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EVALUATION OF CYCLONED TAILINGS FOR EMBANKMENT CONSTRUCTION (REF. NO. 11162/11-1) GRIT 3204

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GRIT 3204

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Association of Consulting Engineers of Canada
Association des ingénieurs-conseils du Canada

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EVALUATION OF CYCLONED TAILINGS FOR EMBANKMENT CONSTRUCTION (REF. NO. 11162/11-1)

SECTION 1.0 - INTRODUCTION

This report provides a preliminary evaluation of the use of cycloned tailings sand for construction of the Mount Polley Mine tailings embankments. The evaluation is required to confirm whether cycloned tailings are suitable as a replacement for some or all of the embankment fill materials. This evaluation includes:

- A review of the existing embankment design.
- Comments on the tailings characteristics and the potential for cycloning.
- A discussion on potential design changes.

Cycloned tailings were produced in a trial program at the Mount Polley mine in September and October, 1998. Two cyclones were used, one with a diameter of 50 inches (Krebs D50) and one with a diameter of 20 inches (Krebs D20). The cyclones were set up on skid mounted frames at the approximate location of setting out point (SOP) S7, near the left abutment of the Perimeter Embankment.

The cyclones were operated intermittently and at varying throughput rates and solids contents. Numerous samples of mill feed, overflow and underflow were collected for particle size gradation testing. The results of the testwork on mill feed, underflow and overflow are discussed in Section 3.0 of this report. One sample of cyclone underflow was sent to a commercial laboratory for detailed testing. To date, no direct measurement of cyclone split has been completed, but the split has been estimated mathematically.

This report summarizes the geotechnical characteristics of the cycloned sand and illustrates that the cycloned sand is well-suited for embankment fill. The report also discusses the trial studies that will be carried out in 1999 in order to evaluate the techniques that will be employed to construct the embankment using cycloned sand. These trials will also be used to confirm the suitability and availability of cycloned sand for embankment construction.

Three options have been analysed that use cycloned sand for embankment fill, as discussed in Section 4.0. Option 1 employs cycloned sand as an embankment fill material for the upstream shell zones only, while the remaining zones of the embankments continue to be composed of earth and rockfill. Option 2 and Option 3 substitute the downstream rockfill zone and the upstream earthfill zones with cycloned sand. Option 2 includes a low permeability glacial till core zone. Option 3 is a more conventional dam section constructed entirely of cycloned sand, with no specific provisions for a seepage barrier.

A Preferred Option has been chosen from the three options outlined above, taking into account cycloned sand availability, geotechnical concerns and capital costs. Detailed construction requirements, scheduling and material quantity estimates for the Preferred Option are outlined for the trial studies in 1999 and the potential Stage 3 embankment raise in 2000.

SECTION 2.0 - EXISTING EMBANKMENT DESIGN

2.1 GENERAL

The Mount Polley Mine Tailings Storage Facility is comprised of the Main, Perimeter and South Embankments. In the final configuration, the tailings embankments will be connected and will form a three-sided impoundment. All three embankments have been designed as modified centreline zoned earthfill structures. The current embankment designs include the following components:

- Low permeability, glacial till core zones.
- Downstream and upstream glacial till fill zones.
- Chimney drains with longitudinal (collector) drains and outlet (conveyance) drains in the downstream glacial till fill zones.
- Downstream shell zones constructed from mine waste rock.
- Upstream shell zones constructed from cycloned sand.
- Toe drains in the upstream shell zone.
- Seepage collection ponds located downstream of the ultimate embankment toes.

A plan view of the final arrangement of the Tailings Storage Facility is shown on Drawing No. 10162-9-200, with sections shown on Drawing No. 10162-9-201.

The Tailings Storage Facility was designed to include staged construction during operations in order to minimize initial capital expenditures and to maintain an inherent flexibility to allow for variations in operation and production throughout the life of the mine. The construction stages incorporate a combination of centreline and modified centreline construction methods, with on-going raises providing incremental storage capacity for one or two years of production. The design requires that the proposed raises must be continually re-evaluated during operations to ensure that adequate storage capacity and embankment freeboard are maintained throughout the mine life.

Staged embankment fill quantities for the current embankment design are shown on Table 2.1.

2.2 CYCLONED SAND TAILINGS FOR UPSTREAM ZONES

The current design includes upstream shell zones for Stage 3 (crest El. 940) through Stage 7 (El. 965). The upstream shell zones are to be constructed using free draining fill (FDF) materials. The permitted design concept includes for incorporation of cycloned tailings sand in the upstream shell zones from Stage 3 onward.

The total quantity of free draining fill (FDF) material for the upstream shell zones is estimated to be 1,118,000 cubic metres for Stages 3 through 7, as shown on Table 2.1. An average of approximately 225,000 cubic metres of cycloned sand is required per stage. With an in-situ dry density of 1.6 tonnes per cubic metre, this volume is equivalent to approximately 360,000 tonnes of cycloned tailings sand. Assuming a daily mill throughput of 20,000 tonnes per day (revised from original design value of 17,800 tonnes per day), a cyclone underflow split of 35 percent and a cyclone availability of 85 percent, approximately 6,000 tonnes of cycloned tailings sand could be produced each day that the cyclone system is operated. Therefore, approximately 60 days, or 2 months of cycloned tailings sand production would be required every two years for each of Stages 3 through 7. This is summarized on the following page.

Embankment Stage	Cycloned Sand for 1.5H:1V Slope (m^3)	Cycloned Sand for 1.5H:1V Slope (tonnes)	No. of Days of Cyclone Production Required
Stage 3	256,000	410,000	68
Stage 4	221,000	354,000	59
Stage 5	230,000	367,000	61
Stage 6	236,000	377,000	63
Stage 7	175,000	281,000	47
Total	1,118,000	1,789,000	298

Cycloned Sand for 1.5H:1V slope defined as Free Draining Fill on the drawings and table of staged embankment fill quantities.

Table 2.1 also includes an estimate of the amount of cycloned sand that could be produced assuming a 35 percent underflow split and an availability of 85 percent. The table indicates that significantly more cycloned sand could be produced than is required for construction of the upstream free draining fill (FDF) zones. Cycloned sand availability is discussed further in Sections 3.5 and 4.5.

SECTION 3.0 - TAILINGS CONSIDERATIONS

3.1 GENERAL

Mount Polley tailings are produced by conventional milling of copper and gold ore. The tailings stream used in the design of the discharge system was based on:

- Solids throughput: 17,808 tpd (6.5 million tonnes per year)
- Percent solids: 35 percent
- Solids specific gravity: 2.78

Since start-up, mill throughput has increased to a maximum monthly average of about 19,600 tpd (i.e. March 1999). For the evaluation of cycloned tailings for embankment construction, an average throughput of 20,000 tpd has been used.

3.2 EXISTING TAILINGS DISCHARGE SYSTEM

For the existing tailings discharge system, tailings slurry is discharged from up to six valved offtakes (spigots) on a movable discharge section. Initial tailings deposition was concentrated at the Main Embankment to cover the basin liners and to fill the lowest area of the tailings basin. The movable discharge section is relocated as required to establish the tailings beach over the length of the Main Embankment. Discharge from the Perimeter Embankment has not yet commenced, but is scheduled for 1999 when the tailings pond reaches the embankment. Tailings are occasionally discharged from two Mark 1 dump valves while relocating the movable discharge section and during pipeline maintenance.

3.3 TAILINGS CHARACTERISTICS

3.3.1 Physical Characteristics

Testwork on the tailings has been conducted at various stages of development and operations, including the following:

- Preliminary testwork was conducted on tailings from drill core samples in 1989 and 1990.

- 1996 testwork conducted on two streams called the finer Slime Tails and the coarser Sand Tails. A particle size distribution for a Bulk Tailings product was mathematically computed by combining the particle size data for the Slimes and Sand Tails.

- 1997 testwork conducted on tailings samples obtained from the Tailings Storage Facility and Mill. Testing was conducted on four samples named BK1 (bulk tailings slurry taken at one of the discharge spigots), BK2 (a composite sample taken from the mill on-stream analyzer), BH1 (taken directly from the exposed tailings beach adjacent to the Main Embankment), and SS1 (fine tailings slurry prepared in the laboratory by allowing bulk tailings to settle and segregate in a large pail and decanting and re-slurrying the finer material on the top).

Testwork included index properties (gradation, specific gravity and Atterberg Limits), as well as drained and undrained settling tests, falling-head permeability tests and slurry consolidation tests. The results of this testwork are summarized below.

- The tailings are relatively fine. Bulk tailings contain about 60 to 80 percent fines (silt and clay sizes passing the No. 200 sieve). Analyses carried out by the on-stream analyzer from mid-October to mid-November, 1997 showed that the fines content varied from 51 to 69 percent and averaged about 61 percent. Results from the cyclone trials (20 samples) have indicated that the tailings are finer, with a range of 60 to 79 percent fines and an average of 69 percent passing the No. 200 sieve.

- Tailings are non-plastic.

- Specific gravity is 2.74 to 2.78.

- Settled dry density (undrained) varies from 0.9 to 1.2 tonnes/m^3 for bulk tailings. Settled dry density is projected to increase to 1.3 tonnes/m^3 with evaporative drying and consolidation.

- Vertical permeability varies from 10^{-5} cm/sec for bulk and beach tailings to 10^{-6} cm/sec for the fine tailings slurry.

- Average void ratio for settled tailings varies from 1.4 to 2.0 for bulk tailings, and is a maximum of 3.8 for the fine tailings slurry.

The results of this testwork are presented on Table 3.1. A plot of the particle size distributions is shown on Figure 3.1.

3.3.2 Geochemical Characteristics

Geochemical testwork on a tailings sample was conducted in 1989. The testwork and results are summarized below:

- Determination of net acid generating potential - The tailings were not acid producing and showed a significant net neutralization potential.

- Special Waste Test using acetic acid - The test indicated that the tailings from the locked cycle tests did not exceed the BC Waste Management Branch regulations for special wastes.

- ASTM waste extraction test using carbonic acid at pH 5.5 - The test showed very low levels of water leachable constituents in the extract, all at concentrations below the lower range concentration for the pollution control objectives for final effluent discharge.

Detailed results of this testwork were presented in the Knight Piésold document "Tailings Storage Facility Design Report, Ref. No. 1625/1, May 26, 1995".

Mount Polley has conducted detailed testwork to evaluate the geochemical characteristics of the tailings since the start of operations. Additional testing was conducted for the evaluation of cycloned sand tailings for use in embankment construction. The results of this testwork are beyond the scope of this report and have been presented separately by Mount Polley Mining Corporation ('Tailings Cyclone Sands Geochemical Evaluation', December 2, 1998).

3.4 CYCLONE TRIALS AND TAILINGS SUITABILITY

3.4.1 General

A cyclone trials program was conducted at Mount Polley during September and October, 1998. Two cyclones were used, one with a diameter of 50 inches (Krebs D50) and one with a diameter of 20 inches (Krebs D20). The cyclones were set up on skid mounted frames at the approximate location of setting out point (SOP) S7, near the left abutment of the Perimeter Embankment.

The cyclones were operated intermittently and at varying throughput rates and solids contents. Numerous samples of mill feed, overflow and underflow were collected for particle size analyses. One sample, denoted C-ZCS-3, was sent to a commercial laboratory for additional detailed testing, including:

- particle size analysis
- Atterberg Limits
- Standard Proctor
- flexible wall permeability
- triaxial compression shear strength
- consolidation

The results of the detailed testing on sample C-ZCS-3 are included in Appendix A. No direct measurements of the cyclone split (underflow and overflow) were carried out during the trials program. However, the split has been estimated mathematically, as discussed in Section 3.4.6. The results of the cyclone trials are discussed in the following sections.

3.4.2 Particle Size Analyses

Mount Polley personnel conducted particle size analyses on twenty-two (22) underflow samples. Nine (9) samples were obtained from the 50-inch cyclone and thirteen (13) samples were from the 20-inch cyclone. In addition, a particle size analysis was carried out on sample C-ZCS-3, also from the 50-inch cyclone. The results of the particle size analyses for the underflow are summarized on Table 3.2. The coarse and fine limits for the underflow from both the 20 and 50-inch cyclones are shown on Figure 3.2 along with the median values. The results from sample C-ZCS-3 are also shown. The results for each cyclone are discussed below.

- The 20-inch cyclone produced a slightly more uniform underflow product ($C_u \approx 3.9$), with approximately 21 to 31 percent fines (passing the No. 200 sieve, 0.075 mm). The uniformity is an indication that the split is cleaner and that there are less fines in the underflow. The range of the D_{10} sizes for this material is estimated to be about 23 to 37 microns.

- The 50-inch cyclone produced an underflow product that was not quite as uniform ($C_u \approx 4.9$) and therefore not as clean. The fines content was approximately 19 to 32 percent. The range of the D_{10} sizes for this material is estimated to be about 27 to 42 microns. Sample C-ZCS-3 is underflow from the 50-inch cyclone. It contained 24.1 percent fines and had a D_{10} size of 41 microns.

- During the trials, the 50-inch cyclone underflow was initially finer. The material was coarser after operating conditions were optimized (i.e. when an operating pressure of 40 psi was established).

- Other data collected indicate that the 50-inch cyclone is more sensitive to mill throughput. The fines content of the underflow varied from 20 percent at a high throughput rate (20,000 tpd) to about 30 percent at a lower throughput rate (14,000 to 15,000 tpd). The 20-inch cyclone consistently produced an underflow with about 24 to 28 percent fines. These results are presented graphically on Figure 3.3.

The particle size distributions obtained from both the 20 and 50 inch cyclones are acceptable. Generally, for a cycloned embankment to have acceptable permeabilities, angles of deposition and adequate stability, the D_{10} value should be greater than about 30 microns (0.030 mm). Results to date indicate that the Mount Polley underflow typically has a D_{10} from 23 to 42 microns, which is within the expected design range.

In order to estimate the underflow split, particle size analysis testing was conducted on sixteen (16) samples of mill feed, underflow and overflow. These results are shown graphically on Figure 3.4. Results from the Ergo Mine are included for comparison. The split evaluation is discussed in Section 3.4.6.

3.4.3 Density, Moisture Content and Permeability

The in-situ density and moisture content of the underflow was measured using a nuclear densometer. The measurements were taken in cycloned sand piles located within the Tailings Storage Facility, in an area without any specific underdrainage provisions. The first set of measurements was taken in fully drained underflow material from the 50-inch cyclone. The dry density was about 1650 kg/m^3 and the moisture content was about 8 percent. The second set of measurements was taken in underflow material from the 20-inch cyclone. The initial measurements were taken approximately 1.5 hours after deposition and the dry density varied from 1477 kg/m^3 at 19.9 percent moisture to 1626 kg/m^3 at 18.6 percent moisture. Another set of measurements was taken in this material 24 hours after initial deposition and the results were 1509 kg/m^3 at 15.0 percent moisture to 1578 kg/m^3 at 14.2

percent moisture. Based on these results, approximately 4 percent moisture was lost from this material in one day.

A Standard Proctor test was conducted on sample C-ZCS-3 (from the 50-inch cyclone). The maximum dry density was 103.6 lb/ft^3 or 1660 kg/m^3 at an optimum moisture content of 18.3 percent.

The permeability of the underflow from the 50-inch cyclone was measured to be 1.4 x 10^{-3} cm/sec, as determined from the Flexible Wall Permeability test for sample C-ZCS-3. Permeability values for the cyclone underflow were also estimated based on the particle gradations, as shown on Table 3.3. The calculated permeability values range from 10^{-3} cm/sec to 10^{-4} cm/sec, which are consistent with the measured permeability. These results indicate that the cycloned sand at Mount Polley is relatively free draining, which will result in a dense, moist, compacted downstream fill zone.

3.4.4 Triaxial Compression and Consolidation Characteristics

Triaxial shear and time consolidation testing was carried out on sample C-ZCS-3. Increments of 125, 250 and 500 kPa were applied to the sample during the triaxial shear testing. The effective angle of friction was measured to be 26 degrees with a cohesion value of 12 kPa.

The time consolidation testing was carried out at 150, 300, 600 and 1200 kPa and the applied pressure versus void ratio was plotted to determine the compressibility characteristics of the material. Over this stress range, the calculated vertical coefficient of consolidation (C_v) values range from 10 to 33 m^2/year, which is consistent with materials composed mainly of silt. A discussion on estimated embankment settlement is presented in Section 4.6.

3.4.5 Pulp Density

Pulp density (solids content) was routinely measured during the cyclone trials. The pulp density of the underflow varied from 67 to 79 percent, with an average value of 75 percent. A general requirement for using cycloned sand in embankment construction is to achieve a pulp density in the range of 70 to 75 percent. This value allows for efficient hydraulic placement of the cycloned sand. At Mount Polley, the pulp density is within the expected range. In addition, field trials at Mount Polley achieved a reported cone slope of approximately 25 % (4H:1V) with no specific allowance for drainage, which further illustrates the suitability of Mount Polley cycloned sand for cycloned sand construction.

The pulp density was also used to estimate the underflow split, as discussed below.

3.4.6 Split Evaluation

The actual split of the mill feed into underflow and overflow materials has not been physically measured. However, the split has been estimated mathematically at about 35 to 45 percent. The split was calculated using two different mathematical methods incorporating properties of the mill feed, underflow and overflow materials. One method was based on solids contents and the other method was based on particle size distributions. The results of the split analysis using solids content are summarized on Table 3.4 and a summary of the results based on particle size distributions is shown on Table 3.5.

The average underflow split using solids content (46 percent) is higher than the split based on the particle size distributions (37 percent). The underflow split based on the solids content is probably more accurate for the following reasons:

- The split calculation based on particle size distributions compares actual underflow and overflow samples from the cyclone to a feed sample from the mill. The feed sample used in the calculations is not the same sample that is separated into overflow and underflow.

- The calculated feed shown on the split calculations is consistently coarser than the actual mill feed. This suggests that either the mill feed is coarser than reported, or the calculated split is too low. It is more likely that the calculated split is too low because the mill feed samples are quite accurate measurements. This conclusion is supported by the fact that when a finer calculated feed is used in the spreadsheet (closer to the actual mill feed), the split value increases.

As stated above, the actual underflow split is not accurately known. An accurate determination of the material split for each cyclone should be determined by directly measuring the concurrent flow rates and pulp densities from the underflow and overflow. This is best achieved by timed discharge of the two streams. As an alternative, a survey of the volume of underflow material and the density of the underflow deposit produced over a period (with the corresponding accurate throughput measurement) will enable the underflow split to be determined.

Based on the calculations and uncertainties described above, a conservative underflow split value of 35 percent has been used in the evaluation of cycloned tailings for embankment construction.

The average gradation results for feed, underflow and overflow are shown on Figure 3.4. On this figure, the feed and overflow gradations are very similar for the average of all samples. This suggests that little material is reporting to the underflow. However, the results for the 50-inch and 20-inch cyclones are more representative.

3.5 CYCLONED SAND AVAILABILITY

Although the actual underflow split has not been measured, it was estimated to be a minimum of 35 percent from the cyclone trials. Mount Polley have suggested that the operating period for the cyclones may be 7 months per year. Based on this, and assuming a mill throughput of 20,000 tonnes per day, a cyclone availability of 85 percent and an in-situ dry density of 1.6 tonnes per cubic metre, it is estimated that approximately 780,000 cubic metres of cycloned sand could be produced each year. If the cyclones can be operated for 9 months per year, the annual cycloned sand production would increase to about 1,000,000 cubic metres for an underflow split of 35 percent, assuming an availability of 85 percent. The estimated cycloned sand availability is shown on Table 3.6 and is discussed further in Section 4.0.

3.6 CONCLUSIONS

The cyclone trials carried out at Mount Polley have shown that underflow material that meets the general requirements for using cycloned tailings for embankment construction can be produced. The underflow material produced during the Mount Polley trials falls within the range of underflow material produced at other operating mines, as shown on Figure 3.5. On this figure, the fine and coarse limits of both the 20-inch and 50-inch cyclone underflows from the Mount Polley cyclone trials are plotted with underflow from many other mines. The Mount Polley underflow plots roughly in the middle. Of note on this figure is the Ergo underflow, which is considerably finer than Mount Polley. Ergo (East Rand Gold and Uranium Limited, Johannesburg, South Africa) has been used as a basis for comparison in the evaluation of cycloned tailings for embankment construction at Mount Polley.

The laboratory and field testing results indicate that construction of the tailings embankments at Mount Polley can be achieved by direct deposition of cycloned tailings sands. Furthermore, with adequate drainage and deposition over a large area, it is anticipated that a deposition slope of 3H:1V can be achieved. However, this will require confirmation during cycloning operations.

Two methods can be used for placement of cyclone underflow in the embankments. These methods are direct deposition or hydraulic placement and mechanical placement. Direct deposition of tailings has several advantages, as follows:

- Direct deposition of the underflow material avoids any costs associated with double handling the material. Double handling would be required if the cycloned sand underflow is placed mechanically.

- Mechanical placement requires the underflow material to be dried to a moisture content that will allow it to be handled and compacted. If excess moisture is present, there will be difficulties with regard to trafficability while placing the material. Precipitation will also interfere with mechanical placement of the underflow, but would not interfere with the direct deposition from the cyclones.

- Direct deposition of underflow with adequate provision for drainage will result in a dense deposit with a surface crust that is resistant to wind and water erosion. Mechanical placement of cycloned sands will result in a relatively loose surficial material on the downstream face. This material will be more prone to wind or water erosion.

The cyclone trials have not provided any definitive data on the material split from cycloning. These data are essential for any future designs incorporating cycloned tailings sands. These data would confirm the quantities of sands that would be available for embankment construction.

Section 4.0 provides conceptual designs for the cycloned sand embankment. Prior to proceeding with a feasibility design for a cycloned sand embankment, definitive measurements of cyclone splits must be made.

Mount Polley has tested two cyclones as described above. The 50-inch diameter cyclone is larger than is typically used for this application and the 20-inch diameter cyclone is at the upper end of the size range. There are two different and somewhat conflicting approaches to the selection of cyclone size, including:

- Larger sized cyclones that handle high throughputs, thereby reducing the number of cyclones required. Larger units are typically used for fixed cyclone banks from where the sand is hauled and placed by mechanical means. Larger cyclones can also be mounted on large skids that can be moved along the embankment for direct placement.

- Small sized cyclones that are easily handled on the embankment and provide a better cyclone separation efficiency. A larger number of smaller cyclones is used to handle the throughput and the cyclones are distributed along the dam crest. Fluctuations in mill throughput and feed pressure can be easily accommodated by varying the number of cyclones in use at any given time.

Based on the above considerations, as well as the requirements of Mount Polley, the optimum arrangement of cyclones is yet to be determined.

SECTION 4.0 - POTENTIAL DESIGN CHANGES

4.1 GENERAL

The cyclone trials program was conducted to evaluate the material properties of cycloned sand tailings at Mount Polley. After determining that these properties supported embankment construction using cycloned sand, potential changes to the design of the tailings embankments were considered. The main objective of the potential design changes was to develop an embankment design that would meet or exceed all existing performance requirements while utilizing cycloned sand as a replacement for higher cost fill materials to the greatest degree possible.

Three potential design concepts were initially considered, as follows:

- Option 1 - Upstream shell zone modifications.
- Option 2 - Downstream shell zone modifications.
- Option 3 - Full cycloned embankment.

A preferred option based on these concepts was then developed. The preferred option and the initial design concepts are discussed in the following sections. All concepts are based on the positive results from the cyclone trials program, as well as data and experience from other mines with cycloned tailings embankments. The design concepts in the following sections do not address specific cyclone operating requirements and are based on the assumption that suitable cyclone underflow material can be produced to all areas of the embankments for the life of the mine.

4.2 UPSTREAM SHELL ZONE – OPTION 1

The upstream shell zone for Stages 3 (El. 940) through Stage 7 (El. 965) in the existing design requires 1,118,000 cubic metres of free draining fill (FDF) material. Suitable free draining material for this zone includes cycloned sand tailings, as discussed in Section 2.2.

The upstream shell zone could be constructed by hydraulic placement of cycloned sand tailings. Hydraulically placed cycloned sand would utilize significantly more cycloned sand in the upstream shell zones because the upstream slope would change from 1.5H:1V to about 4H:1V, as shown on Figure 4.1. It is estimated that upstream fill quantities would be doubled for the flatter slope. Therefore, up to 2 million cubic metres of cycloned sand would be required and, on average, each stage would require about 400,000 cubic metres of cycloned sand. Approximately 3.5 to 4.5 months would be required per stage to produce this volume of cycloned sand, based on the production numbers and assumptions discussed in Section 3.5.

Option 1 results in good utilization of cycloned sand for the upstream shell zone and it does not affect the low permeability core zone. However, it does not minimize the waste rock requirements of the downstream shell zone and does not impact the filling schedule. For this reason, the potential design change involving the only the upstream shell zone is not the preferred option.

4.3 DOWNSTREAM SHELL ZONE – OPTION 2

The current design includes construction of the downstream shell zones in three phases. Approximately three million cubic metres of mine waste rock (Zone C) must be placed and compacted in lifts over the mine life, as shown on Table 2.1. This material could be replaced by cycloned sand tailings. A revised embankment cross-section incorporating cycloned sand in the downstream shell zone is shown on Figure 4.2. The modifications for the upstream shell zone (as discussed for Option 1 in Section 4.2) have been retained for Option 2, as has the low permeability core zone. The modifications for the downstream shell zone shown on Figure 4.2 include the following:

- Replacing most of the Zone C mine waste rock in the downstream shell zone with cycloned sand. Cycloned sand could be placed mechanically or by direct (hydraulic) discharge, as discussed in Section 3.6.

- Flattening the downstream slope from 2H:1V to 3H:1V, and extending the slope into the existing Seepage Collection Pond.

- Construction of a confining berm along the downstream toe of the embankment. The berm would be constructed from free draining rockfill in the topographic lows and from other materials at higher areas. The berm would confine hydraulically deposited cycloned sand tailings and would also provide a drainage path for tailings fluids on the downstream side of the embankments. The berm would require a filter layer (Zone T material) between the cycloned sand and the rockfill in the lower areas. In the higher areas, the berm would require suitable erosion protection on both slopes.

- Hydraulically placed cycloned sand tailings would be utilized in the upstream shell zone, as for Option 1.

Option 2 is the preferred option of the three initial design concepts. Including the modifications for the upstream shell zone (Option 1), approximately 7,000,000 cubic metres of cycloned sand are required for Option 2 (5,000,000 cubic metres for the downstream shell zone and 2,000,000 cubic metres for the upstream shell zone). This option would utilize nearly all of the cycloned sand that could be produced for a system that operates 7 months/year, as shown on Table 3.6. Also, the use of cycloned sand as fill material for downstream sections of the embankment decreases the volume of tailings reporting to the Tailings Storage Facility. Therefore, Option 2 has the potential to reduce the ultimate embankment height by up to 2 metres, to final El. 963 m. This would reduce the amount of downstream fill (cycloned sand) required. The filling schedule for the cycloned sand embankment is presented on Figure 4.9.

Other benefits of Option 2 include:

- The low permeability core zone has been retained.
- Rockfill volumes for the confining berm are minimized.

Option 2 includes significant modifications to the downstream areas of the embankments. The existing drainage and seepage collection and return systems would be impacted. The Seepage Collection Ponds at the Main and Perimeter

Embankments would be reduced in size and the existing pipeworks would have to be extended or relocated. (It should be noted that the ponds are oversized; therefore, this is not foreseen to be a concern). A system of drainage ditches would be required immediately downstream of the confining berm. The water from the ditches would collect in a sump and be pumped back into the Seepage Collection Ponds.

Estimated seepage from the cycloned sand into the underlying low permeability glacial till foundation materials was calculated to be 1.5×10^{-6} l/s, which is deemed to be negligible. The estimated drainage through Zone T and into the collection ditches was calculated to be 23 l/s or 365 US gpm.

Option 2 is the preferred option because it utilizes nearly all of the cycloned sand that could be produced for a system that operates 7 months/year by incorporating it in both the upstream and downstream shell zones. The waste rock requirements are minimized. In addition, the low permeability core zone is retained.

4.4 FULL CYCLONED EMBANKMENT - OPTION 3

Option 3 includes the conversion to a full cycloned sand embankment for Stages 3 to 7 (El. 940 to El. 962). For this modification, all embankment zones would be replaced by cycloned tailings sand. In addition to replacing approximately 3,000,000 cubic metres of mine waste rock for the downstream shell zone, this option also includes replacing approximately 800,000 cubic metres of glacial till for the embankment core zone (Zone S). A revised embankment cross-section incorporating the modifications to a full cycloned embankment is shown on Figure 4.3. The modifications for the a full cycloned embankment include the following:

- Replacing all of the fill materials with cycloned sand tailings. This includes the downstream and upstream shell zones, as well as the Zone S glacial till core zone. As above, it has been assumed that hydraulic discharge would be utilised for placement of the cycloned sand.

- Flattening the downstream slope from 2H:1V to 3H:1V, and extending the slope into the existing Seepage Collection Pond as for Option 2.

- Construction of a confining berm along the downstream toe of the embankment using free draining rockfill in the topographic lows and other materials at higher areas, as for Option 2.

The total cycloned sand volume for Option 3 is estimated to be approximately 9,000,000 cubic metres. This option requires more cycloned sand than could be produced for a system that operates 7 months/year, as shown on Table 3.6. The system would need to operate for more than 8 months/year to meet the demand for cycloned sand. The system would have to be optimized and/or modified from that currently being considered to produce sufficient cycloned sand volumes. Although the cycloned sand could be placed mechanically or by hydraulic discharge, it has been assumed that hydraulic discharge would be utilized.

Option 3 includes the same modifications to the downstream areas of the embankments that were identified for Option 2. This includes the impacts to the existing drainage and seepage collection and return systems, reducing the size of the Seepage Collection Ponds at the Main and Perimeter Embankments and extending or relocating the existing pipeworks. The same system of drainage ditches that convey process water to the Seepage Collection Ponds would be required immediately downstream of the confining berm.

Estimated seepage from the cycloned sand into the underlying low permeability glacial till foundation materials was calculated to be 1.5×10^{-6} l/s, which is deemed to be negligible. The estimated drainage through Zone T and into the collection ditches was calculated to be 23 l/s or 365 US gpm.

Although Option 3 allows the replacement of all of the higher cost embankment fill with cycloned sand, it is the not the preferred option. It requires more cycloned sand than could be produced for a system that operates 7 months/year. In addition, MPMC prefer to retain the low permeability core zone in the embankment, at least until the performance of the revised embankment configuration can be demonstrated.

4.5 PREFERRED OPTION

4.5.1 General

A preferred option based on the concepts presented above has been developed. The preferred option is a variation of Option 2, whereby cycloned sand tailings will be incorporated both upstream and downstream of the embankment core zone. The core zone will be retained. The main difference from Option 2 is that the initial cycloned tailings sand produced from full scale operations will be placed in a large berm inside the impoundment, instead of at the downstream toe of the existing embankment.

As previously stated, the design of the preferred option does not address specific cyclone operating requirements and is based on the assumption that suitable cyclone underflow material can be produced to all areas of the embankments for the life of the mine.

4.5.2 Design Considerations

The Preferred Option for the cycloned sand tailings embankment includes the following:

- Cycloned sand tailings will be utilised in the upstream shell zone. A large cycloned sand berm will be constructed on the upstream side of the embankment in 1999 as a trial run to evaluate a full scale cycloning program.
- An Upstream Toe Drain will be installed in the cycloned sand adjacent to the upstream face of the existing embankment. The Upstream Toe Drain will maintain the phreatic surface of the tailings deposit at low levels for future operations.
- The low permeability core zone is retained. It will be raised to the level of the cycloned sand berm after the berm is completed.

- Cycloned sand tailings will be used to replace most of the Zone C mine waste rock in the downstream shell zone. Rockfill is only required for sections of the confining berm, as discussed below.

- The downstream slope of the embankment will ultimately be flattened to the angle of repose for the cycloned sand, which is estimated to be about 3H:1V. The upstream slope is estimated to be about 4H:1V.

- A confining berm will be constructed along the downstream toe of the embankment. The berm would be constructed from free draining rockfill in the topographic lows and from other materials at higher areas. The berm would confine hydraulically deposited cycloned sand tailings and would also provide a drainage path for tailings fluids on the downstream side of the embankments. The berm would require a filter layer (Zone T material) between the cycloned sand and the rockfill in the lower areas. In the higher areas, the berm would require suitable erosion protection on both slopes.

- A system of ditches to collect seepage downstream of the confining berm and direct it to the seepage collection ponds will be constructed. The ditches will be required over the full length of the embankments, approximately 3,100 metres for Stage 2C.

- The estimated seepage through the Zone T and into the drainage ditches was calculated to be 23 l/s or 365 US gpm. This water will report to the existing seepage control ponds and be pumped back into the Tailings Storage Facility.

The Preferred Option is shown in cross-section on Figures 4.4 and 4.5 and in plan on Figures 4.6 and 4.7 for both the Main and Perimeter Embankments, respectively. A final arrangement is shown for the Preferred Option as Figure

4.8. The final alignment of the South Embankment, Final Spillway and South Seepage Collection Pond are to be confirmed during final design.

4.5.3 Stage 2C Construction Requirements

The Preferred Option for the Stage 2C embankment raise includes a cycloned sand berm to El. 940 m located upstream of the core zone of the embankments. The berm would be constructed by hydraulic placement of cycloned sand on spigotted tailings beaches upstream of the Main Embankment and on native soil and/or tailings upstream of the Perimeter Embankment. Cross-sections of the Main and Perimeter Embankments are shown on Figures 4.4 and 4.6, respectively. Plan views are shown on Figures 4.5 and 4.7. A preliminary schedule of quantities to complete Stage 2C construction is presented on Table 4.1.

For the Preferred Option, an Upstream Toe Drain will be constructed in cycloned sand adjacent to the existing embankment face. The drain will maintain the phreatic surface at low levels for future raises. This drain would be installed at El. 935 m (approx.) in cycloned sand and would extend to El. 940 (invert El. 939) in ground above the abutments of the embankments. This will allow for the extension of the toe drain in future raises. The Upstream Toe Drain would consist of a v-shaped trench containing one 150 mm diameter perforated CPT pipe surrounded by drain gravel (Zone G) and geotextile filter fabric. The drain gravel specification would be designed with a filter relationship with the cycloned sand. The toe drain would be connected to the existing conveyance pipework at the Main Embankment via new outlet pipes through the embankment foundations. New outlet pipes would also be required through the embankment foundations at the Perimeter Embankment. The Perimeter Embankment outlet pipes would discharge to drainage ditches that flow to the Perimeter Embankment Seepage Collection Pond. Preliminary design details for the Upstream Toe Drain are shown on Figures 4.4 to 4.7.

It should be noted that with the inclusion of the Upstream Toe Drain and the transition to a cycloned sand embankment, the installation of the chimney drain at the Perimeter Embankment and the extension of the chimney drain at the Main Embankment will not be required.

4.5.4 Stage 2C Scheduling

In order to accurately schedule the Stage 2C and future embankment raises at Mount Polley, the filling schedule was updated based on data and projections from MPMC. The filling schedule for earth/rockfill construction is shown on Figure 4.8. A second filling schedule, displayed on Figure 4.9, takes into account cycloned sand production of 780,000 m^3/year. As discussed in section 4.3, a significant portion of the bulk tailings would not report to the Tailings Storage Facility. This filling schedule shows that the ultimate embankment elevation may be reduced by up to 2 metres (El. 963), taking into account a bulk density of 1.1 tonnes/m^3 for tailings slimes entering the Tailings Storage Facility and 1.6 tonnes/m^3 for cycloned sand being deposited on the downstream side of the embankment. This lower embankment height would translate into a reduction of cycloned sand volume for the downstream shell zone and earthfill volumes on the crest. In order to focus on Stage 2C and Stage 3 construction, Figure 4.10, shows the cycloned sand embankment filling schedule for years 2 to 5.

A review of the sequencing required for various trial programs, design studies, permit applications and construction of the cycloned sand embankment has been prepared, as shown on Figure 4.11. For the Preferred Option, cycloned sand would be deposited to El. 940 m on the upstream side of the embankment during 1999. This would allow for on-going expansion of the embankment using cycloned sand and would provide additional information and time to obtain the required permits from the agencies. The scheduling of the zoned earthfill construction for the Stage 2C embankment raise are dependant on the progress of upstream cycloned sand construction and the acceptance of cycloned sand as a temporary confining berm, as discussed below.

The current dam elevation is 937 metres. Taking into account 1.5 metres elevation for storm water storage and wave run-up requirements, the tailings pond is not allowed to be above El. 935.5 until further embankment construction takes place. Based on the cycloned sand embankment filling schedule (Figure 4.9), the tailings pond will be at El. 935.5 on August 15, 1999.

Trials scheduled for 1999 include the construction of the upstream cycloned sand berm. To construct the berm, approximately 427,000 cubic metres of cycloned sand, or four months construction time, is required. This temporary confining embankment would provide storm water storage and wave run-up requirements for the TSF. Therefore, the maximum tailings pond elevation could reach El. 937 before earthfill construction would have to take place. As the tailings pond will be at El. 937 at the end of March, 2000, it would be necessary to commence raising the earthfill dam prior to this date.

It is also noted that the required 1.5 metres of freeboard for the 24-hour PMP storage and wave run-up would be available up to El. 938.5 on the cycloned sand berm. This provides additional contingency storage capacity which would not be encroached upon until about August 1, 2000. Any seepage through the temporary confining embankment will be intercepted by the Upstream Toe Drain and recycled back into the TSF. The construction schedule illustrated on Figure 4.11 assumes that the dam crest raise will be completed by early December, 1999, but could be deferred until March 2000 once the upstream sand berm is completed..

4.5.5 Materials Quantities Estimates for Stage 2C and Stage 3 Construction

4.5.5.1 Cycloned Sand

Approximately 427,000 cubic metres of cycloned sand (Zone CS1) is required to complete the cycloned sand berm along the inside of the Perimeter and Main Embankments. An additional 98,000 cubic metres of

Zone CS2 will be required to complete the upstream shell zone. Based on a production rate of 780,000 cubic metres of cycloned sand for 7 months of operation per year (as discussed in Section 3.5), it is estimated that about 5 to 6 months of cycloned sand production will be required to construct the Stage 2C cycloned sand berm and Zone CS2 upstream fill zone. The total length of the embankment (Main and Perimeter) for Stage 2C is about 3,100 metres. Therefore, it will be necessary to construct at least 15-20 metres of the berm per day in order to complete the work within 6 months.

It may be necessary to construct the upstream berm in multiple lifts in order to prevent inundation of the tailings beaches prior to construction of the cycloned sand berm. If two lifts are required and each lift incorporates 50 percent of the required volume of cycloned sand, the berm would have to be constructed at an average rate of about 30 to 40 metres per day to complete the work within 6 months. This required rate of advance must be factored into the selection of the cyclone system.

The volume of cycloned sand required for Stage 3 downstream construction to El. 943 m (the downstream component required to complete the Stage 3 embankment raise to El. 946 m) is about 816,000 cubic metres, excluding any material for the confining berm. This volume of cycloned sand would require about 7 to 8 months of production, assuming the same parameters as above. However, the filling schedule indicates that the embankment crest would have to be raised above El. 940 m by August 1, 2000. This means that there would be a maximum of 5 to 6 months to produce cycloned sand for downstream construction before the crest would have to be raised. This time may not be sufficient, as the raise of the Stage 3 (El. 946 m)is dependent on having all of the downstream cycloned sand in place to El. 943 m. Therefore, an interim raise of the core and upstream cycloned sand zones may be required. An interim raise to El. 941 m would result in 2 to 3 additional months for cyclone production in 2000, and the total time for cycloning should then be sufficient to meet the Stage 3 downstream requirements. This interim core zone construction is shown on Figures 4.4, 4.5 and 4.10.

It should be noted that the cycloned sand quantities are totally dependant on the underflow split, which has yet to be confirmed. In addition, exposed tailings beaches must be constructed ahead of the upstream cycloned sand berm is being carried out.

For this evaluation, the impact of separate construction methods at the Main and Perimeter Embankments has not been considered. For example, sections of the embankments may be built by conventional earthfill construction to reduce the total demand for cycloned sand. The final construction sequencing may include cycloning at the Main Embankment only and continuing to raise the Perimeter Embankment by conventional earthfill construction methods. Any reductions in cycloned sand requirements at the Perimeter Embankment would help to ensure that sufficient quantities are available at the Main Embankment. In addition, it would be possible to supplement some of the downstream fill with borrow material or rockfill along some sections of the embankment in order to compensate for any projected shortfall of cycloned sand.

4.5.5.2 Upstream Toe Drain

The Upstream Toe Drain is to be installed in cycloned sand at El. 935 adjacent to the upstream face of the existing embankments. It will be extended in the ground above El. 935 to El. 940 (Invert El. 939) and will be connected over the full length of the Main and Perimeter Embankments, a total of about 3,100 metres. Construction of the Upstream Toe Drain will be scheduled for the fall/winter period of 1999/2000, during the latter stages of construction of the cycloned sand berm (Zone CS1). As stated above, the Upstream Toe Drain comprises a trench with one 150 mm diameter perforated CPT pipe surrounded by drain gravel (Zone G) and geotextile filter fabric. The drain gravel specification would be designed with a filter relationship with the cycloned sand. The approximate material quantities for the Upstream Toe Drain are summarized as follows:

- Zone G drain gravel - 4,650 cubic metres.

- 150 mm diameter perforated CPT pipe - 3,100 metres.
- Type 1 geotextile filter fabric - 15,500 square metres.

The Upstream Toe Drain will be connected to the existing conveyance pipework at the Main Embankment via new outlet pipes through the embankment foundations. The existing conveyance pipes will be extended to suitable levels at higher elevations on the embankment abutments. New outlet pipes would also be required through the embankment foundations at the Perimeter Embankment. The Perimeter Embankment outlet pipes would discharge to drainage ditches that flow to the Seepage Collection Pond. The material quantities for the outlet and conveyance pipes are summarized as follows:

- Extension of 150 mm HDPE DR17 conveyance pipe at Main Embankment – 140 lineal metres.

- 150 mm HDPE DR17 outlet pipe at the Main and Perimeter Embankments, complete with seepage collars and concrete bedding – 300 lineal metres.

- Downstream conveyance ditches at the Perimeter Embankment - 1,100 lineal metres.

The details for outlet pipes that extend through the embankment foundations are presented in the Stage 1 construction drawings and are not shown in this report.

4.5.5.3 Rockfill and Transition Zone (Zone T)

Approximately 60,000 cubic metres of random rockfill is required to construct the downstream confining berm to El. 920 at the Main Embankment and El. 932 at the Perimeter Embankment. Rockfill, required at the topographic lows, will permit water to filter through the berm into the seepage collection ditches. An additional 36,000 cubic metres of fill is required to construct the remainder of the berm to contain the cycloned sand for Stage 3 construction (El. 943). If cycloned sand or other fine grained fill materials are used for the confining berm, additional rockfill material will be required for erosion protection on both sides of the berm.

Transition Zone Material (Zone T) is required on the prepared downstream foundation and on the upstream face of the confining berm. This material is part of the seepage collection system. It is estimated that 60,000 cubic metres of Zone T material is required. It should be noted that Type 1 geotextile filter fabric is required below Zone T over the same areas or chainages defined for Stage 2A construction. It is estimated that this quantity is approximately 50,000 square metres.

4.5.6 Foundation Preparation and Water Management

For future construction, including Stages 2C and 3, the same foundation preparation standards used for previous embankment raises are required. This typically includes some of the following activities:

- Clearing, stripping, grubbing and removal of topsoil to expose suitable foundation materials.
- Removal of unsuitable material below the topsoil, where present. All weak materials must be removed and replaced with the appropriate material for the embankment zone.
- Trimming, keying-in and compacting the exposed surface.

Previous foundation preparation experience in the vicinity of the tailings storage facility has indicated that most of the embankment foundation areas are comprised of dense glacial till, with very little unsuitable material that requires removal. However, some soft, weak areas have been encountered; primarily associated with topographic lows. In these areas, extra material has been removed for stability purposes. Therefore, it is likely that a similar percentage of unsuitable material will be found during subsequent embankment raises.

The tailings impoundment continues to be designed with adequate storage capacity for ongoing tailings deposition, process water and storm run-off requirements. Seepage through the embankment continues to be restricted by a central low permeability, core zone with accompanying internal filters, drains and cycloned sand. Seepage through the foundation will be restricted by the combination of either low permeability natural materials or constructed liner materials (where required).

With the change to a cycloned sand embankment, confinement berms will be required to divert and filter accumulated seepage into drainage collection ditches. In topographic low areas, the confinement berms will be constructed out of rockfill and will filter accumulated seepage. In higher elevation areas, the berm can be constructed from other materials (i.e. mechanically placed cyclone sand or glacial till) as it will simply provide confinement of the tailings solids and diversion of collected process water and surface runoff into the lower elevation areas. A seepage collection ditch will be constructed immediately downstream of the confinement berms to convey seepage into the seepage collection pond.

A layer of coarser, free draining mine waste (i.e. Zone T) will serve as an underdrainage blanket to dewater the overlying cycloned sand and to assist with dissipation of any increased foundation pore water pressures. A layer of geotextile will be placed between the prepared foundation and overlying Zone T blanket in areas where fine grained materials are exposed or artesian foundation pressures are suspected.

Seepage exiting the impoundment via the foundation is estimated to be very low due to the presence of underlying low permeability natural materials or mechanically placed glacial till liners. The lower permeability tailings also greatly restrict tailings seepage through the embankment. Where seepage through the foundation below the embankments is expected, a series of foundation drains (complete with pressure relief wells where required) have been constructed to intersect and collect seepage and reduce foundation pore water pressures.

A series of groundwater monitoring wells were installed during start-up at various locations around the tailings impoundment. The monitoring wells were installed within the highest permeability overburden and bedrock zones observed within the drillholes. Groundwater quality testing has regularly been carried out by MPMC since prior to mill start-up. The vertical and lateral positioning of the monitoring wells were selected to maximize detection of changes in groundwater chemistry due to potential seepage of process water from the impoundment.

To date, all of the monitoring wells surrounding the impoundment indicate that design groundwater discharge criteria are being met and seepage losses from the impoundment are within tolerable limits. As the impoundment increases, it may become necessary to install additional groundwater wells.

4.5.7 Pipeworks

The existing pipeworks system will have to be modified for cycloned sand embankment construction. The existing tailings delivery pipeworks system can be modified to supply the tailings slurry to the cyclone(s) at appropriate pressures. However, it will be necessary to close the M1A dump valve during cycloning as adequate slurry pressures can only be achieved when the slurry backs up in the pipeline. The lower section of the tailings pipeline will therefore be operated as a pressure pipeline during cycloning operations.

The design and operation of the cyclones and associated pipeworks are key aspects to the conversion to a cycloned sand tailings embankment. Large volumes of cycloned sand must be produced and hydraulically placed along approximately 3,100 metres of embankment length. The feed rate to the cyclone(s) must be calculated to evaluate the amount and size of cyclones required. The number and size of cyclones in a battery should be sufficient to account for fluctuations in feed rate and delivered pressures. It will not be practical to place this amount of material using only one cyclone, as the pipework handling requirements would likely result in excessive down time. It is recommended that two or three "banks" of cyclones be constructed in order to maximize the production of cycloned sand from one location which, in turn shall reduce the frequency of moves, reduce down time during cyclone moves and to smooth out labour requirements during pipeline reconnections. This would allow one bank to produce cycloned sand along a 30 to 40 metre stretch while other banks are being assembled, dismantled and moved.

4.5.8 Overflow/Fresh Water Dump Line

The operation of the tailings pipeworks system as a cycloned sand tailings system could result in a higher probability of overflowing the T2 Dropbox because of the increased pressure heads required for cyclone operation. In addition, fresh water runoff from the Southeast Sediment Pond may affect the operation of the cyclone system. There are several options to prevent fresh water runoff from the Southeast Sediment Pond from disrupting the cyclone system, as follows:

- MPMC has installed a pressure relief line at the M1 offtake to prevent excessive line pressure and/or overlapping of the T2 drop box. It will also be prudent to enhance the existing road and ditching system so that any overflows would be contained and would drain by gravity across the Bootjack Creek Crossing.

- Pump fresh water directly to the mill from the booster pumpstation (i.e. do not let this water enter the tailings pipeworks system).

- Interrupt cycloning if fresh water runoff from the Southeast Sediment Pond impacts cyclone operations and discharge tailings from the spigots, as currently done.

4.5.9 QA/QC Procedures

As part of the upcoming 1999 Stage 2C construction program, Quality Assurance and Quality Control (QA/QC) testing programs will be carried out on the following materials and activities:

- Cycloned tailings sand deposited upstream of the embankment core zone.
- Construction of upstream toe drain and embankment core zone fill placement.
- Preparation of future Stage 3 Embankment footprint foundation (subject to MPMC construction schedule).

Both the bulk and cycloned tailings will be sampled frequently over the next 4 to 5 months to provide a database of information regarding variability in tailings characteristics. The additional data obtained during the proposed tailings QA/QC program will supplement existing information pertaining to the suitability of incorporating cycloned tailings into future design configurations.

Because the tailings QA/QC program will span several months, much of the sampling and laboratory testing will be conducted on-site by MPMC under the guidance of KP. Additional samples will also be collected by KP staff (during periodic site visits) for alternative testwork associated with permeability, strength and consolidation characteristics of the tailings. Some of the samples will likely need to be sent to an outside laboratory for specific testing that can not be performed on site. The results of all tests are to be forwarded to Knight Piésold Ltd. in Vancouver for review and interpretation.

The following proposed testing and sampling program is intended as a guide in order to properly characterise variations in tailings properties. In general, the bulk tailings, underflow, overflow, and deposited tailings sands (beach) are to be tested as follows:

- The bulk tailings, underflow and overflow shall be tested for Solids / Moisture Content (ASTM D2216) and Particle Size Distribution (PSD) (ASTM D422). Every week, a minimum of two representative samples shall be collected of each material and submitted for PSD sieve analyses. Because it is necessary to obtain the PSD D_{10} value for the Underflow tailings, samples of the Underflow split shall periodically (i.e. monthly) include a hydrometer analyses. It is recommended that one sample of Bulk and Overflow Tailings also be submitted for hydrometer analysis on a monthly basis.

  It is understood that MPMC is currently collecting daily to twice daily samples from the individual cyclones and from the bulk tailings. The cyclone sand samples are composited and tested by week., while the bulk tailings are tested daily. This is an appropriate sampling frequency and testing plan.

- The deposited sands (beach) shall be tested for Moisture Content (ASTM D2216). As the deposited sands will be free/slow draining, the time interval between tailings deposition and sampling is required. A minimum of two representative samples shall be collected and tested per week.

  It is anticipated that a nuclear densometer will be on site to carry out QA/QC activities associated with the Stage 2C construction program. During this period, it would be advantageous to conduct the moisture content tests using the nuclear densometer (ASTM D3017) as it provides both immediate moisture content and in-situ dry density values of the beach sands. The in-situ dry density values would assist in characterising the properties of the deposited tailings for current and ongoing design analyses.

The remaining QA/QC activities listed above will be carried out by KP as part of normal construction supervision procedures used in earlier embankment raises. For details on sampling method, documentation and other QA/QC aspects, please refer to the Knight Piésold Ltd. Report "Site Inspection Manual", (Ref. No. 1625/2).

4.6 EMBANKMENT SETTLEMENT

Projected embankment settlements for the current design are forecast to be low. Detailed embankment settlement analyses, based on the current design, are summarised in the following Knight Piésold documents:

- "Tailings Storage Facility, Design Report" (Ref. No. 1625/1), May 26, 1995.
- "Tailings Storage Facility, Updated Design Report" (Ref. No. 1627/2), June 6, 1997.
- "Report on On-going Construction Requirements" (Ref. No. 10162/9-3), December 2, 1997.

These analyses indicate that total settlement will reach about 0.8 m after the completion of Stage 7 construction. The majority of settlement is forecast to occur within the tailings mass, as the incremental upstream raises are constructed.

In addition to these analyses, pore pressure dissipation data within the bulk tailings was collected during the placement of Zone CBL (Coarse Bearing Layer) on the tailings beach during Stage 2A construction. The piezometers indicated that excess pore pressures dissipated approximately eight hours after fill placement was completed. Also, survey monument data was recorded between Stage 1B and Stage 2A construction and following Stage 2A construction. Results indicate that horizontal movements were along the axis of the embankment and that these displacements ranged from 3 to 33 mm. Vertical displacements reached a maximum value of 25 mm, much less than the predicted maximum settlement range of 200 to 400 mm. Results from the survey monument data is shown in Table 4.2.

The recorded and projected future settlements are relatively minor and will not adversely influence the performance of the proposed cycloned sand embankment. Deformation of the low permeability core zone will be minor and will not result in adverse cracking or cause an increased risk for piping failure. Due to the filter relationship with the upstream sandy tailings, the tailings material would tend to act as an efficient crack stopper. Furthermore, the upstream drainage systems will preclude the build-up of high pore pressures on the core zone and provide a significant additional contingency factor against piping and instability.

SECTION 5.0 - CONCLUSIONS AND RECOMMENDATIONS

The evaluation of cycloned tailings for embankment construction has indicated the following:

- Mount Polley tailings are amenable to cycloned sand production.

- The particle size distribution and the underflow product produced to date are comparable with cycloned sands used at other operating mines for cycloned embankment construction.

- Although preliminary calculations indicate that the system will produce an underflow split that is capable of providing the volumes of cycloned sand required for embankment construction, there is no actual data available to define the splits achieved in the cyclone trials to date. Additional information will be required for further design studies.

- There are many ways in which cycloned sands can be incorporated into the Mount Polley tailings embankments. The Preferred Option incorporates cycloned sand zones both upstream and downstream of an embankment core zone. The Preferred Option includes construction of a large cycloned sand berm inside the impoundment from full scale cycloning production, while allowing for on-going expansion of the embankment using cycloned sand and providing additional information and time to obtain the required permits from the agencies.

- The optimum arrangement of cyclones to meet these requirements is yet to be finalized and detailed comparative studies will be needed to determine the most economic methods for cycloned sand production and placement.

- Future design studies and monitoring programs must also demonstrate the stability of the cycloned sand embankment. In particular, the regulatory agencies have requested additional information on the implications of tailings settlements on the performance of the sloping embankment core zone.

Knight Piésold have previously shown that the projected future settlements are relatively minor. The tailings will act as an efficient crack stopper and the upstream drainage systems will preclude the build-up of pore pressures to provide an added contingency against piping and embankment instability. However, Mr. George Headley of the Ministry of Energy and Mines has requested that additional site monitoring be conducted to verify settlement predictions. Therefore, it is recommended that 4 to 5 telescoping settlement plates be installed along the tailings beach to carry out ongoing monitoring of settlements in tailings materials immediately upstream of the core zone.

SECTION 6.0 - REFERENCES

The following publications were used as reference material in the preparation of this report:

1. Watermeyer, Legge, Piésold & Uhlmann, "Hydrocyclone Selection - Internal Design Note", Revision 3, internal Knight Piésold document, March, 1978.

2. Peter Watermeyer and Rob Williamson, Watermeyer, Legge, Piésold & Uhlmann, Tailings Disposal Today, "Ergo Tailings Dam - Cyclone Separation Applied to a Fine Grind Product."

3. Jull, Norman A., Fourth Annual Meeting of the Canadian Mineral Processors, "Parameters for Cyclone Selection", January, 1972.

4. Knight Piésold Ltd., "Tailings Storage Facility, Design Report" (Ref. No. 1625/1), May 26, 1995.

5. Knight Piésold Ltd., "Tailings Storage Facility, Updated Design Report" (Ref. No. 1627/2), June 6, 1997.

6. Knight Piésold Ltd., "Report on On-going Construction Requirements" (Ref. No. 10162/9-3), December 2, 1997.

SECTION 7.0 - CERTIFICATION

This report was approved by the undersigned.

PROFESSIONAL
PROVINCE OF
K. J. BROUWER
BRITISH
COLUMBIA
ENGINEER

Approved by:

Ken J. Brouwer, P.E.
Director

Knight Piésold Ltd.
CONSULTING ENGINEERS

TABLE 2.1

MOUNT POLLEY MINING CORPORATION
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY

STAGED EMBANKMENT FILL QUANTITIES AND CYCLONE SAND AVAILABILITY

M:\11162\11\Data\misc\[CYCSAND.XLS]Table 2.1

16-Jun-99

Stage and Crest (m) (El.)		Estimated Fill Volume (m^3)												
		CBL	Zone B	FDF	Zone S	Filter Sand	Drain Gravel	Zone T	Zone C	Total	Year Constructed	Total Months Available	Months Available for Cyclone	Cycloned Sand Available (m^3)
Stage 1b	934	-	220,000	-	352,000	24,500	2,000	-	-	598,500	1996/97	0	0.0	-
Stage 2A	936	9,000	84,000	-	21,000	800	400	52,000	-	167,200	1998	6	0.0	-
Stage 2B	938	-	29,400	-	45,500	22,900	1,800	137,500	506,600	743,700	1999	6	3.5	395,892
Stage 2C	940	15,500	66,500	-	46,900	5,900	-	23,500	29,300	187,600	1999	6	3.5	395,892
Stage 3	946	-	-	256,455	163,500	23,380	500	93,420	812,500	1,349,755	2000	12	7.0	791,784
Stage 4	951	-	-	221,375	162,500	21,250	200	80,600	130,800	616,725	2002	24	14.0	1,583,568
Stage 5	956	-	-	229,625	167,500	21,350	100	83,400	6,800	508,775	2004	24	14.0	1,583,568
Stage 6	961	-	-	235,510	172,500	21,775	50	85,700	1,368,900	1,884,435	2006	24	14.0	1,583,568
Stage 7	965	-	-	175,400	140,500	-	-	-	61,600	377,500	2008	24	14.0	1,583,568
TOTAL		24,500	399,900	1,118,365	1,271,900	141,855	5,050	556,120	2,916,500	6,434,190		126	70.0	7,917,839
											Average Annual Cyclone Material Produced (m^3):			791,784

NOTES:

1. All quantities listed above are neat line taken from Drawing No. 10162-9-200 (Rev. 0) and 10162-9-201(Rev. 0). No allowance has been added for cut to fill shrinkage.
2. Coarse Bearing Layer (CBL) only included for Stage 2. It may be required for additional expansions, to be determined prior to construction.
3. Free Draining Random Fill (FDF) material type to be determined prior to construction.
4. Estimate of cyclone material availability assumes:
   a. Mill throughput (tpd) 20,000
   b. Underflow split 35.0%
   c. Cycloned sand density (t/m^3) 1.60
   d. Cyclones used for (month/year) 7
   e. Cyclone availability 85.0%

Knight Piésold Ltd.
CONSULTING ENGINEERS

TABLE 3.1

MOUNT POLLEY MINING CORPORATION
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY

SUMMARY OF PHYSICAL TESTWORK ON TAILINGS

M:\11162\11\Data\misc\[TAILSTST.XLS]summary - Table 3.1

16-Jun-99

Year and Sample	Tailings Composition (%)			Specific Gravity	PI[1]	Settled Density ($tonne/m^3$)		Average Void Ratio [2] e	Vertical Permeability (cm/sec)
	Sand	Silt	Clay			Undrained Initial	Drained	(Settled)	
Preliminary Testwork (1989/90)	6	64	30	2.78	NP	0.90 - 1.10 (1.30 final)			1 to 2 x 10^{-5}
1996 Testwork - Slimes Tails (57%)		85 - 90	10 - 15						
1996 Testwork - Sand Tails (43%)	26 - 30	70 - 74							
1996 Testwork - Bulk Tails	13	77 - 82	5 - 10						
1997 Testwork - BK1 (Bulk Slurry)	21	68	11	2.74	NP	0.81	0.91	1.94	4.7 x 10^{-5}
1997 Testwork - BK2 (Bulk Composite)	31	61	8			1.10	1.10	1.39	2.2 x 10^{-5}
1997 Testwork - BH1 (Beach Tailings)	66	31	3			1.19	1.20	1.45	5.5 x 10^{-5}
1997 Testwork - SS1 (Fine Slurry)						0.49	0.57	3.75	5.4 x 10^{-6}

NOTES:

1) PI = plasticity index
2) Average void ratio is after drained settling.

Knight Piésold Ltd.
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TABLE 3.2

MOUNT POLLEY MINING CORPORATION
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY

SUMMARY OF CYCLONE UNDERFLOW GRADATIONS

M:\11162\11\Data\psa\[CYC-PSA.XLS]uf - Fig. 3.2

16-Jun-99

SAMPLE ID	PERCENT FINER THAN											
SIEVE (mm)	2.360	1.000	0.850	0.600	0.425	0.300	0.2120	0.1500	0.1060	0.0750	0.0450	0.0370
SIEVE No.	#8	#16	#20	#28	#35	#48	#65	#100	#150	#200	#325	#400
50 INCH CYCLONE												
01/09/1998, 50"	100.00	100.00	99.90	99.36	97.90	89.70	74.40	51.90	36.90	25.90	18.20	15.80
02/09/1998, 50"	100.00	100.00	99.80	99.30	97.30	92.70	84.30	63.40	46.70	32.40	21.00	6.20
10/09/1998, 50"	100.00	100.00	99.20	96.10	88.50	74.80	58.10	39.20	27.80	19.00	11.80	10.00
16/09/1998, 50"	100.00	100.00	100.00	100.00	99.60	93.10	77.40	53.60	39.10	27.50	16.70	13.90
18/09/1998, 50"	100.00	100.00	99.10	97.70	92.90	79.80	61.60	41.30	30.20	21.40	13.60	11.50
C-ZCS-1 50"	100.00	100.00	99.80	99.50	98.10	93.90	84.30	64.80	42.70	27.10	14.60	11.40
19/10/98, 50"	100.00	100.00	99.90	99.60	97.60	90.90	67.00	44.70	30.70	20.90	11.60	10.00
20/10/98, 50"	100.00	100.00	100.00	99.60	96.80	89.10	66.00	46.10	32.50	22.90	13.70	12.50
22/10/98, 50"	100.00	100.00	99.80	99.70	99.00	99.00	92.30	75.20	48.60	29.80	18.70	13.00
MOUNT POLLEY COARSE LIMIT (50-inch Cyclone)	100.00	100.00	99.10	96.10	88.50	74.80	58.10	39.20	27.80	19.00	11.60	6.20
MOUNT POLLEY FINE LIMIT (50-inch Cyclone)	100.00	100.00	100.00	100.00	99.60	99.00	92.30	75.20	48.60	32.40	21.00	15.80
MOUNT POLLEY MEDIAN (50-inch Cyclone)	100.00	100.00	99.80	99.50	97.60	90.90	74.40	51.90	36.90	25.90	14.60	11.50
20 INCH CYCLONE												
26/09/1998, 20"	100.00	100.00	100.00	99.90	99.40	95.60	83.00	54.70	38.30	26.10	15.30	12.40
27/09/1998, 20"	100.00	100.00	100.00	100.00	99.80	98.00	90.20	65.40	43.60	27.70	15.50	11.90
28/09/1998, 20"	100.00	100.00	100.00	100.00	99.80	98.70	95.10	70.40	41.00	24.50	13.40	10.20
29/09/1998, 20"	100.00	100.00	100.00	100.00	99.70	98.10	91.40	66.50	42.20	26.70	15.80	12.60
C-ZCS-2 20"	100.00	100.00	99.68	99.63	99.25	97.55	89.73	67.73	45.73	31.40	20.40	17.20
05/10/1998, 20"	100.00	100.00	100.00	100.00	99.11	93.80	79.10	51.60	32.90	23.80	15.30	13.00
06/10/98, 20"	100.00	100.00	100.00	100.00	100.00	99.00	94.30	74.30	44.10	26.30	15.10	11.80
07/10/98, 20'	100.00	100.00	100.00	100.00	99.90	99.40	96.00	76.50	44.90	29.50	18.30	15.40
08/10/98, 20"	100.00	100.00	98.90	98.80	98.60	98.40	96.00	83.00	53.00	30.30	16.50	11.60
09/10/98, 20"	100.00	100.00	100.00	100.00	99.00	92.80	74.90	48.00	31.00	21.40	14.10	11.30
10/10/98, 20"	100.00	100.00	100.00	100.00	99.40	91.90	80.30	50.50	30.00	20.90	12.90	10.60
14/10/98, 20"	100.00	100.00	100.00	100.00	99.60	98.80	87.50	61.30	37.60	24.90	13.40	11.20
15/10/98, 20"	100.00	100.00	100.00	100.00	99.90	99.70	94.40	74.00	43.70	28.10	15.20	12.70
MOUNT POLLEY COARSE LIMIT (20-inch Cyclone)	100.00	100.00	98.90	98.80	98.60	91.90	74.90	48.00	30.00	20.90	12.90	10.20
MOUNT POLLEY FINE LIMIT (20-inch Cyclone)	100.00	100.00	100.00	100.00	100.00	99.70	96.00	83.00	53.00	31.40	20.40	17.20
MOUNT POLLEY MEDIAN (20-inch Cyclone)	100.00	100.00	100.00	100.00	99.60	98.10	90.20	66.50	42.20	26.30	15.30	11.90

TABLE 3.3

MOUNT POLLEY MINING CORPORATION
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY

PERMEABILITY OF CYCLONE UNDERFLOW

M:\11162\11\Data\psa\[PERM.XLS]with C-ZCS-3 16-Jun-99

Description	Particle Size (mm)				Calculated Permeability (cm/s)			Average Measured Permeability (cm/s)
	D_{10}	D_{16}	D_{50}	D_{84}	Hazen's Formula $k = D_{10}^2$	Krumbein & Monk $k = 0.734(D_{50}^2)(D_{16}/D_{84})^{0.945}$	Average	
50" cyclone - coarse limit	0.042	0.060	0.180	0.380	1.76E-03	4.16E-03	2.96E-03	-
50" cyclone - fine limit	*0.027*	0.037	0.120	0.180	7.29E-04	2.37E-03	1.55E-03	-
C-ZCS-3	0.037	0.058	0.133	0.230	1.37E-03	3.53E-03	2.45E-03	1.40E-03
20" cyclone - coarse limit	0.037	0.057	0.160	0.260	1.37E-03	4.48E-03	2.92E-03	-
20" cyclone - fine limit	*0.023*	0.035	0.100	0.160	5.29E-04	1.75E-03	1.14E-03	-

D_{10}, D_{16}, D_{50}, D_{84} are taken from underflow samples tested at site. Numbers in *italics* are extrapolated.

TABLE 3.4

MOUNT POLLEY MINING CORPORATION
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY

ESTIMATION OF UNDERFLOW SPLIT USING SOLIDS CONTENT

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DATE	FEED (Tonnes/Hour)	SOLIDS CONTENT (%)			SPLIT CALCULATION (After Krebs)			SPLIT (After Jull)
		Feed	Overflow	Underflow	Circulating Load	Underflow	Underflow Split	
6-Oct-98	372	30%	20%	72%	85.71%	172	46.15%	46.15%
	372	30%	8%	73%	466.86%	306	82.36%	82.36%
	372	30%	16%	72%	150.00%	223	60.00%	60.00%
	372	30%	18%	73%	113.18%	197	53.09%	53.09%
	372	30%	16%	74%	147.16%	221	59.54%	59.54%
	372	30%	19%	72%	99.25%	185	49.81%	49.81%
	372	30%	16%	73%	148.55%	222	59.77%	59.77%
7-Oct-98	799	30%	17%	73%	129.82%	451	56.49%	56.49%
	799	30%	19%	75%	96.49%	392	49.11%	49.11%
	799	30%	21%	74%	72.08%	335	41.89%	41.89%
	799	30%	22%	74%	61.16%	303	37.95%	37.95%
	799	30%	20%	74%	84.09%	365	45.68%	45.68%
8-Oct-98	836	30%	11%	71%	299.11%	627	74.94%	74.94%
	836	30%	16%	75%	145.83%	496	59.32%	59.32%
	836	30%	16%	75%	145.83%	496	59.32%	59.32%
	836	30%	16%	75%	145.83%	496	59.32%	59.32%
	836	30%	16%	75%	145.83%	496	59.32%	59.32%
	836	30%	20%	74%	84.09%	382	45.68%	45.68%
	836	30%	14%	73%	194.02%	552	65.99%	65.99%
	836	30%	8%	78%	446.88%	683	81.71%	81.71%
	836	30%	6%	67%	724.32%	735	87.87%	87.87%
9-Oct-98	637	30%	22%	72%	62.34%	245	38.40%	38.40%
	637	30%	32%	72%	-10.71%			
	637	30%	30%	76%	0.00%			
	637	30%	29%	76%	5.70%	34	5.39%	5.39%
	637	30%	28%	76%	11.80%	67	10.56%	10.56%
10-Oct-98	823	30%	29%	75%	5.75%	45	5.43%	5.43%
	823	30%	27%	76%	18.36%	128	15.51%	15.51%
	823	30%	30%	76%	0.00%			
	823	30%	25%	78%	32.50%	202	24.53%	24.53%
	823	30%	26%	78%	25.00%	165	20.00%	20.00%
19-Oct-98	784	30%	29%	76%	5.70%	42.26	5.39%	5.39%
20-Oct-98	795	30%	31%	75%	-5.38%			
21-Oct-98	491	30%	25%	78%	32.50%	120.43	24.53%	24.53%
22-Oct-98	726	30%	18%	69%	117.95%	392.89	54.12%	54.12%
		MEDIAN	20%	74%		MEDIAN	49.81%	49.81%
		AVERAGE	20%	74%		AVERAGE	46.42%	46.42%

NOTES

1) Feed Solids Content is estimated, not measured.

2) Krebs Calculations (Provided by fax, November 3, 1998)

Circulating Load =	(underflow tonnage / overflow tonnage)
Underflow Tonnage =	(overflow tonnage)(circulating load)
Overflow Tonnage =	(underflow tonnage / circulating load)
Feed Tonnage =	underflow tonnage + overflow tonnage
Feed Tonnage =	underflow tonnage + (underflow tonnage / circulating load)
Feed Tonnage =	(underflow tonnage)[1 + (1 / circulating load)]
Underflow Tonnage =	feed tonnage / [1 + (1/circulating load)]
Underflow Split (%) =	(underflow tonnage/ feed tonnage)

3) Jull Calculations

Underflow Split (%) =	[(feed tonnage - overflow tonnage) / (underflow tonnage - overflow tonnage)](underflow tonnage / feed tonnage)

Knight Piésold Ltd.
CONSULTING ENGINEERS

TABLE 3.5

MOUNT POLLEY MINING CORPORATION
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY

EVALUATION OF UNDERFLOW SPLIT USING PARTICLE SIZE ANALYSES

M:\11162\11\Data\psa\[MPSPLIT1.XLS]AVERAGES - SUMMARY TABLE 16-Jun-99

Sieve No. [1]	Percent Passing [2]			Percent Retained [3]			Combined O/F and U/F Retained [4]	Percent Retained Combined O/F and U/F		Percent Passing Combined O/F and U/F [7]	Difference (%) between Feed and Combined [8]	Split Evaluation Proportion [9]		Split Evaluation Percent [10]	
	Feed	O/F	U/F	Feed	O/F	U/F		Individual [5]	Cumulative [6]			O/F	U/F	O/F	U/F
All Samples, N = 16															
16	100.01	100.01	100.01	*0.0*	*0.0*	*0.0*	-0.02	-0.01	-0.01	100.01	0.00	0.00	0.00	0.00	0.00
20	100.00	99.30	99.79	*0.0*	*0.7*	*0.2*	0.92	0.46	0.45	99.55	-0.46	0.00	0.00	0.00	0.00
28	99.98	99.16	99.39	*0.0*	*0.1*	*0.4*	0.55	0.27	0.73	99.27	-0.71	0.00	0.00	0.00	0.00
35	99.91	98.98	97.84	*0.1*	*0.2*	*1.5*	1.72	0.86	1.59	98.41	-1.49	0.10	0.90	0.01	0.06
48	99.65	98.64	93.27	*0.3*	*0.3*	*4.6*	4.91	2.46	4.04	95.96	-3.69	0.07	0.93	0.02	0.24
65	97.61	97.14	81.27	*2.0*	*1.5*	*12.0*	13.50	6.75	10.79	89.21	-8.40	0.11	0.89	0.23	1.81
100	91.54	91.56	59.34	*6.1*	*5.6*	*21.9*	27.51	13.75	24.55	75.45	-16.09	0.20	0.80	1.23	4.83
150	81.92	81.93	38.72	*9.6*	*9.6*	*20.6*	30.25	15.13	39.68	60.32	-21.60	0.32	0.68	3.06	6.56
200	69.58	69.32	25.47	*12.3*	*12.6*	*13.3*	25.86	12.93	52.61	47.39	-22.19	0.49	0.51	6.02	6.32
325	54.69	54.20	15.31	*14.9*	*15.1*	*10.2*	25.28	12.64	65.25	34.75	-19.94	0.60	0.40	8.91	5.98
400	48.51	48.08	11.74	*6.2*	*6.1*	*3.6*	9.69	4.85	70.09	29.91	-18.61	0.63	0.37	3.90	2.28
-400	48.51	48.08	11.74	*48.5*	*48.1*	*11.7*	59.81	29.91	100.00	29.91	-18.61	0.80	0.20	39.00	9.52
TOTAL				*100.0*	*100.0*	*100.0*	200.00	100.00						62.36	37.61
															99.98
50" Cyclone, N = 7															
16	100.00	100.00	100.00	*0.0*	*0.0*	*0.0*	-0.01	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00
20	99.99	99.93	99.67	*0.0*	*0.1*	*0.3*	0.41	0.21	0.20	99.80	-0.19	0.00	0.00	0.00	0.00
28	99.94	99.86	98.78	*0.1*	*0.1*	*0.9*	0.95	0.48	0.68	99.32	-0.61	0.00	0.00	0.00	0.00
35	99.80	99.76	95.71	*0.1*	*0.1*	*3.1*	3.18	1.59	2.27	97.73	-2.06	0.03	0.97	0.00	0.14
48	99.35	99.16	87.99	*0.4*	*0.6*	*7.7*	8.31	4.16	6.42	93.58	-5.78	0.07	0.93	0.03	0.41
65	96.82	96.20	71.95	*2.5*	*3.0*	*16.0*	19.00	9.50	15.93	84.07	-12.74	0.16	0.84	0.39	2.14
100	89.74	86.77	51.69	*7.1*	*9.4*	*20.3*	29.69	14.85	30.77	69.23	-20.51	0.32	0.68	2.25	4.83
150	79.93	73.87	36.20	*9.8*	*12.9*	*15.5*	28.39	14.19	44.97	55.03	-24.89	0.45	0.55	4.46	5.35
200	67.98	60.15	24.61	*11.9*	*13.7*	*11.6*	25.31	12.66	57.62	42.38	-25.61	0.54	0.46	6.48	5.47
325	53.20	46.15	15.52	*14.8*	*14.0*	*9.1*	23.08	11.54	69.16	30.84	-22.36	0.61	0.39	8.96	5.82
400	47.52	39.91	11.27	*5.7*	*6.2*	*4.3*	10.50	5.25	74.41	25.59	-21.94	0.59	0.41	3.38	2.30
-400	47.52	39.91	11.27	*47.5*	*39.9*	*11.3*	51.17	25.59	100.00	25.59	-21.94	0.78	0.22	37.06	10.46
TOTAL				*100.0*	*100.0*	*100.0*	200.00	100.00						63.01	36.92
															99.94
20" Cyclone, N = 9															
16	100.02	100.01	100.01	*0.0*	*0.0*	*0.0*	-0.02	-0.01	-0.01	100.01	0.00	0.00	0.00	0.00	0.00
20	100.02	98.82	99.88	*0.0*	*1.2*	*0.1*	1.32	0.66	0.65	99.35	-0.67	0.00	0.00	0.00	0.00
28	100.01	98.61	99.85	*0.0*	*0.2*	*0.0*	0.24	0.12	0.77	99.23	-0.78	0.00	0.00	0.00	0.00
35	99.99	98.37	99.51	*0.0*	*0.2*	*0.3*	0.58	0.29	1.06	98.94	-1.05	0.40	0.60	0.01	0.01
48	99.87	98.24	97.38	*0.1*	*0.1*	*2.1*	2.26	1.13	2.19	97.81	-2.06	0.06	0.94	0.01	0.11
65	98.22	97.88	88.51	*1.7*	*0.4*	*8.9*	9.23	4.61	6.80	93.20	-5.02	0.04	0.96	0.07	1.59
100	92.94	95.28	65.30	*5.3*	*2.6*	*23.2*	25.81	12.90	19.71	80.29	-12.65	0.10	0.90	0.53	4.75
150	83.47	88.20	40.68	*9.5*	*7.1*	*24.6*	31.71	15.85	35.56	64.44	-19.03	0.22	0.78	2.12	7.35
200	70.82	76.45	26.13	*12.6*	*11.7*	*14.5*	26.29	13.15	48.71	51.29	-19.53	0.45	0.55	5.65	7.00
325	55.85	60.45	15.14	*15.0*	*16.0*	*11.0*	26.99	13.49	62.20	37.80	-18.06	0.59	0.41	8.87	6.10
400	49.28	54.43	12.10	*6.6*	*6.0*	*3.0*	9.07	4.53	66.73	33.27	-16.02	0.66	0.34	4.36	2.21
-400	49.28	54.43	12.10	*49.3*	*54.4*	*12.1*	66.53	33.27	100.00	33.27	-16.02	0.82	0.18	40.32	8.96
TOTAL				*100.0*	*100.0*	*100.0*	200.00	100.00						61.94	38.07
															100.01

Notes:
[1] The values included are the average of individual split calculations.
[2] An explanation of the spreadsheet is included below, as well as on each individual sheet.

Sieve Nos. are those used by MPMC lab.
Percent passing is the difference between the previous and current percent retained numbers. It matches the original lab measurements by MPMC.
Numbers in *italics* are test results for each of the Feed, Overflow (O/F) and Underflow (U/F), provided by MPMC.
Combined O/F and U/F Retained represents the total weight of the O/F and U/F. It uses the percent retained and assumes that the total weight was 100 for each O/F and U/F.
Percent Retained Combined O/F and U/F represents individual percent of the Combined O/F and U/ F. It uses the total weight of 200 to calculate percent.
Percent Retained Combined O/F and U/F represents cumulative percent of the Combined O/F and U/ F.
Percent Passing Combined O/F and U/F is equal to 100% minus the cumulative percent retained.
Difference Between Feed and Combined is the difference between the percent passing of the actual tested Feed and the calculated Combined O/F and U/F..

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TABLE 3.6

MOUNT POLLEY MINING CORPORATION
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY

CYCLONE SAND AVAILABILITY

M:\11162\11\Data\misc\[CYCSAND.XLS]summary 16-Jun-99

Embankment Stage and Crest (m)	(El.)	Year of Construction	Cyclone Sand Availability (m^3) 7 mo/year operation	9 mo/year operation
Stage 1b	934	1996/97		
Stage 2A	936	1998		
Stage 2B	937	1999		
Stage 2C	940	1999	780,938	1,004,063
Stage 3	946	2000	780,938	1,004,063
Stage 4	951	2002	1,561,875	2,008,125
Stage 5	956	2004	1,561,875	2,008,125
Stage 6	961	2006	1,561,875	2,008,125
Stage 7	965	2008	1,561,875	2,008,125
TOTAL			7,809,375	10,040,625
Average Annual Cyclone Production (m^3):			822,039	1,056,908

NOTES:

Estimate of cyclone material availability assumes:

a. Mill throughput (tpd) 20,000

b. Underflow split 35%

c. Cycloned sand density (t/m^3) 1.60

d. Cyclone availability 85%

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TABLE 4.1

MOUNT POLLEY MINING CORPORATION
MOUNT POLLEY MINE - TAILINGS STORAGE FACILITY

STAGE 2C CONSTRUCTION
PRELIMINARY SCHEDULE OF ESTIMATED QUANTITIES
PERIMETER AND MAIN EMBANKMENTS

M:\11162\11\Data\misc\[2CTOTVOL.XLS]SchedB u-s cyclone sand 16-Jun-99 16:31

ITEM		DESCRIPTION	MAIN EMBANKMENT ESTIMATED QUANTITY[1]	PERIMETER EMBANKMENT ESTIMATED QUANTITY[1]	TOTAL ESTIMATED QUANTITY[1]	UNIT
1	.a	MOBILIZATION	N/A	N/A	1	Lump Sum
	.b	DEMOBILIZATION	N/A	N/A	1	Lump Sum
2		STAGE 2C EMBANKMENT CREST CONSTRUCTION				
	.a	Clearing, Stripping and Grubbing	1,300	5,000	6,300	m^2
	.b	Removal of Topsoil and/or Unsuitable Material	1,300	5,000	6,300	m^3
	.c	Foundation Preparation	1,300	5,000	6,300	m^2
	.d	Supply and Place Zone CS1	185,000	242,000	427,000	m^3
	.e	Supply and Place Zone CS2	42,500	55,500	98,000	m^3
	.f	Supply and Place Zone B	8,000	12,000	20,000	m^3
	.g	Supply and Place Zone S	31,000	37,000	68,000	m^3
3		STAGE 2C UPSTREAM TOE DRAIN CONSTRUCTION (3,100 lineal metres)				
	.a	Supply and Place Non-Woven Type 1 Geotextile (12 oz/yd^2), 4.5 m Width	5,850	7,650	13,500	m^2
	.b	Supply and place 150 mm dia. perforated CPT pipe	1,350	1,750	3,100	m
	.c	Supply and Place Zone F	1,950	2,550	4,500	m^3
	.d	Supply and Place Zone G	650	850	1,500	m^3
4		STAGE 2C TOE DRAIN CONVEYANCE PIPE CONSTRUCTION (330 lineal metres)				
	.a	Supply and Place 150 mm dia. HDPE DR17 Pipe[2]	230	210	440	m
	.b	Ditch Preparation	0	1,100	1,100	m^3

Notes:
1. Quantities are neat line estimates taken from the drawings.
2. Concrete bedding and seepage cutoffs are required for the Toe Conveyance Drain pipes beneath the embankments.
3. Instrumentation, including vibrating wire piezometers and slope inclinometers, are not included.
4. Quantities for Basin Liner are to be determined.

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TABLE 4.2

MOUNT POLLEY MINING CORPORATION
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY

STAGE 2A EMBANKMENT CREST SURVEY MONUMENTS - RECORD OF DISPLACEMENTS

M:\11162\11\Data\misc\[SURV-MON.XLS]monuments

6/16/99 16:32

Monitoring and Survey Data							Displacements Between Readings (m)					Total Displacements (m)				
Monument	Hub No.	Date	Comments	N_n	E_n	El_n	ΔN	ΔE	ΔEl	D_{xy}	D_{xyz}	ΔN	ΔE	ΔEl	$D_{xy-total}$	$D_{xyz-total}$
A2-SM-02		21-Aug-97	Stage 1B - Initial Survey	5818484.664	595600.941	934.210	-	-	-	-	-	-	-	-	-	-
B2-SM-01		21-Aug-97	Stage 1B - Initial Survey	5818631.996	595796.816	934.107	-	-	-	-	-	-	-	-	-	-
C2-SM-03		21-Aug-97	Stage 1B - Initial Survey	5818397.426	595485.086	934.036	-	-	-	-	-	-	-	-	-	-
A2-SM-02		20-Mar-98	Stage 1B - Final Survey	5818484.693	595600.940	934.095	0.029	-0.001	-0.115	0.029	0.119	0.029	-0.001	-0.115	0.029	0.119
B2-SM-01		20-Mar-98	Stage 1B - Final Survey	5818631.977	595796.831	934.032	-0.019	0.015	-0.075	0.024	0.079	-0.019	0.015	-0.075	0.024	0.079
C2-SM-03		20-Mar-98	Stage 1B - Final Survey	5818397.485	595485.065	933.895	0.059	-0.021	-0.141	0.063	0.154	0.059	-0.021	-0.141	0.063	0.154
A2-SM-01	095 (U/S)	11-Jun-98	Stage 2A - Initial Survey	5818496.322	595589.736	935.802	-	-	-	-	-	-	-	-	-	-
A2-SM-02	096 (D/S)	11-Jun-98	Stage 2A - Initial Survey	5818486.754	595597.265	935.965	-	-	-	-	-	-	-	-	-	-
B2-SM-01	093 (U/S)	11-Jun-98	Stage 2A - Initial Survey	5818637.375	595776.540	935.755	-	-	-	-	-	-	-	-	-	-
B2-SM-02	094 (D/S)	11-Jun-98	Stage 2A - Initial Survey	5818627.127	595783.715	936.238	-	-	-	-	-	-	-	-	-	-
B2-SM-03	091 (U/S)	11-Jun-98	Stage 2A - Initial Survey	5818681.655	595835.527	936.021	-	-	-	-	-	-	-	-	-	-
B2-SM-04	092 (D/S)	11-Jun-98	Stage 2A - Initial Survey	5818672.076	595842.154	936.410	-	-	-	-	-	-	-	-	-	-
C2-SM-01	097 (U/S)	11-Jun-98	Stage 2A - Initial Survey	5818407.912	595472.445	936.042	-	-	-	-	-	-	-	-	-	-
C2-SM-02	098 (D/S)	11-Jun-98	Stage 2A - Initial Survey	5818398.806	595479.259	936.529	-	-	-	-	-	-	-	-	-	-
A2-SM-01	095 (U/S)	25-Jun-98	Stage 2A - Intermediate Survey	5818496.321	595589.705	935.815	-0.001	-0.031	0.013	0.031	0.034	-0.001	-0.031	0.013	0.031	0.034
A2-SM-02	096 (D/S)	25-Jun-98	Stage 2A - Intermediate Survey	5818486.738	595597.246	935.969	-0.016	-0.019	0.004	0.025	0.025	-0.016	-0.019	0.004	0.025	0.025
B2-SM-01	093 (U/S)	25-Jun-98	Stage 2A - Intermediate Survey	5818637.365	595776.509	935.749	-0.010	-0.031	-0.006	0.033	0.033	-0.010	-0.031	-0.006	0.033	0.033
B2-SM-02	094 (D/S)	25-Jun-98	Stage 2A - Intermediate Survey	5818627.103	595783.689	936.229	-0.024	-0.026	-0.009	0.035	0.037	-0.024	-0.026	-0.009	0.035	0.037
B2-SM-03	091 (U/S)	25-Jun-98	Stage 2A - Intermediate Survey	5818681.632	595835.519	936.019	-0.023	-0.008	-0.002	0.024	0.024	-0.023	-0.008	-0.002	0.024	0.024
B2-SM-04	092 (D/S)	25-Jun-98	Stage 2A - Intermediate Survey	5818672.034	595842.147	936.407	-0.042	-0.007	-0.003	0.043	0.043	-0.042	-0.007	-0.003	0.043	0.043
C2-SM-01	097 (U/S)	25-Jun-98	Stage 2A - Intermediate Survey	5818408.212	595472.180	935.892	0.300	-0.265	-0.150	0.400	0.427	0.300	-0.265	-0.150	0.400	0.427
C2-SM-02	098 (D/S)	25-Jun-98	Stage 2A - Intermediate Survey	5818398.829	595479.299	936.519	0.023	0.040	-0.010	0.046	0.047	0.023	0.040	-0.010	0.046	0.047
A2-SM-01	095 (U/S)	17-Sep-98	Stage 2A - Final Survey	5818496.307	595589.754	935.798	-0.014	0.049	-0.017	0.051	0.054	-0.015	0.018	-0.004	0.023	0.024
A2-SM-02	096 (D/S)	17-Sep-98	Stage 2A - Final Survey	5818486.740	595597.285	935.940	0.002	0.039	-0.029	0.039	0.049	-0.014	0.020	-0.025	0.024	0.035
B2-SM-01	093 (U/S)	17-Sep-98	Stage 2A - Final Survey	5818637.374	595776.545	935.753	0.009	0.036	0.004	0.037	0.037	-0.001	0.005	-0.002	0.005	0.005
B2-SM-02	094 (D/S)	17-Sep-98	Stage 2A - Final Survey	5818627.116	595783.719	936.233	0.013	0.030	0.004	0.033	0.033	-0.011	0.004	-0.005	0.012	0.013
B2-SM-03	091 (U/S)	17-Sep-98	Stage 2A - Final Survey	5818681.646	595835.541	936.024	0.014	0.022	0.005	0.026	0.027	-0.009	0.014	0.003	0.017	0.017
B2-SM-04	092 (D/S)	17-Sep-98	Stage 2A - Final Survey	5818672.050	595842.175	936.413	0.016	0.028	0.006	0.032	0.033	-0.026	0.021	0.003	0.033	0.034
C2-SM-01	097 (U/S)	17-Sep-98	Stage 2A - Final Survey	5818408.200	595472.146	935.898	-0.012	-0.034	0.006	0.036	0.037	0.288	-0.299	-0.144	0.415	0.439
C2-SM-02	098 (D/S)	17-Sep-98	Stage 2A - Final Survey	5818398.809	595479.259	936.530	-0.020	-0.040	0.011	0.045	0.046	0.003	0.000	0.001	0.003	0.003

Notes:

1. Calculate displacements as follows:

<u>Total Displacements from initial survey</u>

$\Delta N = N_n - N_o$

$\Delta E = E_n - E_o$

$\Delta El = El_n - El_o$

$D_{xy\text{ - total}} = (\Delta N^2 + \Delta E^2)^{1/2}$

$D_{xyz\text{ - total}} = (\Delta N^2 + \Delta E^2 + \Delta El^2)^{1/2}$

<u>Displacements between readings</u>

$\Delta N = N_{(n+1)} - N_n$

$\Delta E = E_{(n+1)} - E_n$

$\Delta El = El_{(n+1)} - El_n$

$D_{xy} = (\Delta N^2 + \Delta E^2)^{1/2}$

$D_{xyz} = (\Delta N^2 + \Delta E^2 + \Delta El^2)^{1/2}$

Comments on calculations:

1. Coordinate system is (Easting, Northing, Elevation) = f(x,y,z).
2. Coordinate system is as shown on Drawings.

m:\11162\11\data\psa\MP-PSD.XLS 3/16/99 9:17 AM

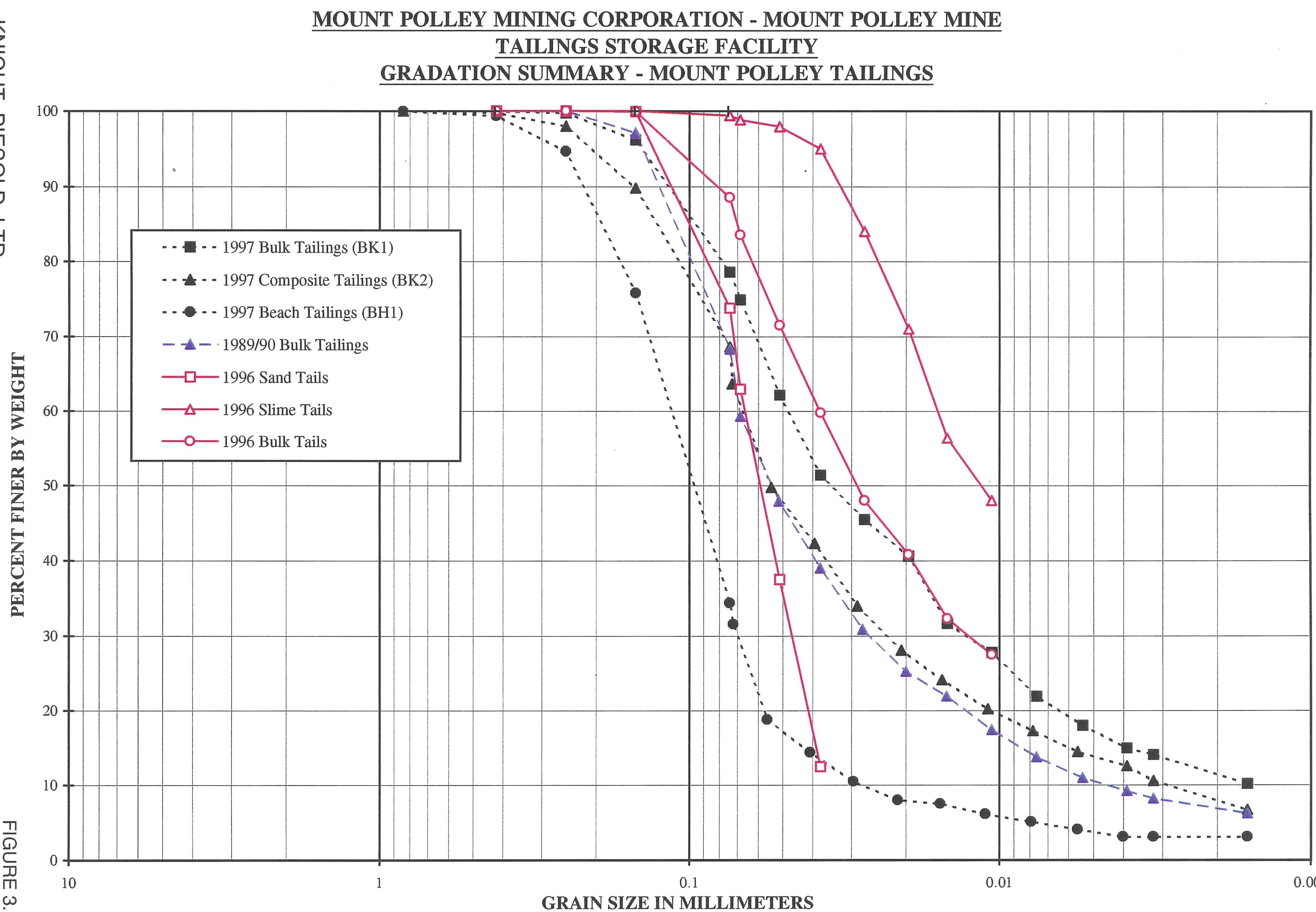

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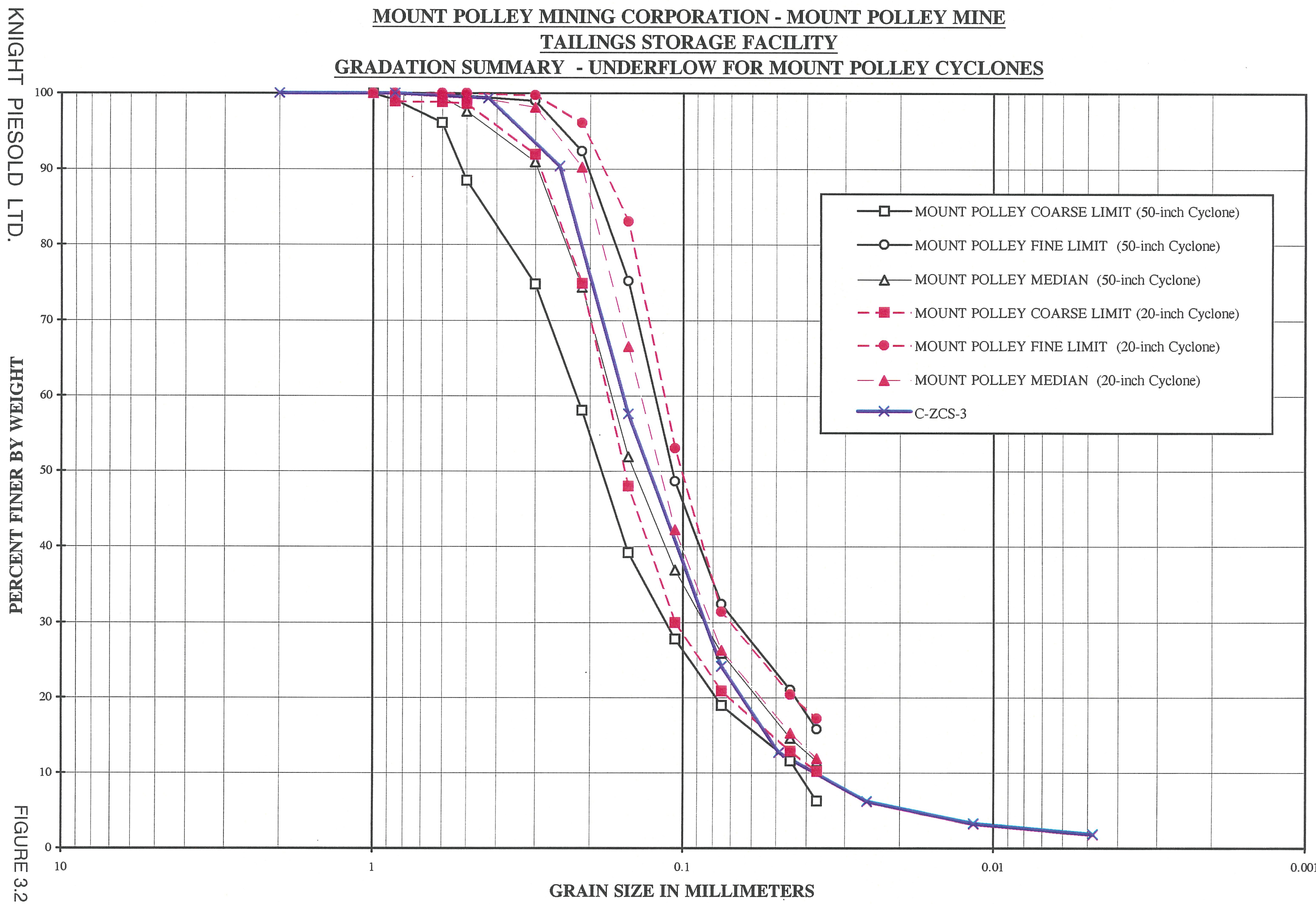
FIGURE 3.1

m:\11162\11\data\psa\CYC-PSA.XLS

3/16/99 1:26 PM



KNIGHT PIESOLD LTD.
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FIGURE 3.2

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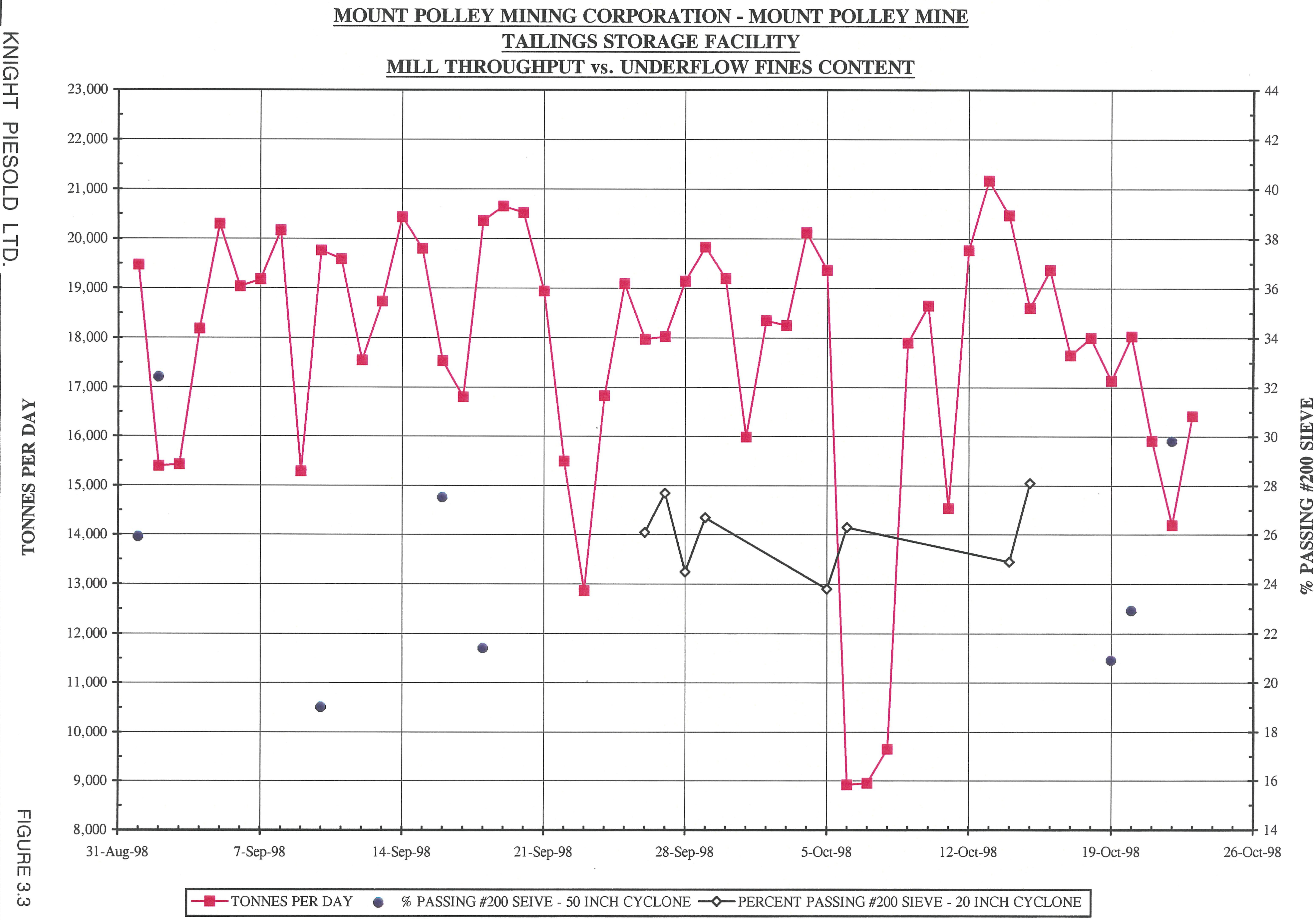


FIGURE 3.3

KNIGHT PIESOLD LTD.
CONSULTING ENGINEERS

MOUNT POLLEY MINING CORPORATION - MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY
GRADATION SUMMARY OF FEED, OVERFLOW AND UNDERFLOW SAMPLES

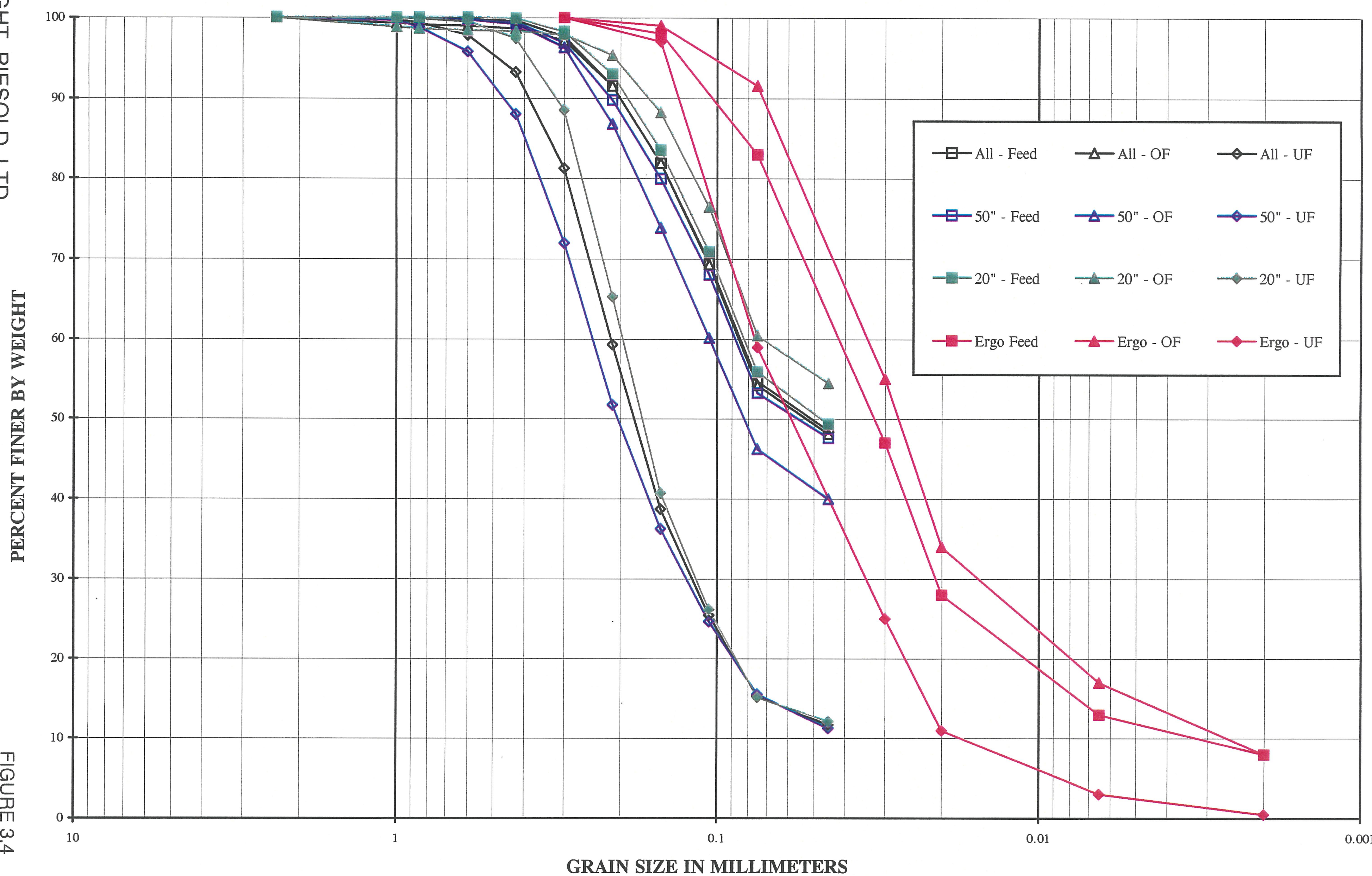


FIGURE 3.4

KNIGHT PIESOLD LTD.
CONSULTING ENGINEERS

MOUNT POLLEY MINING CORPORATION - MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY
GRADATION SUMMARY - UNDERFLOW AT OTHER MINES

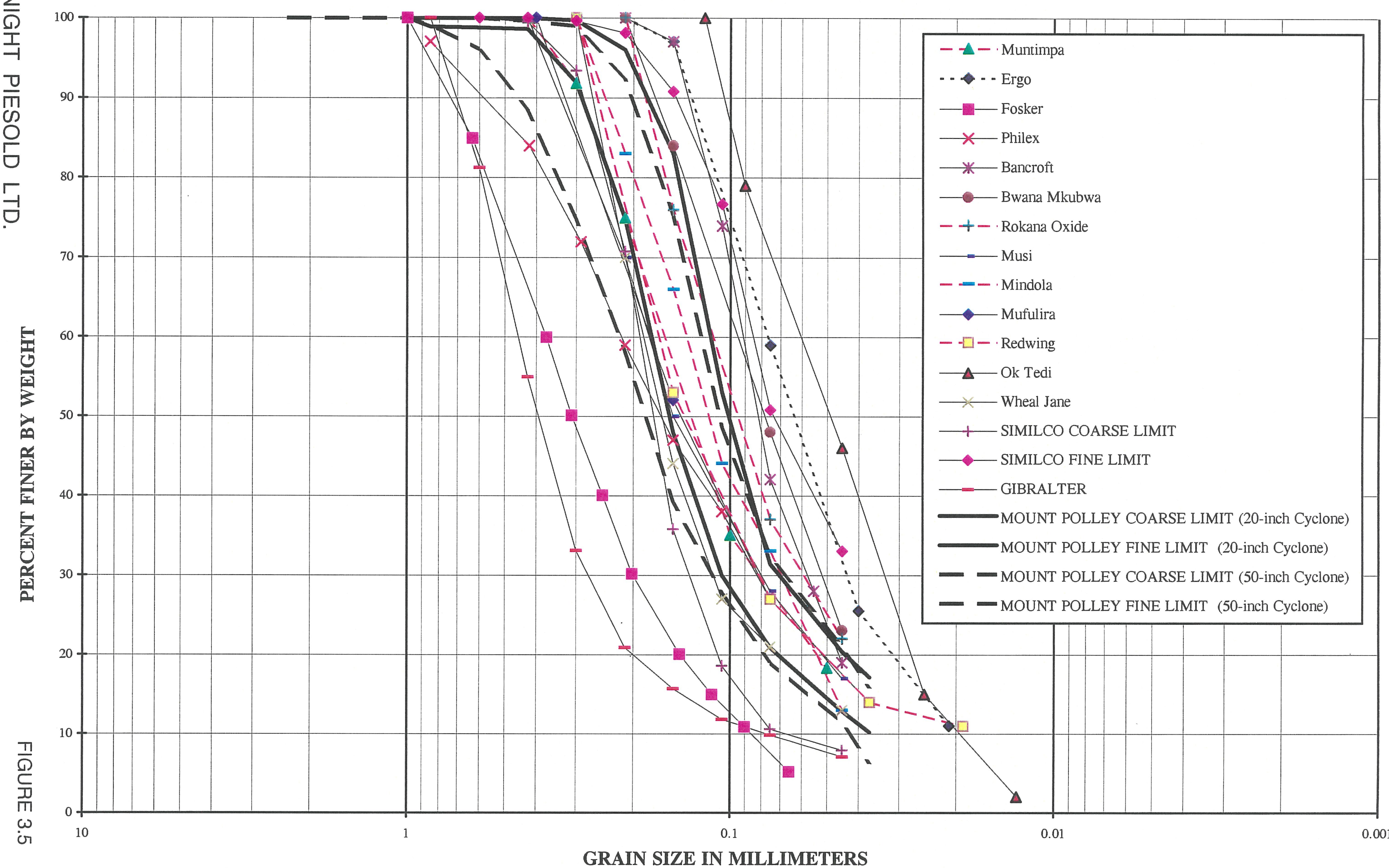
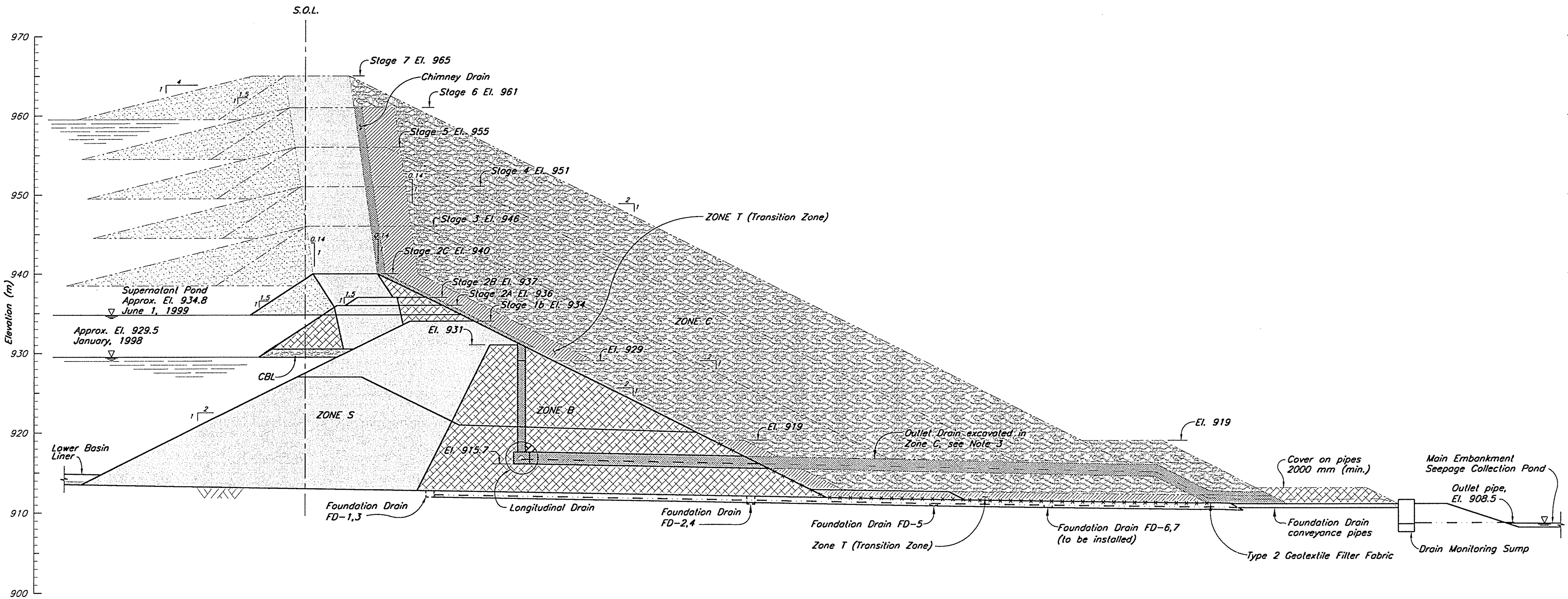


FIGURE 3.5

NOTES

1. Pond elevations measured or estimated from Filling Schedule and Staged Construction Curve.
2. Chimney Drain was constructed to El. 929 during Stage 1b. The Longitudinal Drain was constructed to invert El. 929 during Stage 1b.
3. Outlet Drains to be extended through downstream fill zones. Drains require min. 2% slope.
4. Upstream Toe Drains to be designed and installed as required.
5. Coarse Bearing Layer to be placed on tailings to provide a firm bearing layer for fill placement as required.
6. All dimensions in millimetres with elevations in metres, unless noted otherwise.
7. Type 1 (12 oz/sq. yd) Geotextile Filter Fabric to be placed on tailings as required to improve trafficability.
8. Type 2 (8 oz/sq. yd) Geotextile Filter Fabric required from the right abutment (approx. Ch. 15+75) to El. 920 on the left abutment (approx. Ch. 23+00).



NOT FOR CONSTRUCTION

Scale 5 0 5 10 15 20 25 m

REV.	DATE	DESCRIPTION	DESIGNED	DRAWN	CHECKED	APPROVED
0	14JUN99	ISSUED FOR REPORT 11162/11-1	KDE	OSR		

REVISIONS

MOUNT POLLEY MINING CORPORATION

MOUNT POLLEY MINE

TAILINGS STORAGE FACILITY
CYCLONED SAND EMBANKMENT
OPTION 1

Knight Piésold CONSULTING

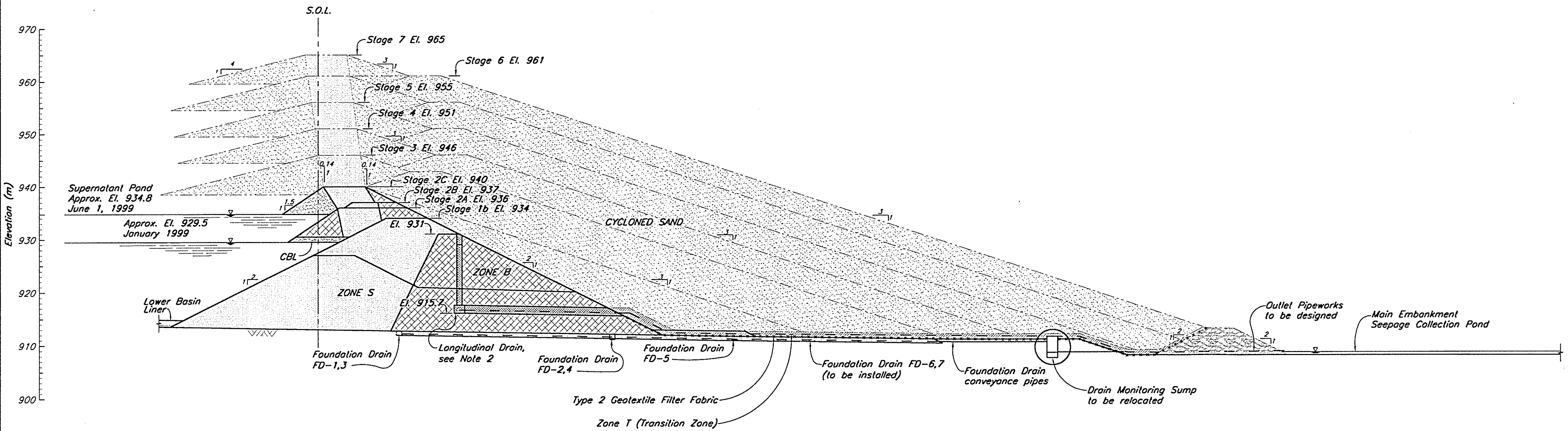
PROJECT NO.	REF. NO.	REV.
11162/11	1	0

FIGURE 4.1

VANCOUVER B.C. CAD FILE: M:\11162\11\ACAD\figs\fig4.1 PLOT 1=0.5 29/03/99 by:OSR

NOTES

1. Pond elevations measured or estimated from Filling Schedule and Staged Construction Curve.
2. Chimney Drain was constructed to El. 929 during Stage 1b. The Longitudinal Drain was constructed to invert El. 929 during Stage 1b.
3. Outlet Drains to be extended through downstream fill zones. Drains require min. 2% slope.
4. Upstream Toe Drains to be designed and installed as required.
5. Coarse Bearing Layer to be placed on tailings to provide a firm bearing layer for fill placement as required.
6. All dimensions in millimetres with elevations in metres, unless noted otherwise.
7. Type 1 (12 oz/sq. yd) Geotextile Filter Fabric to be placed on tailings as required to improve trafficability.
8. Type 2 (8 oz/sq. yd) Geotextile Filter Fabric required from the right abutment (approx. Ch. 15+75) to El. 920 on the left abutment (approx. Ch. 23+00).



NOT FOR CONSTRUCTION

Scale 10 0 10 20 30 40 Metres

REV.	DATE	DESCRIPTION	DESIGNED	DRAWN	CHECKED	APPROVED
0	14JUN99	ISSUED FOR REPORT 11162/11-1	KDE	DSR		

REVISIONS

MOUNT POLLEY MINING CORPORATION

MOUNT POLLEY MINE

TAILINGS STORAGE FACILITY
CYCLONED SAND EMBANKMENT
OPTION 2

Knight Piésold CONSULTING

PROJECT NO.	REF. NO.	REV.
11162/11	1	0

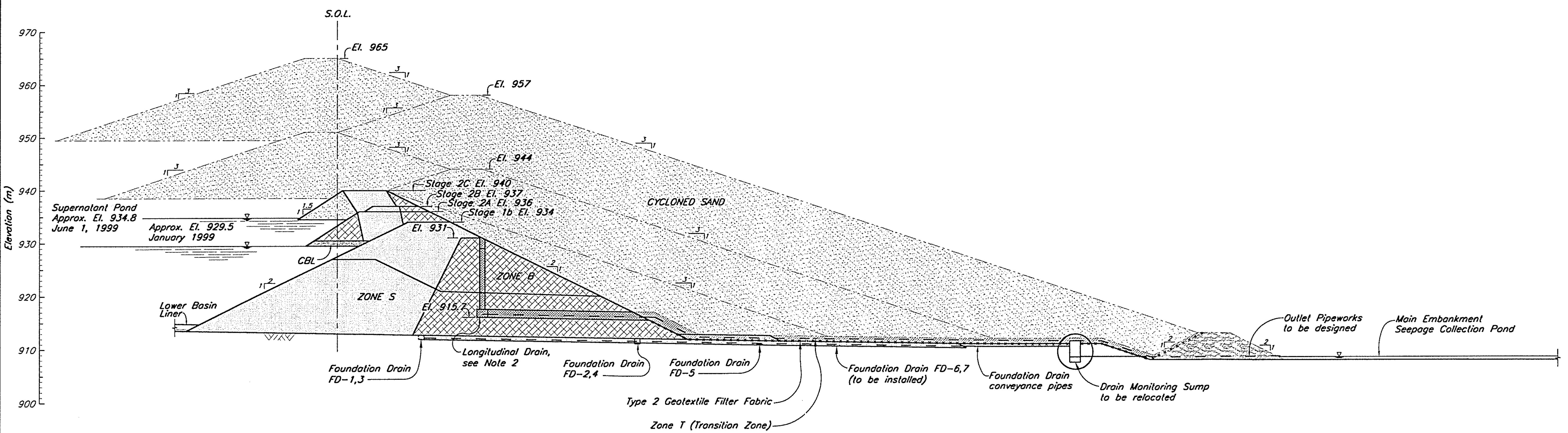
FIGURE 4.2

VANCOUVER B.C. CAD FILE: M:\11162\11\ACAD\figs\f4-2.dwg 1=750 PLOT 1=0.75 16/06/99 by:WAL

XREF FILE : -

NOTES

1. *Pond elevations meausred or estimated from Filling Schedule and Staged Construction Curve.*
2. *Chimney Drain was constructed to El. 929 during Stage 1b. The Longitudinal Drain was constructed to invert El. 929 during Stage 1b.*
3. *Outlet Drains to be extended through downstream fill zones. Drains require min. 2% slope.*
4. *Upstream Toe Drains to be designed and installed as required.*
5. *Coarse Bearing Layer to be placed on tailings to provide a firm bearing layer for fill placement as required.*
6. *All dimensions in millimetres with elevations in metres, unless noted otherwise.*
7. *Type 1 (12 oz/sq. yd) Geotextile Filter Fabric to be placed on tailings as required to improve trafficability.*
8. *Type 2 (8 oz/sq. yd) Geotextile Filter Fabric required from the right abutment (approx. Ch. 15+75) to El. 920 on the left abutment (approx. Ch. 23+00).*



NOT FOR CONSTRUCTION

Scale 10 0 10 20 30 40 Metres

REV.	DATE	DESCRIPTION	DESIGNED	DRAWN	CHECKED	APPROVED
0	14JUN99	ISSUED FOR REPORT 11162/11-1	KDE	DSR		

REVISIONS

MOUNT POLLEY MINING CORPORATION

MOUNT POLLEY MINE

TAILINGS STORAGE FACILITY
CYCLONED SAND EMBANKMENT
OPTION 3

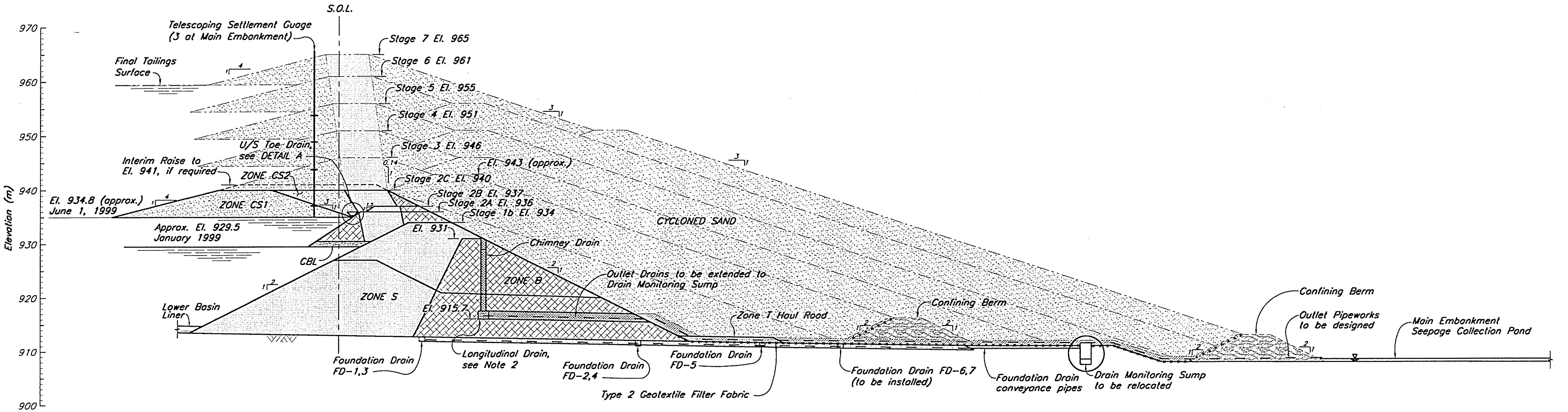
Knight Piésold CONSULTING

PROJECT NO.	REF. NO.	REV.
11162/11	1	0

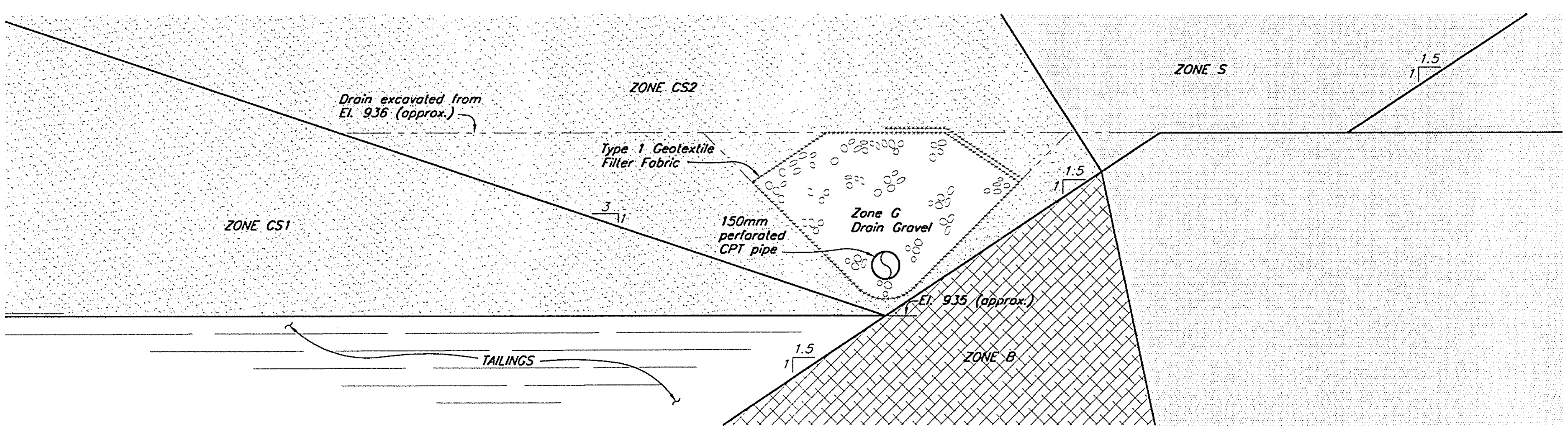
FIGURE 4.3

VANCOUVER B.C. CAD FILE: M:\11162\11\ACAD\fig4\f2.dwg 1=750 PLOT 1=0.75 16/06/99 by:WAL

XREF FILE: -



SECTION $\frac{1}{FIG.4.6}$
Scale A



DETAIL A
Scale B

NOTES

1. Pond elevations measured or estimated from Filling Schedule and Staged Construction Curve.
2. All dimensions in millimetres and elevations in metres, unless noted otherwise noted.
3. Cycloned Sand in Zone CS1 to be placed hydraulically by direct discharge.
4. Cycloned Sand in Zone CS2 to be placed mechanically in lifts as embankment is raised.

NOT FOR CONSTRUCTION

Scale B: 0.50 0 0.50 1.00 1.50 Metres

Scale A: 10 0 10 20 30 40 Metres

REV.	DATE	DESCRIPTION	DESIGNED	DRAWN	CHECKED	APPROVED
0	14JUN99	ISSUED FOR REPORT 11162/11-1	KDE	DSR		

REVISIONS

MOUNT POLLEY MINING CORPORATION

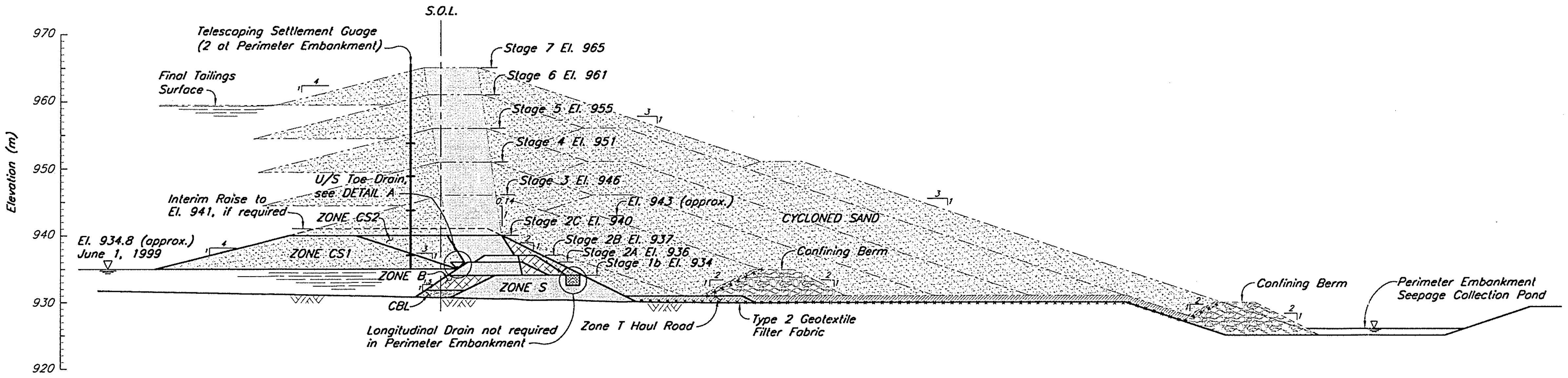
MOUNT POLLEY MINE

CYCLONED SAND EMBANKMENT
MAIN EMBANKMENT - SECTION
PREFERRED OPTION

Knight Piésold CONSULTING

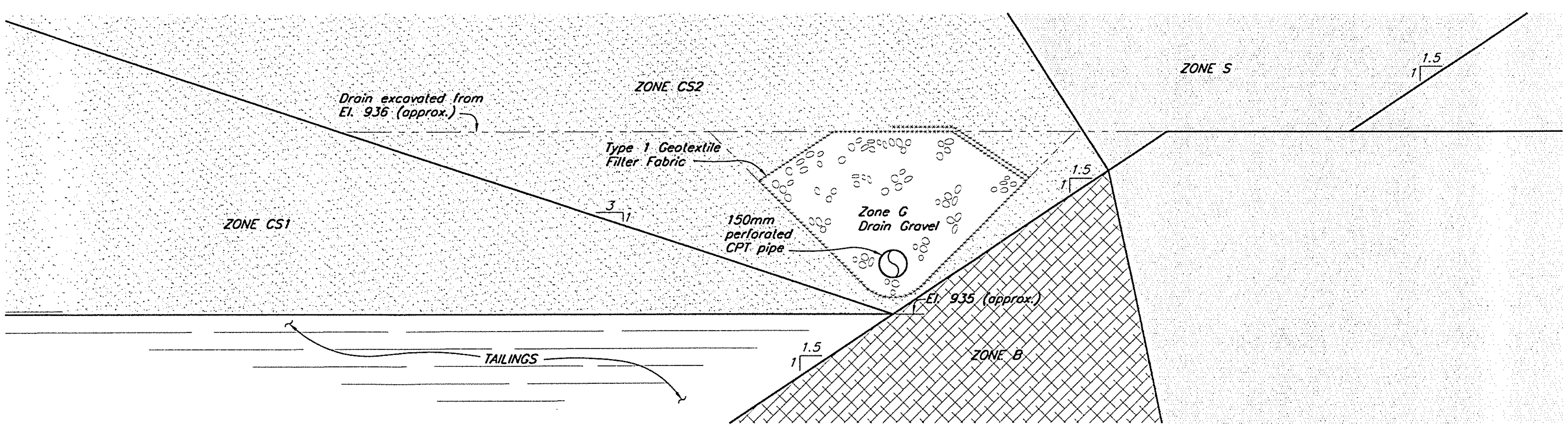
PROJECT NO.	REF. NO.	REV.
11162/11	1	0

FIGURE 4.4



SECTION $\frac{1}{FIG.4.7}$

Scale A



DETAIL A

Scale B

Scale B 0.50 0 0.50 1.00 1.50 Metres

Scale A 10 0 10 20 30 40 Metres

NOTES

1. Pond elevations measured or estimated from Filling Schedule and Staged Construction Curve.
2. All dimensions in millimetres and elevations in metres, unless noted otherwise noted.
3. Cycloned Sand in Zone CS1 to be placed hydraulically by direct discharge.
4. Cycloned Sand in Zone CS2 to be placed mechanically in lifts as embankment is raised.

NOT FOR CONSTRUCTION

REV.	DATE	DESCRIPTION	DESIGNED	DRAWN	CHECKED	APPROVED
0	14JUN99	ISSUED FOR REPORT 11162/11-1	KDE	DSR		

REVISIONS

MOUNT POLLEY MINING CORPORATION

MOUNT POLLEY MINE

CYCLONED SAND EMBANKMENT
PERIMETER EMBANKMENT – SECTION
PREFERRED OPTION

Knight Piésold CONSULTING

PROJECT NO.	REF. NO.	REV.
11162/11	1	0

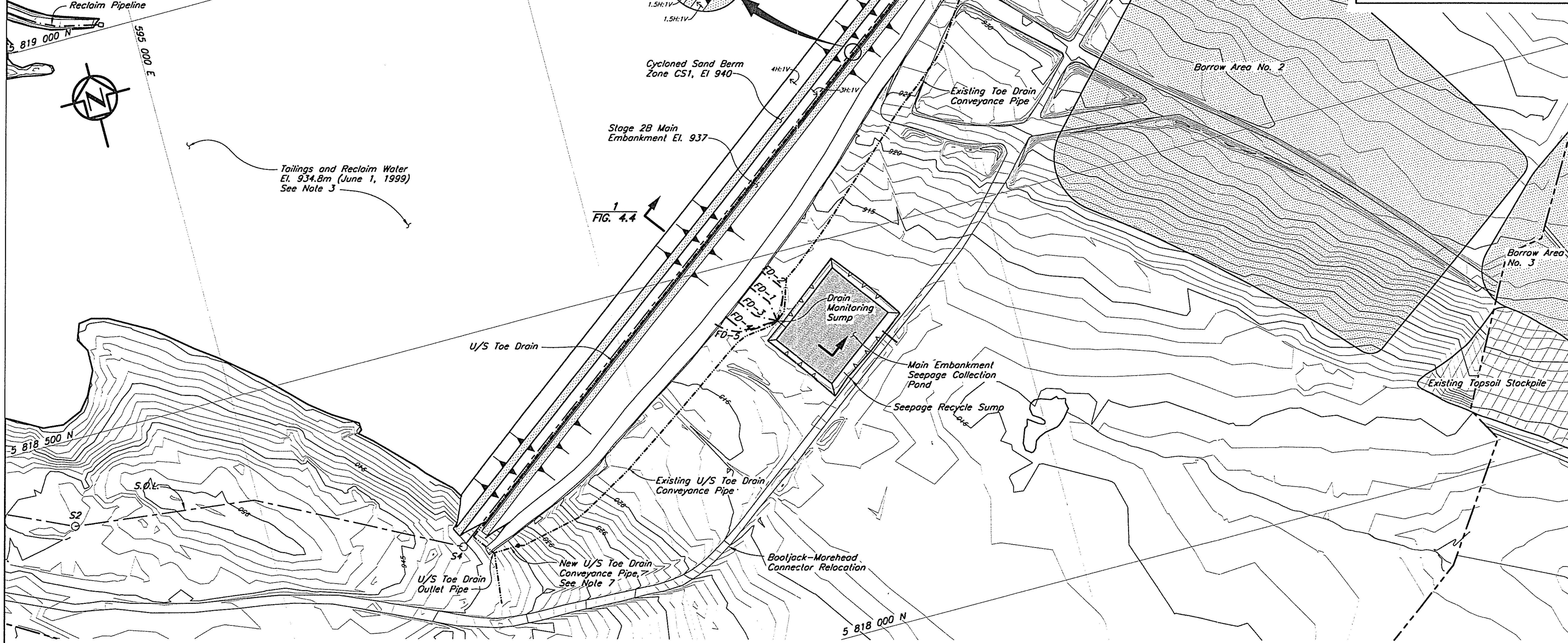
FIGURE 4.5

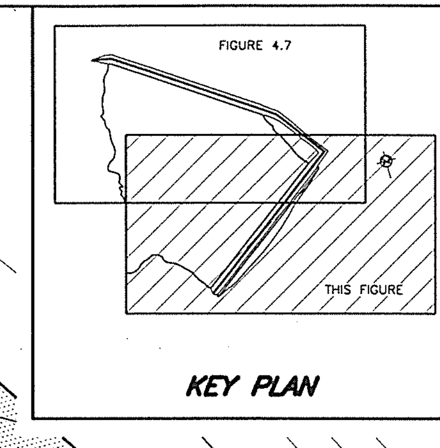
VANCOUVER B.C. CAD FILE: M:\11162\11\ACAD\fig4\B16.dwg 1=750 and 30 PLOT 1=1(PS) 16/06/99 by:MAL

XREF FILE: -

NOTES

1. *Chainage defined by Setting Out Point S1 at Ch. 5+00.*
2. *Stripping and clearing required 5 m beyond toe of embankments.*
3. *Pond elevation measured or estimated from Filling Schedule and Staged Construction Curve.*
4. *Topography was provided by MPMC on May 29/98. File: TSFBSP12.dwg*
5. *Tailings pipeworks not shown for clarity.*
6. *Cycloned Sand Berm (Zone CS1) shown on plan view.*
7. *U/S Toe Drain Outlet Pipe extensions to slope upwards for drainage.*





NOT FOR CONSTRUCTION

Scale 50 0 50 100 150 200 250 Metres

REV.	DATE	DESCRIPTION	DESIGNED	DRAWN	CHECKED	APPROVED
0	14JUN99	ISSUED FOR REPORT 11162/11-1	KDE	DSR		

REVISIONS

MOUNT POLLEY MINING CORPORATION

MOUNT POLLEY MINE

CYCLONED SAND EMBANKMENT
MAIN EMBANKMENT – PLAN
PREFERRED OPTION

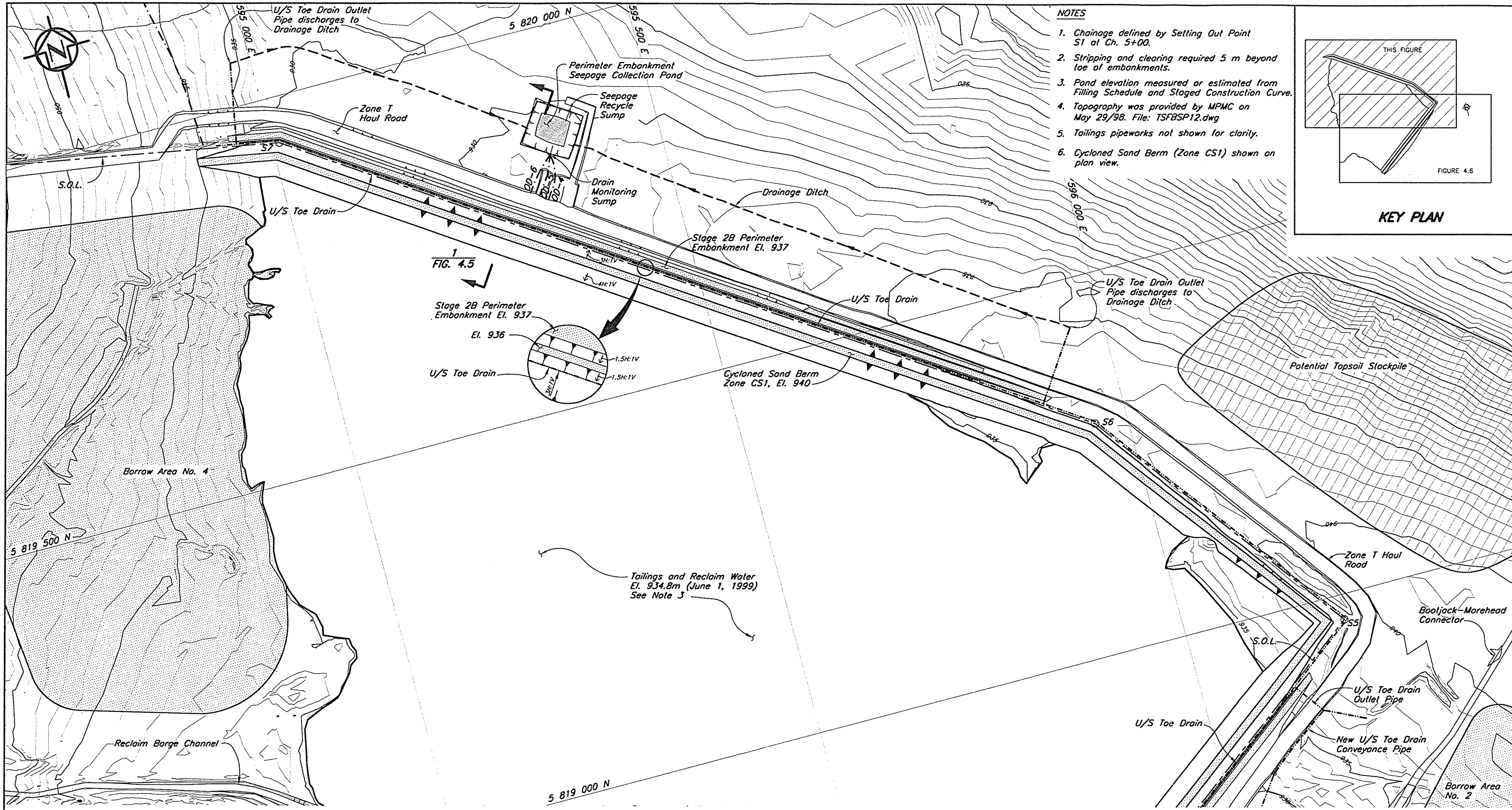
Knight Piésold CONSULTING

PROJECT NO.	REF. NO.	REV.
11162/11	1	0

FIGURE 4.6

XREF FILE : TOPONEW , STOCKPILES

VANCOUVER B.C. CAD FILE: M:\11162\11\ACAD\fig4B12.dwg



NOT FOR CONSTRUCTION

Scale 50 0 50 100 150 200 250 Metres

REV.	DATE	DESCRIPTION	DESIGNED	DRAWN	CHECKED	APPROVED
0	14JUN99	ISSUED FOR REPORT 11162/11-1	KDE	DSR		

REVISIONS

MOUNT POLLEY MINING CORPORATION

MOUNT POLLEY MINE

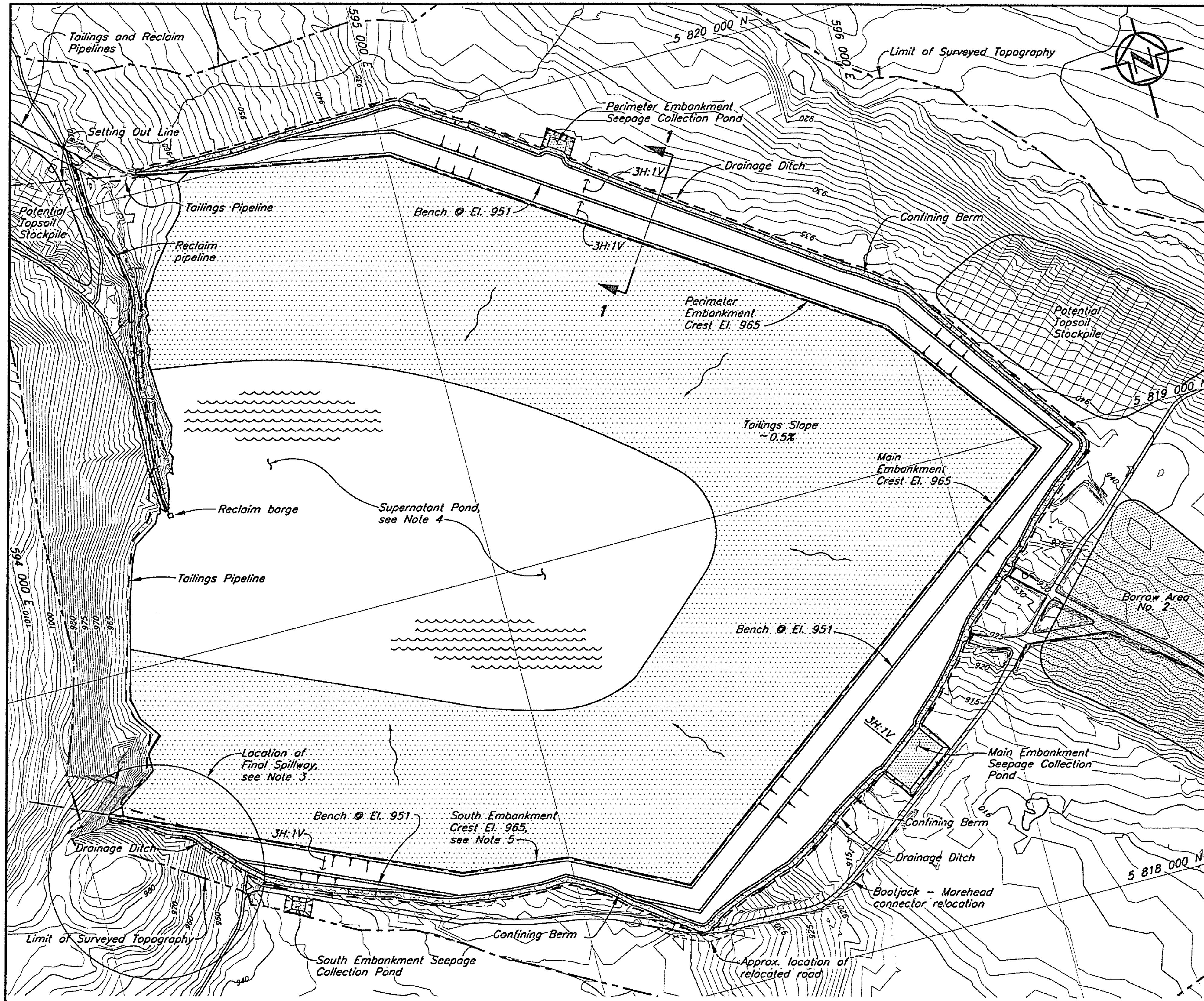
CYCLONED SAND EMBANKMENT
PERIMETER EMBANKMENT – PLAN
PREFERRED OPTION

Knight Piésold CONSULTING

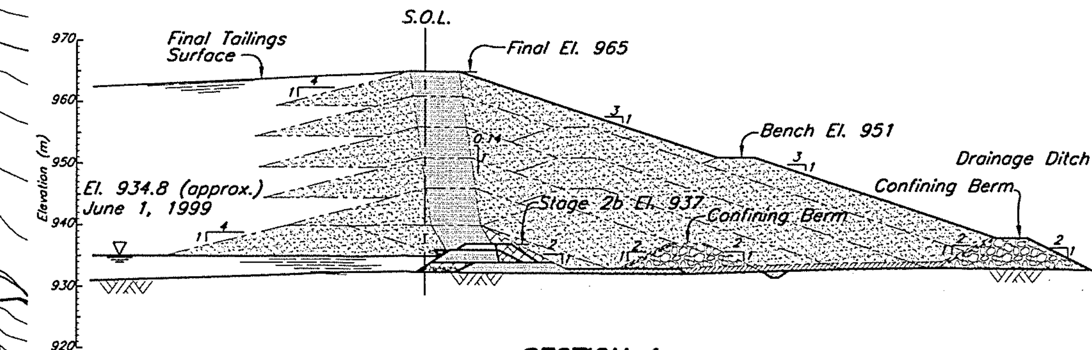
PROJECT NO.	REF. NO.	REV.
11162/11	1	0

FIGURE 4.7

XREF FILE : TOPONEW , STOCKPILES



PLAN
Scale B



SECTION 1
Scale A

NOTES

1. D/S Cyclone sand bench is approximate only. Shown at El. 951.
2. Drain Monitoring Sumps to be relocated.
3. Final Spillway dimensions and alignment to be confirmed during Final Design.
4. Tailings discharge to be adjusted in later years of operation to ensure supernatant pond adjacent to Final Spillway.
5. Final South Embankment and alignment to be confirmed during Final Design.

NOT FOR CONSTRUCTION

B 100 0 100 200 300 400 500 m

A 10 0 10 20 30 40 50 60 m

MOUNT POLLEY MINING CORPORATION

MOUNT POLLEY MINE

TAILINGS STORAGE FACILITY
FINAL ARRANGEMENT – PLAN AND SECTION
PREFERRED OPTION

Knight Piésold CONSULTING

PROJECT NO.	REF. NO.	REV.
11162/11	1	0

FIGURE 4.8

REV.	DATE	DESCRIPTION	DESIGNED	DRAWN	CHECKED	APPROVED
0	14JUNE99	ISSUED FOR REPORT 11162/11-1	KDE/PJP	WAL		

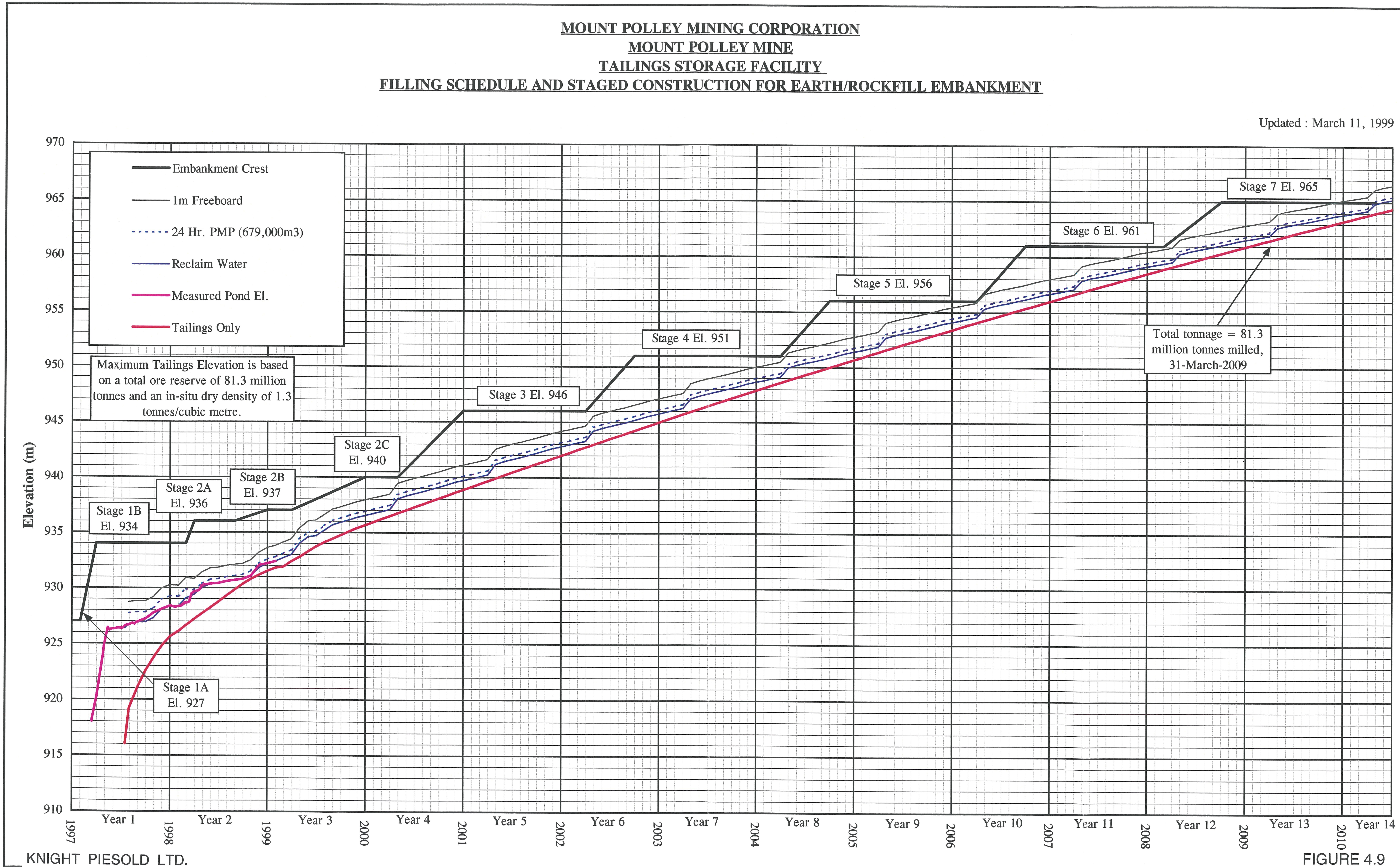
REVISIONS

VANCOUVER B.C. CAD FILE: M:\11162\11\ACAD\figs\B17.dwg 1:10 000 AND 1:1250 PLOT 1=1(PS) 15/06/99 by:WAL

XREF FILE : TOPONEW

m:\11162\10\data\misc\Dacfeb99.xls fillsch (conventional)

6/15/99 4:41 PM



KNIGHT PIESOLD LTD.
CONSULTING ENGINEERS

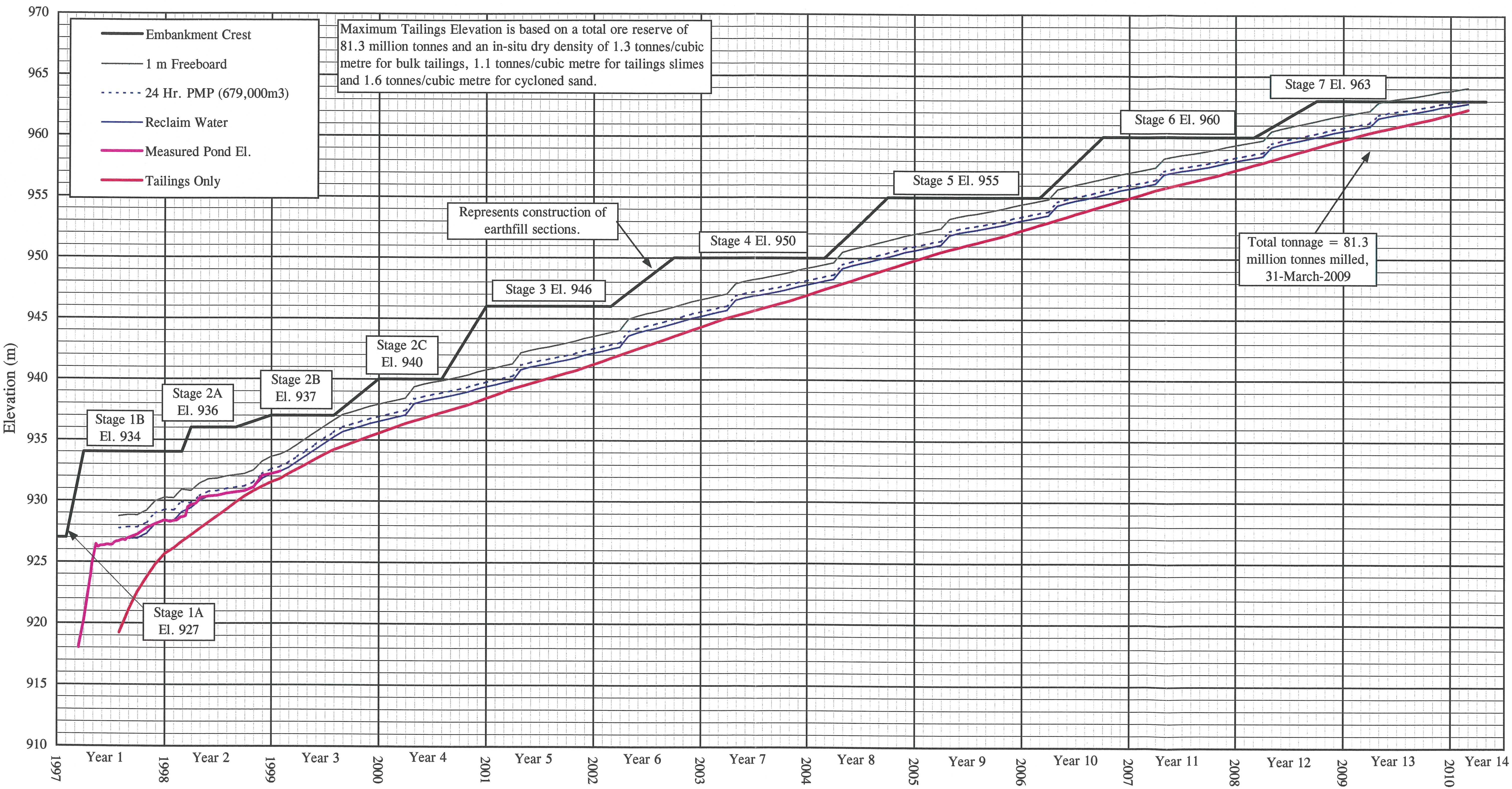
FIGURE 4.9

m:\11162\10\data\misc\Dacfeb99.xls fillsch (cycloned sand)

6/15/99 4:42 PM

MOUNT POLLEY MINING CORPORATION
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY
FILLING SCHEDULE AND STAGED CONSTRUCTION FOR CYCLONED SAND EMBANKMENT

Updated : March 11, 1999

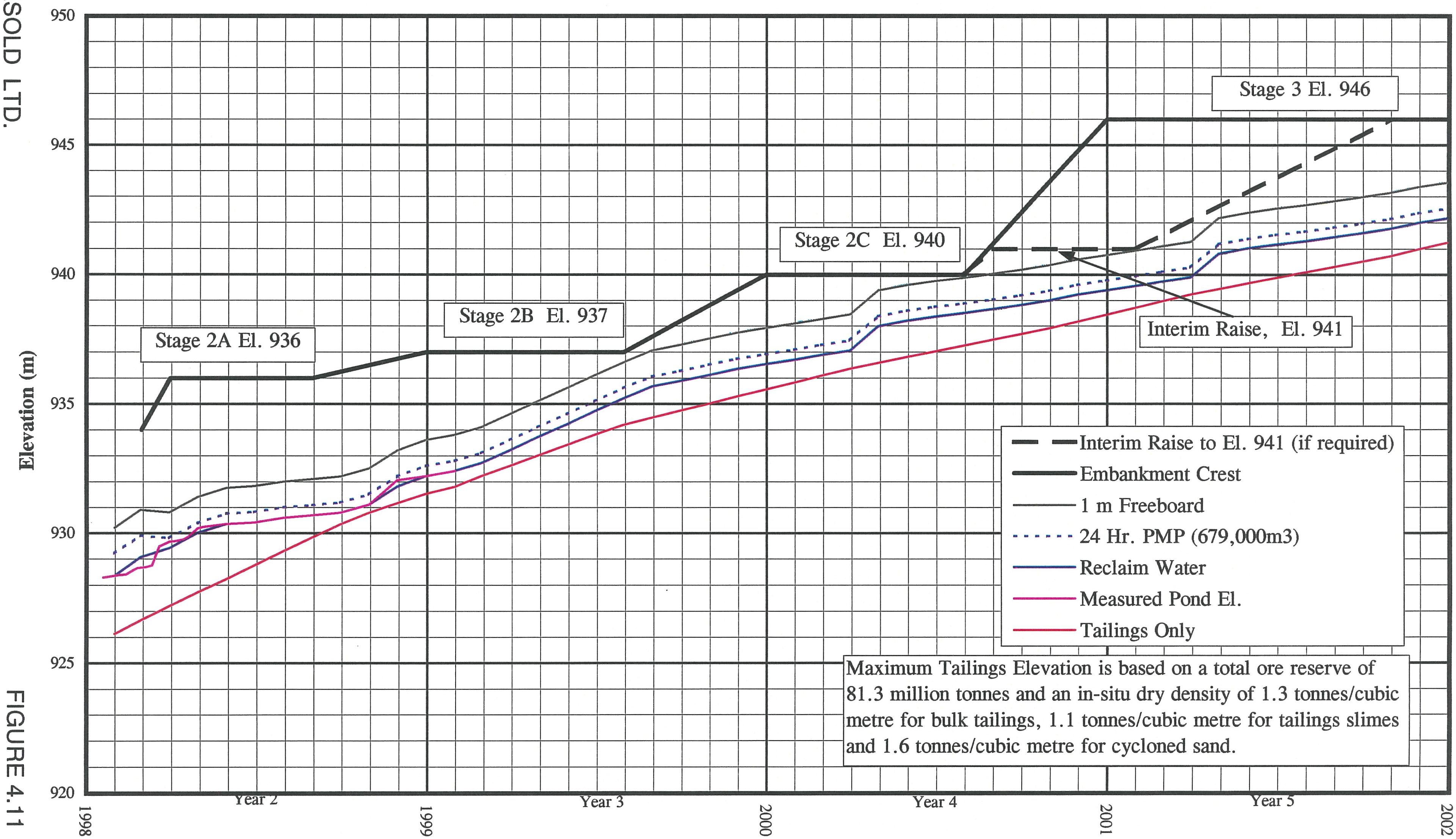


KNIGHT PIESOLD LTD.
CONSULTING ENGINEERS

FIGURE 4.10

MOUNT POLLEY MINING CORPORATION
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY
FILLING SCHEDULE AND STAGED CONSTRUCTION
FOR CYCLONED SAND EMBANKMENT (Years 2 to 5)

Updated : March 16, 1999



KNIGHT PIESOLD LTD.
CONSULTING ENGINEERS

FIGURE 4.11

MOUNT POLLEY MINING CORPORATION
MOUNT POLLEY MINE
PREFERRED OPTION - STAGE 2C EMBANKMENT CONSTRUCTION

SCHEDULE OF ACTIVITIES

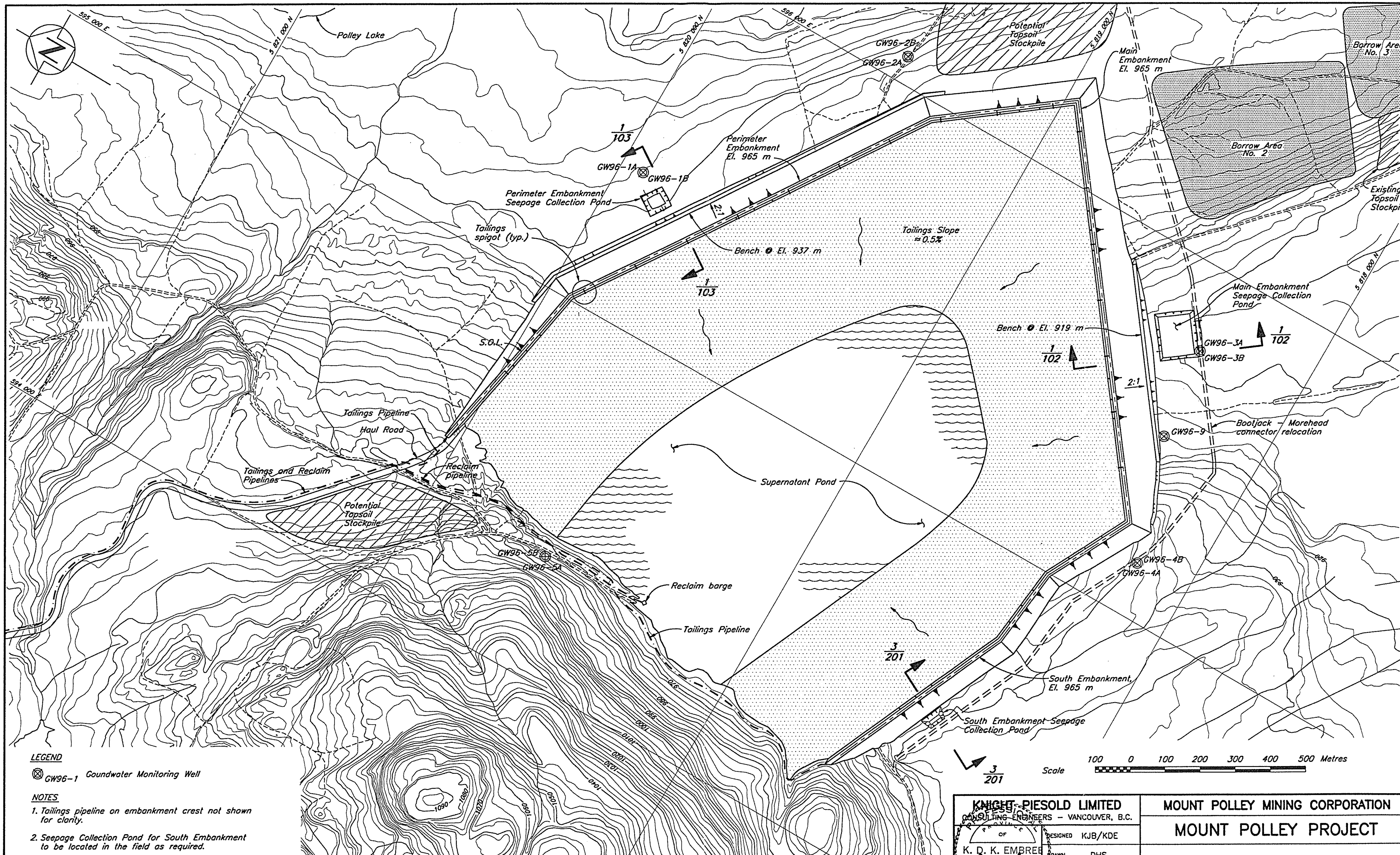
M:\11162\11\Data\misc\[2C-SCHED.XLS]RevFig. 4.11

ITEM	DESCRIPTION	1999												2000				
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
1	Confirm options for Stage 2C.	COMPLETED																
2	Review With MPMC	COMPLETED																
3	Finalize Earthworks Design	COMPLETED																
4	Design Pipeworks	COMPLETED																
5	Construct Upstream Toe Drain	COMPLETED																
6	Site Investigation For Basin Liner	COMPLETED																
7	Construct Basin Liner																	
8	Construct Cyclone Banks and Associated Pipeworks	COMPLETED																
9	Construct Overflow and Pressure Relief Contingency Measures	COMPLETED																
10	Construct Cycloned Sand Berm - Zone CS1 (427,000 m^3)																	
11	Construct Stage 2C Embankment Fill (100,000 m^3 of Zone CS2, 90,000 m^3 of Zones S and B)																	
	- if sand berm incomplete																	
	- if sand berm completed																	
12	Submit Application For Downstream Cycloning to Ministry of Mines																	
13	Agency Review																	
14	Complete Detailed Design																	
15	Construct Downstream Berms, Drains, etc. (100,000 m^3 fill)																	
16	Modify Cyclone System For Downstream Deposition																	
17	Stage 3 Downstream Cyclone Sand Construction to El. 943 m (816,000 m^3)																	

15-Jun-99

KNIGHT PIESOLD LTD.
CONSULTING ENGINEERS

FIGURE 4.12



LEGEND

⊗ GW96-1 Goundwater Monitoring Well

NOTES

1. Tailings pipeline on embankment crest not shown for clarity.
2. Seepage Collection Pond for South Embankment to be located in the field as required.

DRG. NO.	DESCRIPTION
201	TSF - FINAL TAILINGS EMBANKMENT - SECTIONS

REFERENCE DRAWINGS

REV.	DATE	DESCRIPTION	APPROVED
0	DEC 1/97	ISSUED FOR DESIGN REPORT	

REVISIONS

KNIGHT PIESOLD LIMITED
CONSULTING ENGINEERS - VANCOUVER, B.C.

PROVINCE OF BRITISH COLUMBIA
K. D. K. EMBREE

DESIGNED KJB/KDE
DRAWN DHS
CHECKED
APPROVED

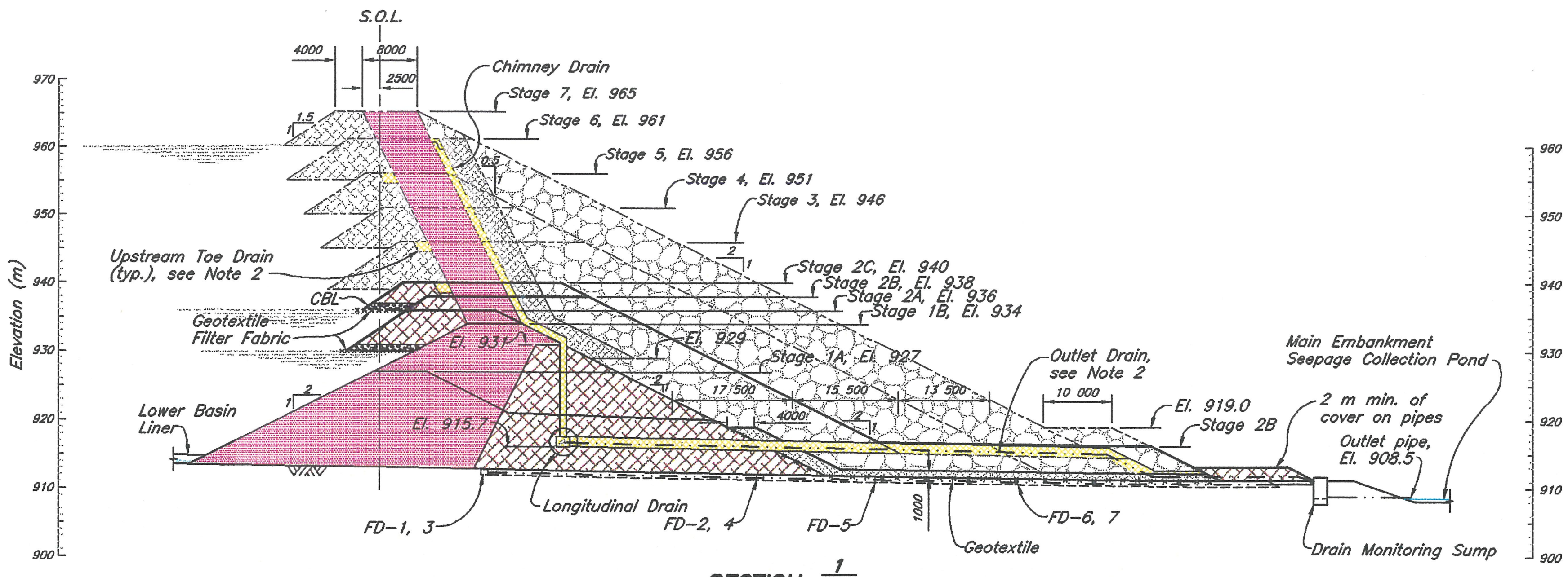
MOUNT POLLEY MINING CORPORATION

MOUNT POLLEY PROJECT

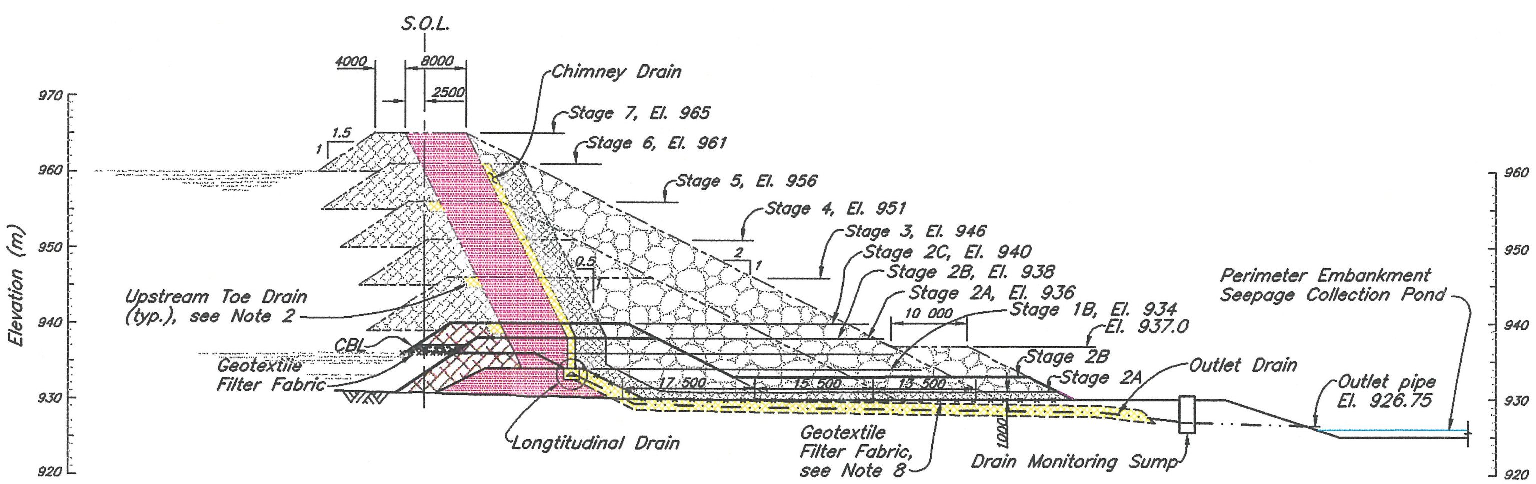
TAILINGS STORAGE FACILITY
FINAL ARRANGEMENT

DATE DEC. 1, 1997 | SCALE AS SHOWN | DRG. NO. 10162-9-200 | REV. 0

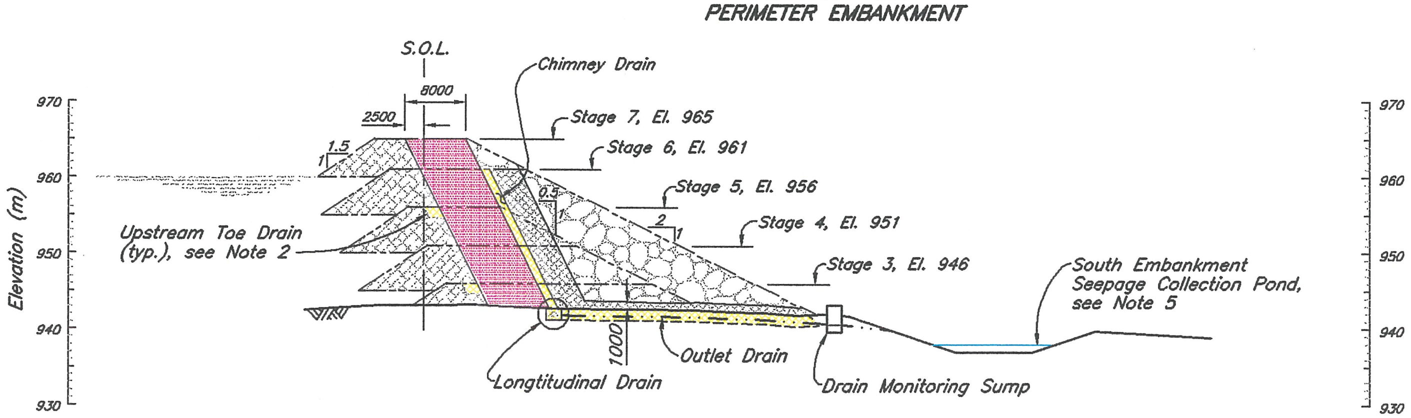
CAD FILE: 10162\PL024\024 1:5000 Plot 1=5 DEC 1, 1997



SECTION 1/101
MAIN EMBANKMENT



SECTION 2/200
PERIMETER EMBANKMENT



SECTION 3/200
SOUTH EMBANKMENT

ZONE	LOCATION	MATERIAL TYPE	PLACEMENT AND COMPACTION REQUIREMENTS
S	Core Zone	Glacial till	Placed, moisture conditioned and spread in maximum 300 mm thick layers (after compaction). Vibratory compaction to 98% of Standard Proctor maximum dry density or as approved by the Engineer.
B	Fill Zone	Glacial till, glaciolacustrine or granular material	Placed, moisture conditioned and spread in maximum 1000 mm thick layers (after compaction). Vibratory compaction to 92% of Standard Proctor maximum dry density or as approved by the Engineer.
T	Transition Zone	Mine Rock	Placed and spread in maximum 600 mm thick layers. Compaction as directed by the Engineer.
C	Shell Zone	Mine Rock	Placed and spread in maximum 1000 mm thick lifts. Four passes with a specified vibratory roller.
F	Chimney Drain	Filter sand	Placed and spread in maximum 600 mm thick lifts. Compaction as directed by the Engineer.
F	Longitudinal/ Outlet Drain	Filter Sand	Placed and spread carefully around filter fabric/drain gravel. Compaction as directed by the Engineer.
G	Foundation/ Longitudinal/ Outlet Drain	Drain Gravel	Placed and spread carefully around seepage collection pipes. Compaction as directed by the Engineer.
–	Basin Liner	Glacial till, glaciolacustrine or granular material	Placed and spread in maximum 150 mm thick lifts. Compaction as directed by the Engineer.
CBL	Coarse Bearing Layer	Random Rockfill	End dumped and spread as required for trafficability and fill placement.
FDF	Upstream Shell Zone	Free draining Random Fill	Placement and compaction requirements to be determined.

NOTES

1. Pond elevations estimated from Filling Schedule and Staged Construction Curve and include provision for 2.5 million cubic metres of reclaim water.
2. Stage 2 Upstream Toe Drains to be designed and installed during Stage 3. Future Upstream Toe Drains to be added as required.
3. Dashed lines imply preliminary design. Ongoing design and crest elevations to be modified as required based on filling records and monitoring data.
4. Chimney Drain extension requirements to be reviewed for each raise. Chimney Drain to have a minimum continuous width of 1000 mm.
5. South Embankment Seepage Collection Pond and Drain Monitoring Sump to be constructed during Stage 3.
6. Coarse Bearing Layer required on tailings. To be added on ground as required to provide a firm bearing layer for fill placement.
7. All dimensions in millimetres with elevations in metres, unless noted otherwise.
8. Extent of Geotextile Filter Fabric on foundation to be determined in the field.

NOT FOR CONSTRUCTION

Scale 10 5 0 10 20 30 40 50 m

CAD FILE\10162\9\020\D20 1:500 Plot 1=0.5 DEC 1, 1997

DRG. NO.	DESCRIPTION
200	TSF – FINAL ARRANGEMENT

REFERENCE DRAWINGS

REV.	DATE	DESCRIPTION	APPROVED
0	DEC 1/97	ISSUED FOR DESIGN REPORT	

REVISIONS

KNIGHT PIESOLD LIMITED
CONSULTING ENGINEERS – VANCOUVER, B.C.

PROFESSIONAL ENGINEER – PROVINCE OF BRITISH COLUMBIA – K. D. K. EMBREE

DESIGNED KJB/KDE
DRAWN DHS
CHECKED
APPROVED

MOUNT POLLEY MINING CORPORATION

MOUNT POLLEY PROJECT

TAILINGS STORAGE FACILITY
FINAL TAILINGS EMBANKMENT
SECTIONS

DATE DEC. 1, 1997 | SCALE AS SHOWN | DRG. NO. 10162-9-201 | REV. 0

Knight Piésold Ltd.
CONSULTING ENGINEERS

APPENDIX A

SAMPLE C-ZCS-3
DETAILED LABORATORY
TESTING RESULTS

Knight Piésold LLC
CONSULTING ENGINEERS AND ENVIRONMENTAL SCIENTISTS
GEOTECHNICAL LABORATORY

5030 Nome Street, Suite A
Denver, Colorado 80239

Telephone (303) 371-8440
Telefax (303) 371-6936

KNIGHT PIÉSOLD LTD.				
INITIAL 1/15/99				
Name	Routing	Date Read	Action By	Reply Date
JPF				
BHS				
KJB				
TAV				
AH				
WJ				
SMP				
FILE				

YOUR REFERENCE 1377P100
OUR REFERENCE 98220.dat

January 5, 1999

Mr. Wilson Muir
Knight Piésold Ltd.
1400 - 750 West Pender Street
Vancouver, B.C. V6C 2T8
Canada

Re: Mount Polley Test Data

Dear Mr. Muir,

Enclosed are copies of the test results for Grain Size Distribution w/Hydrometer (ASTM D 422), Atterberg Limits (ASTM D 4318), Standard Proctor (ASTM D 698), Flexible Wall Permeability (ASTM D 5084), Trixial Compression (TX-ICU, COE Method EM-1110-2-1906) and Time Consolidation (ASTM 2435) performed on the Cyclone Sand sample C-ZCS-3.

The time consolidation test data includes rebound points and compression curve plots for both void ratio vs. Log pressure and percent compression vs. Log pressure. The laboratory compaction curve reflects the driest data point compacted as the samples as-received moisture content.

The samples will be stored in our laboratory until February 1, 1999 at which time they will be scheduled for disposal. Please contact us with other storage arrangements if necessary.

Thank you for selecting Knight Piésold LLC to perform these tests for you. Please contact us if we may be of further service to Knight Piésold Ltd. in the future.

Sincerely,

Knight Piésold LLC

Samuel P. Bush,
Laboratory Manager

GRAIN SIZE DISTRIBUTION TEST DATA

Test No.: 19

ate: 12/21/98
roject No.: 1377
Project: Mount Polley Mine - TSF

Sample Data

Location of Sample: C-ZCS-3
ample Description: silty SAND
SCS Class: SM
Liquid limit:
ASHTO Class:
Plasticity index: NPL

Notes

Remarks: Natural moisture content 16.9%.

ig. No.:

Mechanical Analysis Data

	Initial
Dry sample and tare=	101.71
are =	0.00
ry sample weight =	101.71

Tare for cumulative weight retained= 0

Sieve	Cumul. Wt. retained	Percent finer
# 10	0.00	100.0
# 20	0.04	100.0
# 40	0.76	99.3
# 60	9.87	90.3
# 100	43.11	57.6
# 200	77.15	24.1

Hydrometer Analysis Data

eparation sieve is number 4
ercent -# 4 based on complete sample= 100.0
Weight of hydrometer sample: 101.71
alculated biased weight= 101.71
utomatic temperature correction
Composite correction at 20 deg C =-3.5

eniscus correction only= 1
Specific gravity of solids= 2.812
pecific gravity correction factor= 0.966
ydrometer type: 152H Effective depth L= 16.294964 - 0.164 x Rm

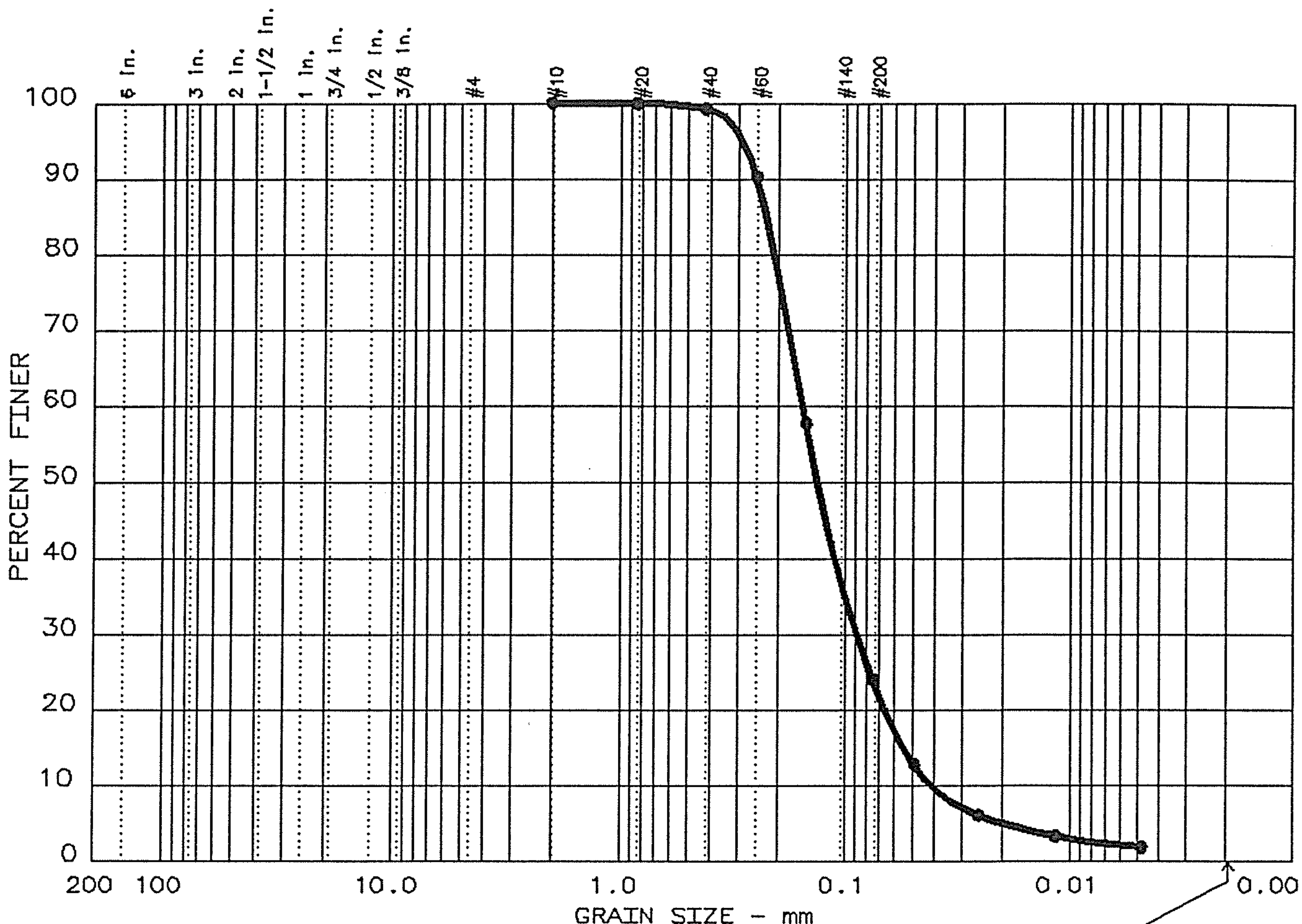
Elapsed time, min	Temp, deg C	Actual reading	Corrected reading	K	Rm	Eff. depth	Diameter mm	Percent finer
1.0	17.4	17.5	13.4	0.0135	18.5	13.3	0.0490	12.7
1.0	17.4	17.5	13.4	0.0135	18.5	13.3	0.0490	12.7
4.0	17.4	10.5	6.4	0.0135	11.5	14.4	0.0255	6.1
4.0	17.4	10.5	6.4	0.0135	11.5	14.4	0.0255	6.1
20.0	17.4	7.5	3.4	0.0135	8.5	14.9	0.0116	3.2
20.0	17.3	7.5	3.4	0.0135	8.5	14.9	0.0116	3.2
120.0	17.3	6.0	1.9	0.0135	7.0	15.1	0.0048	1.8
120.0	17.3	6.0	1.9	0.0135	7.0	15.1	0.0048	1.8

Fractional Components

Gravel/Sand based on #4 sieve
Sand/Fines based on #200 sieve
% + 3 in. = 0.0 % GRAVEL = 0.0 % SAND = 75.9
% FINES = 24.1

D85= 0.23 D60= 0.155 D50= 0.133
D30= 0.0877 D15= 0.05408 D10= 0.04102
Cc = 1.2064 Cu = 3.7888

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	19	0.0	0.0	75.9	24.1	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●		NPL	0.225	0.155	0.133	0.0877	0.0541	0.0410	1.21	3.8

MATERIAL DESCRIPTION	USCS	AASHTO
● silty SAND	SM	

Project No.: 1377
Project: Mount Polley Mine - TSF
● Location: C-ZCS-3

Date: 12/21/98

Remarks:
Natural moisture content 16.9%.

GRAIN SIZE DISTRIBUTION TEST REPORT
Knight Piesold LLC

Figure No. ______

PROCTOR TEST REPORT

Curve No.:

Project No.: 1377 Date: 12-16-98

Project: Mount Polley Mine TSF

Location: C-ZCS-3, Cyclone sand

Elev/Depth:

Remarks:

One point run at natural moisture content.

MATERIAL DESCRIPTION

Description: SAND

Classifications: USCS: AASHTO:

Nat. Moist. = % Sp.G. = 2.60

Liquid Limit = Plasticity Index = NP

%> No.4 = 0%

TEST RESULTS
Maximum dry density = 103.6 pcf
Optimum moisture = 18.3 %

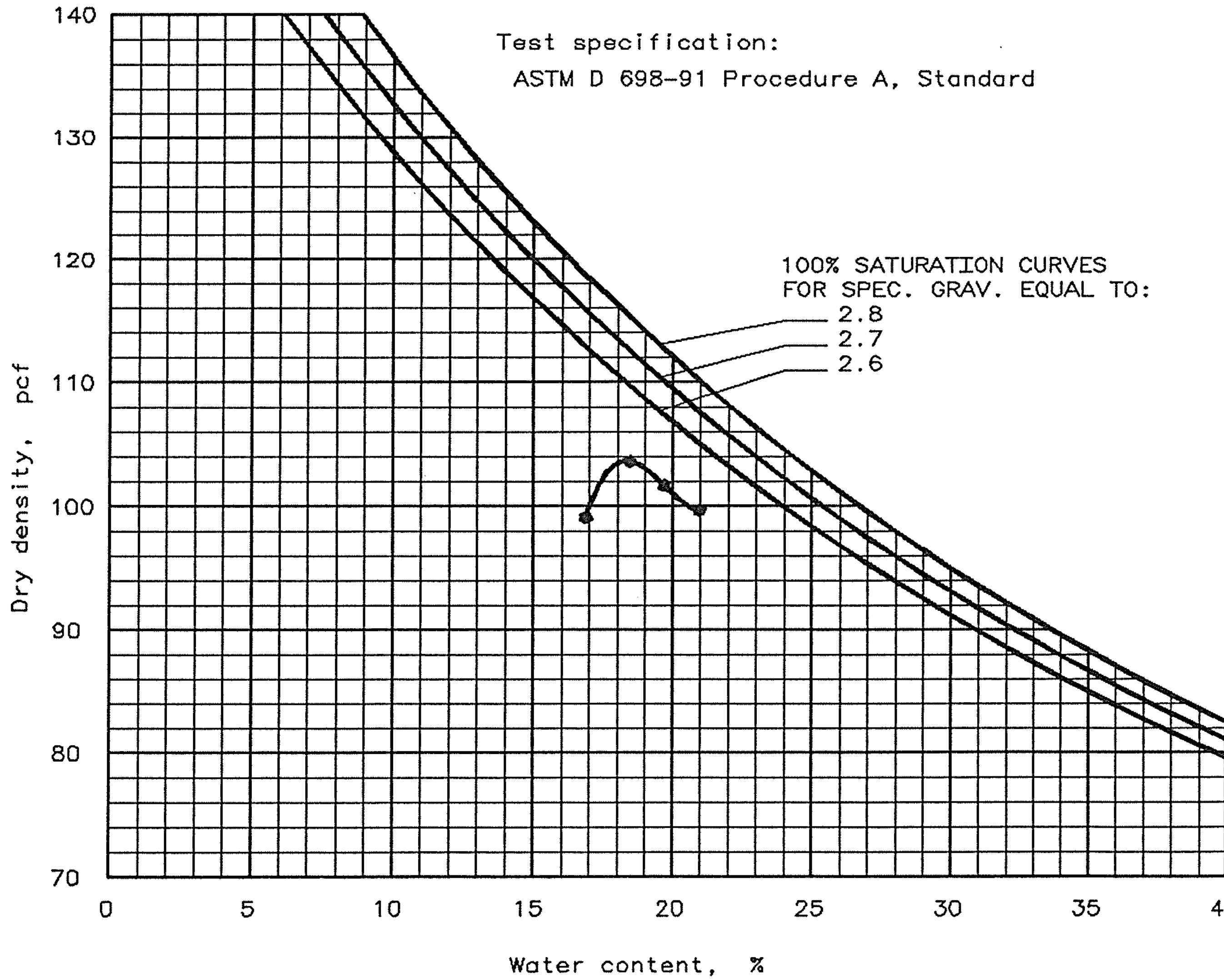


Fig.

Knight Piesold LLC

A-5

MOISTURE-DENSITY TEST DATA

DATA FILE: 148

PROJECT DATA

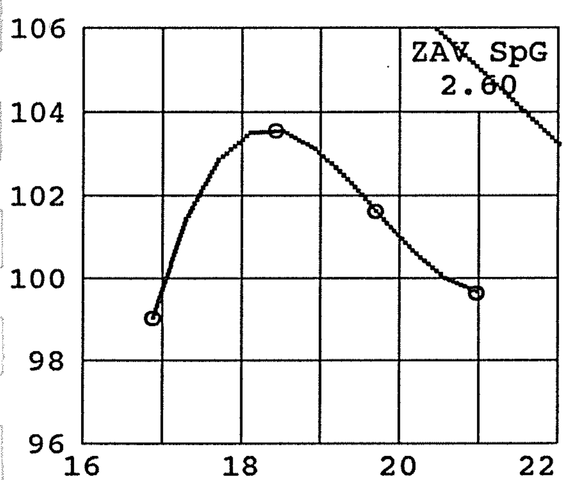
ate: 12-16-98
roject no.: 1377
Project: Mount Polley Mine TSF
ocation 1: C-ZCS-3, Cyclone sand
:
Remarks 1: One point run at natural
2: moisture content.
:
aterial 1: SAND
description 2:
levation or depth:
ig no:

SPECIMEN DATA

USCS classification:
AASHTO classification:
atural moisture:
Specific gravity: 2.60
ercent retained on No.4 sieve: 0
Percent passing No. 200 sieve:
iquid limit:
Plastic limit:
Plasticity index: NP

TEST DATA AND RESULTS

ype of test: Standard, ASTM D 698-91 Procedure A



POINT NO.	1	2	3	4
WM + WS	13.36	13.59	13.56	13.52
WM	9.50	9.50	9.50	9.50
WW+T #1	835.60	811.00	737.10	812.90
WD+T #1	775.00	749.80	684.80	744.70
TARE #1	415.70	417.60	419.10	419.40
MOIST #1	16.9	18.4	19.7	21.0
MOISTURE	16.9	18.4	19.7	21.0
DRY DEN	99.1	103.6	101.7	99.7

Max dry den= 103.6 pcf, Opt moisture= 18.3 %

versize Correction Not Applied

FLEXIBLE WALL PERMEABILITY TEST
ASTM D 5084-90
Increasing Tailwater Pressure - Method C

CLIENT:	Mount Polley Mining Corporation		
PROJECT:	Mount Polley Mine - TSF	PROJECT NO. :	1377
BORING NO.	C-ZCS-3	LAB NO. :	L98220
DEPTH	cyclone sand	SAMPLE ID:	
SAMPLE NO.		TEST STARTED :	12/16/98
SAMPLE TYPE	slurried, drained	TEST FINISHED :	12/18/98
CONF. PRESSURE. (psi)	18	SATURATED TEST:	YES

MOISTURE/DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil + Moisture (g)	289.80	318.20
Wt. Wet Soil & Pan (g)	289.80	463.80
Wt. Dry Soil & Pan (g)	246.80	379.10
Wt. Moisture Lost (g)	43.00	84.70
Wt. of Pan Only (g)	0.00	145.60
Wt. of Dry Soil (g)	246.80	233.50
Moisture Content %	17.4	36.3
Wet Density (pcf)	98.6	115.3
Dry Density (pcf)	84.0	84.6

Init. Diameter	(in)	1.907	(cm)	4.844
Init. Area	(sq in)	2.856	(sq cm)	18.427
Init. Height	(in)	3.920	(cm)	9.957
Height Change	(in)	0.043	(cm)	0.109
Consol. Height	(in)	3.877	(cm)	9.848
Area After Consol.	(sq in)	2.711	(sq cm)	17.494

Vol. Before Consol.	(cu ft)	0.00648	Specific Gravity	2.812
Vol. Before Consol.	(cc)	183.476	Assumed?	No
Change in Vol.	(cc)	11.200		
Cell Exp.	(cc)	0.000	Init. Saturation	44.9
Vol. After Consol.	(cc)	172.276	Init. Void Ratio	1.090
Vol. After Consol.	(cu ft)	0.00608	Final Saturation	100.0
Effective Porosity %		52.16	Final Void Ratio	0.963
Pressure Difference (psi):		0.00		
C =		0.20668		

FLEXIBLE WALL PERMEABILITY TEST
ASTM D 5084-90
Increasing Tailwater Pressure - Method C

CLIENT: Mount Polley Mining Corporation
PROJECT: Mount Polley Mine - TSF
BORING NO. C-ZCS-3
DEPTH cyclone sand
SAMPLE NO.
SAMPLE TYPE slurried, drained
CONF. PRESSURE. (psi) 18

PROJECT NO. : 1377
LAB NO. : L98220
SAMPLE ID:
TEST STARTED : 12/16/98
TEST FINISHED : 12/18/98
SATURATED TEST: YES

Permeability Test Trials

Time sec.	Cap Elevation cm	Pedestal Elevation cm	Elevation Head cm	Total Head cm	Permeability k cm/sec
0.0	40.0	5.0	35.0	35.0	
42.7	30.0	15.0	15.0	15.0	1.8E-03
0.0	40.0	5.0	35.0	35.0	
42.6	30.0	15.0	15.0	15.0	1.8E-03
0.0	40.0	5.0	35.0	35.0	
44.1	30.0	15.0	15.0	15.0	1.7E-03
0.0	40.0	5.0	35.0	35.0	
43.9	30.0	15.0	15.0	15.0	1.7E-03
0.0	40.0	5.0	35.0	35.0	
44.2	30.0	15.0	15.0	15.0	1.7E-03
0.0	40.0	5.0	35.0	35.0	
44.8	30.0	15.0	15.0	15.0	1.7E-03
0.0	40.0	5.0	35.0	35.0	
44.9	30.0	15.0	15.0	15.0	1.7E-03

Average of Last 4 Readings 1.7E-03

FLEXIBLE WALL PERMEABILITY TEST
ASTM D 5084-90
Increasing Tailwater Pressure - Method C

CLIENT:	Mount Polley Mining Corporation		
PROJECT:	Mount Polley Mine - TSF	PROJECT NO. :	1377
BORING NO.	C-ZCS-3	LAB NO. :	L98220
DEPTH	cyclone sand	SAMPLE ID:	
SAMPLE NO.		TEST STARTED :	12/16/98
SAMPLE TYPE	slurried, drained	TEST FINISHED :	12/18/98
CONF. PRESSURE. (psi)	36.2	SATURATED TEST:	YES

MOISTURE/DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil + Moisture (g)	281.00	310.60
Wt. Wet Soil & Pan (g)	281.00	369.00
Wt. Dry Soil & Pan (g)	239.40	295.80
Wt. Moisture Lost (g)	41.60	73.20
Wt. of Pan Only (g)	0.00	58.40
Wt. of Dry Soil (g)	239.40	237.40
Moisture Content %	17.4	30.8
Wet Density (pcf)	97.4	122.6
Dry Density (pcf)	83.0	93.7

Init. Diameter (in)	1.887	(cm)	4.793
Init. Area (sq in)	2.797	(sq cm)	18.043
Init. Height (in)	3.930	(cm)	9.982
Height Change (in)	0.068	(cm)	0.173
Consol. Height (in)	3.862	(cm)	9.809
Area After Consol. (sq in)	2.500	(sq cm)	16.128

Vol. Before Consol. (cu ft)	0.00636	Specific Gravity	2.812
Vol. Before Consol. (cc)	180.106	Assumed?	No
Change in Vol. (cc)	21.900		
Cell Exp. (cc)	0.000	Init. Saturation	43.8
Vol. After Consol. (cc)	158.206	Init. Void Ratio	1.116
Vol. After Consol. (cu ft)	0.00559	Final Saturation	100.0
Effective Porosity %	52.73	Final Void Ratio	0.858
Pressure Difference (psi):	0.00		
C =	0.22332		

FLEXIBLE WALL PERMEABILITY TEST
ASTM D 5084-90
Increasing Tailwater Pressure - Method C

CLIENT:	Mount Polley Mining Corporation		
PROJECT:	Mount Polley Mine - TSF	PROJECT NO. :	1377
BORING NO.	C-ZCS-3	LAB NO. :	L98220
DEPTH	cyclone sand	SAMPLE ID:	
SAMPLE NO.		TEST STARTED :	12/16/98
SAMPLE TYPE	slurried, drained	TEST FINISHED :	12/18/98
CONF. PRESSURE. (psi)	36.2	SATURATED TEST:	YES

Permeability Test Trials

Time sec.	Cap Elevation cm	Pedestal Elevation cm	Elevation Head cm	Total Head cm	Permeability k cm/sec
0.0	40.0	5.0	35.0	35.0	
63.3	30.0	15.0	15.0	15.0	1.3E-03
0.0	40.0	5.0	35.0	35.0	
63.4	30.0	15.0	15.0	15.0	1.3E-03
0.0	40.0	5.0	35.0	35.0	
63.1	30.0	15.0	15.0	15.0	1.3E-03
0.0	40.0	5.0	35.0	35.0	
63.6	30.0	15.0	15.0	15.0	1.3E-03
0.0	40.0	5.0	35.0	35.0	
64.3	30.0	15.0	15.0	15.0	1.3E-03
0.0	40.0	5.0	35.0	35.0	
64.9	30.0	15.0	15.0	15.0	1.3E-03
0.0	40.0	5.0	35.0	35.0	
64.9	30.0	15.0	15.0	15.0	1.3E-03
		Average of Last 4 Readings			1.3E-03

FLEXIBLE WALL PERMEABILITY TEST
ASTM D 5084-90
Increasing Tailwater Pressure - Method C

CLIENT:	Mount Polley Mining Corporation		
PROJECT:	Mount Polley Mine ~ TSF	PROJECT NO. :	1377
BORING NO.	C~ZCS~3	LAB NO. :	L98220
DEPTH	cyclone sand	SAMPLE ID:	
SAMPLE NO.		TEST STARTED :	12/16/98
SAMPLE TYPE	slurried, drained	TEST FINISHED :	12/18/98
CONF. PRESSURE. (psi)	72.5	SATURATED TEST:	YES

MOISTURE/DENSITY DATA	BEFORE TEST	AFTER TEST	
Wt. Soil + Moisture (g)	281.20	299.00	
Wt. Wet Soil & Pan (g)	281.20	425.30	
Wt. Dry Soil & Pan (g)	239.70	367.30	
Wt. Moisture Lost (g)	41.50	58.00	
Wt. of Pan Only (g)	0.00	126.30	
Wt. of Dry Soil (g)	239.70	241.00	
Moisture Content %	17.3	24.1	
Wet Density (pcf)	95.5	131.3	
Dry Density (pcf)	81.4	105.8	
Init. Diameter (in)	1.909	(cm)	4.849
Init. Area (sq in)	2.862	(sq cm)	18.466
Init. Height (in)	3.920	(cm)	9.957
Height Change (in)	0.126	(cm)	0.320
Consol. Height (in)	3.794	(cm)	9.637
Area After Consol. (sq in)	2.286	(sq cm)	14.752
Vol. Before Consol. (cu ft)	0.00649	Specific Gravity	2.812
Vol. Before Consol. (cc)	183.861	Assumed?	No
Change in Vol. (cc)	41.700		
Cell Exp. (cc)	0.000	Init. Saturation	42.1
Vol. After Consol. (cc)	142.161	Init. Void Ratio	1.157
Vol. After Consol. (cu ft)	0.00502	Final Saturation	100.0
Effective Porosity %	53.64	Final Void Ratio	0.668
Pressure Difference (psi):	0.00		
C =	0.23986		

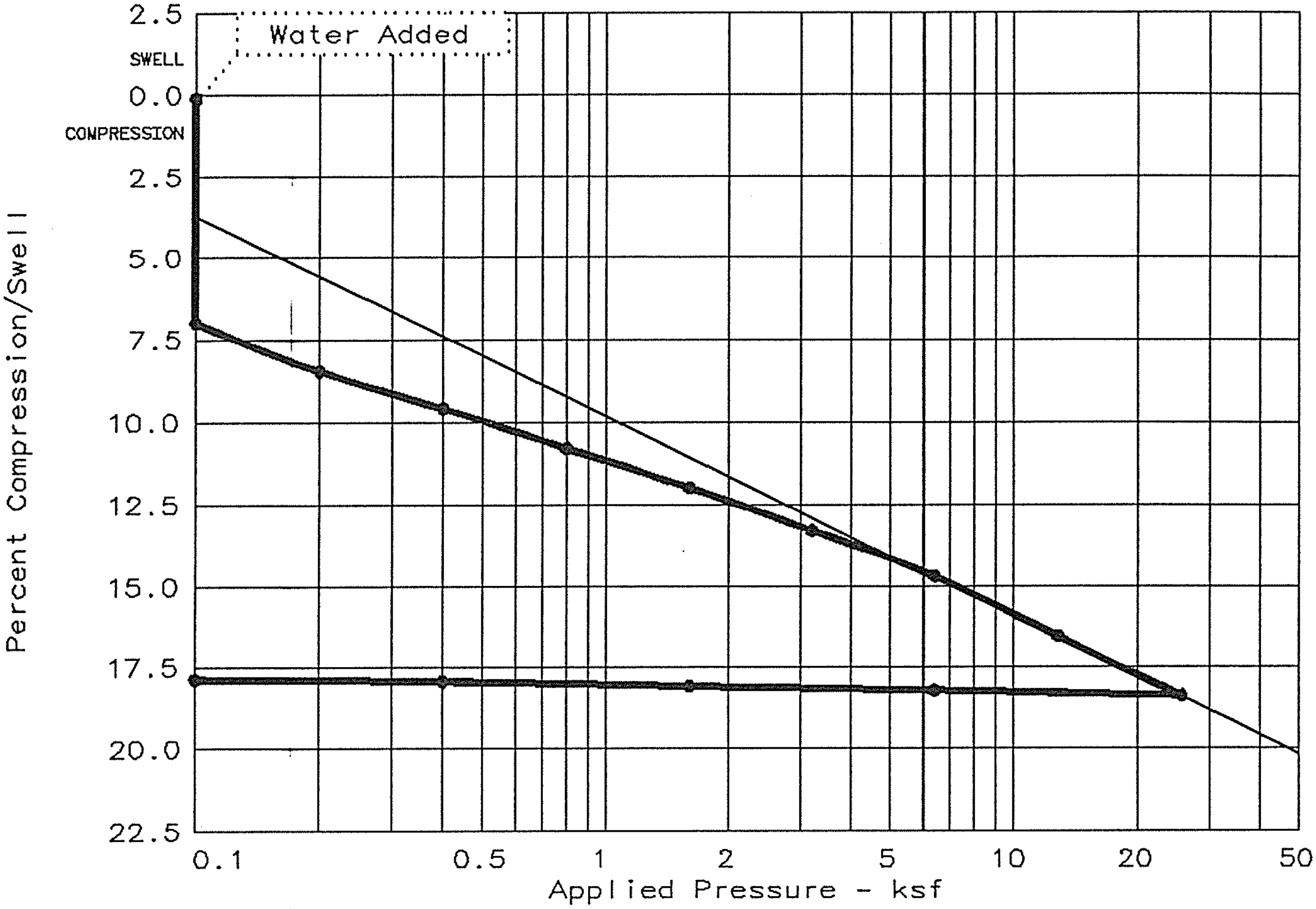
FLEXIBLE WALL PERMEABILITY TEST
ASTM D 5084-90
Increasing Tailwater Pressure - Method C

CLIENT:	Mount Polley Mining Corporation		
PROJECT:	Mount Polley Mine - TSF	PROJECT NO. :	1377
BORING NO.	C-ZCS-3	LAB NO. :	L98220
DEPTH	cyclone sand	SAMPLE ID:	
SAMPLE NO.		TEST STARTED :	12/16/98
SAMPLE TYPE	slurried, drained	TEST FINISHED :	12/18/98
CONF. PRESSURE. (psi)	72.5	SATURATED TEST:	YES

Permeability Test Trials

Time sec.	Cap Elevation cm	Pedestal Elevation cm	Elevation Head cm	Total Head cm	Permeability k cm/sec
0.0	40.0	5.0	35.0	35.0	
69.7	30.0	15.0	15.0	15.0	1.3E-03
0.0	40.0	5.0	35.0	35.0	
70.7	30.0	15.0	15.0	15.0	1.2E-03
0.0	40.0	5.0	35.0	35.0	
76.2	30.0	15.0	15.0	15.0	1.2E-03
0.0	40.0	5.0	35.0	35.0	
70.7	30.0	15.0	15.0	15.0	1.2E-03
0.0	40.0	5.0	35.0	35.0	
70.1	30.0	15.0	15.0	15.0	1.3E-03
0.0	40.0	5.0	35.0	35.0	
74.5	30.0	15.0	15.0	15.0	1.2E-03
0.0	40.0	5.0	35.0	35.0	
76.6	30.0	15.0	15.0	15.0	1.2E-03
			Average of Last 4 Readings		1.2E-03

TIME CONSOLIDATION TEST REPORT



Coefficients of Consolidation (sq. in./min.)								
No.	Load	Cv	No.	Load	Cv	No.	Load	Cv
7	3.20	0.098						
8	6.40	0.058						
9	12.80	0.028						
10	25.60	0.063						

Clpse. %	Nat. Sat.	Nat. Moist.	Dry Dens. (pcf)	LL	PI	Sp.Gr.	Precons. (ksf)	C_c	e_o
6.9	29.3 %	14.2 %	74.3		NPL	2.810	5.92	0.14	1.3607

TEST RESULTS

C_v at 12.80 ksf applied = 0.028 sq. in./min.
C_v at 25.60 ksf applied = 0.063 sq. in./min.

MATERIAL DESCRIPTION

SAND

Project No.: 1377P
Project: Mount Polley Mine
Location: ZCS-3 -C, Cyclone Sand

Date: 12/26/98

Remarks:

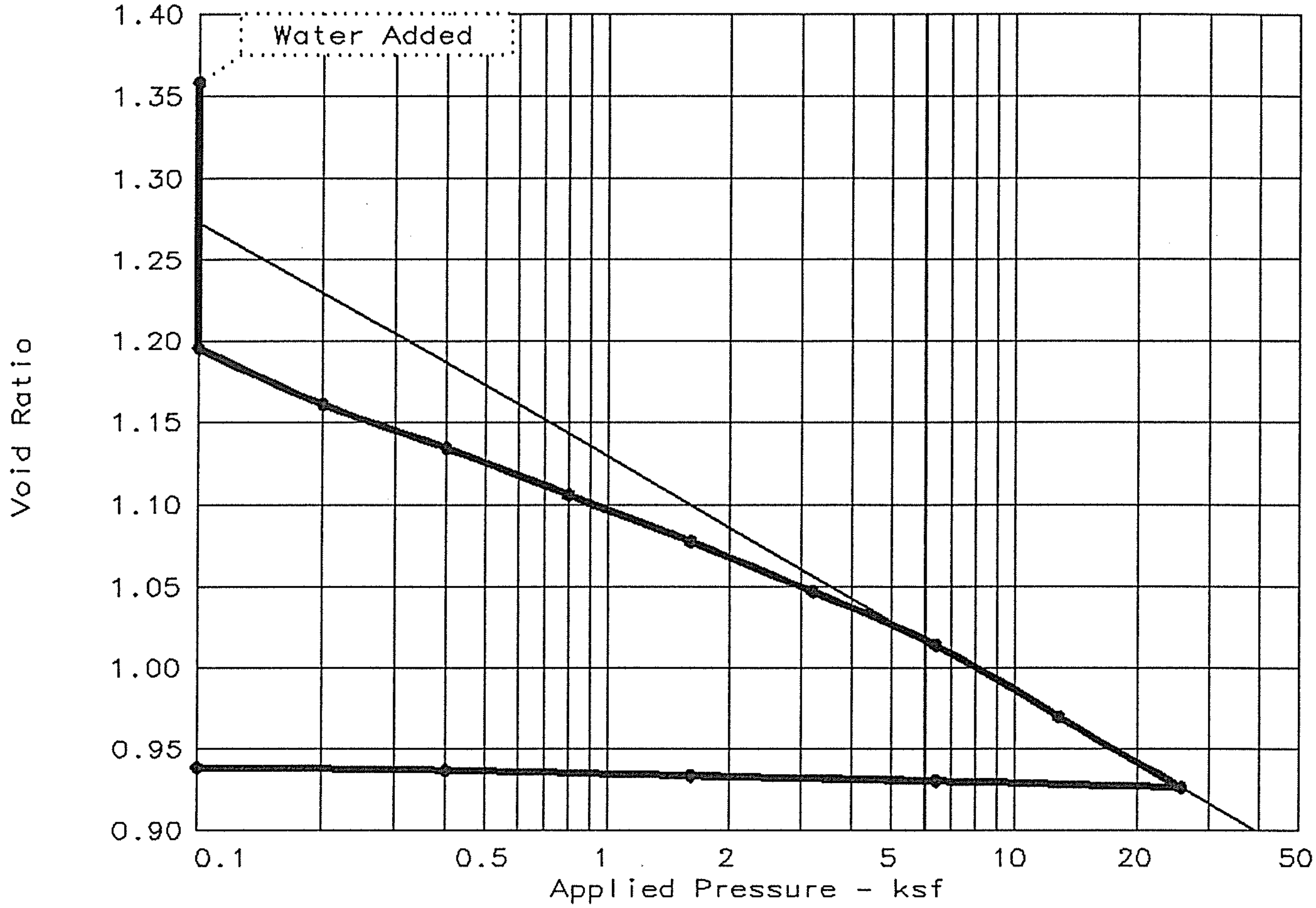
Inundated at 0.1 ksf.
Specific gravity: 2.81
Sample was slurried and allowed to drain to achieve intial density.

TIME CONSOLIDATION TEST REPORT

Knight Piésold LLC

Fig. ______

TIME CONSOLIDATION TEST REPORT



Coefficients of Consolidation (sq. in./min.)								
No.	Load	Cv	No.	Load	Cv	No.	Load	Cv
7	3.20	0.098						
8	6.40	0.058						
9	12.80	0.028						
10	25.60	0.063						

Clpse. %	Nat. Sat.	Nat. Moist.	Dry Dens. (pcf)	LL	PI	Sp.Gr.	Precons. (ksf)	C_c	e_o
6.9	29.3 %	14.2 %	74.3		NPL	2.810	5.92	0.14	1.3607

TEST RESULTS

C_v at 12.80 ksf applied = 0.028 sq. in./min.
C_v at 25.60 ksf applied = 0.063 sq. in./min.

MATERIAL DESCRIPTION

SAND

Project No.: 1377P
Project: Mount Polley Mine
Location: ZCS-3 -C, Cyclone Sand

Date: 12/26/98

TIME CONSOLIDATION TEST REPORT

Knight Piésold LLC

Remarks:

Inundated at 0.1 ksf.
Specific gravity: 2.81
Sample was slurried and allowed to drain to achieve intial density.

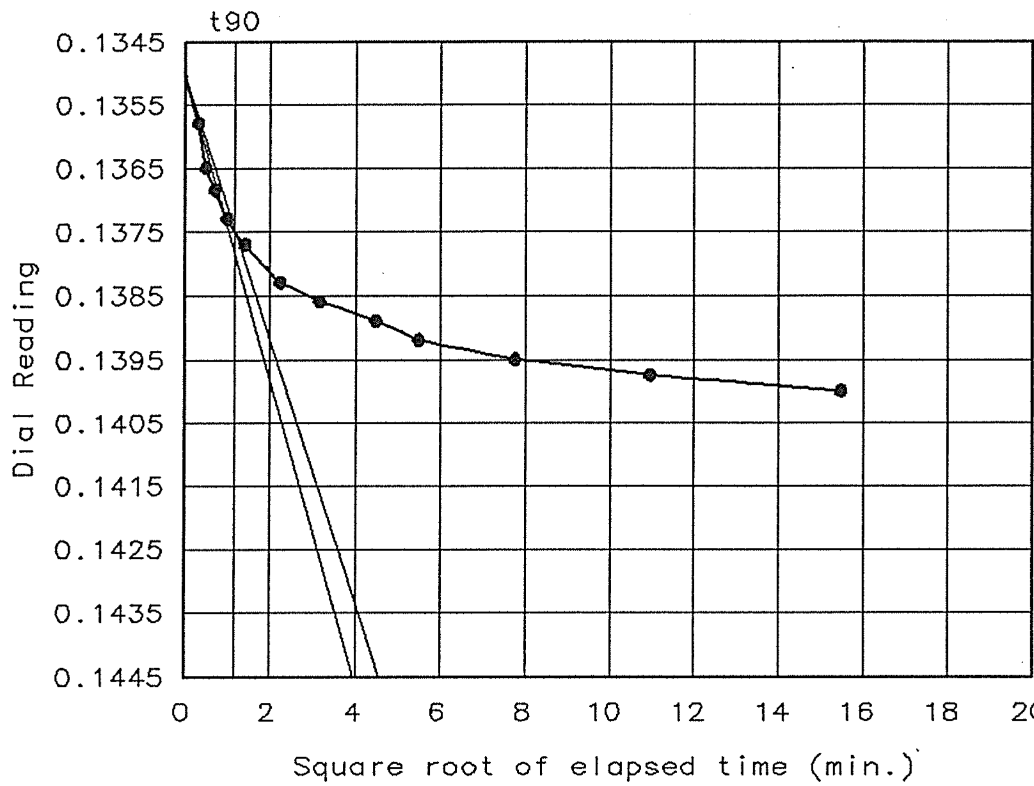
Fig. ______

A-14

Dial Reading vs. Time

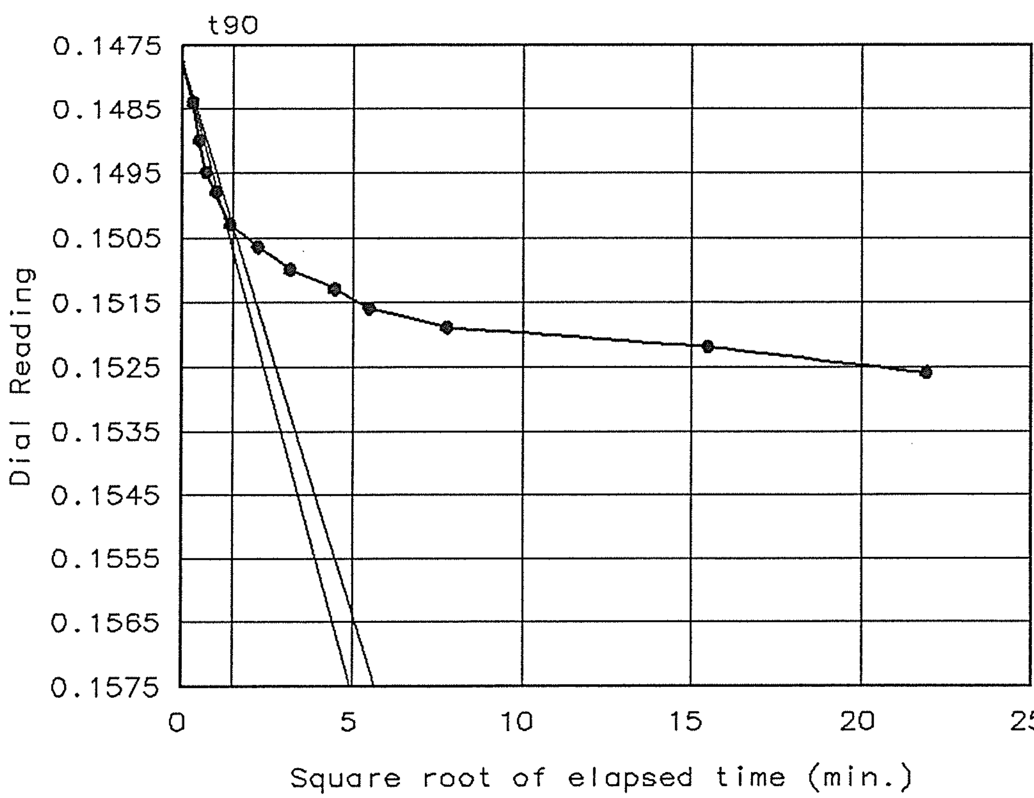
Project No.: 1377P
Project: Mount Polley Mine
Location: ZCS-3 -C, Cyclone Sand

Date: 12/26/98



Load No.= 7
Load= 3.20 ksf
D_0 = 0.1350
D_{90} = 0.1375
D_{100}= 0.1377
T_{90}= 1.33 min.

C_v @ T_{90} =
.098 in.^{2}/min.



Load No.= 8
Load= 6.40 ksf
D_0 = 0.1478
D_{90} = 0.1503
D_{100}= 0.1506
T_{90}= 2.21 min.

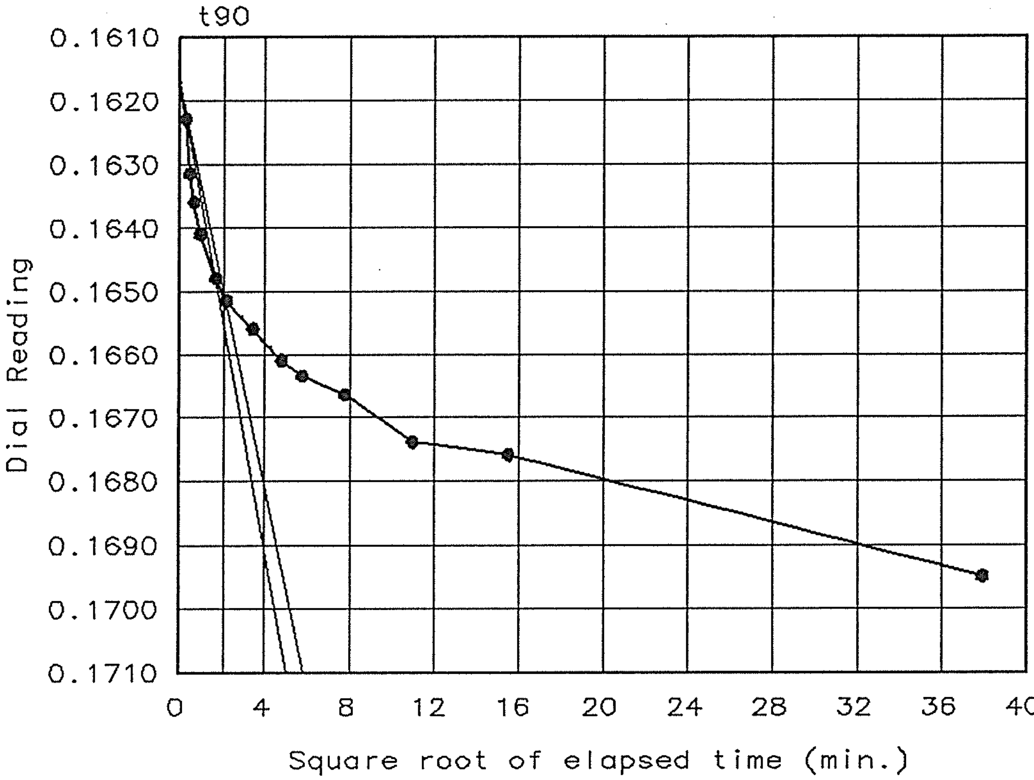
C_v @ T_{90} =
.058 in.^{2}/min.

Knight Piésold LLC

Dial Reading vs. Time

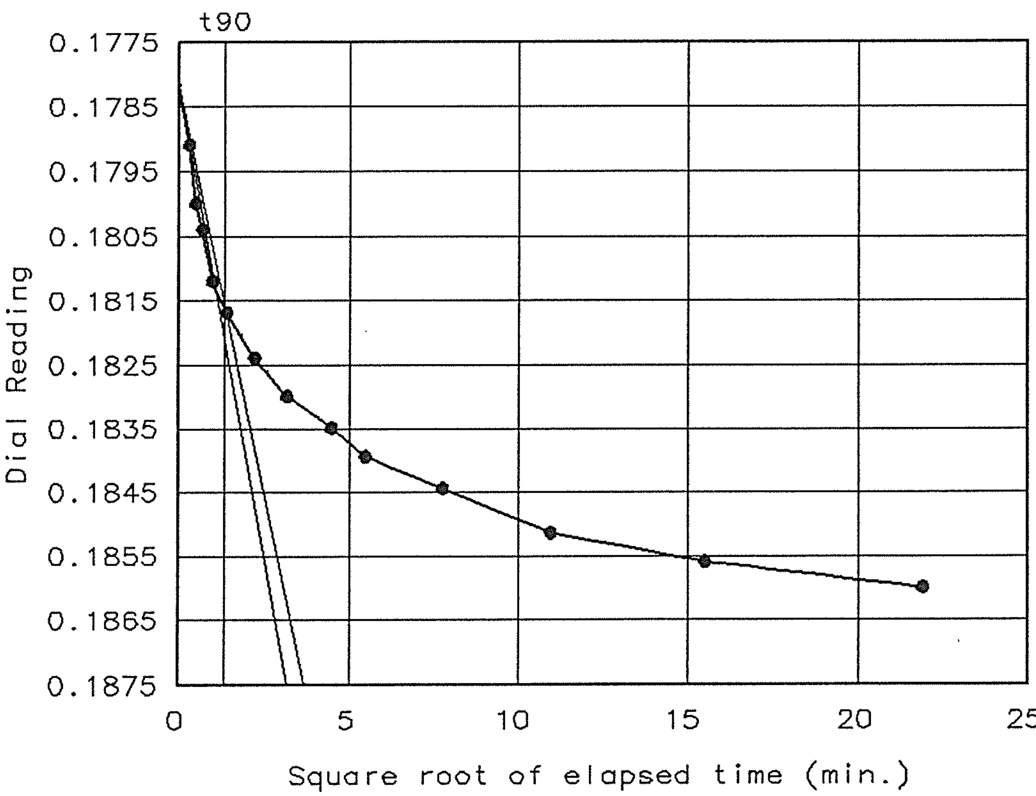
Project No.: 1377P
Project: Mount Polley Mine
Location: ZCS-3 -C, Cyclone Sand

Date: 12/26/98



Load No.= 9
Load= 12.80 ksf
D_0 = 0.1617
D_{90} = 0.1650
D_{100}= 0.1654
T_{90}= 4.31 min.

C_v @ T_{90} =
.028 in.^{2}/min.



Load No.= 10
Load= 25.60 ksf
D_0 = 0.1782
D_{90} = 0.1816
D_{100}= 0.1820
T_{90}= 1.86 min.

C_v @ T_{90} =
.063 in.^{2}/min.

Knight Piésold LLC

06:56, 1-05-1999 CONSOLIDATION TEST PROJECT DATA Test No. 93

Project Number: 1377P
Project: Mount Polley Mine
Date: 12/26/98
Location 1: ZCS-3 -C, Cyclone Sand
2:
Remarks 1: Inundated at 0.1 ksf.
2: Specific gravity: 2.81
3: Sample was slurried and
4: allowed to drain to
5: achieve intial density.
Material description SAND

Classification:
Liquid limit:
Plasticity index: NPL
Figure Number:

CONSOLIDATION TEST SPECIMEN DATA

TOTAL SAMPLE	BEFORE TEST	AFTER TEST
Wet w+t = 289.05 g.	Oedometer No. = 1	Wet w+t = 239.12 g.
Dry w+t = 268.12 g	Machine No. = 3	Dry w+t = 215.75 g.
Tare wt. = 120.74 g.	Spec. Gravity = 2.810	Tare wt. = 135.80 g.
Height = 0.9000 in.	Height = 0.9000 in.	
Diameter = 2.4160 in.	Diameter = 2.4150 in.	
Weight = 91.91 g.		
Moisture = 14.2 %	Ht. Solids = 0.3812 in.	Moisture = 29.2 %
Wet Den. = 84.9 pcf	Dry wt. = 80.41 g. *	Dry wt. = 79.95 g.
Dry Den. = 74.3 pcf	Void ratio = 1.3607	Void ratio = 0.9381
	Saturation = 29.3 %	

* Initial dry weight used in calculations

CONSOLIDATION TEST READINGS SUMMARY

LOAD (ksf)	DIAL (in.)	DEFLECTION (in.)	CORRECTED DIAL (in.)	VOID RATIO	% SWELL/COMPRS.
Initial	0.02030			1.3607	
0.10	0.02090	-0.0006	0.02150	1.3576	0.1 Comprs.
0.10	0.08290	-0.0006	0.08350	1.1949	7.0 Comprs.
0.20	0.09650	-0.0002	0.09670	1.1603	8.5 Comprs.
0.40	0.10770	0.0009	0.10680	1.1338	9.6 Comprs.
0.80	0.12040	0.0028	0.11760	1.1055	10.8 Comprs.
1.60	0.13350	0.0051	0.12840	1.0772	12.0 Comprs.
3.20	0.14770	0.0077	0.14000	1.0467	13.3 Comprs.
6.40	0.16320	0.0106	0.15260	1.0137	14.7 Comprs.
12.80	0.18250	0.0130	0.16950	0.9694	16.6 Comprs.
25.60	0.20210	0.0161	0.18600	0.9261	18.4 Comprs.
6.40	0.19510	0.0106	0.18450	0.9300	18.2 Comprs.
1.60	0.18840	0.0051	0.18330	0.9332	18.1 Comprs.
0.40	0.18290	0.0009	0.18200	0.9366	18.0 Comprs.

CONSOLIDATION TEST READINGS SUMMARY

LOAD (ksf)	DIAL (in.)	DEFLECTION (in.)	CORRECTED DIAL (in.)	VOID RATIO	% SWELL/COMPRS.
0.10	0.18080	-0.0006	0.18140	0.9381	17.9 Comprs.

CONSOLIDATION TEST RESULTS

ompression index = 0.14
Preconsolidation pressure = 5.92 ksf
Collapse percentage = 6.9 @ 0.1 ksf applied

Load 0.40 ksf CONSOLIDATION TEST READINGS Load No. 4

Machine Deflection 0.0009

No.	Elapsed Time	Dial Reading	No.	Elapsed Time	Dial Reading
1	0.00	0.09650	11	60.00	0.10740
2	0.10	0.10440	12	126.00	0.10750
3	0.25	0.10500	13	180.00	0.10770
4	0.58	0.10540			
5	1.00	0.10570			
6	2.00	0.10620			
7	5.00	0.10650			
8	10.00	0.10660			
9	20.00	0.10690			
10	30.00	0.10720			

Void Ratio: 1.1338 Compression: 9.6 %

oad 0.80 ksf CONSOLIDATION TEST READINGS Load No. 5

Machine Deflection 0.0028

No.	Elapsed Time	Dial Reading	No.	Elapsed Time	Dial Reading
1	0.00	0.10770	11	60.00	0.11980
2	0.10	0.11660	12	120.00	0.12010
3	0.25	0.11710	13	240.00	0.12040
4	0.50	0.11750			
5	1.00	0.11780			
6	2.00	0.11820			
7	5.00	0.11860			
8	10.00	0.11890			
9	20.00	0.11930			
10	30.00	0.11940			

Void Ratio: 1.1055 Compression: 10.8 %

Load	1.60 ksf	CONSOLIDATION TEST READINGS	Load No. 6

Machine Deflection 0.0051

No.	Elapsed Time	Dial Reading	No.	Elapsed Time	Dial Reading
1	0.00	0.12040	11	60.00	0.13340
2	0.10	0.12940	12	120.00	0.13350
3	0.25	0.13030			
4	0.50	0.13075			
5	1.00	0.13120			
6	2.00	0.13150			
7	5.00	0.13200			
8	10.00	0.13240			
9	20.00	0.13270			
10	30.00	0.13300			

Void Ratio: 1.0772 Compression: 12.0 %

Load	3.20 ksf	CONSOLIDATION TEST READINGS	Load No. 7

Machine Deflection 0.0077

No.	Elapsed Time	Dial Reading	No.	Elapsed Time	Dial Reading
1	0.00	0.13350	11	60.00	0.14720
2	0.10	0.14350	12	120.00	0.14745
3	0.25	0.14420	13	240.00	0.14770
4	0.50	0.14455			
5	1.00	0.14500			
6	2.00	0.14540			
7	5.00	0.14600			
8	10.00	0.14630			
9	20.00	0.14660			
10	30.00	0.14690			

Void Ratio: 1.0467 Compression: 13.3 %
D0 = 0.1350 D90 = 0.1375 D100 = 0.1377 T90 = 1.33 min.
Cv @ 1.3 min.= 0.098 sq. in./min.

Load No. 8

CONSOLIDATION TEST READINGS

Load 6.40 ksf

Machine Deflection 0.0106

No.	Elapsed Time	Dial Reading	No.	Elapsed Time	Dial Reading
1	0.00	0.14770	11	60.00	0.16250
2	0.10	0.15900	12	240.00	0.16280
3	0.25	0.15960	13	480.00	0.16320
4	0.50	0.16010			
5	1.00	0.16040			
6	2.00	0.16090			
7	5.00	0.16125			
8	10.00	0.16160			
9	20.00	0.16190			
10	30.00	0.16220			

Void Ratio: 1.0137 Compression: 14.7 %
D0 = 0.1478 D90 = 0.1503 D100 = 0.1506 T90 = 2.21 min.
Cv @ 2.2 min.= 0.058 sq. in./min.

Load No. 9

CONSOLIDATION TEST READINGS

Load 12.80 ksf

Machine Deflection 0.0130

No.	Elapsed Time	Dial Reading	No.	Elapsed Time	Dial Reading
1	0.00	0.16320	11	60.00	0.17965
2	0.10	0.17530	12	120.00	0.18040
3	0.25	0.17615	13	240.00	0.18060
4	0.50	0.17660	14	1440.00	0.18250
5	1.00	0.17710			
6	3.00	0.17780			
7	5.00	0.17815			
8	12.00	0.17860			
9	23.00	0.17910			
10	33.00	0.17935			

Void Ratio: 0.9694 Compression: 16.6 %
D0 = 0.1617 D90 = 0.1650 D100 = 0.1654 T90 = 4.31 min.
Cv @ 4.3 min.= 0.028 sq. in./min.

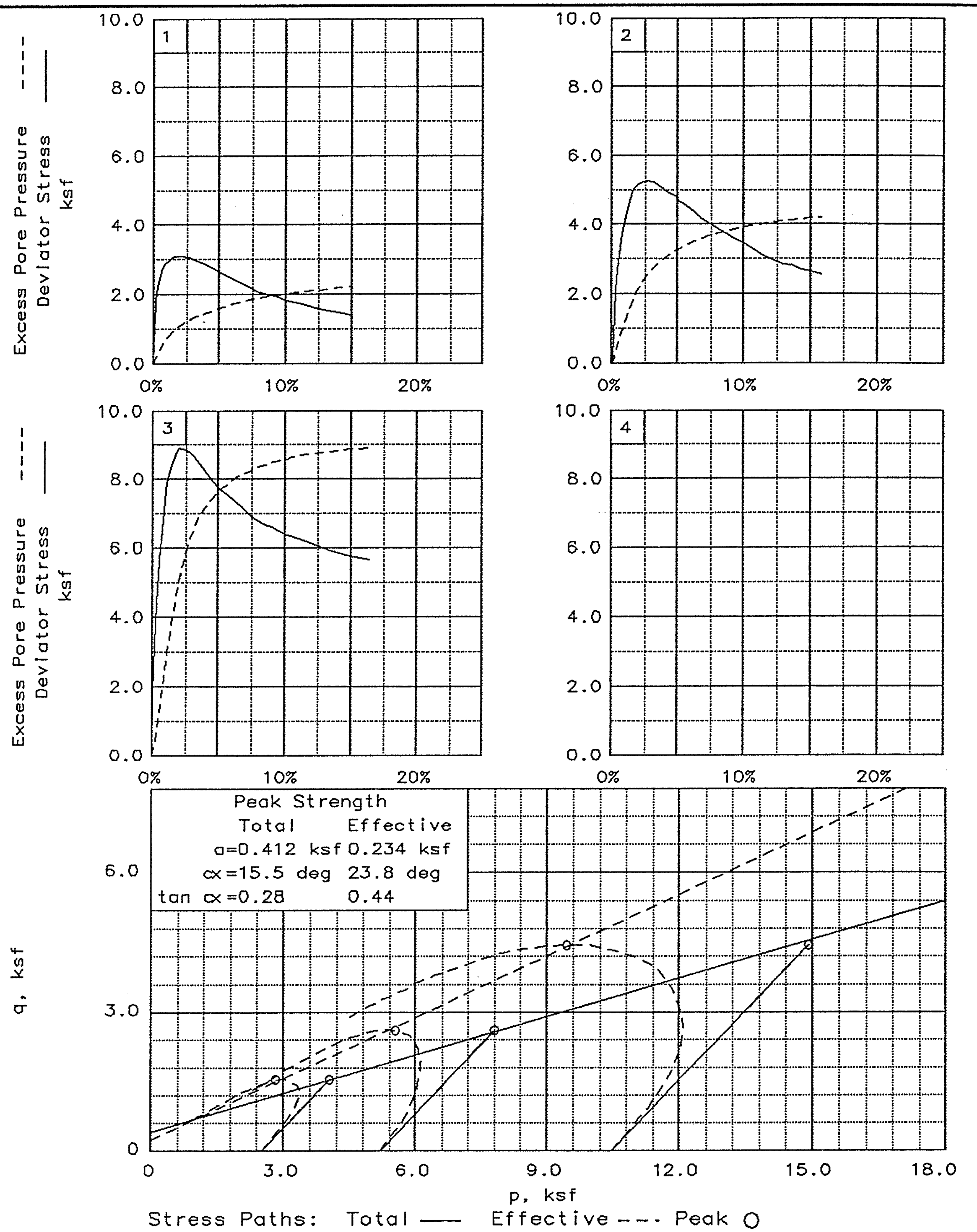
A

Load 25.60 ksf CONSOLIDATION TEST READINGS Load No. 10

Machine Deflection 0.0161

No.	Elapsed Time	Dial Reading	No.	Elapsed Time	Dial Reading
1	0.00	0.18250	11	60.00	0.20055
2	0.10	0.19520	12	120.00	0.20125
3	0.25	0.19610	13	240.00	0.20170
4	0.50	0.19650	14	480.00	0.20210
5	1.00	0.19730			
6	2.00	0.19780			
7	5.00	0.19850			
8	10.00	0.19910			
9	20.00	0.19960			
10	30.00	0.20005			

Void Ratio: 0.9261 Compression: 18.4 %
D0 = 0.1782 D90 = 0.1816 D100 = 0.1820 T90 = 1.86 min.
Cv @ 1.9 min.= 0.063 sq. in./min.

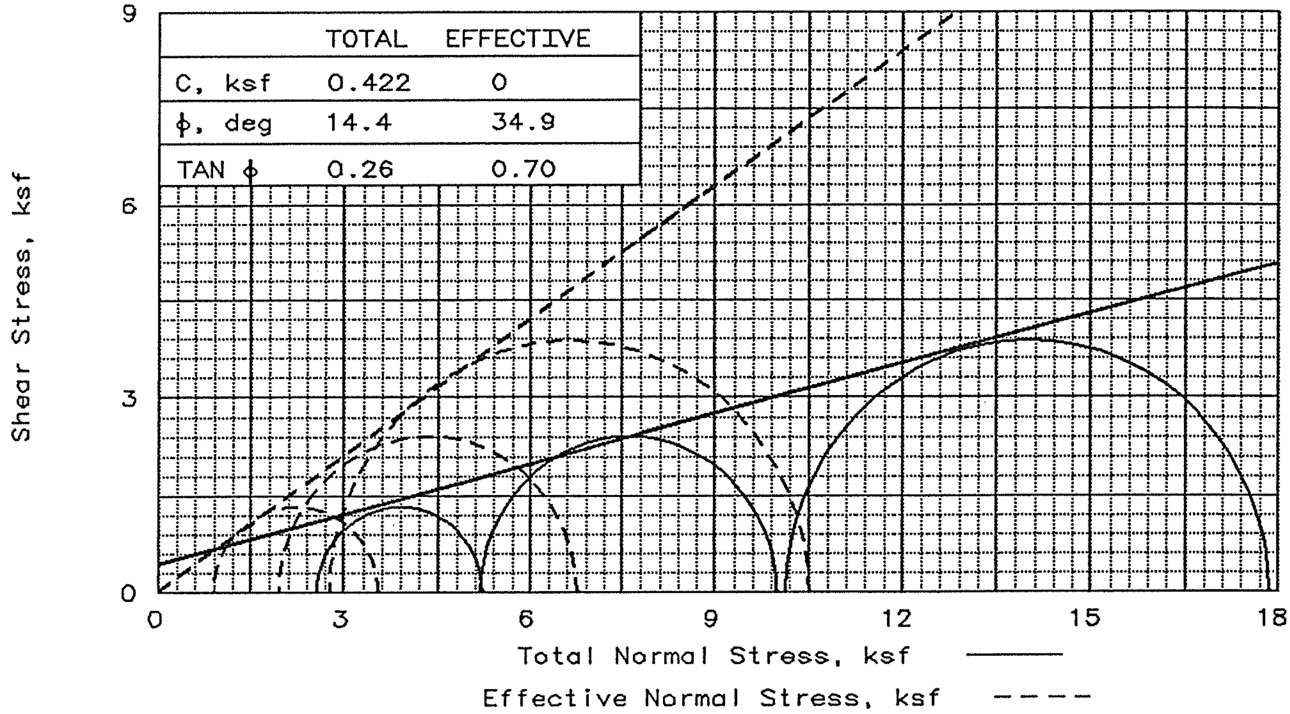


Client: Mount Polley Mining Corporation

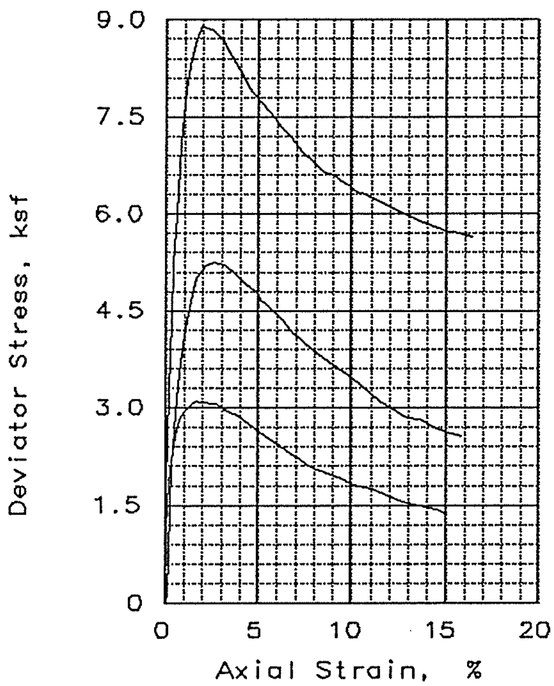
Project: Mount Polley Mine TSF

Location: C-ZCS-3, Cyclone Sand

File: MPCSZ3 Project No.: 1377



	TOTAL	EFFECTIVE
C, ksf	0.422	0
ϕ, deg	14.4	34.9
TAN ϕ	0.26	0.70



Sample No.		1	2	3
INITIAL	WATER CONTENT, %	17.4	17.4	17.3
	DRY DENSITY, pcf	84.0	83.0	81.4
	SATURATION, %	44.9	43.8	42.1
	VOID RATIO	1.090	1.116	1.157
	DIAMETER, in	1.91	1.89	1.91
	HEIGHT, in	3.92	3.93	3.92
AT TEST	WATER CONTENT, %	36.3	30.8	24.1
	DRY DENSITY, pcf	86.9	94.0	104.7
	SATURATION, %	100.0	100.0	100.0
	VOID RATIO	1.020	0.867	0.677
	DIAMETER, in	1.88	1.79	1.71
	HEIGHT, in	3.88	3.86	3.79
Strain rate, in/min		0.0040	0.0040	0.0040
EFF CELL PRESSURE, ksf		2.59	5.21	10.15
FAIL. STRESS, ksf		2.65	4.80	7.73
EXCESS PORE PR., ksf		1.67	3.24	7.36
STRAIN, %		5.1	4.9	5.1
ULT. STRESS, ksf				
EXCESS PORE PR., ksf				
STRAIN, %				
$\bar{\sigma}_1$ FAILURE, ksf		3.57	6.77	10.52
$\bar{\sigma}_3$ FAILURE, ksf		0.92	1.97	2.79

TYPE OF TEST:
CU with Pore Pressures

CLIENT: Mount Polley Mining Corporation

PROJECT: Mount Polley Mine TSF

SAMPLE LOCATION: C-ZCS-3, Cyclone Sand

PROJ. NO.: 1377 DATE: 12/21/98

TRIAXIAL SHEAR TEST REPORT

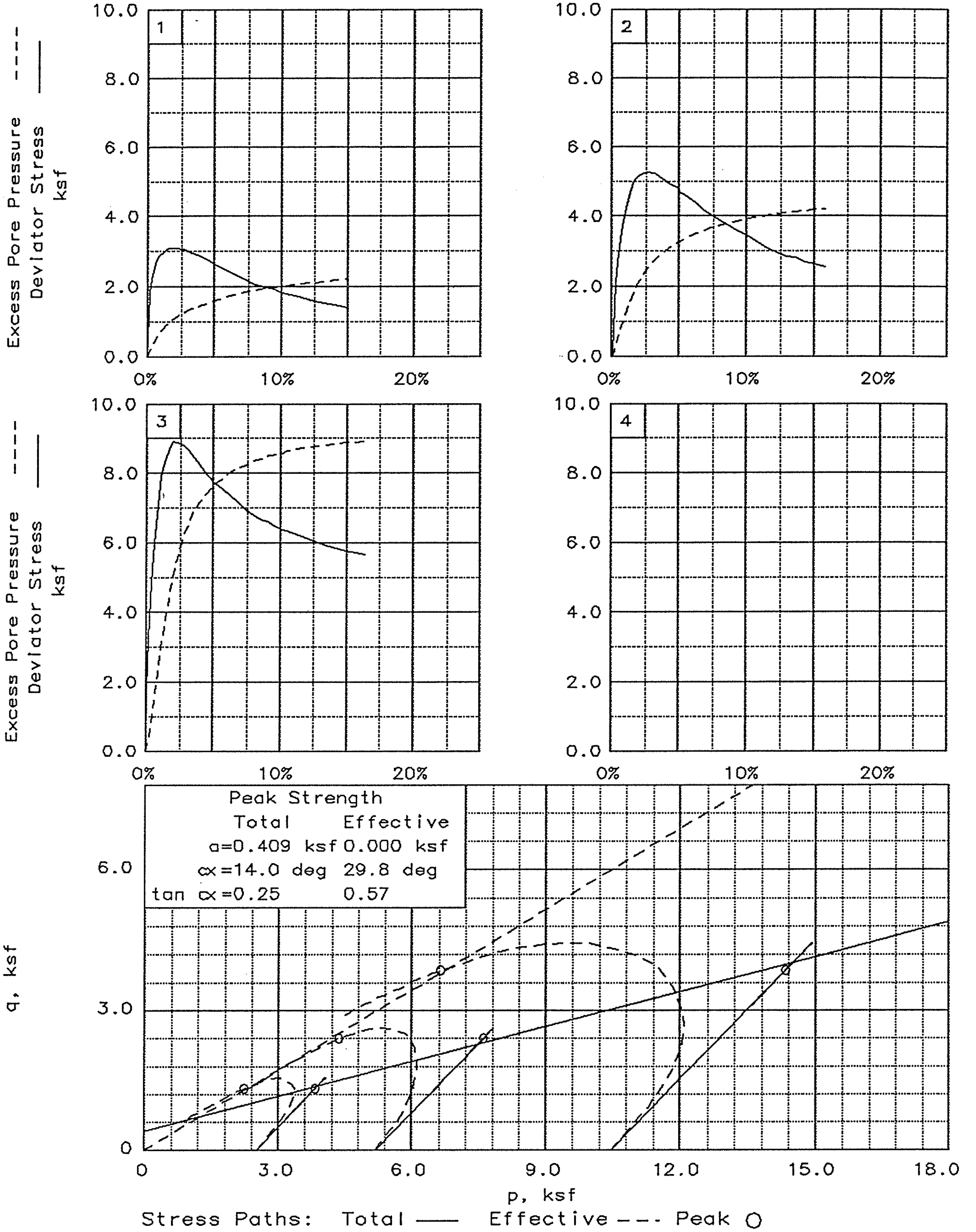
Knight Piésold LLC

SAMPLE TYPE: remolded, slurried

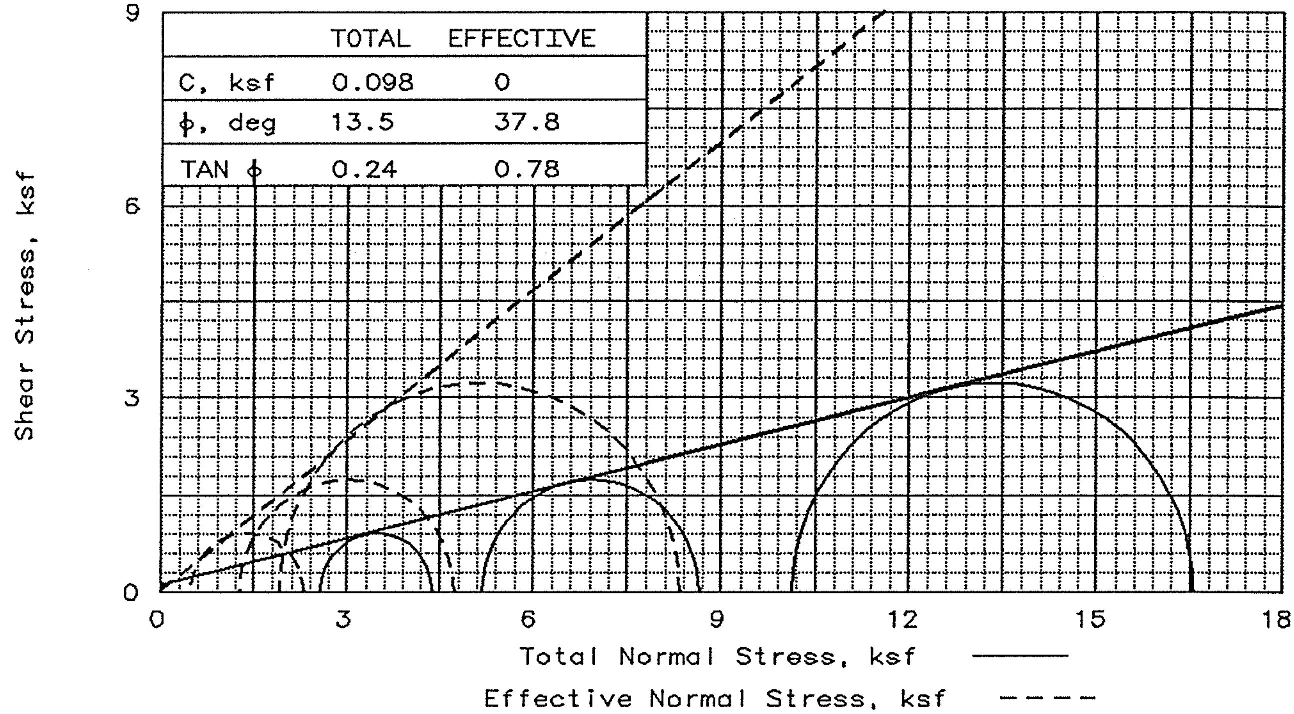
DESCRIPTION: SAND

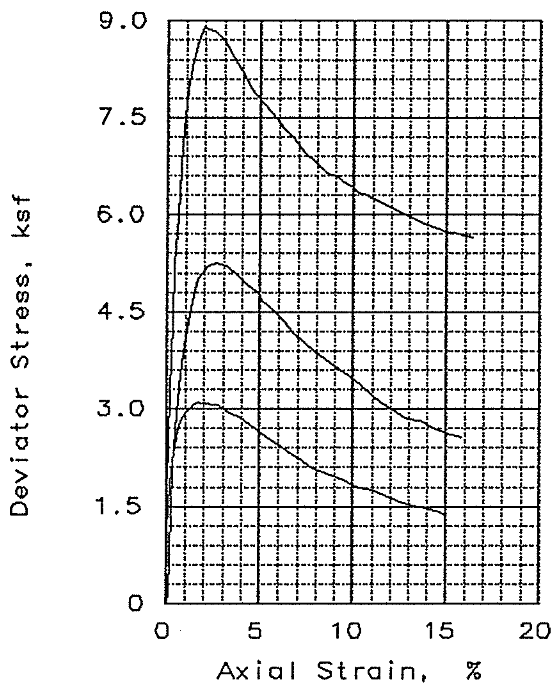
SPECIFIC GRAVITY= 2.812

REMARKS: Failure tangent drawn at approximately 5% strain. No filter strips used.



Client: Mount Polley Mining Corporation
Project: Mount Polley Mine TSF
Location: C-ZCS-3, Cyclone Sand
File: MPCSZ3 Project No.: 1377





	Sample No.	1	2	3
INITIAL	WATER CONTENT, %	17.4	17.4	17.3
	DRY DENSITY, pcf	84.0	83.0	81.4
	SATURATION, %	44.9	43.8	42.1
	VOID RATIO	1.090	1.116	1.157
	DIAMETER, in	1.91	1.89	1.91
	HEIGHT, in	3.92	3.93	3.92
AT TEST	WATER CONTENT, %	36.3	30.8	24.1
	DRY DENSITY, pcf	86.9	94.0	104.7
	SATURATION, %	100.0	100.0	100.0
	VOID RATIO	1.020	0.867	0.677
	DIAMETER, in	1.88	1.79	1.71
	HEIGHT, in	3.88	3.86	3.79
	Strain rate, in/min	0.0040	0.0040	0.0040
	EFF CELL PRESSURE, ksf	2.592	5.213	10.152
	FAIL. STRESS, ksf	1.810	3.454	6.427
	EXCESS PORE PR., ksf	2.088	3.917	8.222
	STRAIN, %	10.1	10.1	10.0
	ULT. STRESS, ksf			
	EXCESS PORE PR., ksf			
	STRAIN, %			
	$\bar{\sigma}_1$ FAILURE, ksf	2.314	4.750	8.357
	$\bar{\sigma}_3$ FAILURE, ksf	0.504	1.296	1.930

TYPE OF TEST:
CU with Pore Pressures

CLIENT: Mount Polley Mining Corporation

PROJECT: Mount Polley Mine TSF

SAMPLE LOCATION: C-ZCS-3, Cyclone Sand

PROJ. NO.: 1377 DATE: 12/21/98

TRIAXIAL SHEAR TEST REPORT

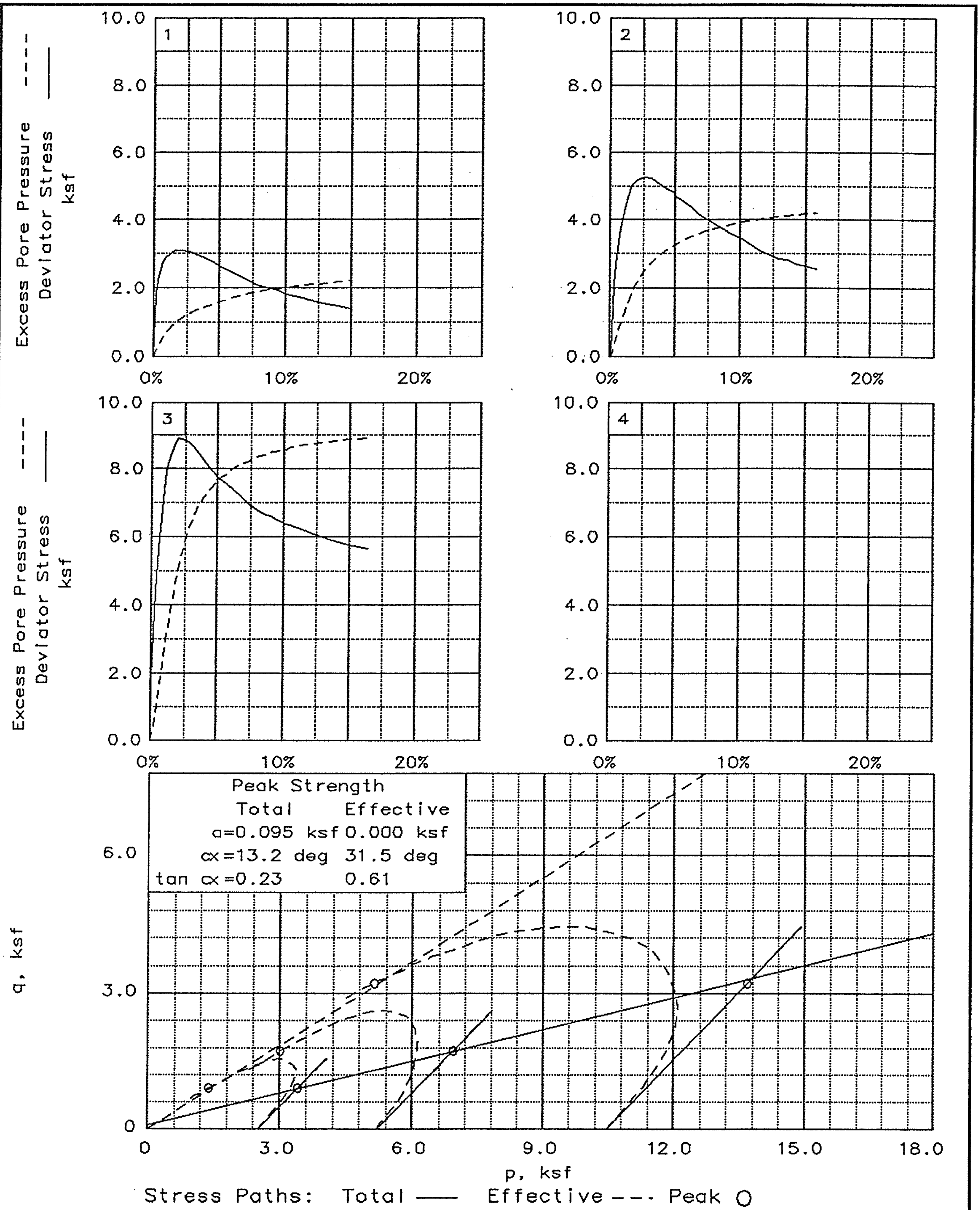
Knight Piésold LLC

SAMPLE TYPE: remolded, slurried

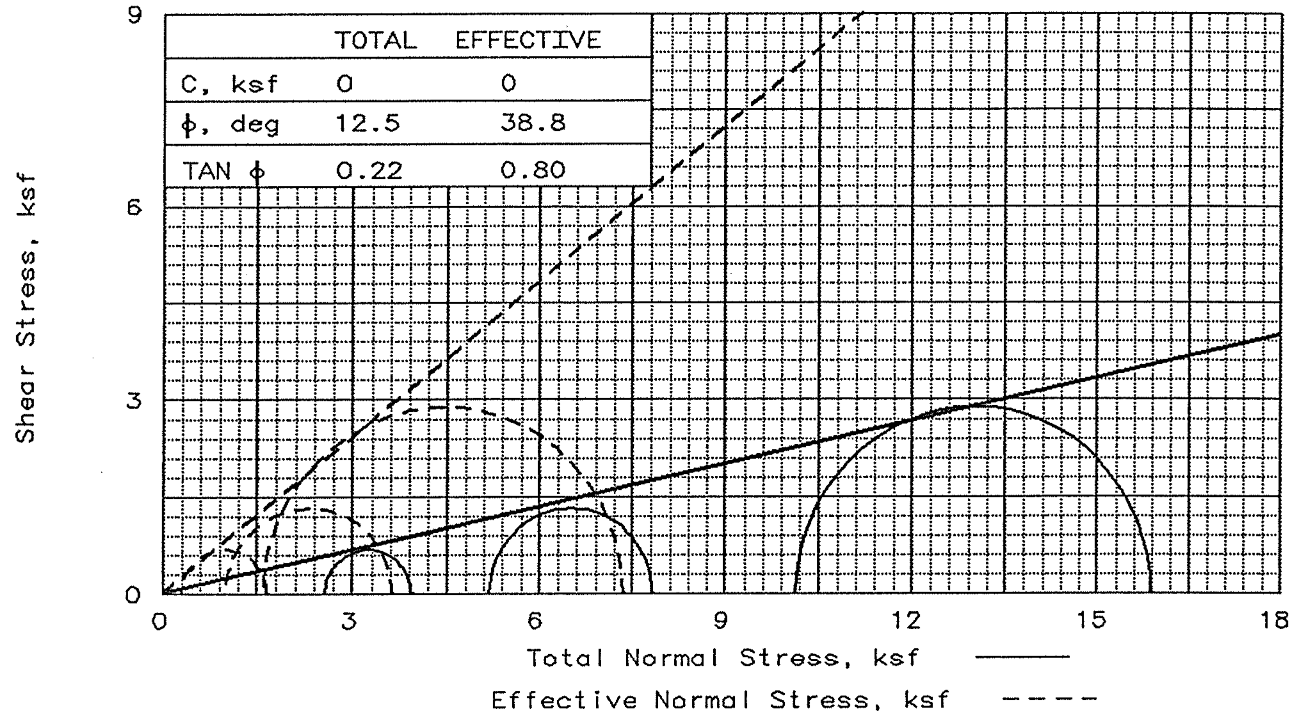
DESCRIPTION: SAND

SPECIFIC GRAVITY= 2.812

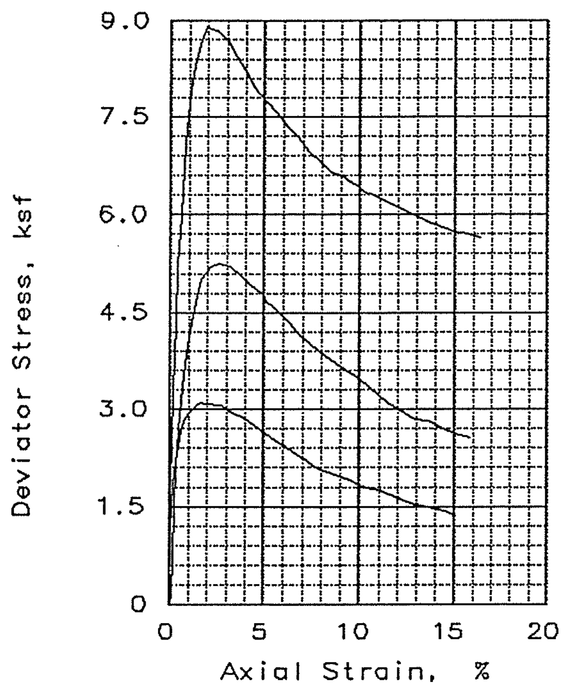
REMARKS: Failure tangent drawn at approximately 10% strain. No filter strips used.



Client: Mount Polley Mining Corporation
Project: Mount Polley Mine TSF
Location: C-ZCS-3, Cyclone Sand
File: MPCSZ3 Project No.: 1377



	TOTAL	EFFECTIVE
C, ksf	0	0
ϕ, deg	12.5	38.8
TAN ϕ	0.22	0.80



Sample No.		1	2	3
INITIAL	WATER CONTENT, %	17.4	17.4	17.3
	DRY DENSITY, pcf	84.0	83.0	81.4
	SATURATION, %	44.9	43.8	42.1
	VOID RATIO	1.090	1.116	1.157
	DIAMETER, in	1.91	1.89	1.91
	HEIGHT, in	3.92	3.93	3.92
AT TEST	WATER CONTENT, %	36.3	30.8	24.1
	DRY DENSITY, pcf	86.9	94.0	104.7
	SATURATION, %	100.0	100.0	100.0
	VOID RATIO	1.020	0.867	0.677
	DIAMETER, in	1.88	1.79	1.71
	HEIGHT, in	3.88	3.86	3.79
Strain rate, in/min		0.0040	0.0040	0.0040
EFF CELL PRESSURE, ksf		2.592	5.213	10.152
FAIL. STRESS, ksf		1.358	2.628	5.752
EXCESS PORE PR., ksf		2.275	4.190	8.539
STRAIN, %		15.1	15.1	15.0
ULT. STRESS, ksf				
EXCESS PORE PR., ksf				
STRAIN, %				
$\bar{\sigma}_1$ FAILURE, ksf		1.675	3.650	7.365
$\bar{\sigma}_3$ FAILURE, ksf		0.317	1.022	1.613

TYPE OF TEST:
CU with Pore Pressures

CLIENT: Mount Polley Mining Corporation

PROJECT: Mount Polley Mine TSF

SAMPLE LOCATION: C-ZCS-3, Cyclone Sand

PROJ. NO.: 1377 DATE: 12/21/98

TRIAXIAL SHEAR TEST REPORT

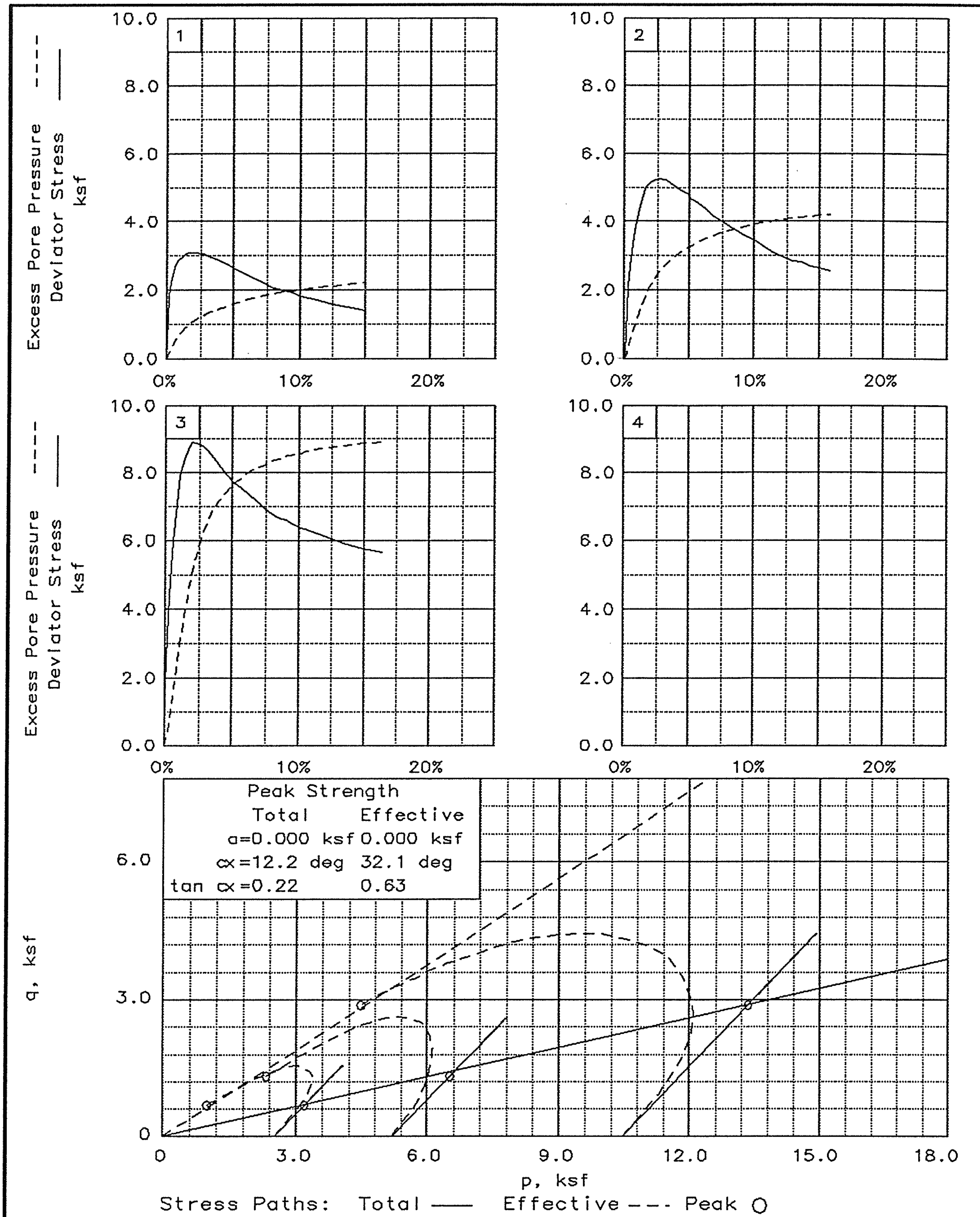
Knight Piésold LLC

SAMPLE TYPE: remolded, slurried

DESCRIPTION: SAND

SPECIFIC GRAVITY= 2.812

REMARKS: Failure tangent drawn at approximately 15% strain. No filter strips used.



Client: Mount Polley Mining Corporation
Project: Mount Polley Mine TSF
Location: C-ZCS-3, Cyclone Sand
File: MPCSZ3 Project No.: 1377

TRIAXIAL COMPRESSION TEST CU with Pore Pressures	12-21-1998 2:46 pm

Project and Sample Data

ate: 12/21/98
lient: Mount Polley Mining Corporation
Project: Mount Polley Mine TSF
ample location: C-ZCS-3, Cyclone Sand
ample description: SAND
Remarks: Failure tangent drawn at approximately 15% strain.
No filter strips used.
ig no.: 2nd page Fig no. (if applicable):
ype of sample: remolded, slurried
Specific gravity= 2.81 LL= PL= NPL PI=
est method: ASTM - Method B

Specimen Parameters for Specimen No. 1

Specimen Parameter	Initial	Saturated	Consolidated	Final
Wt. moist soil and tare:	289.800			463.800
Wt. dry soil and tare:	246.800			379.100
t. of tare:	0.000			145.600
weight, gms:	289.8			
Diameter, in:	1.907	1.933	1.885	
rea, in²:	2.856	2.934	2.791	
eight, in:	3.920	3.920	3.877	
Net decrease in height, in:		0.000	0.043	
et decrease in water volume, cc:			11.200	
Moisture:	17.4	40.8	36.3	36.3
Wet density, pcf:	98.6	115.1	118.4	
Dry density, pcf:	84.0	81.7	86.9	
oid ratio:	1.0905	1.1476	1.0200	
Saturation:	44.9	100.0	100.0	

Test Readings Data for Specimen No. 1

Deformation dial constant= 1 in per input unit
rimary load ring constant= 1 lbs per input unit
econdary load ring constant= 1 lbs per input unit
Crossover reading for secondary load ring= 1 input units
Consolidation cell pressure = 58.00 psi = 8.35 ksf
onsolidation back pressure = 40.00 psi = 5.76 ksf
onsolidation effective confining stress = 2.59 ksf
Strain rate, in/min = 0.0040
AIL. STRESS = 1.36 ksf at reading no. 32
LT. STRESS = not selected

Test Readings Data for Specimen No. 1

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs	Strain %	Deviator Stress ksf	Effective Stresses Minor ksf	Major ksf	1:3 Ratio	Pore Pres. psi	P ksf	Q ksf
0	0.0000	0.000	9.00	0.0	0.0	0.00	2.52	2.52	1.00	40.50	2.52	0.00
1	0.0040	0.004	31.00	22.0	0.1	1.13	2.45	3.58	1.46	41.00	3.02	0.57
2	0.0080	0.008	45.00	36.0	0.2	1.85	2.35	4.20	1.79	41.70	3.27	0.93
3	0.0140	0.014	52.00	43.0	0.4	2.21	2.25	4.46	1.98	42.40	3.35	1.11
4	0.0240	0.024	61.00	52.0	0.6	2.67	2.04	4.71	2.30	43.80	3.38	1.33
5	0.0340	0.034	65.00	56.0	0.9	2.86	1.87	4.74	2.53	45.00	3.30	1.43
6	0.0450	0.045	67.00	58.0	1.2	2.96	1.73	4.69	2.71	46.00	3.21	1.48
7	0.0560	0.056	69.00	60.0	1.4	3.05	1.61	4.66	2.89	46.80	3.14	1.53
8	0.0660	0.066	70.00	61.0	1.7	3.09	1.51	4.61	3.05	47.50	3.06	1.55
9	0.0770	0.077	70.00	61.0	2.0	3.09	1.44	4.53	3.14	48.00	2.98	1.54
10	0.0880	0.088	70.00	61.0	2.3	3.08	1.35	4.43	3.27	48.60	2.89	1.54
11	0.0980	0.098	70.00	61.0	2.5	3.07	1.31	4.38	3.34	48.90	2.84	1.53
12	0.1090	0.109	70.00	61.0	2.8	3.06	1.25	4.31	3.44	49.30	2.78	1.53
13	0.1200	0.120	69.00	60.0	3.1	3.00	1.21	4.21	3.48	49.60	2.71	1.50
14	0.1300	0.130	68.00	59.0	3.4	2.94	1.17	4.11	3.52	49.90	2.64	1.47
15	0.1520	0.152	67.00	58.0	3.9	2.88	1.08	3.96	3.66	50.50	2.52	1.44
16	0.1740	0.174	65.00	56.0	4.5	2.76	1.01	3.77	3.74	51.00	2.39	1.38
17	0.1960	0.196	63.00	54.0	5.1	2.65	0.92	3.57	3.87	51.60	2.24	1.32
18	0.2180	0.218	61.00	52.0	5.6	2.53	0.86	3.40	3.93	52.00	2.13	1.27
19	0.2400	0.240	59.00	50.0	6.2	2.42	0.79	3.21	4.06	52.50	2.00	1.21
20	0.2620	0.262	57.00	48.0	6.8	2.31	0.73	3.04	4.14	52.90	1.89	1.15
21	0.2830	0.283	55.00	46.0	7.3	2.20	0.69	2.89	4.18	53.20	1.79	1.10
22	0.3050	0.305	53.00	44.0	7.9	2.09	0.65	2.74	4.23	53.50	1.69	1.05
23	0.3270	0.327	52.00	43.0	8.4	2.03	0.60	2.64	4.36	53.80	1.62	1.02
24	0.3490	0.349	51.00	42.0	9.0	1.97	0.56	2.53	4.51	54.10	1.55	0.99
25	0.3700	0.370	50.00	41.0	9.5	1.91	0.55	2.46	4.50	54.20	1.50	0.96
26	0.3910	0.391	48.00	39.0	10.1	1.81	0.50	2.31	4.59	54.50	1.41	0.90
27	0.4300	0.430	47.00	38.0	11.1	1.74	0.46	2.20	4.78	54.80	1.33	0.87
28	0.4870	0.487	44.00	35.0	12.6	1.58	0.40	1.98	4.92	55.20	1.19	0.79
29	0.5150	0.515	43.00	34.0	13.3	1.52	0.37	1.90	5.06	55.40	1.14	0.76
30	0.5430	0.543	42.00	33.0	14.0	1.46	0.35	1.81	5.24	55.60	1.08	0.73
31	0.5710	0.571	41.00	32.0	14.7	1.41	0.32	1.72	5.44	55.80	1.02	0.70
32	0.5860	0.586	40.00	31.0	15.1	1.36	0.32	1.67	5.29	55.80	1.00	0.68

Specimen Parameters for Specimen No. 2

Specimen Parameter	Initial	Saturated	Consolidated	Final
Wt. moist soil and tare:	281.000			369.000
Wt. dry soil and tare:	239.400			295.800
Wt. of tare:	0.000			58.400
Weight, gms:	281.0			
Diameter, in:	1.887	1.891	1.788	
Area, in²:	2.797	2.808	2.512	
Height, in:	3.930	3.930	3.862	
Net decrease in height, in:		0.000	0.068	
Net decrease in water volume, cc:			21.900	
% Moisture:	17.4	40.0	30.8	30.8
Wet density, pcf:	97.4	115.7	123.0	
Dry density, pcf:	83.0	82.6	94.0	
Void ratio:	1.1155	1.1243	0.8671	
% Saturation:	43.8	100.0	100.0	

Test Readings Data for Specimen No. 2

Deformation dial constant= 1 in per input unit
Primary load ring constant= 1 lbs per input unit
Secondary load ring constant= 1 lbs per input unit
Crossover reading for secondary load ring= 1 input units
Consolidation cell pressure = 76.20 psi = 10.97 ksf
Consolidation back pressure = 40.00 psi = 5.76 ksf
Consolidation effective confining stress = 5.21 ksf
Strain rate, in/min = 0.0040
FAIL. STRESS = 2.63 ksf at reading no. 33
ULT. STRESS = not selected

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs	Strain %	Deviator Stress ksf	Effective Stresses Minor ksf	Effective Stresses Major ksf	Effective Stresses 1:3 Ratio	Pore Pres. psi	P ksf	Q ksf
0	0.0460	0.000	31.00	0.0	0.0	0.00	5.21	5.21	1.00	40.00	5.21	0.00
1	0.0510	0.005	33.00	2.0	0.1	0.11	5.18	5.30	1.02	40.20	5.24	0.06
2	0.0560	0.010	56.00	25.0	0.3	1.43	5.05	6.48	1.28	41.10	5.77	0.71
3	0.0610	0.015	68.00	37.0	0.4	2.11	4.88	6.99	1.43	42.30	5.94	1.06
4	0.0660	0.020	78.00	47.0	0.5	2.68	4.69	7.38	1.57	43.60	6.03	1.34
5	0.0710	0.025	86.00	55.0	0.6	3.13	4.52	7.65	1.69	44.80	6.09	1.57
6	0.0760	0.030	93.00	62.0	0.8	3.53	4.36	7.89	1.81	45.90	6.13	1.76
7	0.0810	0.035	99.00	68.0	0.9	3.86	4.19	8.05	1.92	47.10	6.12	1.93
8	0.0920	0.046	108.00	77.0	1.2	4.36	3.89	8.25	2.12	49.20	6.07	2.18
9	0.1020	0.056	115.00	84.0	1.5	4.75	3.61	8.36	2.31	51.10	5.99	2.37
10	0.1120	0.066	120.00	89.0	1.7	5.02	3.36	8.37	2.49	52.90	5.86	2.51
11	0.1230	0.077	122.00	91.0	2.0	5.11	3.12	8.24	2.64	54.50	5.68	2.56
12	0.1340	0.088	124.00	93.0	2.3	5.21	2.95	8.16	2.77	55.70	5.56	2.61
13	0.1490	0.103	125.00	94.0	2.7	5.25	2.72	7.97	2.93	57.30	5.34	2.62
14	0.1700	0.124	125.00	94.0	3.2	5.22	2.48	7.69	3.11	59.00	5.08	2.61
15	0.1920	0.146	123.00	92.0	3.8	5.08	2.28	7.35	3.23	60.40	4.81	2.54
16	0.2120	0.166	121.00	90.0	4.3	4.94	2.12	7.06	3.33	61.50	4.59	2.47
17	0.2350	0.189	119.00	88.0	4.9	4.80	1.97	6.77	3.43	62.50	4.37	2.40
18	0.2450	0.199	117.00	86.0	5.2	4.68	1.93	6.61	3.42	62.80	4.27	2.34
19	0.2560	0.210	116.00	85.0	5.4	4.61	1.87	6.48	3.46	63.20	4.18	2.30
20	0.2670	0.221	115.00	84.0	5.7	4.54	1.81	6.35	3.50	63.60	4.08	2.27
21	0.2890	0.243	112.00	81.0	6.3	4.35	1.71	6.07	3.54	64.30	3.89	2.18
22	0.3100	0.264	109.00	78.0	6.8	4.17	1.64	5.81	3.54	64.80	3.72	2.08

Test Readings Data for Specimen No. 2

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs	Strain %	Deviator Stress ksf	Effective Stresses Minor ksf	Effective Stresses Major ksf	1:3 Ratio	Pore Pres. psi	P ksf	Q ksf
23	0.3320	0.286	107.00	76.0	7.4	4.03	1.56	5.59	3.59	65.40	3.57	2.02
24	0.3530	0.307	105.00	74.0	7.9	3.91	1.50	5.40	3.61	65.80	3.45	1.95
25	0.3750	0.329	103.00	72.0	8.5	3.78	1.43	5.20	3.65	66.30	3.31	1.89
26	0.3850	0.339	102.00	71.0	8.8	3.71	1.41	5.12	3.63	66.40	3.27	1.86
27	0.3960	0.350	101.00	70.0	9.1	3.65	1.38	5.03	3.64	66.60	3.21	1.82
28	0.4350	0.389	98.00	67.0	10.1	3.45	1.30	4.75	3.67	67.20	3.02	1.73
29	0.4910	0.445	92.00	61.0	11.5	3.09	1.20	4.29	3.59	67.90	2.74	1.55
30	0.5470	0.501	88.00	57.0	13.0	2.84	1.12	3.97	3.53	68.40	2.55	1.42
31	0.5750	0.529	88.00	57.0	13.7	2.82	1.09	3.91	3.58	68.60	2.50	1.41
32	0.6020	0.556	86.00	55.0	14.4	2.70	1.07	3.76	3.53	68.80	2.42	1.35
33	0.6300	0.584	85.00	54.0	15.1	2.63	1.02	3.65	3.57	69.10	2.34	1.31
34	0.6580	0.612	84.00	53.0	15.8	2.56	1.01	3.57	3.54	69.20	2.29	1.28

Specimen Parameters for Specimen No. 3

Specimen Parameter	Initial	Saturated	Consolidated	Final
Wt. moist soil and tare:	281.200			425.300
Wt. dry soil and tare:	239.700			367.300
Wt. of tare:	0.000			126.300
Weight, gms:	281.2			
Diameter, in:	1.909	1.913	1.711	
Area, in²:	2.862	2.874	2.299	
Height, in:	3.920	3.920	3.794	
Net decrease in height, in:		0.000	0.126	
Net decrease in water volume, cc:			41.700	
% Moisture:	17.3	41.5	24.1	24.1
Wet density, pcf:	95.5	114.7	129.9	
Dry density, pcf:	81.4	81.0	104.7	
Void ratio:	1.1569	1.1659	0.6767	
% Saturation:	42.1	100.0	100.0	

Test Readings Data for Specimen No. 3

Deformation dial constant= 1 in per input unit
Primary load ring constant= 1 lbs per input unit
Secondary load ring constant= 1 lbs per input unit
Crossover reading for secondary load ring= 1 input units
Consolidation cell pressure = 110.50 psi = 15.91 ksf
Consolidation back pressure = 40.00 psi = 5.76 ksf
Consolidation effective confining stress = 10.15 ksf
Strain rate, in/min = 0.0040
FAIL. STRESS = 5.75 ksf at reading no. 32
ULT. STRESS = not selected

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs	Strain %	Deviator Stress ksf	Effective Stresses Minor ksf	Major ksf	1:3 Ratio	Pore Pres. psi	P ksf	Q ksf
0	0.0000	0.000	29.00	0.0	0.0	0.00	10.48	10.48	1.00	37.70	10.48	0.00
1	0.0030	0.003	58.00	29.0	0.1	1.82	10.38	12.20	1.17	38.40	11.29	0.91
2	0.0070	0.007	81.00	52.0	0.2	3.25	10.17	13.42	1.32	39.90	11.79	1.63
3	0.0130	0.013	99.00	70.0	0.3	4.37	9.85	14.22	1.44	42.10	12.03	2.18
4	0.0170	0.017	113.00	84.0	0.4	5.24	9.49	14.73	1.55	44.60	12.11	2.62
5	0.0230	0.023	125.00	96.0	0.6	5.98	9.07	15.05	1.66	47.50	12.06	2.99
6	0.0330	0.033	143.00	114.0	0.9	7.08	8.29	15.37	1.85	52.90	11.83	3.54
7	0.0430	0.043	157.00	128.0	1.1	7.93	7.52	15.44	2.05	58.30	11.48	3.96
8	0.0540	0.054	165.00	136.0	1.4	8.40	6.78	15.18	2.24	63.40	10.98	4.20
9	0.0650	0.065	170.00	141.0	1.7	8.68	6.12	14.80	2.42	68.00	10.46	4.34
10	0.0760	0.076	174.00	145.0	2.0	8.90	5.52	14.42	2.61	72.20	9.97	4.45
11	0.0860	0.086	174.00	145.0	2.3	8.88	5.03	13.90	2.77	75.60	9.46	4.44
12	0.0970	0.097	174.00	145.0	2.6	8.85	4.61	13.46	2.92	78.50	9.03	4.43
13	0.1080	0.108	173.00	144.0	2.8	8.76	4.28	13.04	3.05	80.80	8.66	4.38
14	0.1190	0.119	172.00	143.0	3.1	8.68	4.00	12.68	3.17	82.70	8.34	4.34
15	0.1290	0.129	170.00	141.0	3.4	8.53	3.70	12.23	3.31	84.80	7.97	4.27
16	0.1510	0.151	166.00	137.0	4.0	8.24	3.33	11.57	3.48	87.40	7.45	4.12
17	0.1720	0.172	162.00	133.0	4.5	7.95	3.07	11.02	3.59	89.20	7.04	3.98
18	0.1940	0.194	159.00	130.0	5.1	7.73	2.79	10.52	3.77	91.10	6.66	3.86
19	0.2160	0.216	157.00	128.0	5.7	7.56	2.64	10.20	3.87	92.20	6.42	3.78
20	0.2380	0.238	154.00	125.0	6.3	7.34	2.46	9.80	3.98	93.40	6.13	3.67
21	0.2590	0.259	152.00	123.0	6.8	7.18	2.35	9.53	4.06	94.20	5.94	3.59
22	0.2810	0.281	149.00	120.0	7.4	6.96	2.28	9.24	4.06	94.70	5.76	3.48

Test Readings Data for Specimen No. 3

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs	Strain %	Deviator Stress ksf	Effective Stresses Minor ksf	Effective Stresses Major ksf	Effective Stresses 1:3 Ratio	Pore Pres. psi	P ksf	Q ksf
23	0.3030	0.303	147.00	118.0	8.0	6.80	2.15	8.95	4.17	95.60	5.55	3.40
24	0.3250	0.325	145.00	116.0	8.6	6.64	2.09	8.73	4.18	96.00	5.41	3.32
25	0.3460	0.346	145.00	116.0	9.1	6.60	1.99	8.59	4.32	96.70	5.29	3.30
26	0.3570	0.357	144.00	115.0	9.4	6.53	1.97	8.50	4.31	96.80	5.24	3.26
27	0.3790	0.379	143.00	114.0	10.0	6.43	1.93	8.36	4.33	97.10	5.14	3.21
28	0.3890	0.389	142.00	113.0	10.3	6.35	1.93	8.28	4.29	97.10	5.11	3.18
29	0.4000	0.400	142.00	113.0	10.5	6.33	1.84	8.18	4.44	97.70	5.01	3.17
30	0.4560	0.456	140.00	111.0	12.0	6.12	1.74	7.86	4.51	98.40	4.80	3.06
31	0.5120	0.512	138.00	109.0	13.5	5.91	1.67	7.58	4.54	98.90	4.62	2.95
32	0.5680	0.568	137.00	108.0	15.0	5.75	1.61	7.36	4.57	99.30	4.49	2.88
33	0.5960	0.596	137.00	108.0	15.7	5.70	1.60	7.30	4.57	99.40	4.45	2.85
34	0.6240	0.624	137.00	108.0	16.4	5.65	1.56	7.21	4.63	99.70	4.38	2.83

Knight Piésold Ltd.
CONSULTING ENGINEERS

APPENDIX B

PHOTOGRAPHS

December 16, 1998 - View of the tailings beach looking upstream from the Main Embankment. Bulk tailings are being discharged from the Movable Discharge Section.

September 26,1998 - View of the tailings beach looking west along the Main Embankment. Beach developed from discharged of bulk tailings from the Movable Discharge Section.

September 26, 1998 - Cycloned sand from trial program. Pile is fully drained, with slope 4H:1V. Sand produced from 50 inch cyclone. Sand dry density is 1650 kg/m^3 at 8% moisture.