approximately 13.2 m^3/s for the 100-yr return storm and approximately 50 m^3/s under the PMP conditions.

Based on the design drawing (Kilborn, 1977), the diversion channel base is approximately 5.5 m wide and it has a base gradient of 0.7%.

Design flows conditions are summarized on Table 14. The calculated flow depth under the PMP conditions is 2.2 m and the estimated flow velocity is 2.9 m/s.

6.6.3 Design Details

6.6.3.1 Dike Protection Measures

Considering the design flow conditions described in Section 6.6.2, it is recommended that the Diversion Dike be protected with rip rap with mean particle size of 300 mm. Construction volumes for the East Twin Lake Diversion Channel Upgrade are provided in Table 15.

A radius is provided to ensure uniform flow near the dam. Protection beyond the ends of the dam is required. As a preliminary basis, a 20 m length is assumed. This will have to be confirmed in the field.

6.6.3.2 Repair of Existing Channel Erosion

Where signs of erosion are evident on the outside (west) Diversion Channel slope and east slope of the groin at the channel outlet, it is recommended that the side slopes be flattened to 3H:1V and the existing bank protection be restored. This assumes the median particle diameter on the existing banks along the channel is 100 mm and will offer protection under modest storm flows.

If during routine surveillance, erosion of the channel slope is evident, maintenance will be required.

6.7 Discharge Water Quality

The outflow from the Polishing Pond (Station 159-4) is a defined “Final Discharge Point” in the Water Licence to which the effluent discharge criteria apply. This location is included in the Reclamation and Closure Monitoring Plan and will continue to be sampled throughout the closure monitoring period.

The outflow from the Polishing Pond immediately mixes with outflow from East Twin Lake, which is unaffected by mine activities. The combined water, Twin Lakes Creek, flows approximately 8 km to Strathcona Sound, receiving runoff from natural sulphide outcrops, the

West Adit area, the town site, the Industrial Complex and the concentrate haulage road along the flow path. It is well documented that Twin Lakes Creek typically carries high concentrations and high loads of heavy metals introduced from these source areas downstream of the WTDA. Further, this was the case both pre-mining and during mine operations.

A study completed prior to mining by B.C. Research (1975) states that Twin Lakes Creek does not support fish due to the poor habitat characteristics.

A water quality projection has been developed to identify the anticipated post-reclamation water quality at the outflow from the Polishing Pond.

The intent of the reclamation measures for the Surface Cell, the Test Cell area, the Reservoir and the Polishing Pond is, in part, to protect the environment. Water quality at the outflow from the Polishing Pond is one of the means of assessing the level of environmental protection that is being provided. Therefore, the water quality projection provided herein is of interest in providing an indication of the anticipated success of the reclamation measures in this regard.

The Water Quality Projection uses the following sources of information:

- A site specific water balance developed for this project by Golder (2004d), which is included in Appendix I;
- Projections of water volumes expelled over time from the Surface Cell and Test Cell taliks developed for this project by BGC;
- 2002 and 2003 groundwater quality analyses from the Surface Cell; and
- The record of water quality in East Twin Lake and other "unaffected" locations.

The Water Quality Projection focuses on total zinc as the parameter of interest. This is because experience at this site demonstrates that zinc is the most mobile metal and that control of zinc will provide control of other metals. For example, kinetic testing conducted on Nanisivik tailings, as described in Section 4 of this report, specifically demonstrated that zinc was mobilized at an order of magnitude greater than other metals. This approach is consistent with other base metal mines.

The potential for diffusive transport of contaminants from submerged tailings into the Reservoir Pond was considered in the context of the current state-of-the-art technical understanding of this topic. The review of literature on diffusive transport under water cover is documented by Lorax Environmental in Appendix VII. The review indicates that, in this case, the potential for diffusive transport that would have an observable effect on pond water quality is extremely low. References for current research in this topic are provided in Appendix VII.

6.7.1 Inputs to the Water Quality Projection

6.7.1.1 Natural Runoff

Quantity

The development of a water balance for the Polishing Pond, in its proposed reclaimed state, is described by Golder Associates in Appendix I. In summary, the water balance provides estimates for average monthly flows at the outflow of the Polishing Pond, which includes consideration of rainfall, snowfall, snow melt, evaporation and runoff coefficient.

For the purposes of the Water Quality Projection, flows are considered only for a six-month period from May through October. The average monthly flows used, in m^3/s, are as follows:

- May: 0.01
- June: 0.10
- July: 0.04
- August: 0.02
- Sept.: 0.01
- October: 0.005
- Annual: 0.015

Quality

The concentration of total zinc applied to runoff through the reclaimed WTDA is 0.056 mg/L. This is the average concentration of total zinc reported for stations NML-23, East Twin Lake, and NML-24, tributary to East Twin Lake, from 1996 to 2001, which are unaffected by mine activities. This concentration is greater than the federal guideline for the protection of Fresh Water Aquatic Life, 0.03 mg/L, which is attributed to the general abundance of natural sulphide mineralization in the area.

A listing of the water quality record for total zinc is provided in Appendix VII.

6.7.1.2 Water Expelled During Freezeback of Taliks

Quantity

The Talik Report describes the anticipated progression of the freezeback of the two taliks under the Surface Cell and Test Cell areas. As the ground freezes, the expansion of water into ice results in increased pore pressures that can include migration of water, if a hydraulic gradient and flowpath are present.

Water within the Surface Cell talik may migrate into the Reservoir Pond if a hydraulic connection is developed. This possibility is not anticipated but is applied to the Water Quality Projection to provide an additional degree of conservatism to the estimation. Water from the Test Cell talik is anticipated to migrate into the Reservoir pond through a thawed zone in the tailings base of the Test Cell dike. This anticipated occurrence has been applied in the Water Quality Projection.

The rate of water migration from a freezing talik decreases with time as a result of the progressive reduction in unfrozen water content as water freezes to ice. The rate of water migration from the Surface Cell and Test Cell taliks has been estimated based on an average volumetric water content of 40% and an expulsion rate of 9%, as listed in Appendix VII.

The volume of water, in m^3, anticipated to be expelled from the Surface Cell talik is estimated to be:

- Years 1 – 5: 32,400 m^3
- Years 5 – 10: 12,960 m^3
- Years 10 – 15: 11,160 m^3
- Years 15 – 20: 10,440 m^3
- Years 20 – 25: 2,844 m^3
- Years 25 – 30: 2,196 m^3

The volume of water, in m^3, anticipated to be expelled from the Test Cell talik is estimated to be:

- Years 1 – 5: 18,000 m^3
- Years 5 – 10: 9,900 m^3
- Years 10 – 15: 3,600 m^3
- Years 15 – 20: 0 m^3

It should be noted that the difference between the freezeback time in the Surface Cell Talik (25-30 years) and the Test Cell Talik (approximately 15 years) is attributed to the relative difference between the size of the two taliks.

The Water Quality Projection recognizes that these small inflows may enter into the Reservoir pond on a continuous basis. However, winter inflows are assumed to be stored as ice and released from the pond during the 6-month flow season. For the Water Quality Projection, the 6-month winter inflows are considered to be released according to the normal monthly distribution of snowmelt.

Quality

The initial concentration of zinc within the talik, 0.025 mg/L, is the higher of two groundwater samples collected from the Surface Cell talik in August 2003 during the Phase 3 Environmental Site Assessment. Other groundwater samples were analysed, but these were not used for the reasons described in Section 4.1.4. The concentration used is the concentration of dissolved zinc since total metal analyses of groundwater samples are generally not considered valid due to agitation in the well during purging and sampling that can bring suspended sediment from around the well into the sample.

Cryoconcentration is a process where the concentrations of parameters in the pore water increase over time as a talik freezes. This is a result of the preferential migration of solutes to the water rather than ice. The ice that forms within a talik is consequently likely to contain lower concentrations of solutes than the water. The exact mechanisms and rates of how cryoconcentration occurs will vary according to many site-specific circumstances. For example, the rate of frost penetration, which will vary with time and soil conditions, will affect the rate of water freezing and the rate of cryoconcentration into water.

For this Water Quality Projection, cryoconcentration was included based on an approach, suggested as being conservative in nature, wherein fully 90% of the zinc that was present in the water at the beginning of each 5-year time step was retained in the water. That is, only 10% of the zinc is assumed to be captured into ice.

This approach resulted in the 5-year time step concentrations for the Surface Cell talik listed below:

- Years 0 – 5: 0.025 mg/L
- Years 5 – 10: 0.033 mg/L
- Years 10 – 15: 0.051 mg/L
- Years 15 – 20: 0.141 mg/L
- Years 20 –25: 0.291 mg/L

This approach resulted in the 5-year time step concentrations for the Test Cell talik listed below:

- Years 0 – 5: 0.025 mg/L
- Years 5 – 10: 0.041 mg/L
- Years 10 – 15: 0.101 mg/L

6.7.1.3 Perimeter of the Reservoir Pond

Quantity

The perimeter of the Reservoir pond is proposed to be reclaimed in three zones, as described in Section 6.2.4.

Zone 1 is generally the southern and eastern sides of the pond where any residual tailings will be relocated to at least 1 m below the ultimate water level. This zone does not receive any further consideration in the Water Quality Projection since the water cover will protect the tailings from oxidation and physical effects.

Zones 2 and 3 are the sides of the pond located directly below the West Twin Dike and the Test Cell Dike, respectively. In these areas, the pond perimeter represents a transition from water cover to thermal barrier cover. Over the long term (possibly decades), permafrost is anticipated to aggrade to, and just under, the shoreline such that the tailings in the transition zone will be permanently isolated from the environment. Nonetheless, reclamation measures are included to account for the interim timeframe to promote the aggradation of permafrost and to ensure that tailings in the transition zone do not affect the environment while they freeze.

These reclamation measures will reduce any contact of tailings with the environment to a narrow "strip" located immediately above the water level. These tailings will lie beneath the 1.25 m thermal barrier cover and rip rap rock but may take some time to freeze because of the heat effects of the adjacent pond.

The Water Quality Projection includes recognition that, in the interim period while permafrost aggrades completely into the transition area tailings, it is possible that some of the runoff water that passes through the base of the cover materials in the area immediately above Zones 2 and 3 may contact the tailings. The quantity of water that could contact the tailings is restricted by:

- The small "catchment" area above these zones, which restricts the quantity of water that could possibly be directed in this direction;
- The grade of the "catchment areas" which is steep enough to promote surface flow of runoff water; and
- The thermal barrier cover materials, which will promote freezing of the underlying tailings and which will restrict water contact with tailings to a small portion of the runoff flow that lies at the base of the 1.25 m thickness.

The Water Balance Projection incorporates average precipitation and snow melt during the 6-month flow season over catchment areas of 2 ha for each of Zones 2 and 3 with a contact factor of 0.15.

Quality

Several sources of information were available to assess the possible interim influence of tailings in the transition zone. These include:

- Acid rock drainage characterization static and testing reported by Lorax Environmental (Lorax 2000);
- Humidity cell kinetic testing for acid rock drainage potential reported by Lorax (Lorax 2001);
- Column leach testing of Nanisivik tailings reported by Dr. Elberling of the University of Copenhagen (Elberling et al. 2002); and
- A review of the above, in the context of this study, by Lorax as provided in Appendix VII.

All of the above sources of information, plus site specific knowledge suggests the following observations that are incorporated into the Water Quality Projection:

- Tailings in the transition zone will be undergoing progressive permafrost aggradation and this, combined with the generally cold climate, will maintain a consistent or decreasing environmental influence during the interim freezing timeframe;
- Neutral-pH data suggested by Lorax (Appendix VII) is appropriate for use because of the following: tailings pH was neutral throughout the humidity cell test, permafrost aggradation and the generally cold climate will inhibit oxidation and tailings that have been locally exposed on surface for more than a decade remain at neutral pH; and
- The influence of tailings in the transition zone would be expected to vary throughout the summer season from a minimum during the near-frozen freshet to a maximum during the low flow, maximum thaw depth conditions at the end of the summer season.

Therefore, the site specific conditions regarding climate, the operational experience with managing tailings exposed on surface and the results of site specific testwork suggest the following influence for total zinc released to water that contacts tailings in the transition areas, that has been incorporated into the Water Quality Projection:

- May 0.3 mg/L
- June 0.3 mg/L
- July: 6.0 mg/L
- August 12.0 mg/L
- September 18.0 mg/L
- October 24.0 mg/L

6.7.2 Results

The Water Quality Projection is in the form of a spreadsheet that can provide projections for the Polishing Pond outflow based on various input values. Table 16 shows summary results from the Water Quality Projection for input values that are based on the inputs described above. The summary results are presented in 5-year increments to capture the influence of changing rates and concentrations of porewater expelled from the Surface Cell and Test Cell taliks. The detailed results of the Water Quality Projection for each 5-year time step are provided in Appendix VII.

The following observations are drawn from the results summarized in Table 16:

1. Natural runoff is projected to represent a dominant controlling factor (80% of Zn load) for Polishing Pond outflow.
2. Porewater expulsion is projected to represent a small contributing factor (less than 1% of Zn load) to Polishing Pond outflow.
3. Runoff over the Reservoir Perimeter during the interim period of permafrost aggradation is projected to represent a moderate contributing factor (20% of Zn load) to Polishing Pond outflow.

4. The quality of Polishing Pond outflow is not anticipated to vary on an annual basis.
5. The volume of water passing through the Polishing Pond is projected to decrease slightly over time due to the decreasing rate of porewater expulsion.

In summary, the annual quality of water passing through the Polishing Pond (0.07 mg/L Zn) is projected to remain similar to natural conditions (0.056 mg/L).

7.0 CONSTRUCTION PLAN

7.1 Construction Materials

7.1.1 Quantities

At closure, shale cover will be required for the following facilities around the WTDA:

- Surface Cell tailings and crest of West Twin Dike.
- Downstream face of West Twin Dike (including completion of shale cover for consistent grade over the currently exposed beaches).
- Tailings at the toe of West Twin Dike (including transition zone at shoreline).
- Test Cell tailings and Test Cell Dike (including transition zone at shoreline).

In addition to the shale cover at these locations, a top layer of sand and gravel armouring will also be required. This material will be obtained from the Twin Lakes sand and gravel deposit, located between West Twin and East Twin Lakes. The total in-place volume of shale required for the reclamation covers at the WTDA is estimated to be about 590,000 m^3. The total in-place volume of sand and gravel armouring required at the WTDA is estimated to be about 139,500 m^3.

7.1.2 Borrow Development Areas

The quantities of shale in each quarry were estimated on the basis of the exposures of shale in the existing working faces, supplemented by several shallow drill holes to confirm the depth of cover and lateral extent of the deposit. More drilling will be carried out during quarrying operations to help delineate the final quarry limits. The quarry development plans provide for 1,350,000 m^3 (in-situ) of shale cover material, which is about 1.5 times the estimated volume required for all of the reclamation covers around the Nanisivik Mine. If the cover quantity needs to be increased, additional volumes are available from the other quarries at the mine.

The Mt. Fuji Quarry development plan has been designed to provide approximately 350,000 m^3 (in-situ) of shale cover material. This volume was estimated from visual reconnaissance, available published geological information for the Nanisivik area and survey data of the quarry area. The Mt. Fuji Quarry is considered to be the most viable source of shale cover material for the WTDA, due to it's close proximity.

The West Twin Quarry development plan has been designed to provide approximately 150,000 m^3 (in-situ) of shale cover material. This volume was determined through visual reconnaissance, available published geological information for the Nanisivik area, geological information from borehole data and survey data.

The East Twin Quarry is designed to provide approximately 750,000 m^3 (in-situ) of shale cover material. This volume was determined through visual reconnaissance, geological information of Nanisivik, borehole data, and survey data.

Approximately 139,500 m^3 of armouring sand and gravel material are required for surface reclamation covers at the WTDA. The Twin Lakes sand and gravel deposit contains a sufficient volume of protective armour material to satisfy the requirements of the surface reclamation covers. This was determined utilizing topographic information and available borehole data. Three boreholes were drilled in the deposit as part of the hydraulic connectivity assessment by Tordon (1998). The location of the boreholes is illustrated on Figure 8. These boreholes (TC-22, TC-23, TC-24) ranged in depth from 10.2 m to 13.3 m and the sand and gravel material was encountered throughout much of the borehole profile. On the basis of this work, the deposit it estimated to contain a minimum thickness of 10 m of sand and gravel. Due to its aerial extent, it is not necessary to develop the entire thickness of the deposit to recover the required volumes. The required volume of material will be obtained by excavating into the top 2 m of the deposit. The bottom of the quarry will remain at least 2 m above the level of West Twin Lake (elevation 370 m) to ensure that hydraulic connectivity does not develop between the two water bodies.

7.2 Construction Outline

At the time of preparation of this report, CanZinco is exploring three options with respect to construction approaches, as summarized below:

1) Use the available Nanisivik Mine fleet of equipment and manpower to undertake the reclamation work over two construction seasons.
2) Contract a fleet of equipment from outside contractors and operators to undertake the reclamation work in one construction season (or possibly two).
3) Transfer the mine fleet of equipment to the Government of Nunavut (GN) and have the reclamation work undertaken as a training and employment exercise over several construction seasons.

No final decision on the contracting approach or duration of operations has yet been made. As a result of this uncertainty, no detailed schedule for reclamation works at the WTDA has been prepared. Within the monitoring requirements noted in other design reports, the reclamation period has been assumed to occur over two years. This assumption is a reasonable one for the magnitude of the reclamation work required.

Construction of the West Twin Dike spillway will be somewhat dependent upon placement of the cover in the Surface Cell, coupled with considerations with regard to control of existing surface water in the existing surface water drainage channel. The inlet to the new spillway would not be operational until the Surface Cell cover is completed but portions downstream from the inlet could be constructed before the inlet is completed. The discharge portion of the spillway would be constructed when the Reservoir level is lowered.

In order to undertake a number of the reclamation tasks for the WTDA, the Reservoir water level needs to be drained down to approximately Elevation 368 m. Given that this level is lower than the natural channel grade in Twin Lakes Creek, pumps will be required to discharge water from both the Reservoir and the Polishing Pond. The pumping and water level lowering rates will have to be synchronized to ensure no major head difference develops across the access road dike. Following lowering of the Reservoir level, the following reclamation tasks will need to be undertaken:

- Relocation of any exposed tailings around the shoreline (Zone 1) to lower than Elev. 369.2 m.
- Lowering of any high points in the exposed sub-aqueous tailings located in the Reservoir.
- Placement of thermal cover, bedding and rip rap at the toes of the West Twin Dike and the Test Cell Dike.
- Breaching of the baffle dike.
- Construction of the discharge end of the West Twin Dike spillway should also be undertaken.

As noted later in the contingency planning section, in the unlikely event that Reservoir water quality does not meet discharge criteria, it may be necessary to both retain and treat water within the Reservoir and possibly the polishing pond. Therefore, both the access road causeway and the current outlet discharge structure will remain in-place until water quality is within discharge limits and appears stable. Then the water level will be reduced once again by pumping and the following three tasks will be undertaken:

- Breaching of the access road causeway and removal of the culverts.
- Removal of the existing outlet discharge structure.
- Construction of the new outlet channel and overflow weir. The weir construction requires the use of concrete and grout which are both typically undertaken during warm weather conditions.

Since these three tasks may be completed several years later (when water quality trends are stable), it is likely that construction materials such as rip rap and bedding may be stockpiled near the outlet during the main construction work on-going at the WTDA.

The proposed rip rap rehabilitation of the upstream face of the East Twin Diversion Dike and Channel could be undertaken at any time when appropriate material is available and access is possible.

7.3 Quality Assurance/ Quality Control Requirements

A quality assurance/quality control (QA/QC) program is proposed to provide a means to ensure the reclamation works are constructed to the design specifications and intent. At the current time, the proposed contractual details on who will be undertaking the reclamation work, has not been determined. As a result, the exact components of the QA/QC program have not been finalized. The following sections outline the general components of the QA/QC program to be used during the construction of the required reclamation works at the WTDA.

7.3.1 General

It is assumed that a qualified technical representative responsible for the execution of QA and QC program will include a suitably-trained Field Representative working under the direction of a professional geotechnical engineer. The Field Representative will be on-site daily throughout the construction. This continuous attendance is a requirement in order to produce the as-built report required later. The QA/QC program will be the responsibility of the Field Representative, in concert with the Site Supervisor. The Field Representative will ensure that the constructed works conform to contract documents (construction drawings) and the design intent of the reclamation works described in this document. The Field Representative will have the authority to reject any substandard work and order the contractor to redo the work such that it meets the requirements and the intent of the contract and drawings. The Field Representative will provide daily inspection reports summarizing work undertaken, methodology used, manpower and equipment utilized and written confirmation regarding field decisions made and design alterations permitted.

The Site Supervisor, representing the contractor, will be required to maintain accurate records of all construction operations and shall provide the Field Representative with a copy of the daily record at the end of each shift. The following information will be recorded on the fill placement summary sheets:

- Location and elevation at the start and end of all excavation operations, fill placement, for each major individual area (e.g. Surface Cell) for each shift;
- Tailings volume relocated and concrete/ grout placed;
- Quantity of concrete/ grout placed;
- Estimated quantity of materials placed during the shift.
- Location and elevation of material sources from the borrow pits placed in each shift.
- Quality control results on fill, concrete and grout materials.
- Number of workers and equipment engaged during the shift.
- Unusual occurrences during reclamation operations such as unstable soil conditions, extreme precipitation events or variations in fill quality.

These reports will supplement the daily reports to be filled out by the Field Representative.

As such, a geotechnical and materials testing laboratory will be required on-site during the reclamation operations.

7.3.2 Fill Placement and QC Testing

Placement of fill materials for the various layers of the cover, toe protection and spillway lining shall be subject to the following conditions:

- No fill material shall be placed until the substrate have been appropriately prepared and graded (if required) and has been approved by the Field Representative.
- Fill materials shall be placed in accordance with lines, slopes, grades and elevations as provided on final construction drawings.
- The placement, handling, spreading and compaction of the fill materials shall be performed in such a manner that the fill material is free of particle segregation, lumps, sizeable lenses, pockets and layers of material that are substantially different in gradation and texture from surrounding materials.
- Any fill material not meeting the noted requirements will be removed, remixed, blended or otherwise reworked to meet the specified requirements.
- Fill materials shall be placed and spread in continuous and approximately horizontal layers of uniform thickness.
- Hauling and placement equipment shall be routed over the fill surface such that they do not follow the same path but that the equipment track loads are spread consistently across the upper surface.

The compaction process will be performance based and will consist of a number of passes from the proposed construction equipment (e.g., dozer, loaded hauled trucks and possibly loaded water trucks, if required). Other criteria for the compaction operation, subject to verification in the test fill, will consist of the following general guidelines:

- Compaction of each layer of fill shall proceed in a systematic and continuous manner so that each portion of the layer receives an equal amount of compactive effort.
- The method of changing direction of the equipment shall result in uniform compaction.
- Overlap should occur between the various passes of the construction equipment.
- It is expected that the upper surface will be free from ruts. If any are noted, re-levelling and/or additional passes will be required.
- Any oversized particle sizes will be removed from the fill before proceeding with compactive effort.

Alternatively, no compaction specification, other than a firm and tight final surface, is required for the Twin Lakes sand and gravel. Table 17 provides recommended testing frequencies for the shale cover and Twin Lakes sand and gravel materials for grain size and moisture content determinations. Additional testing requirements for the materials in the spillway and toe erosion protection elements will be detailed later during the preparation of final drawings and technical specifications.

Test pits will be excavated by the contractor in locations determined by the Field Representative. Spot thickness of the reclamation cover, bedding and rip rap layers will be measured in these test pits. This information will be recorded by the Field Representative to ensure the minimum thickness requirements for each material are being met.

7.3.3 Excavation

Prior to starting work, the Field Representative will request from the contractor details of the proposed excavation methods, including, blasting, ripping equipment, method of excavation, details and locations of weigh scales, schedules and sequence of operations to complete the work.

7.3.3.1 Soil Excavation

Soil excavation is required in the spillway and outlet channel. In general, excavated soil may be used as common fill throughout the WTDA, to fill in low spots and general site re-contouring, possibly including access roads

Soil excavation may involve ripping and blasting to loosen and excavate permafrost-affected soils. Materials are expected to include a variety of soils of glacial origin, including till, sand and gravel with cobble and boulder fragments as well. Excavations within the Surface Cell and Reservoir may encounter a minor amount of tailings. At the outlet end of the spillway, massive ground ice has been observed. Close to the bedrock surface, detached blocks of weathered bedrock may be included. There is no topsoil component that needs to be segregated and stockpiled.

Within the spillway area, soil excavation will be almost entirely in the dry, except for some wet conditions at the outlet (which will be undertaken when the Reservoir is lowered). Unsuitable materials, such as massive ice lenses will be sub-excavated and backfilled with granular fill, then covered with bedding and rip rap. The excavated ice-rich soils, which are not suitable as backfill elsewhere, will be placed in the Reservoir to thaw or in low areas of the tailings cover. If placed in the Reservoir, these materials will thaw and any ice-entrained sediments will settle into the Reservoir. The volume of unsuitable materials from the required excavations is expected to be minor, and no spoil disposal area has been designated.

Any soil excavation undertaken within, or adjacent to, existing water courses will need to be cognizant of water management issues to ensure that flows can either be retained within the system (upstream of an excavation) or be passed around an excavation. It will be critical to ensure that no high sediment water is discharged to the environment. Proper pumping procedures and possibly settling ponds, rockfill check dams and silt curtains may be required to control construction-affected surface water.

The excavation requirements and limits will be shown on the construction drawings, based on the results of subsurface explorations. The Field Representative will examine the conditions exposed at the required excavation lines and, if the conditions are deemed to be unacceptable, will require excavation to be continued locally beyond the lines, slopes and elevations shown on the drawings, to remove unacceptable material. The Field Representative will ensure that the contractor takes the necessary precautions to preserve, in an undisturbed condition, all material outside of the required excavation lines and that the stability of the excavated slopes is not impaired. The Field Representative will ensure that no construction traffic is routed over the excavated surfaces, unless they have been suitably protected to prevent damage.

7.3.3.2 Rock Excavation

Rock excavation includes the excavation of weathered and unweathered, in-situ bedrock and individual rock fragments each having a volume greater than one cubic metre. Rock excavation will only be required at the West Twin Dike Spillway and West Twin Outlet Channel. The excavation will encounter dolostone bedrock, which has been frost-shattered near the surface and along the bedrock-overburden contact.

Excavation will be done by a combination of drilling and blasting and ripping, depending on the quality of the rock and the extent of frozen conditions at the time. The materials excavated from the frost-shattered and intact bedrock zones are expected to be suitable as backfill for re-contouring or as rip rap for other areas of the WTDA, subject to screening requirements. The intact dolostone bedrock however, must be excavated and transported to a designated stockpile area where it can be used for backfill and/ or rip rap.

The Field Representative will be responsible for designating which material will go to the stockpile and which can be used for backfill.

In general, all of the bedrock excavation will be done in the dry. The construction drawings will show the required excavation limits based on the results of the subsurface explorations. The contractor will be responsible for ensuring that the structural integrity of the rock is preserved. The excavation methods must produce smooth and sound rock surfaces, with a minimum of fracturing of the rock outside the excavation. The Field Representative and the contractor will develop controlled blasting techniques that satisfy the specified excavation requirements. The contractor's initial blasts will be performed as trials. The burden, drillhole pattern, hole depth, explosive type and quantity, blasting sequence and delay pattern will be modified to achieve the specified results.

Prior to the start of drilling and blasting, the contractor will submit complete details of the blast to the Field Representative, including the following:

- The location, depth and area of each blast.
- The diameter, spacing, depth, pattern and inclination of blast holes.
- The type, strength, quantity, column load and distribution of explosives to be used per hole, per delay and per blast.
- The sequence and pattern of delay.
- The description and purposes of any special methods to be adopted.

Excavation cannot proceed without the review and approval of the contractor's plan by the Field Representative. The Field Representative will inspect all excavated rock faces and assess the degree of disturbance outside the required lines of excavation. Depending on the conditions observed, the Field Representative may require blasting practices to be modified in order to minimize blast induced damages. Excavated surfaces will not contain overhanging rock. The Field Representative will direct the contractor to scale and remove all loosened rock from the excavated slopes, even if this requires enlarging the excavation beyond the required excavation lines.

The Field Representative will map the exposed geological conditions during construction to document "as-built" conditions. This information may be used during construction to aid in design modifications that may be required due to unexpected conditions. The contractor may be required by the Field Representative to expose a fresh, undisturbed surface to permit inspection and mapping.

7.3.4 Drilling and Grouting

The Field Representative will be responsible for monitoring the drilling and grouting program for the new overflow weir. As a part of the final engineering and design of the structure, a detailed grouting program will be developed that will provide guidance to the contractor and the Field

Representative on critical items such as:

- Drill location, size, orientation and depth.
- Pressure testing criteria.
- Grout mixes, pressures, pumping rates, locations and sequences.
- Criteria for selection of additional grout holes.

7.3.5 Concrete

The Field Representative will be responsible for monitoring the placement of concrete for the overflow weir structure. This work will include acceptance of the bearing surface, confirmation of the final weir elevation, climatic conditions for the concrete placement and review of the forming arrangements and placement methodology.

Quality control testing will be required to validate the concrete placed for the weir. Information to be reviewed and tests to be undertaken include the following:

- Review of concrete mix design, including water/ cement ratio, aggregate suitability and use of special additives, if required;
- Slump cone to assess placement consistency;
- Air entrainment; and,
- Moulds of placed concrete to assess compressive strength (if critical).

7.3.6 Rip Rap

Within the WTDA reclamation works, rip rap will be placed as erosion protection along the spillway channel, the toe of the Test Cell Dike, adjacent to the new overflow weir, the existing Diversion Dike and portions of the outlet channel upstream and downstream of hydraulic structures.

Rip rap will be sourced from the following areas:

- bedrock from excavated channels (i.e. West Twin Dike Spillway);
- bedrock from specific quarries (possibly); and,
- cobbles and boulders from the Twin Lakes sand and gravel deposit.

The material will consist of clean, well graded, hard, bedrock fragments or coarse-grained particles. Screening of the host material will be required to produce the required particle size gradation.

Inspection of the processing of this material will be done by the Field Representative to ensure that the source material meets the required grain size and quality.