe. With the 50 mm diameter HDPE SDR11 slurry pipe, the total head required for this deposition is 1,620 kPa.

The SDR 11 pipeline design pressure rating is suitable for the working pressure of up to 1,100 kPa. The pressure required for transport of slurry at the end of the year 1-4 deposition will exceed the SDR11 pipeline pressure rating by less than 20%. However, the pipeline extension after the Year 4 will require installation of the higher pressure rating (SDR 9) pipeline along the 300 meters longs section from the plant to the tailings impoundment.

4 Hydraulic Calculations for Reclaim and Overflow Pipelines

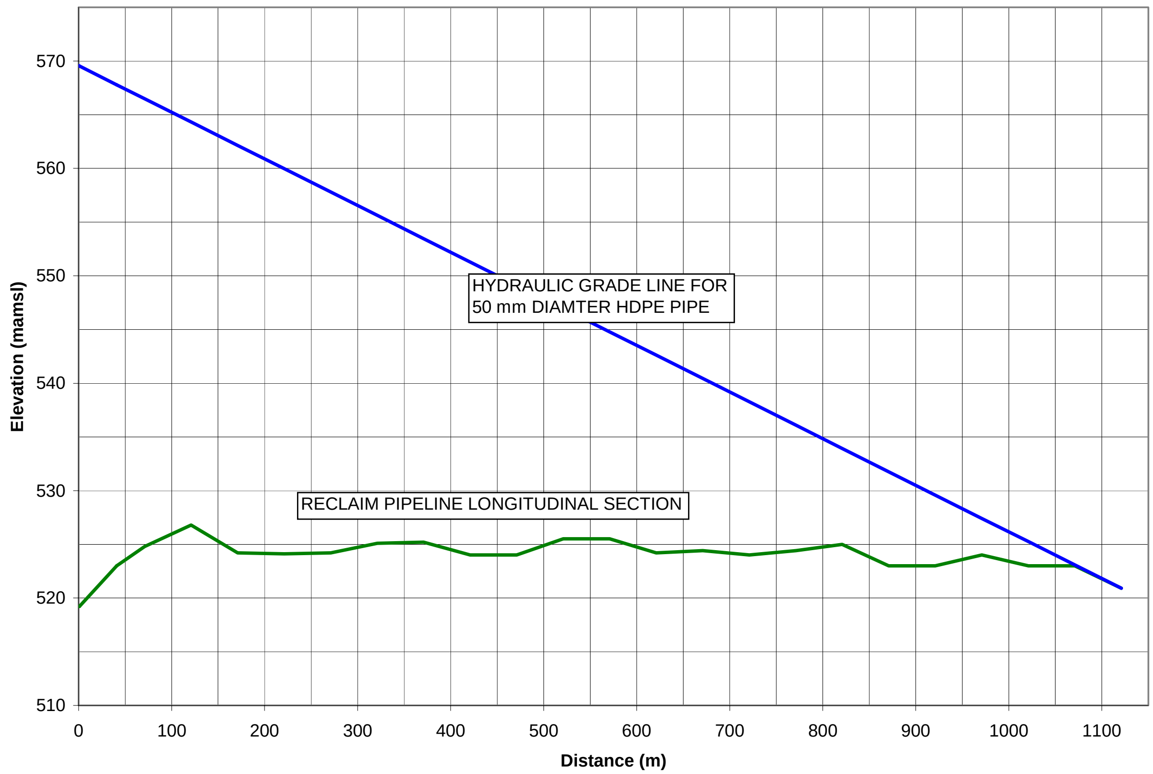
4.1 Reclaim Pipeline

Water management facilities for the PKCA include reclaim/decant facilities. Reclaim to the process plant and decanting of excess water to Stream C3 will likely only occur during the summer months. For the design purposes it was assumed that 80% of the process plant water will be reclaimed, pumped back and used in the process circuit. The fine PK slurry contains 3.5 l/s, which results in a reclaim design flow of 2.8 l/s.

Hydraulic calculations for the reclaim pipeline were carried out using the Darcy-Weisbach formulae. Using a 50 mm diameter HDPE pipe to convey the design flow of reclaim water will result in a flow velocity of 1.5 m/s and will require a pump capable of generating a 500 kPa of head. The results of the hydraulic calculations are presented on Figure 3.

It is anticipated that a barge with a barge pump will be used to pump the reclaim water back to the plant during summer months. The barge and the pump will be removed from the reclaim pond and the 1,120 meters long reclaim pipeline will be winterized prior to onset of the freezing weather.

Figure 2: Reclaim Water - Long Sections and Hydraulic Grade Lines



4.2 Seasonal Discharge Pipeline

Under operational conditions water will be decanted from the PKCA via a pump to a position downstream of the West dam each summer to remove excess water that meets discharge criteria. The amount of water to be removed will vary depending on inflow inputs and water management criteria. A normal operating basis would be to maintain the free standing water level in the PKCA at the west dam near the natural existing level to maintain seasonal flows in stream C3.

Water balance calculations were used to determine design flow for the design of the seasonal discharge pipeline. It is anticipated that the flows will be paced to those in the receiving environment over the four summer months with the highest flow in June (~117 l/s) adopted as the design flow, ~ 28 l/s during July and August and ~ 14 l/s during September.

The controlled release pipeline will be about 200 m long. A 350 mm diameter HDPE SDR 32.5 pipe and a barge pump capable of pumping 117 l/s at a head of 200 kPa are required to convey the design flow. The barge pump will be installed on the same barge used to house the reclaim pump. The seasonal discharge pump will be disconnected and removed from the barge and the pipeline winterized prior to the onset of the freezing weather.

5 References:

[1] Wasp, E.J., T.C. Aude, J.P. Kenny, R.H. Seiter and R.B. Jacques (1970) *"Deposition Velocities, Transition Velocities and Spatial Distribution of Solids in Slurry Pipelines",* 1st International Conference on the Hydraulic Transport of Solids in Pipes, BHRA, Coventry, UK, September.

[2] Durand, R. and E.J.Condolios (1952*) de l'Hydraulique, Soc. Hydro-technique de France*

[3] Swamee and Jain (1976) *Journal of Hydraulic Engineering, ASCE, May*

Appendix D

Schedule of Quantities

Schedule of Quantities for Jericho Project's PKCA

ITEM	DESCRIPTION	UNIT	QUANT.	RATE	AMOUNT
1	**Preliminary and General**				
1.1	Mobilization, including establishment of all plant, equipment and personnel on site to enable performance of the workscope to the specifications required.	LS			
1.2	Time related running costs including supervision, survey, maintenance and testing required to enable performance of the workscope to the specifications required.	week			
1.3	De-mobilization, including dis-establishment of all plant, equipment and personnel, and leaving the site in a neat, safe condition.	LS			
1				**Subtotal**	
2	**Excavation and Earthworks**				
2.1	Install structural storm water controls (BMP's) - hay bales, silt fences etc as required.	LS	1		
2.2	Bulk excavation to dam embankment footprint to remove surface deleterious material. Material to be disposed of as directed by the Engineer.				
2.2.1	West Dam	m^3	8,500		
2.2.2	East Dam	m^3	3,150		
2.2.3	Southeast Dam	m^3	2,475		
2.2.4	North Dam	m^3	490		
2.3	Extra Surface Preparation to base of West Dam under the ice core - assumed to be an additional 1 m.	m^3	650		
2.4	Bulk excavation for dam embankment key-cut as shown on drawings. Material to be disposed as directed by the Engineer.				
2.4.1	West Dam	m^3	3,300		
2.4.2	East Dam	m^3	2,800		
2.4.3	Southeast Dam	m^3	2,450		
2.4.4	North Dam	m^3	0		
2.5	Frozen core fill (material A) to dam embankment as shown on drawings. Esker sand material from identified borrow sources to be used. Rate to include loading, haulings, drying, controlled moisture addition, placement and compaction in thin lifts.				
2.5.1	West Dam	m^3	13,500		
2.5.2	East Dam	m^3	2,700		
2.5.3	Southeast Dam	m^3	2,250		
2.5.4	North Dam	m^3	7,000		
2.5.5	Divider dyke	m^3	1,500		

Schedule of Quantities for Jericho Project's PKCA

ITEM	DESCRIPTION	UNIT	QUANT.	RATE	AMOUNT
2.6	Structural fill of transition zone material (material B) to dam embankments as shown on drawings. Selected/screened waste rock not exceeding 150 mm to be used. Rate to include for crushing, screening, loading, hauling, placement and compaction.				
2.6.1	West Dam	m^3	8,200		
2.6.2	East Dam	m^3	3,800		
2.6.3	Southeast Dam	m^3	3,250		
2.6.4	North dam	m^3	4,800		
2.7	Structural fill of selected shell material (material C) to dam embankments as shown on drawings. Run-of-mine waste rock to be used. Rate to include for selecting, loading, hauling, placement and compaction.				
2.7.1	West Dam	m^3	27,500		
2.7.2	East Dam	m^3	0		
2.7.3	Southeast Dam	m^3	0		
2.7.4	North Dam	m^3	16,000		
2.8	Structural fill of shell material (material D) to portions of dam embankments. Coarse PK to be used. Rate to include for loading, hauling, placement and compaction.				
2.8.1	West Dam	m^3	0		
2.8.2	East Dam	m^3	32,500		
2.8.3	Southeast Dam	m^3	28,000		
2.8.4	North Dam Road Access Causeway	m^3	4,000		
2.8.5	North Dam	m^3	0		
2.8.6	Divider dyke	m^3	6,000		
2.9	Excavate embankment spillway to West Dam embankment as shown on the drawing. Material to be disposed of as directed by the Engineer.	m^3	3,400		
2				**Subtotal**	
3	**Geocomposite Clay Liner (GCL)**				
3.1	Supply and install GCL at the downstream side and base of the of dam embankments.				
3.1.1	West Dam	m^2	3,000		
3.1.2	East Dam	m^2	--		
3.1.3	Southeast Dam	m^2	--		
3.1.4	North Dam Road Access Causeway	m^2	680		
3.1.5	North dam	m^2	1,800		
3				**Subtotal**	