Klohn Crippen Berger

Teck Resources Ltd.

Quintette Coal Operations

Plantsite Tailings Dam

2014 Dam Safety Inspection

Revision 1

November 2014
M09684A10.730

November 26, 2014

Teck Resources Ltd.
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Tumbler Ridge, British Columbia
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Mr. Kevin Sharman, P.Geo
Senior Geologist Supervisor

Dear Mr. Sharman:

Quintette Coal Operations
Plantsite Tailings Dam - 2014 Dam Safety Inspection
Revision 1

We are pleased to submit an electronic copy of the 2014 Dam Safety Inspection Report for the Plantsite Tailings Dam.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

Rick Friedel P.Eng, P.E.
Project Manager

RF: cd

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EXECUTIVE SUMMARY

Klohn Crippen Berger Ltd. (KCB) were engaged by Teck Coal Ltd. (Teck) to complete a dam safety inspection for the Plantsite Tailings Dam (PTD) at the Quintette Coal Operations (QCO) site to comply with Section 10.5.3 of the Health, Safety and Reclamation Code for Mines in British Columbia (the Code) and the requirements specified in the Ministry of Energy and Mines (MEM) "Guidelines for Annual Dam Safety Inspection Reports". The inspection was completed by Mr. Rick Friedel (P.Eng.) on July 23, 2014.

The PTD is considered a Major Dam and Major Impoundment under the Code. The PTD has a "High" consequence classification based on CDA (2007) as reported in the most recent dam safety review (DSR) which was completed in 2013 (KCB, 2014). The next DSR is due in 2020, every 7 years based on CDA (2007). There have been no changes to the downstream environment or operation of the structure that would require a revision to this classification.

The PTD is horseshoe shaped, approximately 2.4 km long with a maximum downstream slope height (crest to toe) of 52 m. The impoundment served to store the fine coal tailings slurry produced from the QCO wash plant between 1984 and early 1997 (Golder, 2003). The impoundment has been inactive since 1997 and a closure spillway was constructed between 2001 and 2002. Since 2002, there has been no construction activity (raises, upgrades, or repairs) on the dam.

The catchment for the PTD impoundment is 134.1 ha including the tailings beach and pond area (97.7 ha). During operations, tailings were discharged from the northeastern edge of the impoundment which formed a tailings beach slope towards the horse-shoe shaped outer embankment. Based on Quintette (2002), most of the water ponded in the southern portions of the impoundment at the end of operations where the closure spillway has since been constructed. The embankments comprise compacted coarse coal rejects with a low permeability, compacted till blanket on the upstream slope to limit seepage. The upstream and downstream zones are separated by a chimney drain.

The closure spillway was designed to accommodate the 1000-year 24-hour flood event, peak flow 9.7 m^3/s (Golder, 2001). Vegetation is now established along the channel. CDA (2007) specifies the Inflow Design Flood (IDF) for a "High" consequence classification structure as 1/3rd between the 1000 year return period and probable maximum flood (PMF) events. KCB completed a simplified hydraulic review as part of this DSI and found that the spillway is suitable for the IDF but recommend a separate design assessment be completed to confirm this.

Teck does not have an operations, maintenance or surveillance (OMS) manual or an emergency preparedness plan (EPP) for the PTD. These documents are under development by Teck and are scheduled to be available in December 2014.

New surface monuments were established on the dam crest during 2014 for long term monitoring for crest movements. Pore pressures from pneumatic piezometers installed in the dam embankment and foundation were measured in July 2014 and October 2014. Approximately half of the piezometers were located and functional. The functional piezometers are sufficient for ongoing monitoring of the

structure under closure conditions. In general, piezometer readings were similar to or lower than historical readings except for the July, 2014 readings at Sta. 0+300 and Sta. 0+475 which were significantly greater. A second set of pressure measurements were collected in October and the high readings reduced back to values similar to historic readings. The high pressure readings in July 2014 may have been due to the effect of ponding in localized tailings surface depressions upstream of these instrumentation lines or some other seasonal effect not detected in the historical readings that were typically taken in the early and late months of the year.

Downstream slope rill erosion monitoring points were established which should be photographed annually and compared to previous images to monitor change. If rill erosion increases significantly or progresses through the crest towards the impoundment then a remediation plan should be prepared, but is not required at this time.

The PTD appears in good condition with respect to stability and water management. Comparison with available annual inspection reports and 2014 piezometer readings indicate there has been no significant change to the condition of the structure over the past 10 years. Recommendations regarding deficiencies, non-conformances and future work are summarized in Table 1.

Table 1 Summary of Recommendations for Deficiencies and Non-conformances

Number (Year Raised – Priority[(1)])	Deficiency/ Non-conformance	Regulation or OMS Reference	Recommended Action	Recommended Deadline (Status)
DSI-PS-01 (2013 – Priority 2)	No OMS manual and EPP.	HSRC Code	Prepare an OMS manual and EPP for the facility based on the MAC (2011) guidelines.	December, 2014 (Teck advise this is underway)
DSI-PS-02 (2012)	*Incomplete monitoring records.*	*HSRC Code*	*Confirm whether the found instrument cables are functional and if possible what instruments they are.*	*CLOSED.*
DSI-PS-03 (2012 – Priority 3)	Monitoring requirements.	HSRC Code (DSI reporting requirement)	Define monitoring and instrument reading frequency for PTD and include in OMS. Establish survey monuments along crest. Consult EoR with monitoring requirements.	December, 2014 (survey monuments installed, document in the OMS manual)
DSI-PS-04 (2013)	*No flow or water quality measurements.*	*HSRC Code (DSI reporting requirement)*	*Monthly monitoring of flow rate and collect samples for water quality (total suspended solids) of the outflow.*	*CLOSED. Recommendation now superseded by amended MOE permit.*
DSI-PS-05 (2012 – Priority 3)	Downstream slope erosion	n/a	Establish rill monitoring into OMS (DSI-PS-01): photographs of downstream slope from recommended rill monitoring points; and walk crest to confirm rills are not extending through crest.	December, 2014. (proposed rill monitoring should be included in the OMS manual).
DSI-PS-06 (New – Priority 3)	Survey monument monitoring	n/a	Complete minimum 3 survey readings in 2015 after appropriate survey method has been established with appropriate accuracy for this purpose.	(1) before May 30, 2015 (2) 1 month after first 2015 survey. (3) between August and October, 2015
DSI-PS-07 (New – Priority 3)	Monitoring requirements	n/a	Add ID tags to piezometer tips to allow for reliable comparison of future readings.	Prior to July, 2015
DSI-PS-08 (New – Priority 3)	Monitoring requirements	n/a	Establish piezometer threshold values that trigger action or design review. Include these in the OMS document (DS-PS-01).	December, 2015
DSI-PS-09 (New – Priority 3)	Piezometer monitoring data	n/a	Complete minimum 3 piezometer readings in 2015 at Sta. 0+300 and Sta. 0+475 instrumentation lines.	(1) before May 30, 2015 (2) between July and August, 2015 (3) between September and November, 2015.
DSI-PS-10 (New – Priority 3)	Closure spillway IDF	CDA (2007)	KCB recommend Teck complete a design assessment with summary report to confirm the closure spillway is suitable for the IDF.	December, 2015

Notes:

1. Recommendation priority guidelines, specified by Teck and assigned by KCB:
   - *Priority 1*: A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant risk of regulatory enforcement.
   - *Priority 2*: If not corrected could likely result in dam safety issues leading to injury, environmental impact or significant regulatory enforcement; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
   - *Priority 3*: Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
   - *Priority 4*: Best Management Practice – Further improvements are necessary to meet industry best practices or reduce potential risks.

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1 INTRODUCTION

Klohn Crippen Berger Ltd. (KCB) was engaged by Teck Coal Ltd. (Teck) to complete the 2014 dam safety inspection (DSI) of the dam structures on the Quintette Coal mine site. The Quintette mine has not been in operation since 2000. Portions of the site have been reclaimed, but otherwise the site has been on care and maintenance since operations stopped.

This report presents the DSI for the Plantsite Tailings Dam (PTD). The inspection was completed by Mr. Rick Friedel (P.Eng.) on July 22, 2014 between 8:30 am and 2:30 pm. During the inspection the weather was cloudy with periods of light precipitation. Refer to Figure 1 for an overview of the structure with satellite imagery and GPS waypoints from the DSI.

The inspection and this report was prepared to comply with Section 10.5.3 Health, Safety and Reclamation Code for Mines in British Columbia (the Code) and the requirements specified in the "Guidelines for Annual Dam Safety Inspection Reports" (Appendix IV).

In 2013 and 2014, Teck received new permits for a restart of mining operations at the QCO site:

- Ministry of Energy and Mines (MEM), Permit No. C-156 (amended June 20, 2013); and
- Ministry of Environment (MOE), Permit No. 6739 (amended July 9, 2014).

The PTD would not be recommissioned as part of the proposed restart of the QCO site. However, the 2014 MOE permit amendment includes provisions for water quality monitoring of the PTD that apply to care and maintenance as well as restart operations. As of late 2014, Teck has deferred the restart of operations at the Quintette site pending an improvement in market conditions.

The PTD is considered a Major Dam and Major Impoundment under the Code. The PTD was classified as a "High" consequence classification structure (CDA, 2007) based on the most recent dam safety review (DSR) which was completed in 2013 (KCB, 2014). The next DSR is due in 2020, every 7 years based on CDA (2007). Teck is in the process of preparing a dam break inundation study for the PTD (planned completion December, 2014).

Inspection observations are summarized in the following sections and photographs in Appendix I.

2 BACKGROUND AND RECENT ACTIVITY

The PTD is located approximately 2 km north of the Quintette plantsite and gatehouse. The foundation subsoil profiles at the site consist of silty glacial till soils and bedrock. The impoundment stored the fine coal tailings slurry from 1984 to early 1997 (Golder, 2003). The impoundment has been inactive since 1997 and the closure spillway was constructed between 2001 and 2002. Since 2002, there has been no construction activity (raises, upgrades, or repairs) on the dam.

The tailings dam is horseshoe shaped, approximately 2.4 km long and is a compacted, zoned earthfill structure constructed by the downstream method. The dam comprises an upstream till blanket supported by compacted coarse coal rejects (CCR), with a granular chimney blanket drain immediately downstream of the till zone. A system of finger drains were constructed that discharge at the downstream toe of the dam. The maximum downstream slope height of the structure is 52 m.

The following reports were available as reference material prior to and following the inspection:

- Klohn Crippen (2005). North Tailings Pond Spillway – Review of As-built Channel, January 14.
- Klohn Crippen Berger (2012c). Quintette Coal Project: 2012 Dam Inspections: Plantsite Tailings Dam, M11 Diversion Dam, Shikano North Tailings Dam, December 19.
- Klohn Crippen Berger (2013). Plantsite Tailings Dam - 2013 Dam Safety Inspection Report, December 12.
- Klohn Crippen (2014). Quintette Dam Safety Review: Plantsite Tailings Storage Facility, May 27.
- Golder (2001). Permanent Spillway for Closure of the North Tailings Pond, March, 7.
- Golder (2003). Stability Assessment for North Tailings Pond, March.
- Quintette (1996). Operation and Upkeep of the Tailings Impoundment - August 1994 to July 1995.
- Quintette (1997). Operation and Upkeep of the Tailings Impoundment - August 1995 to July 1996.
- Quintette (2002). Operation and Upkeep of Plantsite Tailings Impoundment - August 1999 to October 2001.
- Quintette (2006). Plantsite North Tailings Impoundment – 2005 Annual Dam Safety Inspection.

The PTD design was completed by Golder (the original design report was not available for review) and Teck confirm they are the “Engineer of Record”. The impoundment was commissioned in 1984. Based on a review of available inspection reports and Golder (2003), no major construction or performance related issues were reported. A typical design cross section of the Plantsite tailings dam is included in Appendix III.

3 WATER MANAGEMENT

The catchment for the PTD impoundment is 134.1 ha including the tailings beach and pond area (97.7 ha). The dam includes a low permeability, compacted till blanket along the upstream slope to limit seepage losses. During operations, tailings were discharged from the northeastern edge of the impoundment which formed a tailings beach slope towards the horseshoe shaped outer embankment. Ponded water was pumped back to the mill for re-use by a reclaim barge. At the time of the July, 2014 inspection, water was ponded in local depressions (Photo I-9) in the tailings surface near the closure spillway inlet. These ponds are upstream of the dam and can be seen on the aerial image (Figure 1). Ponded water is eventually lost as evaporation or seepage.

Based on Quintette (2002), most of the water ponded in the southern area of the impoundment at the end of operations; as a result the majority of the tailings beach slopes towards the south abutment. The closure spillway was constructed in this area. The closure spillway channel is approximately 650 m long with a base width ranging from 17 m to 25 m (KC, 2005) with a meandering low flow channel 2 m to 5 m wide. The closure spillway channel slopes (typical slope 0.5% to 0.8%) down from the tailings surface to original ground and flows between the abutment and dam fill into M17 Creek. The vertical distance between the invert of the closure spillway and the dam crest is smallest at the inlet but is still greater than 4 m.

With the closure spillway in place, the PTD impoundment is no longer capable of storing a large pond, similar to what was present during operations which reduces the likelihood of failure.

The closure spillway was designed for the 1000-year 24-hour flood event, peak flow 9.7 m^3/s (Golder, 2001). During a review of the as-built channel (KC, 2005), a temporary risk of channel erosion during the design event was identified until vegetation had been established. Vegetation is now fully established. CDA (2007) specifies the Inflow Design Flood (IDF) for a “High” consequence classification structure as $1/3^{rd}$ between the 1000 year return period and probable maximum flood (PMF) events. The original closure spillway design and analysis is not available. Although not part of the standard DSI scope, KCB completed a simplified hydraulic review to assess spillway performance under the IDF, refer to Table 3.1. The analysis was completed based on hydrologic parameters adopted from the recent hydraulic designs completed for the proposed Quintette restart operations (KCB, 2013) and the software package HEC-HMS. The calculated IDF peak flow of 9.9 m^3/s is only slightly higher than the design peak flow in the original design, 9.7 m^3/s (Golder, 2001) which was for the smaller 1000-year flood event. The closure spillway design report (Golder, 2001) is not available to review the basis for the design peak flow and why it is so similar to the calculated IDF.

Table 3.1 Simplified Hydraulic Assessment of Closure Spillway for IDF

Flow Condition	Spillway Flow (m^3/s)	Flow Depth (m)	Velocity (m/s)
Peak	9.9	0.37 to 0.46	1.1 to 1.3
Average	3.4	0.20 to 0.24	0.8 to 0.9

Notes:
1. 1000 year 24 hour return period event = 119 mm; and Probable maximum 24 hour precipitation = 440 mm.

The flow capacity of the closure spillway is high because of the channel width (17 m to 25 m) and depth (greater than 4 m). Erosion protection is provided primarily by vegetation, except for the outer bend of the sharp bend in the channel alignment where riprap has been placed (Photo I-3). The estimated velocities through the channel, peak and average, are within the permissible velocities for grassed channels (USACE, 1994). Based on this review, the closure spillway is suitable for the IDF for a "High" consequence classification structure. KCB recommend Teck complete a design assessment with summary report to confirm the closure spillway is suitable for the larger IDF and confirm that no upgrade works are required.

Precipitation data from October, 2013 to September, 2014 (367.7 mm) for the PTD is summarized in Table 3.2. Data from May, 2014 to September, 2014 was measured by a Teck maintained climate station along the mine haul road (km 10). However, the rain gauge at the climate station is not heated so winter precipitation results are not reliable. Therefore, data from October, 2013 to April, 2014 was downloaded for the Environment Canada Chetwynd Airport climate station (ID: 1181508). The data was corrected for orographic effects using the elevation-rainfall relationship developed as part of the hydrology work done for the restart permit application (KCB, 2012b). The annual, monthly and maximum daily precipitation records from the Chetwynd Airport climate station (14 years) showed no consistent year on year changes.

Table 3.2 Summary of 2014 Quintette Site Precipitation

Month	Precipitation (mm)
October, 2013	27.2
November, 2013	46.9
December, 2013	57.1
January, 2014	12.2
February, 2014	22.8
March, 2014	16.8
April, 2014	35.0
May, 2014	5.3
June, 2014	42.6
July, 2014	34.3
August, 2014	18.7
September, 2014	48.8

Notes:
1. October, 2013 to April, 2014 was interpreted from Chetwynd Airport climate station (ID: 1181508), with elevation correction from KCB (2012b).

Inflows to the impoundment are from precipitation runoff. Outflows from the impoundment are predominately through the closure spillway with minor seepage and evaporation losses. Golder (2003) estimated a seepage rate of 1.1 l/s through the underdrains. A simplified water balance calculation for the PTD impoundment for the period of October, 2013 to September, 2014 is summarized below:

- Inflows:
  - Precipitation on ponded surface = 5,389 m^3 (assumed ponded surfaces on average is 1.5% of tailings beach);

- Runoff from tailings beach (excl. pond area) = 141,542 m^3 (assumed average runoff coefficient of 0.4); and
- Runoff from upstream catchment = 53,537 m^3 (assumed average runoff coefficient of 0.4).

- Outflows:
  - Evaporation from pond surface = 8,060 m^3 (evaporation rate for this site 550 mm/yr (KCB,2013a);
  - Seepage losses from the impoundment = 34,690 m^3 (estimate as 1.1 l/s based on measured flows reported in Golder (2003)); and
  - Flow through closure spillway = 157,718 m^3 (the remainder of inflows minus evaporation and seepage losses).

Based on the simplified water balance, the average flow rate through the closure spillway between October 2013 and September 2014 was 5.0 l/s. The flow through the closure spillway during the time of the inspection couldn't be reliably estimated due to the riprap placed at the outlet (Photo I-5) and the vegetation in the channel. Construction of a flow station at the closure spillway outlet is not required to assess dam safety.

The water balance is within the expected performance range with the closure spillway in operation and there are no planned changes to surface water management that would alter this observation.

4 REVIEW OF MONITORING RECORDS

4.1 Monitoring Plan

Teck is in the process of developing an Operations, Maintenance and Surveillance (OMS) manual for the PTD (planned completion December, 2014); it was not available for review as part of this DSI. Golder reviewed ongoing monitoring requirements for the dam (Appendix C from Quintette, 2006). Recommended monitoring for the structure included annual reviews of closure spillway erosion and rilling of the downstream slope. No ongoing instrumentation reviews were recommended. The OMS document must meet the requirements specified in CDA (2007) and KCB recommends following the format proposed in MAC (2011).

4.2 Inspections

DSIs are the only documented inspections of the PTD which have been completed 4 of the last 5 years (no 2011 DSI was completed). Given the long performance history of the PTD, no permanent pond and closure spillway through the south abutment, annual DSIs are appropriate for ongoing formal inspections. The OMS should include surveillance and “event-driven” inspections following flood and seismic events.

4.3 Downstream Slope Erosion

Based on comparison of available photographs and DSI reports, rill erosion of the downstream slope observed during previous DSIs and the 2013 DSR (KCB, 2014) has undergone modest, if any, change since 2011. The 2013 DSR recommended repairs be undertaken to prevent rill erosion from extending through the crest into the impoundment. However, no maintenance activities have been completed on the slope for more than 10 years and no rills are observed to be eroding toward the impoundment. Therefore no maintenance activities are not currently required but KCB recommend annual visual inspections of the rills as an appropriate level of monitoring.

KCB propose 11 locations (Table 4.1) for annual photographs of the downstream slope that will allow for consistent comparisons to identify changing conditions. Photographs from these locations taken during the 2014 DSI as well as previous DSI at approximately the same location are shown in Appendix II. No significant year-over-year changes are evident. Annual inspection of the crest to confirm no rills are eroding towards the impoundment should also be undertaken.

Table 4.1 Rill Monitoring Point Locations

Rill Monitoring Point	Northing (m)	Easting (m)
PS-Rill-01	6097603.6	628135.4
PS-Rill-02	6097599.6	628128.6
PS-Rill-03	6097654.1	628064.7
PS-Rill-04	6097706.1	628024.0
PS-Rill-05	6097955.8	627976.7
PS-Rill-06	6098278.2	628044.4
PS-Rill-07	6098654.2	628204.4
PS-Rill-08	6098945.2	628270.2
PS-Rill-09	6099031.2	628394.9
PS-Rill-10	6099029.1	628747.9
PS-Rill-11	6099034.7	628820.0

4.4 Pore Pressures

Pneumatic piezometers are installed along instrumentation lines in the dam fill (upstream and downstream of the chimney drain) and foundation. Refer to Appendix III for a plan view of instrumentation lines with cross sections and historical readings. Pneumatic piezometer cables are accessible in corrugated steel culvert risers at several locations along the downstream toe. Some of instrument risers could not be found or the cables buried, refer to Table 4.2. The 15 functional piezometers are considered sufficient for monitoring of the structure under closure conditions. The EoR should be consulted to confirm ongoing monitoring requirements, including piezometers.

Table 4.2 Piezometer Readout Locations and 2014 Monitoring Summary

Station	2014 DSI Report Waypoint	Northing (m)	Easting (m)	Functional Piezometers	Reading Collected	
					July 2014	October 2014
-0+179	n/a			0	-	-
-0+060	PS-2014-17(PZ)	6097322.0	628387.8	-	-	-
0+188	PS-2014-18(PZ)	6097529.2	628209.9	1	X	X
0+300	PS-2014-24(PZ)	6097676.4	628052.1	4	X	X
0+475	PS-2014-26(PZ)	6097913.5	627978.7	3	X	X
0+575	PS-2014-28(PZ)	6098050.4	628002.1	-	-	-
0+696	PS-2014-29(PZ)	6098172.0	628044.7	3	-	X
0+800	PS-2014-34(PZ)	6098278.2	628093.5	3	-	X
0+975	n/a			-	-	-
1+150	n/a			-	-	-
1+340	n/a			-	-	-
1+535	n/a			-	-	-
1+825	n/a			-	-	-
2+040	PS-2014-44(PZ)	6099035.3	628875.1	1	-	X
2+145	n/a			-	-	-

Pore pressure measurements along Sta. 0+300, 0+475, 0+696 and 0+800 are graphically compared to historical readings and in cross section on Figures 2 to 5. The following observations are made:

- Labels were not present on instrumentation leads, therefore measurements were inferred to piezometer ID based on comparison of measured pore pressure to historical readings. KCB recommend that new ID tags be added to instrument leads so reliable comparison of future readings can be made.
- Pore pressures measured at Sta. 0+300 and 0+475 during the July 2014 inspection were greater than historical readings. A second set of pressure measurements were collected in October and the high readings reduced back to values similar to historic readings. The high pressure readings in July 2014 may have been due to the effect of ponding in localized tailings surface depressions upstream of these instrumentation lines (visible in Figure 1) or some other seasonal effect (eg. freshet, snow melt) not detected in the historical readings that were typically taken in the early and late months of the year. There were no indications noted during the DSI that the pore pressures were impacting the structural integrity of the dam. To confirm whether the July 2014 readings represent seasonal variability, 3 readings for piezometers at Sta. 0+300 and Sta. 0+475 are recommended for 2015.
- Pore pressure measurements, from October 2014, at Sta. 0+696 and Sta. 0+800 are similar to or lower than historical readings and relatively “low” pressure (less than 1 m of pressure head). There is no ponded water immediately upstream of these locations since the installation of the closure spillway.
- “Piezo 2” at Sta. 0+300 was noted as “plugged” in Golder (2003). A very high pressure (21 m of pressure head) was measured from one of the piezometer leads during in July, 2014. This reading was associated to Piezo 2. When plotted on the dam cross section (Figure 2), the pore pressure projects to the tailings surface (elevation of ponded water). The October, 2014 reading from the same instrument reduced significantly to less than 2 m of pressure head. These measurements indicate that the instrument is no longer plugged.
- The chimney drain appears to be performing as designed based on reduced pore pressures in the downstream shell of the dam compared to upstream of the chimney drain, particularly at Sta. 0+300 and 0+475.
- “Low” pore pressures in the downstream shell of the dam (at measured locations) indicate that dam drainage capacity exceeds flow requirements.

No threshold values for the piezometers (or maximum design piezometric surface) are included in the available design documents. Based on historical readings, Golder (2003) identified no concerns of dam performance based on instrumentation or observations. KCB recommends that threshold values for the functional piezometers be developed and included in the OMS manual.

4.5 Survey Monument Pins

Survey monitoring pins were installed along the PTD dam crest in 2014 for displacement monitoring. Surveys were performed on April 29, 2014 and October 10, 2014 (refer to Table 4.3). Historical displacement monitoring records are not available for comparison but visual inspections made since 2003, indicate that no significant crest or slope movements have occurred (eg. slumping, cracking, bulging at toe).

Table 4.3 PTD Crest Survey Monument Data

Monument	April 29, 2014			October 10, 2014			Change Between Surveys		
	E (m)	N (m)	El. (m)	E (m)	N (m)	El. (m)	E (m)	N (m)	El. (m)
CP1	628918.358	6099000.208	883.090	628918.390	6099000.205	883.096	0.032	-0.003	0.006
CP2	628607.699	6098967.329	882.762	628607.755	6098967.247	882.823	0.056	-0.082	0.061
CP3	628368.980	6098932.284	882.756	628369.044	6098932.273	882.794	0.064	-0.011	0.038
CP4	628319.696	6098718.751	882.755	628319.776	6098718.766	882.809	0.080	0.015	0.054
CP5	628260.836	6098443.884	882.223	628260.935	6098443.873	882.240	0.099	-0.011	0.017
CP6	628067.085	6097987.170	882.605	628067.129	6097987.150	882.594	0.044	-0.020	-0.011
CP7	628102.148	6097722.645	882.372	628102.234	6097722.693	882.356	0.086	0.048	-0.016
CP8	628246.860	6097539.367	882.495	628246.912	6097539.409	882.522	0.052	0.042	0.027

Each of the surveys were completed using the same equipment (GPS base station with portable rod mounted survey device) but different operators. The observed movement between readings (up to 100 mm horizontal and 60 mm settlement, with 2 stations showing negative settlement) is greater than expected for this structure which has not undergone any significant loading change for more than 10 years. A third survey was completed on October 20, 2014 by Teck and showed similar degree of variability when compared to both of the previous surveys.

Given the variability in measurements over the 3 surveys, error in the survey method or equipment appear to be influencing the results. Visual observations of the PTD indicate no significant movements or deformation of the structure. Teck are planning to review alternate survey techniques or equipment to resolve the variability in the data and establish a set of baseline measurements. After survey reliability has been resolved, a minimum of 3 surveys of the PTD monuments should be completed in 2015.

4.6 Water Quality

Water quality monitoring points M17A and M17B which are included in MOE Permit No. 6739, are downstream of the PTD. Monitoring at these locations include:

- M17A:
  - Weekly: Flow rate (April 1 to October 31); Dissolved Oxygen; TSS and field turbidity;
  - Monthly: Flow rate (November to March); and
  - Quarterly: Field turbidity; Lab turbidity and total suspended solids; total extractable hydrocarbons (TEH); Metals and non-metals parameters as defined by the permit.

- M17B:
  - Quarterly: Flow, metals and non-metals parameters as defined by the permit.

Water quality monitoring data is submitted to MOE for compliance reporting and will be summarized in a Teck prepared annual report in March, 2015. Seepage flows from the PTD are one of multiple inflows into M17A and M17B; therefore, the water quality at monitoring points M17A and M17B is not directly representative of PTD seepage water quality. Teck confirm there have been no non-conformances and that monitoring frequency meets the permit requirements. M17B was attempted to be sampled in September with the other quarterly samples but there was no flow at the time of sampling.

5 VISUAL OBSERVATIONS AND PHOTOGRAPHS

The following observations were made during the inspection:

- **Dam Crest**: Good condition. No sign of lateral movement, significant differential settlement or cracking of the dam crest (Photo I-8).
- **Downstream Slope**: Good condition. No visible sign of displacement. Refer to Section 4.2 for discussion regarding rill erosion. (Photos I-7, I-11, I-13, I-17 and I-18)
- **Upstream Slope**: Good condition. No visible sign of significant erosion or displacement. Vegetation cover over most of slope, primarily grasses and bushes. (Photos I-6, I-9, I-12 and I-19).
- **North Abutment**: Good condition. No visible sign of significant erosion or displacement along the fill / natural material interface.
- **South Abutment**: The PTD does not have a south abutment as the closure spillway excavation leaves a gap between the native abutment and dam fill. (Photos I-3 and I-4).
- **Tailings Impoundment**: There is some locally ponded water in isolated depressions (upstream of instrument lines at Sta. 0+300 and Sta. 0+475) in the tailings surface likely formed by post-operations settling of the tailings (Photo I-9). The impoundment area is partially vegetated and the tailings surface is well drained, except in areas of ponded water, and can support human traffic easily. There were no visual indicators of significant tailings erosion near the closure spillway inlet or other areas of the impoundment (Photo I-6).
- **Closure Spillway Channel**: Good condition. The vegetation cover is well established and there are no signs of erosion damage (Photo I-1 and Photo I-2). The riprap on the natural slope bank is in good condition (Photo I-3).
- **Closure Spillway Outlet to M17 Channel**: Good condition. Vegetation is well established and no obstructions or debris blocking outlet (Photos I-4 and I-5). Near the outlet, the M17 channel riprap also appeared to be in good condition.
- **Seepage**: Minor seepage was observed from the underdrains constructed in the downstream shell at several locations along the downstream toe (Photos I-16). Where seepage was notably flowing from the underdrain, the water was clear. Most of the seepage areas or underdrains had no discernible flow but were identified based on wet ground or ponded water.
- **Seepage Collection Pond**: Good condition (Photos I-20 and I-21). There was no flow through the seepage pond outlet (Photos I-22).

6 ASSESSMENT OF DAM SAFETY

The PTD has a hazard classification of "High" (KCB, 2013). There have been no changes to the downstream environment or operation of the structure that would require a revision to this classification.

Teck advise that the dam safety management documents, OMS manual and Emergency Preparedness Plan (EPP), required by the Code are under development and will be available for December, 2014.

Based on the inspection and review of available documents regarding the PTD the potential failure modes included in the Canadian Dam Safety Guidelines (CDA, 2007) were reviewed:

- **Overtopping:** The construction of the closure spillway that breaches the dam in the low point of the tailings surface (invert more than 4 m below average dam crest), makes the probability of overtopping very low. The closure spillway is more than 17 m wide which makes the probability of blockage also very low.
- **Internal Erosion and Piping:** The dam was constructed with a chimney drain filter between the low permeability till upstream blanket and downstream coarse coal rejects to protect against internal erosion and piping. The low piezometric levels in the dam, long performance record and clear seepage from the underdrains indicate the filter is performing and the probability of failure due to piping is very low.
- **Slope Instability:** Golder (2003) completed a slope stability review of the PTD for the same conditions as the dam and calculated a high safety factor (1.88) for a section at the maximum dam height of 52 m. This analysis and long performance history with no visible or documented displacements indicates the probability of failure due to slope instability is very low.
- **Foundation Irregularities:** Golder (2003) characterizes the dam foundation as a combination of silty sand till and bedrock. No weak soil units or bedding planes were noted in the design documents or assumed in the analysis. Site investigation records are not available for the PTD but the probability of a failure through the foundation is very low based on: the discussion in Golder (2003); no observed bulging or signs of distress at the toe of the dams and the area immediately downstream indicating no movements in the foundation; and the subsequent performance history of the structure.
- **Surface Erosion:** There is significant rilling (erosion gullies) of the downstream slope; refer to discussion in Section 4.2. The rills observed during the DSI do not significantly reduce the structural integrity of the dam and do not extend through the crest towards the impoundment. Recommendations for ongoing monitoring are discussed in Section 4.2.
- **Earthquakes:** Stability of the dam under seismic loading was reviewed as part of the Golder (2003) stability review and the dam was noted to not be susceptible to failure or significant deformation during seismic events.

The PTD visually appears in good condition with respect to stability and water management. Comparison with reviewed annual inspection reports and piezometer measurements indicate there has been no significant change to the condition of the structure noted in the available inspection and design documents. Recommendations for future work or items of concern for the dam are summarized in Table 6.1.

Table 6.1 Summary of Recommendations for Deficiencies and Non-conformances

Number (Year Raised – Priority[(1)])	Deficiency/ Non-conformance	Regulation or OMS Reference	Recommended Action	Recommended Deadline (Status)
DSI-PS-01 (2013 – Priority 2)	No OMS manual and EPP.	HSRC Code	Prepare an OMS manual and EPP for the facility based on the MAC (2011) guidelines.	December, 2014 (Teck advise this is underway)
DSI-PS-02 (2012)	*Incomplete monitoring records.*	*HSRC Code*	*Confirm whether the found instrument cables are functional and if possible what instruments they are.*	*CLOSED.*
DSI-PS-03 (2012 – Priority 3)	Monitoring requirements.	HSRC Code (DSI reporting requirement)	Define monitoring and instrument reading frequency for PTD and include in OMS. Establish survey monuments along crest. Consult EoR with monitoring requirements.	December, 2014 (survey monuments installed, document in the OMS manual)
DSI-PS-04 (2013)	*No flow or water quality measurements.*	*HSRC Code (DSI reporting requirement)*	*Monthly monitoring of flow rate and collect samples for water quality (total suspended solids) of the outflow.*	*CLOSED. Recommendation now superseded by amended MOE permit.*
DSI-PS-05 (2012 – Priority 3)	Downstream slope erosion	n/a	Establish rill monitoring into OMS (DSI-PS-01): photographs of downstream slope from recommended rill monitoring points; and walk crest to confirm rills are not extending through crest.	December, 2014. (proposed rill monitoring should be included in the OMS manual).
DSI-PS-06 (New – Priority 3)	Survey monument monitoring	n/a	Complete minimum 3 survey readings in 2015 after appropriate survey method has been established with appropriate accuracy for this purpose.	(1) before May 30, 2015 (2) 1 month after first 2015 survey. (3) between August and October, 2015
DSI-PS-07 (New – Priority 3)	Monitoring requirements	n/a	Add ID tags to piezometer tips to allow for reliable comparison of future readings.	Prior to July, 2015
DSI-PS-08 (New – Priority 3)	Monitoring requirements	n/a	Establish piezometer threshold values that trigger action or design review. Include these in the OMS document (DS-PS-01).	December, 2015
DSI-PS-09 (New – Priority 3)	Piezometer monitoring data	n/a	Complete minimum 3 piezometer readings in 2015 at Sta. 0+300 and Sta. 0+475 instrumentation lines.	(1) before May 30, 2015 (2) between July and August, 2015 (3) between September and November, 2015.
DSI-PS-10 (New – Priority 3)	Closure spillway IDF	CDA (2007)	KCB recommend Teck complete a design assessment with summary report to confirm the closure spillway is suitable for the IDF.	December, 2015

Notes:

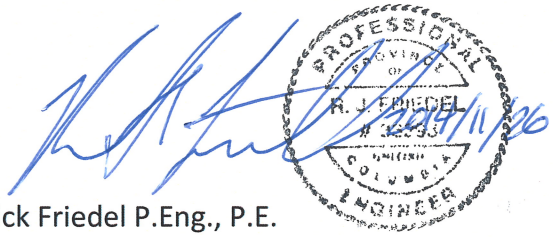
2. Recommendation priority guidelines, specified by Teck and assigned by KCB:
   - *Priority 1*: A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant risk of regulatory enforcement.
   - *Priority 2*: If not corrected could likely result in dam safety issues leading to injury, environmental impact or significant regulatory enforcement; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
   - *Priority 3*: Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
   - *Priority 4*: Best Management Practice – Further improvements are necessary to meet industry best practices or reduce potential risks.

7 CLOSING

We trust that this document meets the requirements for dam safety inspections specified by Teck and the Ministry of Energy, Mines and Natural Gas. Please contact the undersigned if you have any questions or comments.

This report is an instrument of service of Klohn Crippen Berger Ltd. The report has been prepared for the exclusive use of Quintette Coal Operations (Client) for the specific application to the2014 Dam Safety Inspections. The report"s contents may not be relied upon by any other party without the express written permission of Klohn Crippen Berger. In this report, Klohn Crippen Berger has endeavoured to comply with generally-accepted professional practice common to the local area. Klohn Crippen Berger makes no warranty, express or implied.

KLOHN CRIPPEN BERGER LTD.



Rick Friedel P.Eng., P.E.
Senior Geotechnical Engineer
Project Manager

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FIGURES

628,000 628,500 629,000

N

6,099,000 6,098,500 6,098,000 6,097,500

PS-2014-38
PS-2014-39
PS-Rill-09 (PS-2014-40)
PS-2014-41
PS-Rill-11 (PS-2014-43)
PS-Rill-10 (PS-2014-42)
PS-2014-44(PZ)
PS-2014-45
PS-2014-16(SP)
CP1
PS-2014-15(SP)
CP2
PS-Rill-08 (PS-2014-37)
CP3
PS-2014-14(SP)
PS-2014-13
CP4
PS-Rill-07 (PS-2014-36)
PLANTSITE
TAILINGS FACILITY
PS-2014-35
PS-2014-12(SP)
CP5
PS-2014-32
PS-2014-31
PS-2014-30
Seepage
Collection
Pond
PS-Rill-06 (PS-2014-33)
PS-2014-34(PZ)
PS-2014-11
PS-2014-29(PZ)
PS-2014-28(PZ)
PS-2014-10(SP)
CP6
PS-Rill-05 (PS-2014-27)
PS-2014-26(PZ)
PS-2014-09
PS-2014-08
PS-Rill-04 (PS-2014-25)
CP7
PS-2014-24(PZ)
PS-2014-07
PS-Rill-3 (PS-2014-23)
PS-Rill-01 (PS-2014-22)
PS-Rill-02 (PS-2014-21)
PS-2014-19
PS-2014-18(PZ)
CP8
PS-2014-06
PS-2014-17(PZ)
PS-2014-02
PS-2014-05
PS-2014-03
PS-2014-04
M17 CREEK

628,000 628,500 629,000

LEGEND

- CP# ▲ Survey Monument (2014 Installation)
- PS-2014-## ● 2014 Waypoint
- PS-2014-## (PZ) ● 2014 Waypoint and Piezometer Readout Location
- PS-Rill-## (PS-2014-##) ● 2014 Waypoint and Rill Monitoring Location
- Existing Road
- Drainage
- Closure Spillway Channel

Notes:
1. UTM Zone 10N, NAD83
2. 2010 orthophoto from Teck

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED NOVEMBER 2014.

0 250 m

CLIENT: Teck

Klohn Crippen Berger

PROJECT: QUINTETTE COAL OPERATIONS
2014 DAM SAFETY INSPECTION

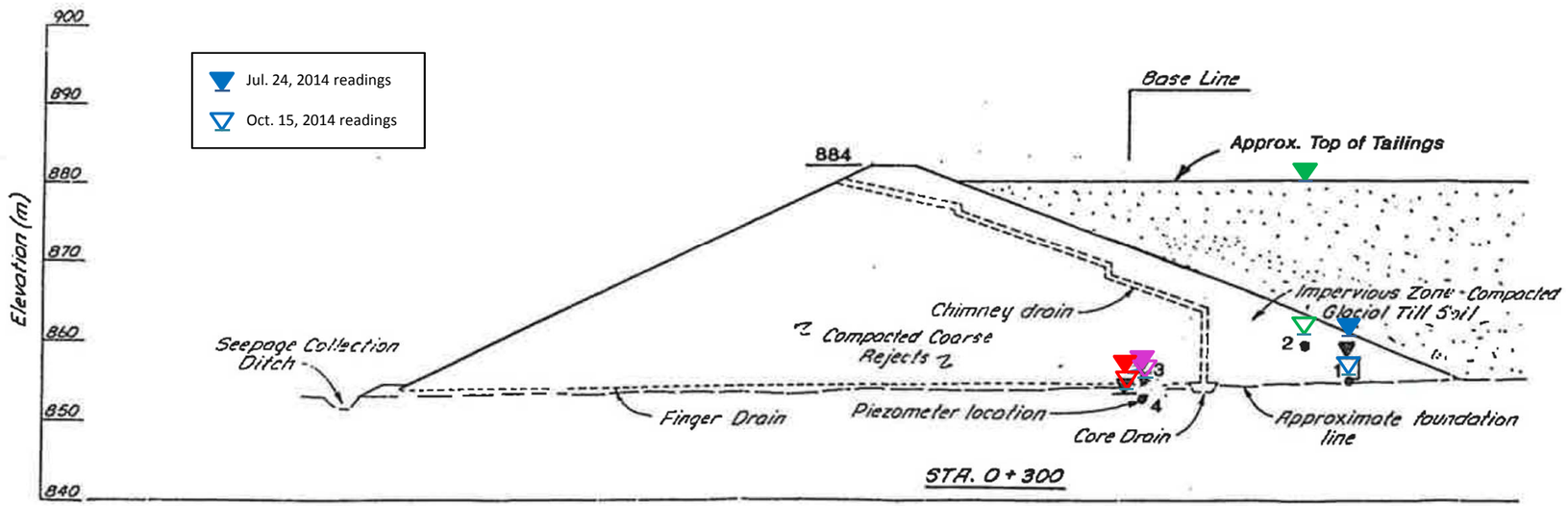
TITLE: PLANTSITE TAILINGS DAM
2014 INSPECTION WAYPOINTS

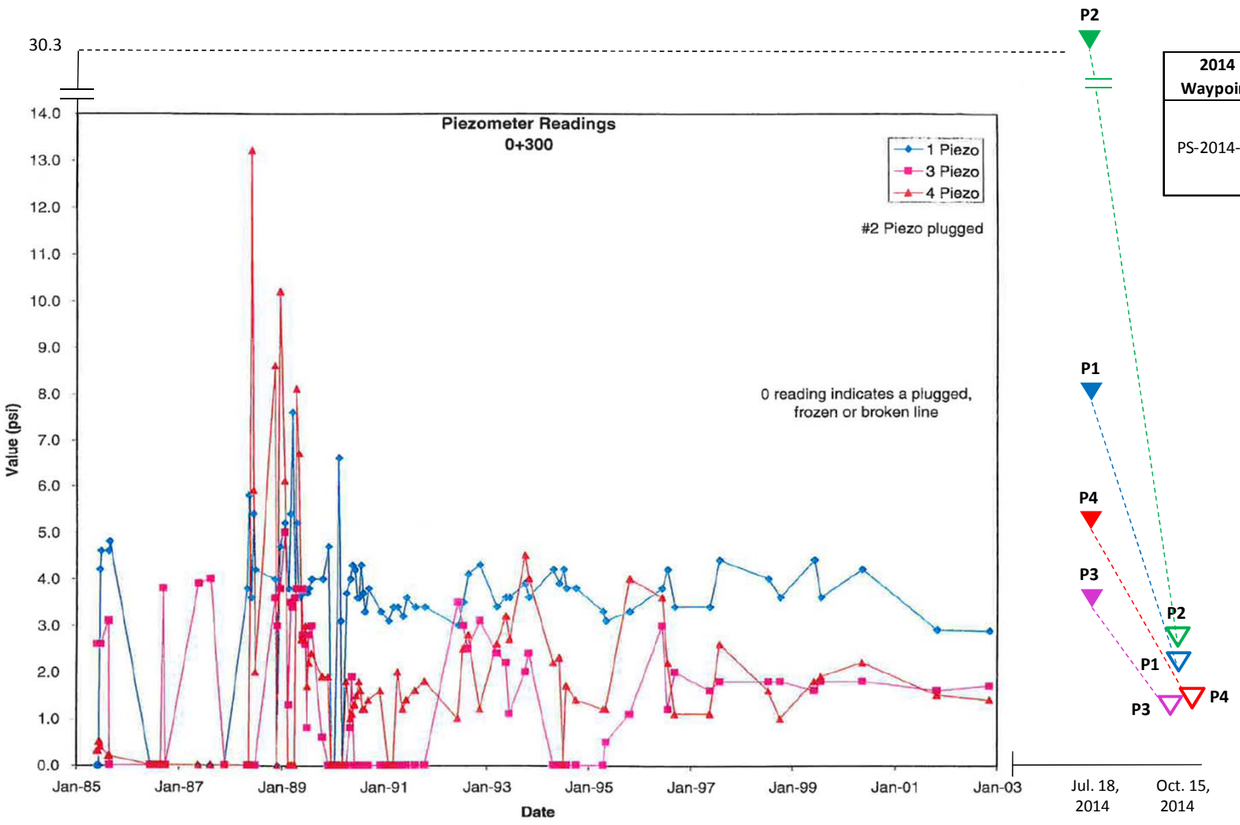
PROJECT No. M09684A10

FIG No. 1

Path: Z:\MV\CRM\09684A10 - TCL-Quintette 2014 DSI\300 Design\OCT 2011 FIGURES\140819Fig1_Plant_Site.mxd apoon

STA. 0+300





2014 Waypoint	Instrument ID (Note 2)	Jul. 18, 2014 Reading (psi)	Pressure		Tip Elevation (m)	Last Reading (Jan '03)		Post Op. Average Reading	
			Head (m)	Elevation (m)		(psi)	Change (m)	(psi)	Change (m)
PS-2014-24	P1	8.0	5.6	860.6	855.0	2.9	3.6	3.7	3.0
	P2	30.3	21.3	880.3	859.0	n/a	n/a	n/a	n/a
	P3	3.5	2.4	857.4	855.0	1.8	1.2	1.7	1.3
	P4	5.2	3.7	856.7	853.0	1.4	2.7	1.6	2.5

Instrument ID (Note 2)	Oct. 15, 2014 Reading (psi)	Pressure		Tip Elevation (m)	Change From Jul. 18 (m)
		Head (m)	Elevation (m)		
P1	2.1	1.5	856.5	855.0	-4.1
P2	2.6	1.8	860.8	859.0	-19.5
P3	1.1	0.8	855.8	855.0	-1.7
P4	1.3	0.9	853.9	853.0	-2.8

STA. 0+188 (NO HISTORIC DATA AVAILABLE)

2014 Waypoint	Instrument ID (Note 2)	Jul. 18, 2014 Reading (psi)	Pressure		Tip Elevation (m)
			Head (m)	Elevation (m)	
PS-2014-18	1A	2.2	1.5	856.5	855.0

Instrument ID (Note 2)	Oct. 15, 2014 Reading (psi)	Pressure		Tip Elevation (m)	Change From Jul. 18 (m)
		Head (m)	Elevation (m)		
1A	0.1	0.1	855.1	855.0	-1.4

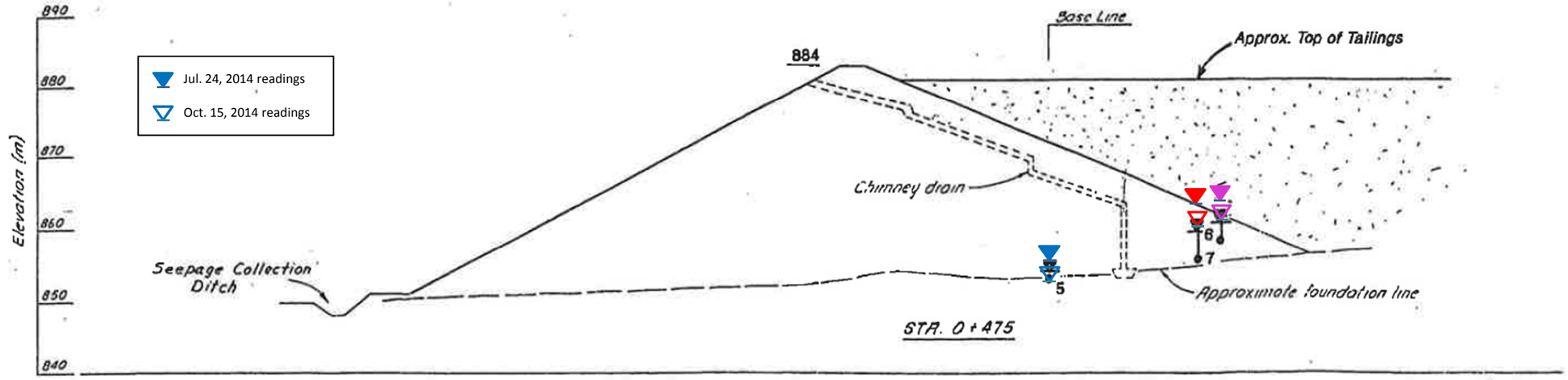
Notes:
1. Instrument section and historic readings chart from Golder(2003). Historic piezometric reading values were unavailable.
2. No labels on piezometer leads. Comparison of past readings and tip location used to infer what readings apply to what instruments. Labels should be added for ongoing comparison purposes.

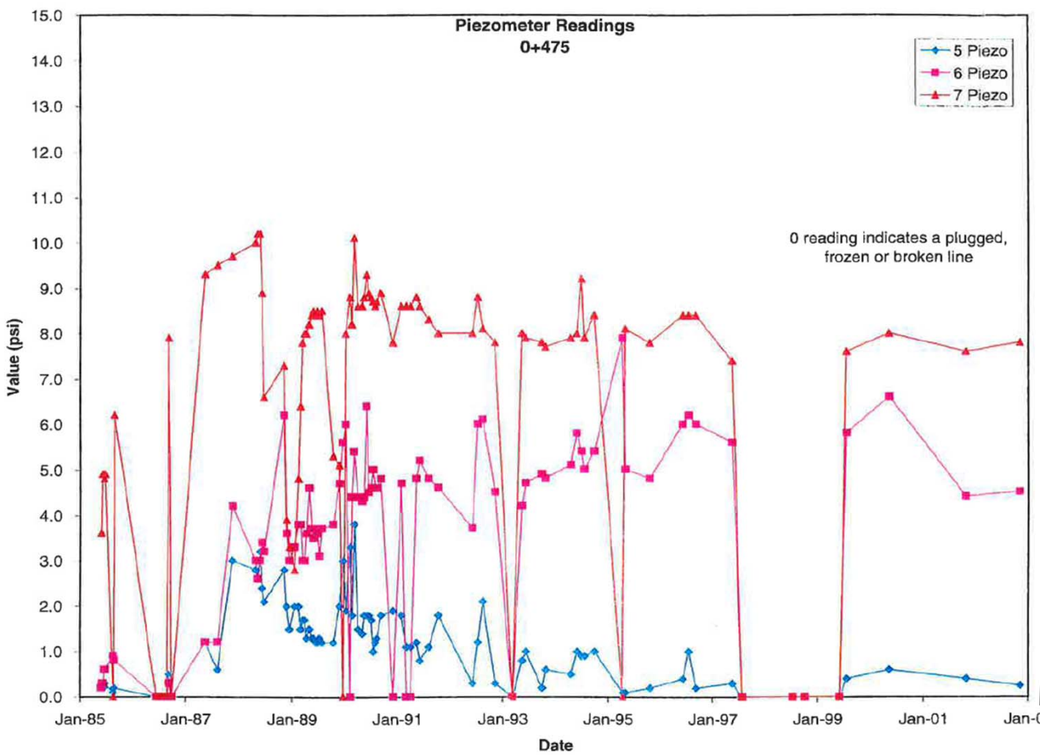
Klohn Crippen Berger

PROJECT:
Quintette Coal Operations 2014 Dam Safety Inspections

TITLE:
Plantsite Tailings Dam Piezometer Readings
Sta. 0 + 188 and Sta. 0 + 300

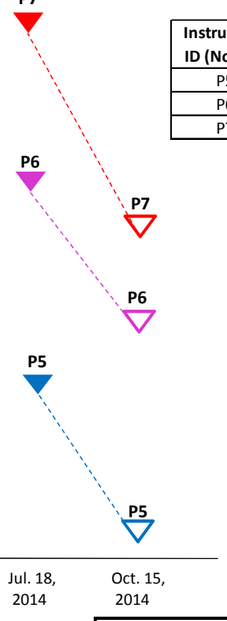
PROJECT NO. M09684A10 | **FIGURE** 2





2014 Waypoint	Instrument ID (Note 2)	Jul. 24, 2014 Reading (psi)	Pressure		Tip Elevation (m)	Last Reading (Jan '03)		Post Op. Average Reading	
			Head (m)	Elevation (m)		(psi)	Change (m)	(psi)	Change (m)
PS-2014-26	P5	3.8	2.7	856.2	853.5	0.3	2.4	0.4	2.4
	P6	8.3	5.8	864.8	859.0	4.5	2.6	5.5	1.9
	P7	11.7	8.3	864.3	856.0	7.8	2.8	7.8	2.8

Instrument ID (Note 2)	Oct. 15, 2014 Reading (psi)	Pressure		Tip Elevation (m)	Change From Jul. 18 (m)
		Head (m)	Elevation (m)		
P5	0.4	0.3	853.8	853.5	-2.3
P6	5.1	3.6	862.6	859.0	-2.2
P7	7.3	5.1	861.1	856.0	-3.2



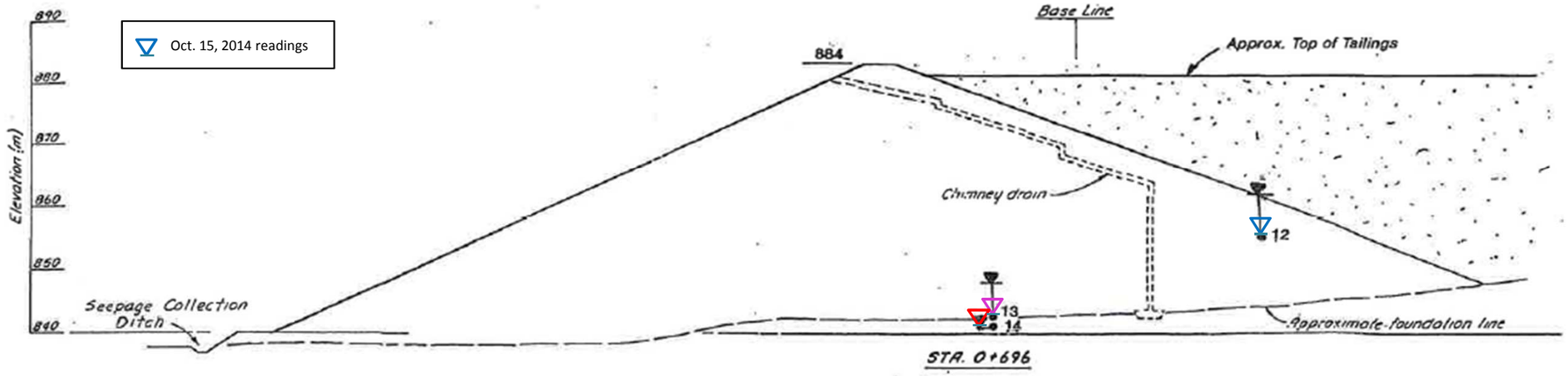
Notes:
1. Instrument section and historic readings chart from Golder(2003). Historic piezometric reading values were unavailable.
2. No labels on piezometer leads. Comparison of past readings and tip location used to infer what readings apply to what instruments. Labels should be added for ongoing comparison purposes.

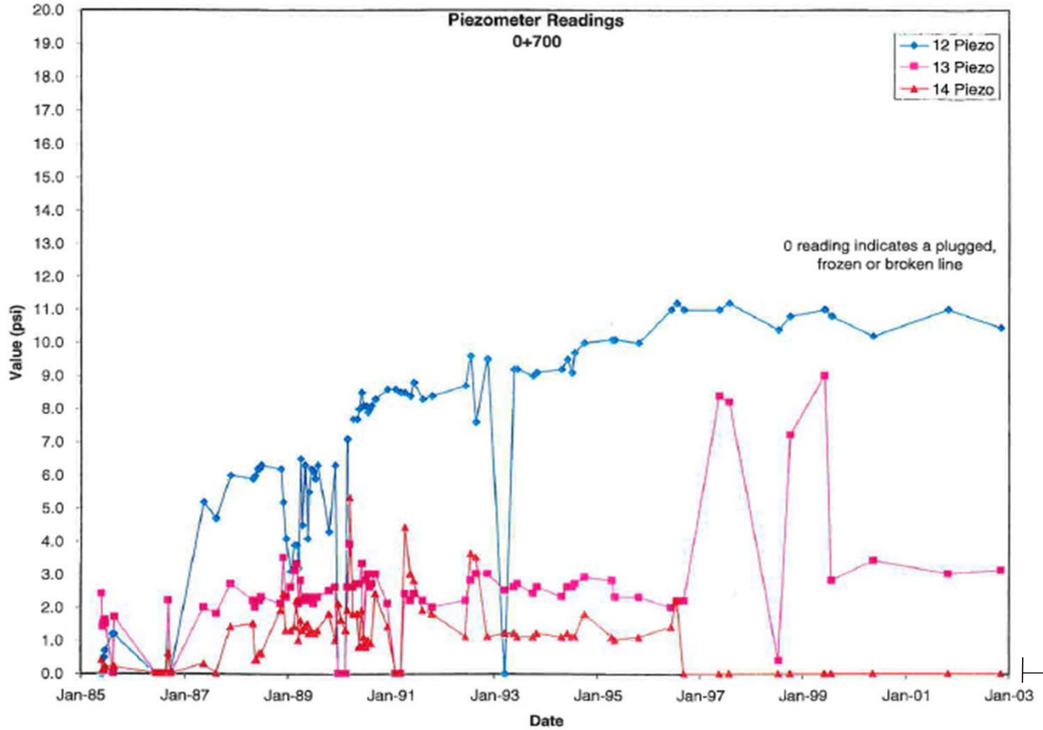
Klohn Crippen Berger

PROJECT:
Quintette Coal Operations 2014 Dam Safety Inspections

TITLE:
Plantsite Tailings Dam Piezometer Readings
Sta. 0 + 475

PROJECT NO. M09684A10 **FIGURE** 3





Instrument ID (Note 2)	Oct. 15, 2014 Reading (psi)	Pressure Head (m)	Pressure Elevation (m)	Tip Elevation (m)	Last Reading (Jan '03) (psi)	Last Reading (Jan '03) Change (m)	Post Op. Average Reading (psi)	Post Op. Average Reading Change (m)
P12	1.5	1.0	856.0	855.0	10.5	-6.4	10.6	-6.4
P13	0.7	0.5	843.0	842.5	3.2	-1.8	5.3	-3.3
P14	0.6	0.4	841.9	841.5	n/a	n/a	n/a	n/a

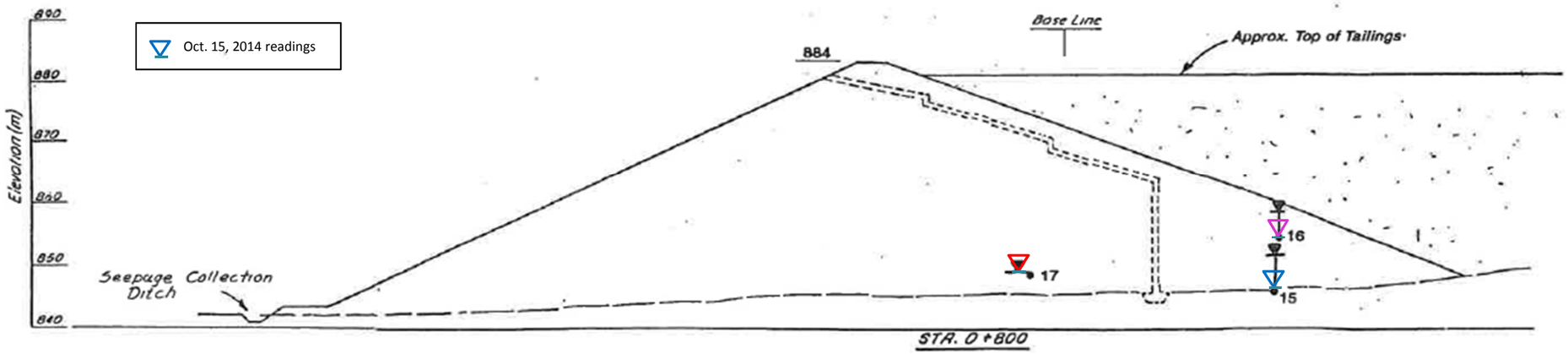
Notes:
1. Instrument section and historic readings chart from Golder(2003). Historic piezometric reading values were unavailable.
2. No labels on piezometer leads. Comparison of past readings and tip location used to infer what readings apply to what instruments. Labels should be added for ongoing comparison purposes.

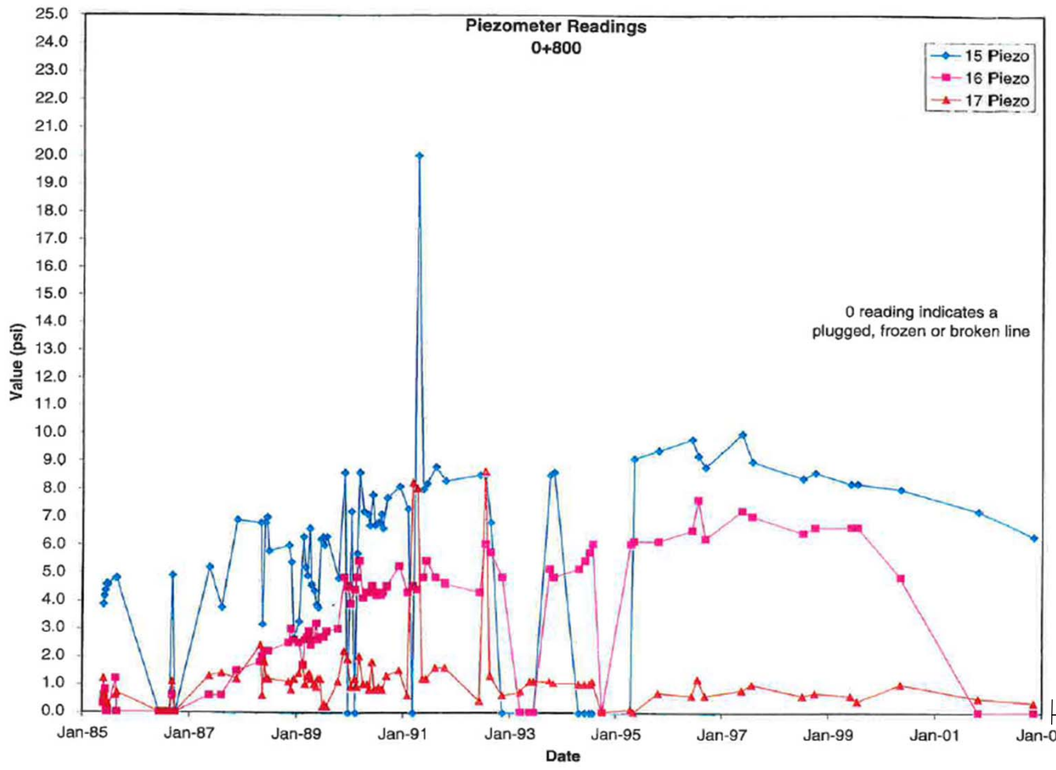
Klohn Crippen Berger

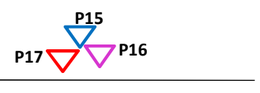
PROJECT:
Quintette Coal Operations 2014 Dam Safety Inspections

TITLE:
Plantsite Tailings Dam Piezometer Readings
Sta. 0 + 696

PROJECT NO. M09684A10 **FIGURE** 4







Oct. 15, 2014

Instrument ID (Note 2)	Oct. 15, 2014 Reading (psi)	Pressure Head (m)	Pressure Elevation (m)	Tip Elevation (m)	Last Reading (Jan '03) (psi)	Last Reading (Jan '03) Change (m)	Post Op. Average Reading (psi)	Post Op. Average Reading Change (m)
P15	1.0	0.7	846.7	846.0	6.2	-3.6	7.5	-4.6
P16	0.4	0.3	854.8	854.5	n/a	n/a	n/a	n/a
P17	0.3	0.2	848.2	848.0	0.3	0.0	0.7	-0.3

Notes:
1. Instrument section and historic readings chart from Golder(2003). Historic piezometric reading values were unavailable.
2. No labels on piezometer leads. Comparison of past readings and tip location used to infer what readings apply to what instruments. Labels should be added for ongoing comparison purposes.

Klohn Crippen Berger

PROJECT:
Quintette Coal Operations 2014 Dam Safety Inspections

TITLE:
Plantsite Tailings Dam Piezometer Readings
Sta. 0 + 800

PROJECT NO. M09684A10 | FIGURE 5

APPENDIX I

Inspection Photos

Appendix I
Plantsite Tailings Dam Inspection Photographs

LEGEND:

- PTD = Plantsite Tailings Dam.
- PTD-2014-## refers to 2014 DSI waypoint shown on Figure 1.
- All photographs taken during inspection on July 23, 2014.

Photo I-1 **Overview of spillway channel, photograph taken from inside PTD impoundment looking west towards discharge into M17 Creek. (PS-2014-01)**

Photo I-2 **Overview of spillway channel looking north towards the spillway inlet. Channel is well vegetated. (PS-2014-01)**

Photo I-3 **Riprap (partially overgrown) along outer edge at the sharp bend in spillway channel. (PS-2014-02)**

Photo I-4 **Photograph taken standing at spillway discharge, looking north (downstream) at M17 creek. (PS-2014-03)**

Photo I-5 **Photograph taken standing at spillway discharge, looking south (upstream) at M17 creek. (PS-2014-04)**

Photo I-6 **Inlet to the spillway channel (red dashed area) which is clear with no obstructions. (PS-2014-08)**

Photo I-7 **Overview of downstream slope of dam, Sta. 0+475. (PS-2014-09)**

Photo I-8 **Overview of dam crest, approximately Sta. 0+270. (PS-2014-07)**

Photo I-9 **Ponded water in a local depression in the tailings surface near the spillway outlet, approximately Sta. 0+400. (PS-2014-08)**

Photo I-10 **Typical PTD crest survey prism (steel bar inside protective tire) installed during 2014. (PS-2014-10)**

Photo I-11 **Overview of downstream slope of the dam, approximately Sta. 1+150. (PS-2014-12)**

Photo I-12 **Ponded water in northwest corner of impoundment. Ponding was noted in this area noted during 2012 and 2013 DSI. (PS-2014-13)**

Photo I-13 **Overview of downstream slope of dam, approximately Sta. 1+550. (PS-2014-14)**

Photo I-14 **Overview of access to Seepage Collection Pond, approximately Sta 0+825. (PS-2014-11)**

Photo I-15 **Pneumatic piezometer leads (x3) at downstream toe of embankment. Sta. 0+475 readings collected during 2014 DSI. (PS-2014-26)**

Photo I-16 Typical underdrain daylighting at toe of dam slope. Low rate of seepage visible from underdrain, approximately Sta. 1+150. (PS-2014-35)

Photo I-17 Overview of downstream slope, approximately Sta. 2+040. (PS-2014-45)

Photo I-18 Overview of downstream slope, approximately Sta. 0+270. (PS-2014-07)

Photo I-19 Overview of tailings basin along northeast embankment. (PS-2014-16)

Photo I-20 **Seepage Collection Pond - north of the facility which discharges into M17B creek. (PS-2014-30)**

Photo I-21 **Downstream slope of Seepage Collection Pond embankment. (PS-2014-31)**

Photo I-22 Seepage Collection Pond outfall channel, no flow observed. (PS-2014-32)

APPENDIX II

Plantsite Rill Monitoring Photos

Appendix II
Plantsite Rill Monitoring Photos

LEGEND:

- PS-RILL-## refers to proposed rill monitoring point, plan location shown on Figure 1. Coordinates for monitoring points are summarized in Table 1.
- All 2014 photographs taken during inspection on July 23, 2014.

Table 1 Rill Monitoring Point Locations

Rill Monitoring Point	Northing	Easting
PS-Rill-01	6097603.6	628135.4
PS-Rill-02	6097599.6	628128.6
PS-Rill-03	6097654.1	628064.7
PS-Rill-04	6097706.1	628024.0
PS-Rill-05	6097955.8	627976.7
PS-Rill-06	6098278.2	628044.4
PS-Rill-07	6098654.2	628204.4
PS-Rill-08	6098945.2	628270.2
PS-Rill-09	6099031.2	628394.9
PS-Rill-10	6099029.1	628747.9
PS-Rill-11	6099034.7	628820.0

II-1 PS-RILL-01

2014

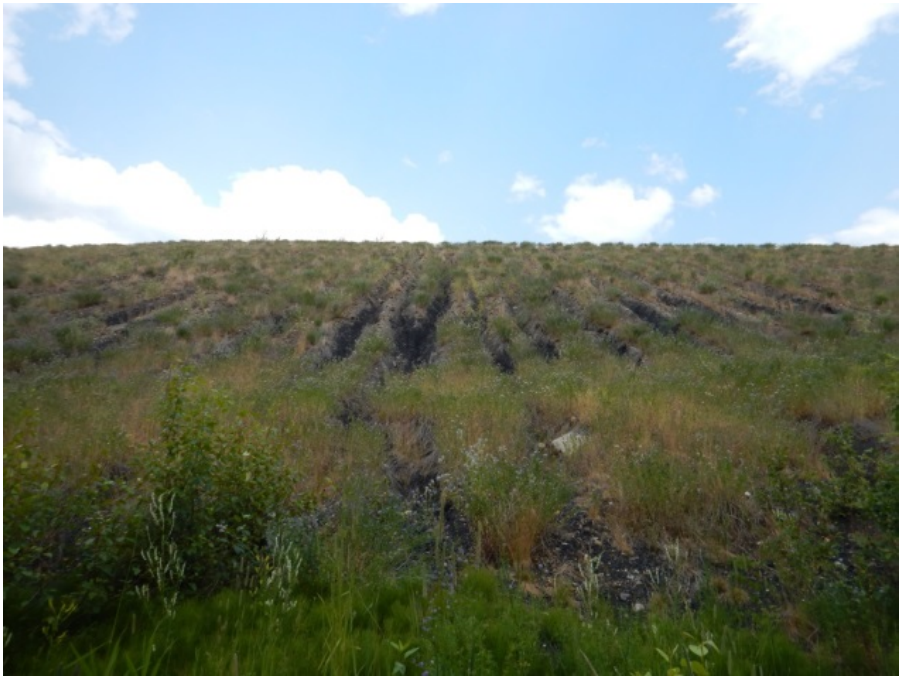
II-2 PS-RILL-02

2013

2014

II-3 PS-RILL-03

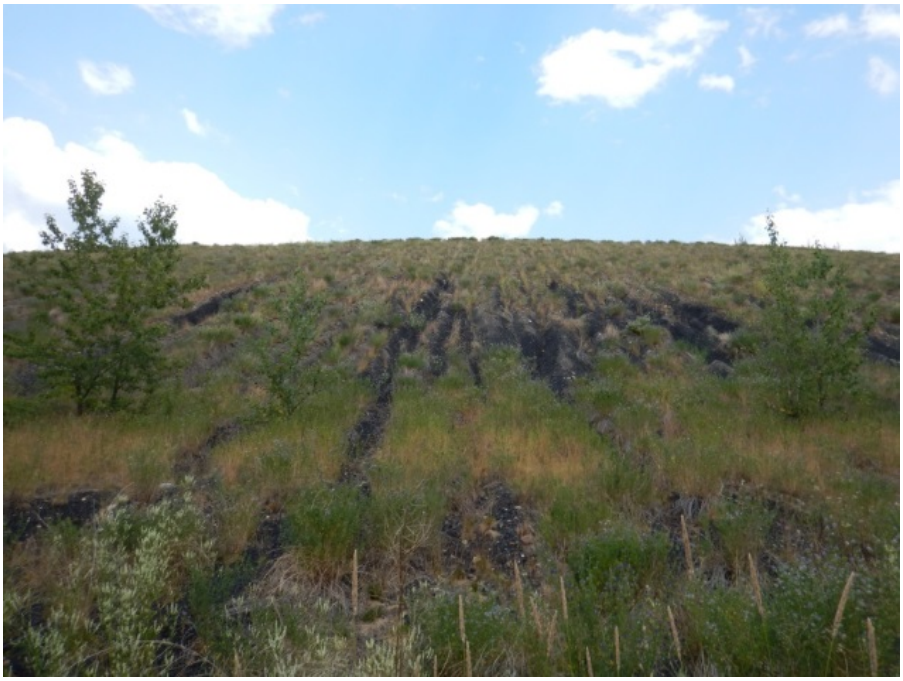
2014



II-4 PS-RILL-04

2013

2014



II-5 PS-RILL-05

2014

II-6 PS-RILL-06

2013

2014

II-7 PS-RILL-07

2014

II-8 PS-RILL-08

2012

2013

2014

II-9 PS-RILL-09

2014

II-10 PS-RILL-10

2014

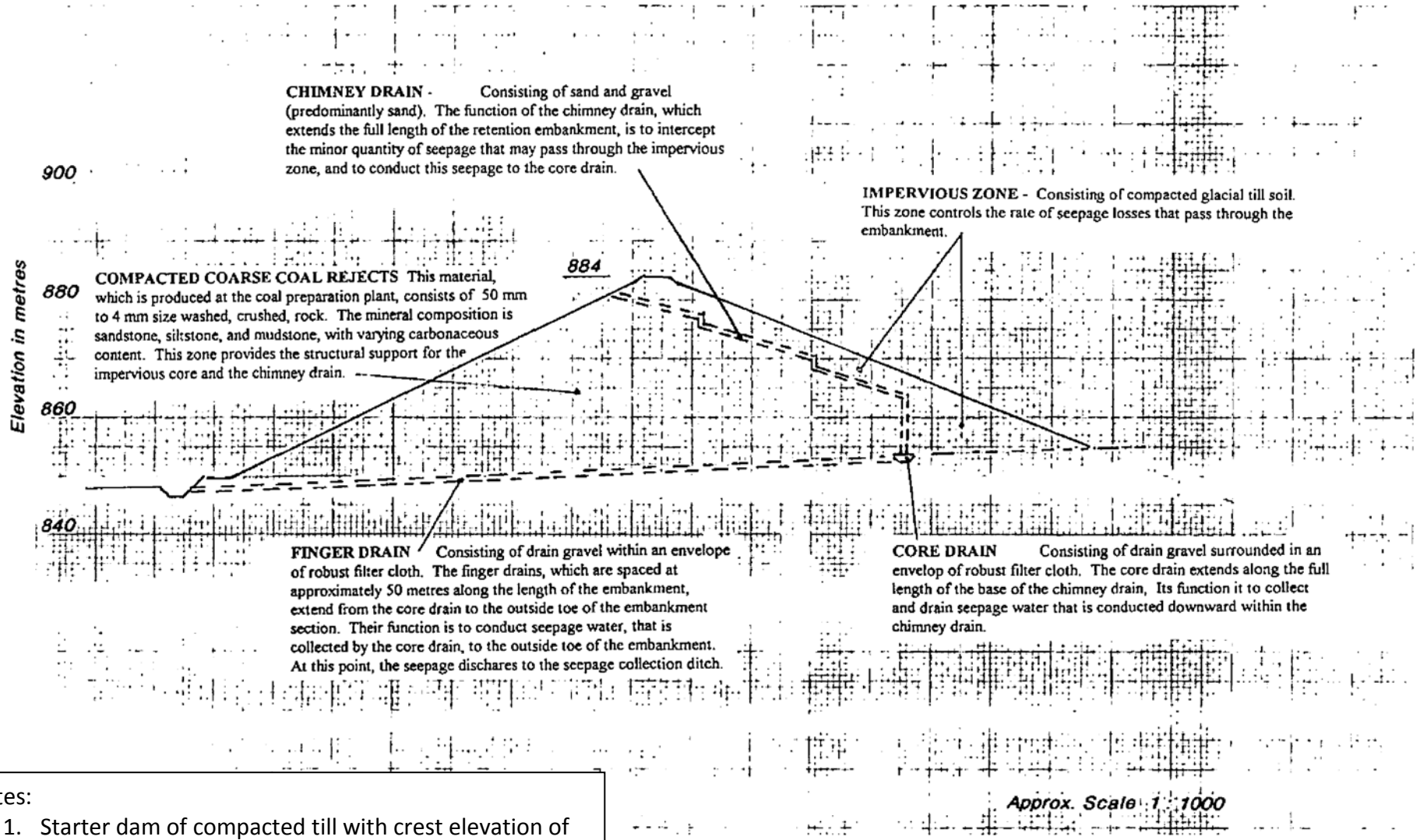
II-11 PS-RILL-11

2012

2014

APPENDIX III

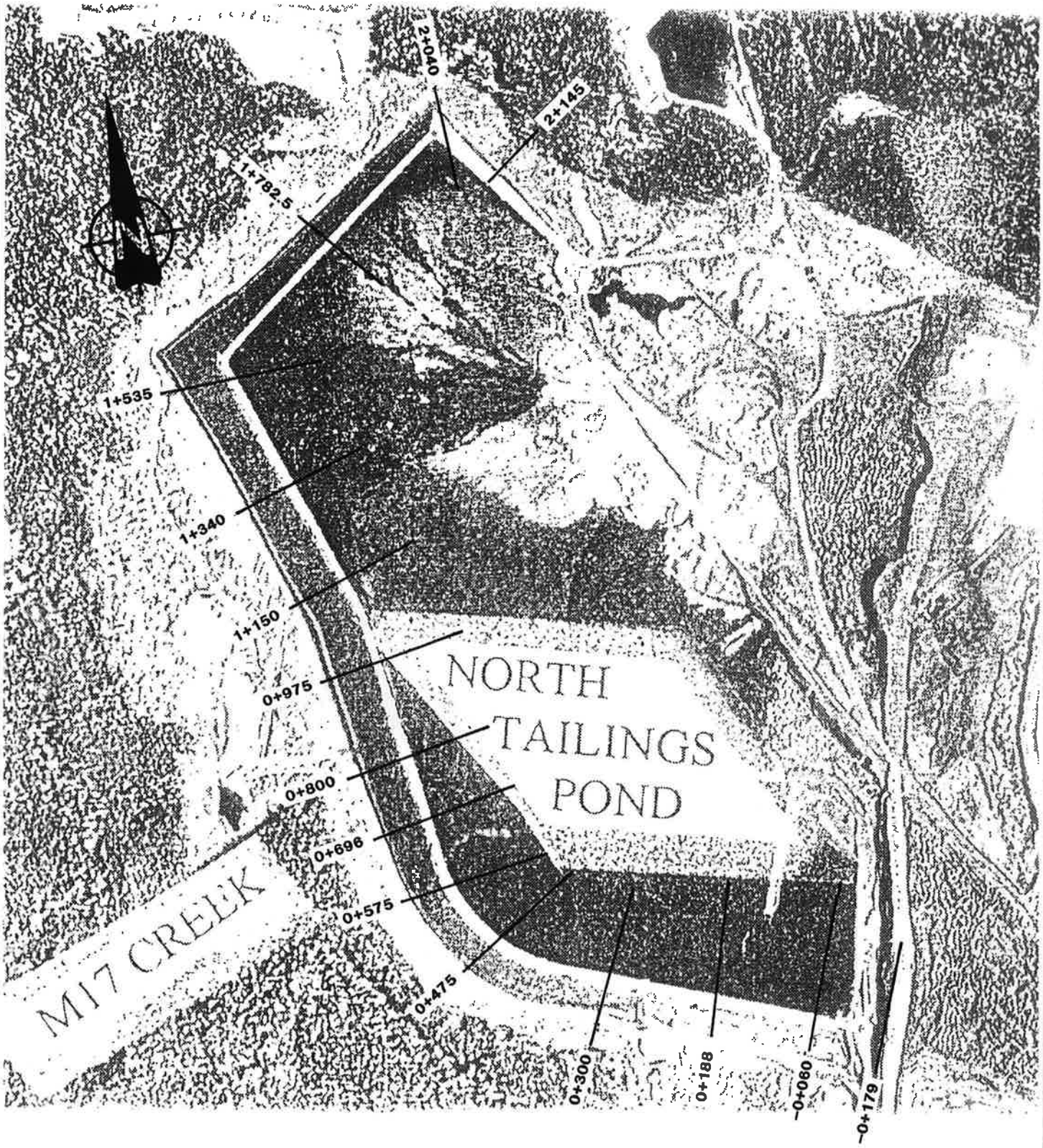
Dam Design Drawings



Notes:

1. Starter dam of compacted till with crest elevation of 864 m is not shown.

Project No. 962-1493 Drawn BAD Reviewed DBC Date Jan.'97	Golder Associates	QOC - TUMBLER RIDGE SECTION THROUGH CONFINING DYKE AT NORTH TAILINGS POND	Figure 3



Approx. Scale 1 : 10000

Project No. 022-1520 Drawn BAD Reviewed ..... Date Mar.'03

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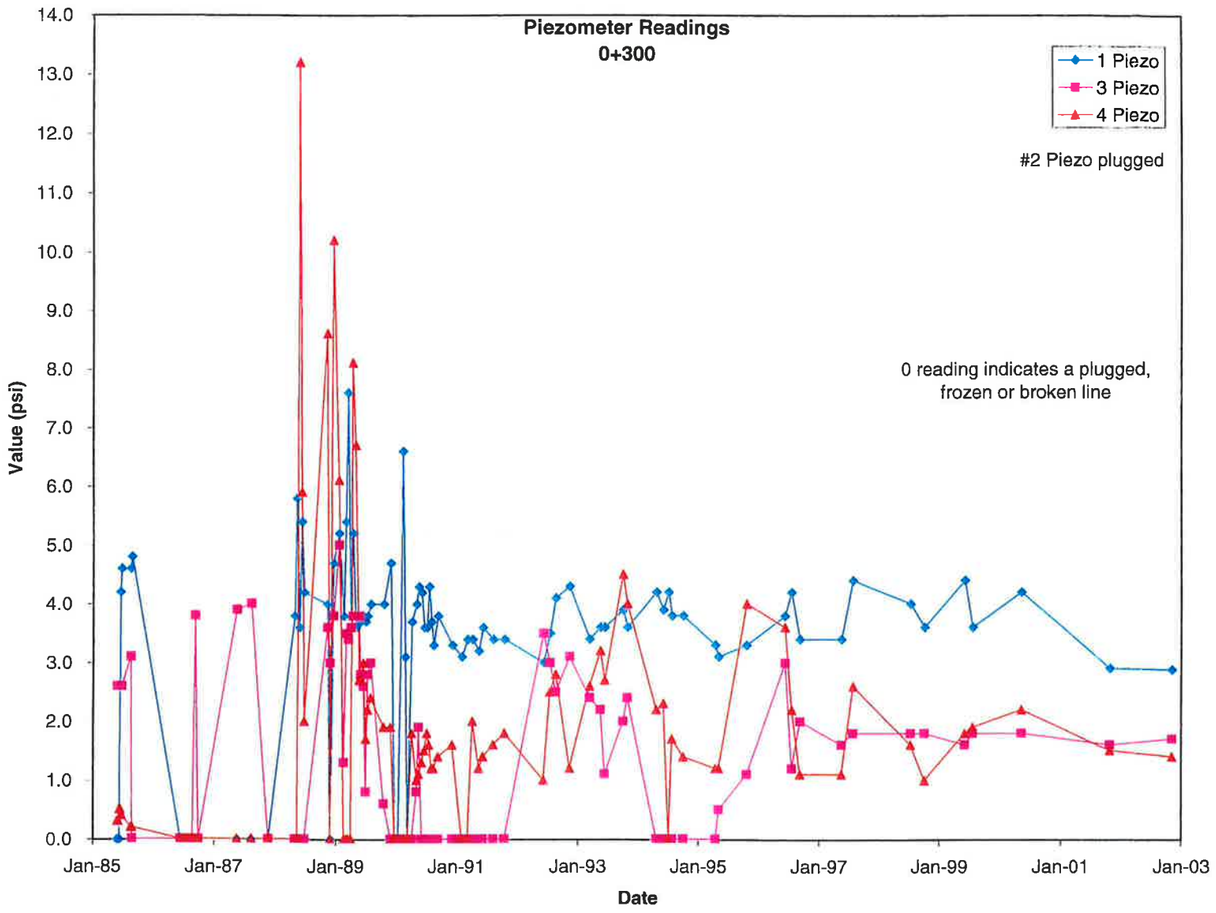
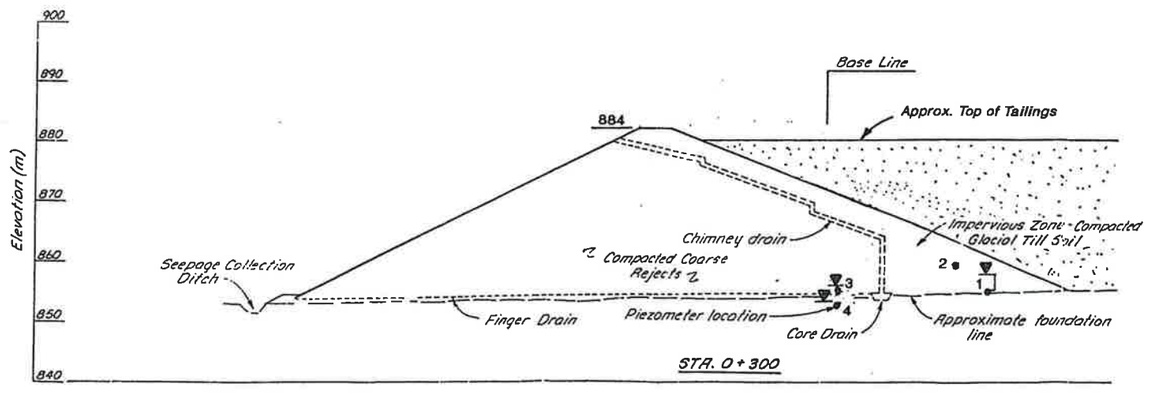
QOC TUMBLER RIDGE–NORTH TAILINGS POND
LOCATIONS OF PIEZOMETER SECTIONS

Figure **B–1**





Project No. 022-1520 Drawn BAD Reviewed Date Mar.'03

STATION 0+300

The piezometers at Station 0+300 are located within a vertical plane at horizontal distances of approximately 25 metres from the adjacent finger drains on either side of the plane.

Piezometer No. 1 is located on the upstream (pond) side of the Chimney/Core drain at shallow depth below the embankment fill/foundation surface of contact. Piezometer 2 within the compacted glacial till fill (impervious zone) on the upstream side of the chimney drain.

Piezometers 3 and 4 are located within the foundation soils on the downstream side of the core drain. Piezometer No. 4 is located at shallow depth below the fill/foundation contact, and Piezometer No. 3 is located at the fill/foundation surface of contact.

The piezometric pressures that have been recorded over the past decade indicate that significant head loss occurs as the seepage water passes through the settled tails and through the zone of compacted glacial till fill (the impervious zone) on the upstream side of the chimney drain. On the downstream side of the chimney drain, the piezometric head remains low.

NOTES

1 Location of section is shown on Figure B1 of this Appendix.
2 1 (one) psi of pressure is equivalent to a head of 0.704 metres of water. Plotted piezometric heights above piezometer tips are to scale.
3 Occasional zero readings at a piezometer are an indication that the piezometer leads were frozen or otherwise blocked at the time of the readings.

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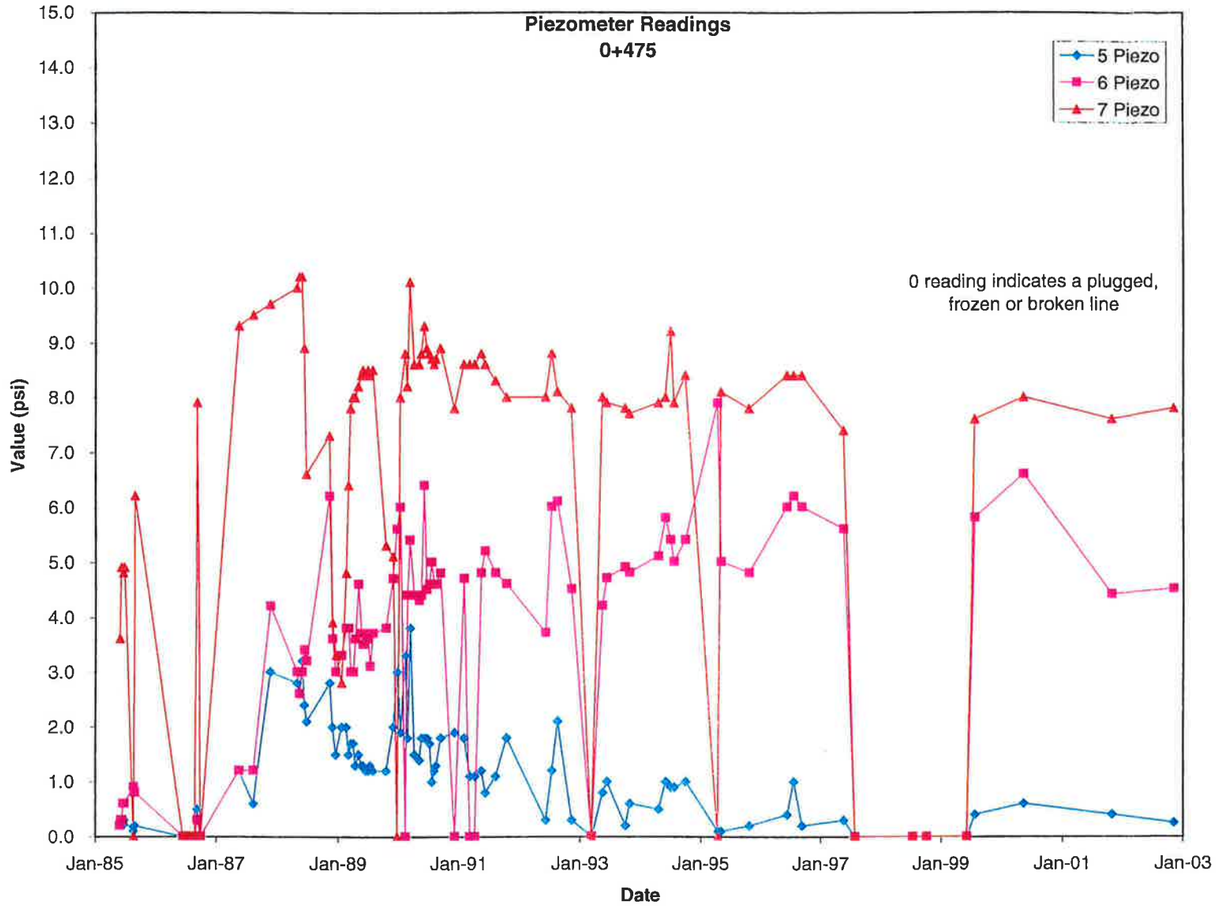
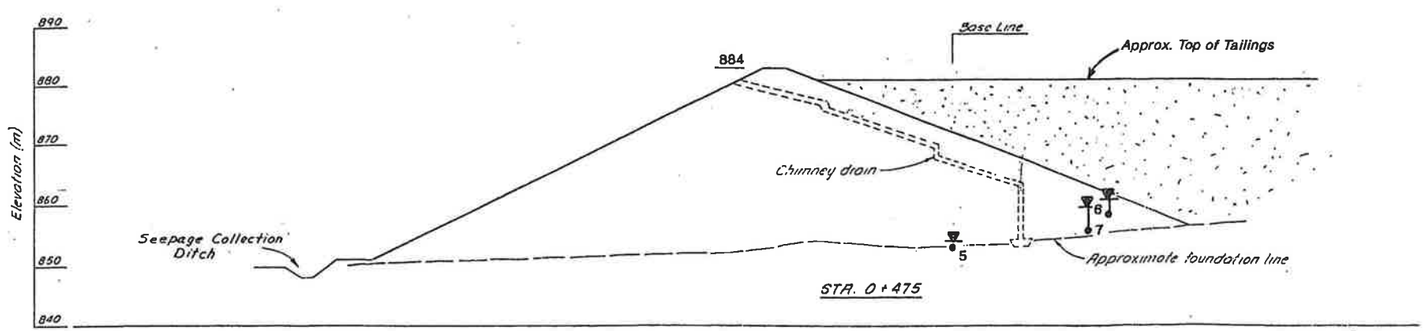
QOC – NORTH TAILINGS DAM
PIEZOMETER DATA – STATION 0 + 300

Figure **B-2**





STATION 0+475

The piezometers at Station 0+475 are located within a vertical plane at horizontal distances of approximately 25 metres from the adjacent finger drains on either side of the plane.

Piezometers 6 and 7 are located on the upstream (pond) side of the Chimney/Core drain at shallow depth below the embankment fill/foundation surface of contact. Piezometer 6 is located within the compacted glacial till fill (impervious zone) on the upstream side of the chimney drain, and Piezometer 7 is located at the fill/foundation contact.

Piezometer No. 5 is located within the foundation soils on the downstream side of the core drain at a shallow depth below the fill/foundation contact.

The piezometric pressures that have been recorded over the past decade indicate that significant head loss occurs as the seepage water passes through the settled tails and through the zone of compacted glacial till fill (the impervious zone) on the upstream side of the chimney drain.

The piezometer data show that the bulk of the section remains well drained. These low piezometric levels contribute to the stability of the embankment section.

NOTES

1. Location of section is shown on Figure B1 of this Appendix.
2. 1 (one) psi of pressure is equivalent to a head of 0.704 metres of water. Plotted piezometric heights above piezometer tips are to scale.
3. Occasional zero readings at a piezometer are an indication that the piezometer leads were frozen or otherwise blocked at the time of the readings.

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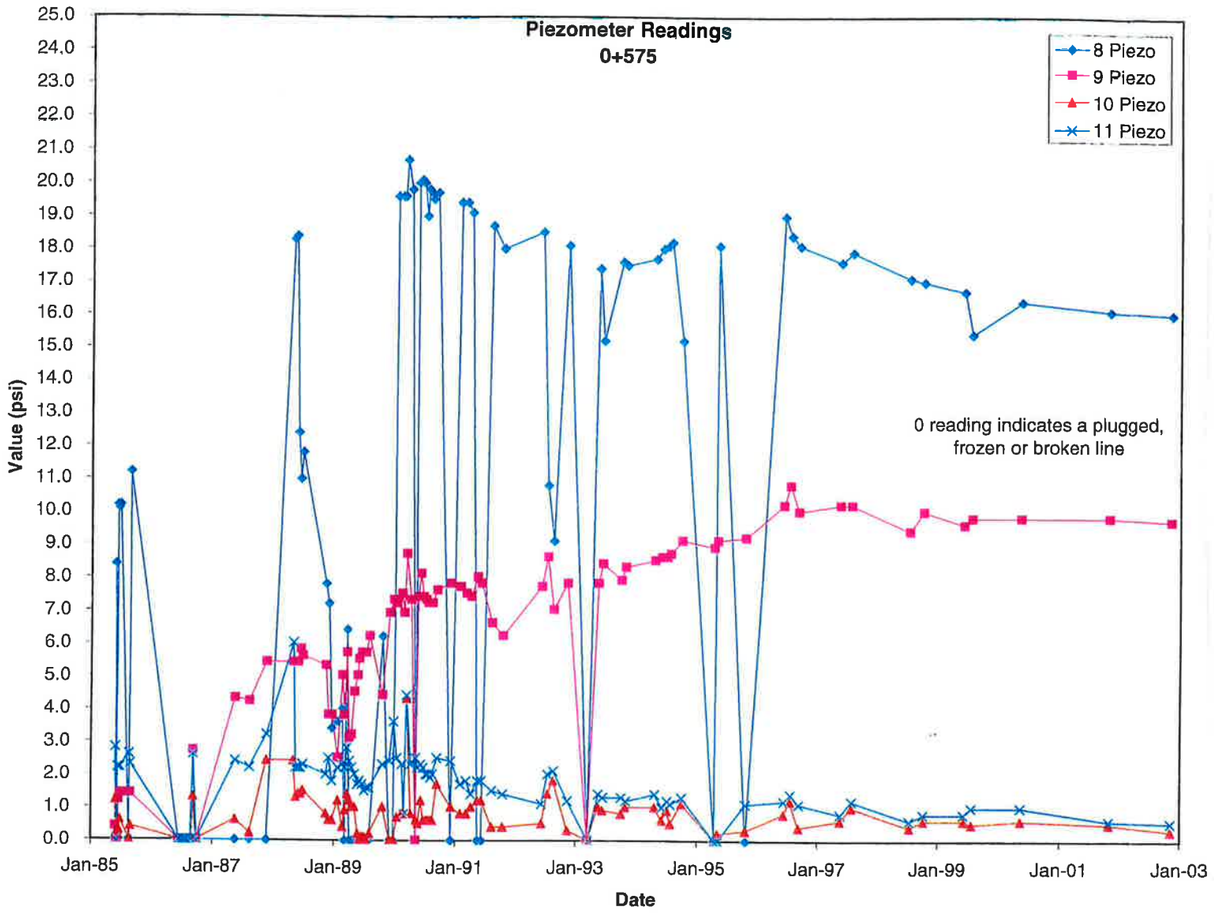
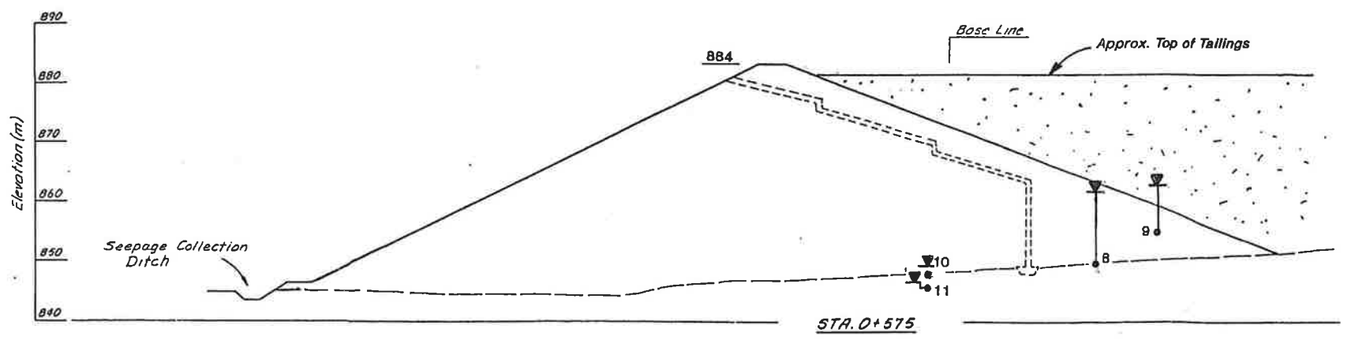
QOC – NORTH TAILINGS DAM
PIEZOMETER DATA – STATION 0 + 475

Figure **B–3**





STATION 0+575

The piezometers at Station 0+575 are located within a vertical plane at horizontal distances of approximately 25 metres from the adjacent finger drains on either side of the plane.

Piezometers 8 and 9 are located upstream (inside) of the Chimney/Core drain. Piezometer No. 8 is at shallow depth below the fill/foundation surface of contact, and Piezometer No. 9 is located within the compacted glacial till fill on the upstream (pond) side of the chimney/core drain.

Piezometers 10 and 11 are located within the foundation soils on the downstream side of the core drain. Piezometer No. 11 is located at shallow depth below the fill/foundation surface of contact, and Piezometer No. 10 is located at the fill/foundation interface.

The piezometric levels at Piezometers 8 and 9 indicate that a significant head loss occurs as seepage passes from the pond, and through the settled tails and the impervious glacial till fill.

The piezometric heads at Piezometers 10 and 11, downstream of the chimney drain, have remained at 1 metre or less over the past 7 years.

The piezometric pressures that have been recorded over the past decade indicate that significant head loss occurs as the seepage water passes through the settled tails and through the zone of compacted glacial till fill (the impervious zone) on the upstream side of the chimney drain. On the downstream side of the chimney drain, the piezometric pressures are insignificant, relative to the stresses imposed by the overlying fill and the settled tails.

The piezometer data show that the bulk of the section remains well drained. The low piezometric levels on the downstream (outside) of the chimney drain contribute to the stability of the embankment.

NOTES

1. Location of section is shown on Figure B1 of this Appendix.
2. 1 (one) psi of pressure is equivalent to a head of 0.704 metres of water. Plotted piezometric heights above piezometer tips are to scale.
3. Occasional zero readings at a piezometer are an indication that the piezometer leads were frozen or otherwise blocked at the time of the readings.

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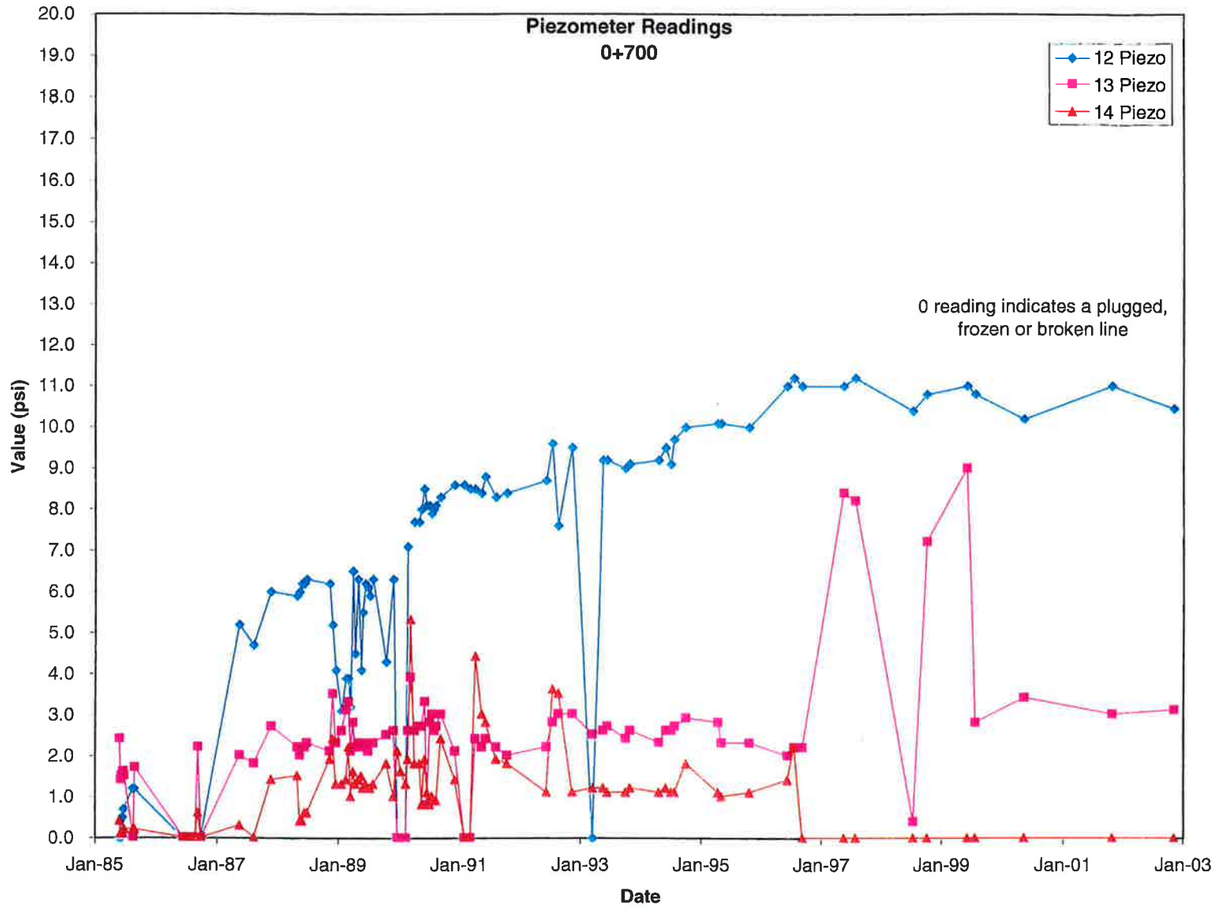
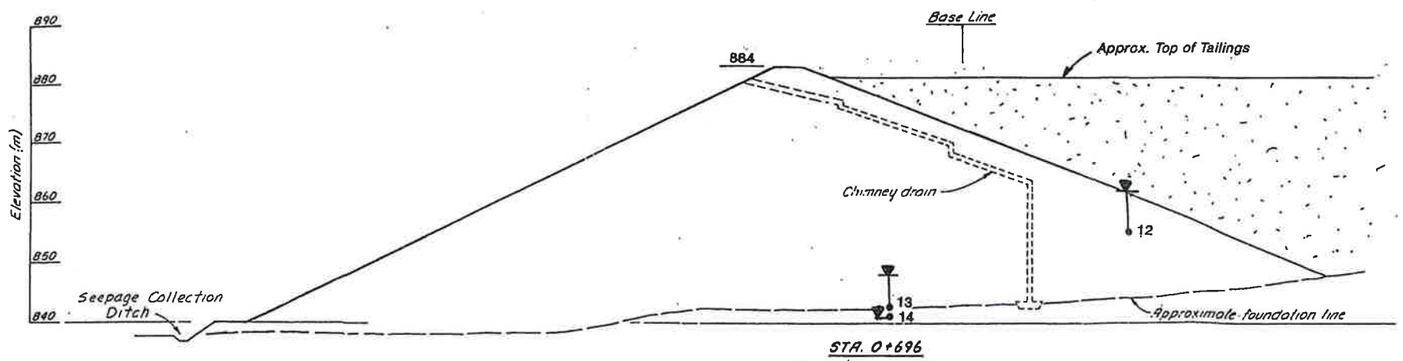
QOC – NORTH TAILINGS DAM
PIEZOMETER DATA – STATION 0 + 575

Figure **B-4**





STATION 0+700

The piezometers at Station 0+696 are located within a vertical plane at horizontal distances of approximately 25 metres from the adjacent finger drains on either side of the plane.

Piezometer 12 is located within the compacted glacial till fill on the upstream (pond) side of the Chimney/Core drain.

Piezometers 13 and 14 are located within the foundation soils on the downstream side of the core drain. Piezometer No. 14 is located at shallow depth below the fill/foundation contact, and Piezometer No. 13 is located at the fill/foundation interface.

The piezometric pressures that have been recorded over the past decade indicate that significant head loss occurs as the seepage water passes through the settled tails and through the zone of compacted glacial till fill (the impervious zone) on the upstream side of the chimney drain. Piezometer No. 12 within the compacted glacial till fill has been constant for the last 4 years.

The piezometer data show that the bulk of the section remains well drained. The low piezometric levels on the downstream (outside) of the chimney drain contribute to the stability of the embankment.

NOTES

1. Location of section is shown on Figure B1 of this Appendix.
2. 1 (one) psi of pressure is equivalent to a head of 0.704 metres of water. Plotted piezometric heights above piezometer tips are to scale.
3. Occasional zero readings at a piezometer are an indication that the piezometer leads were frozen or otherwise blocked at the time of the readings.

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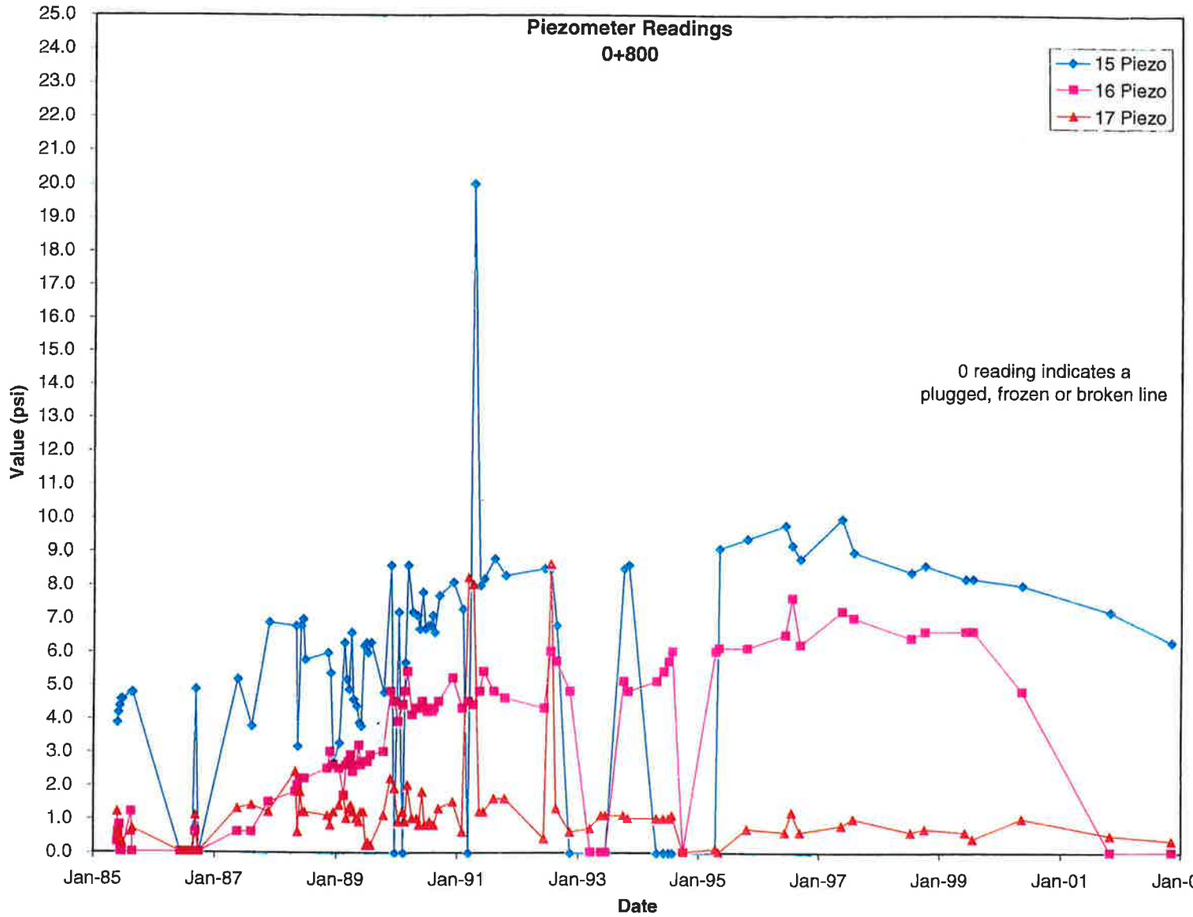
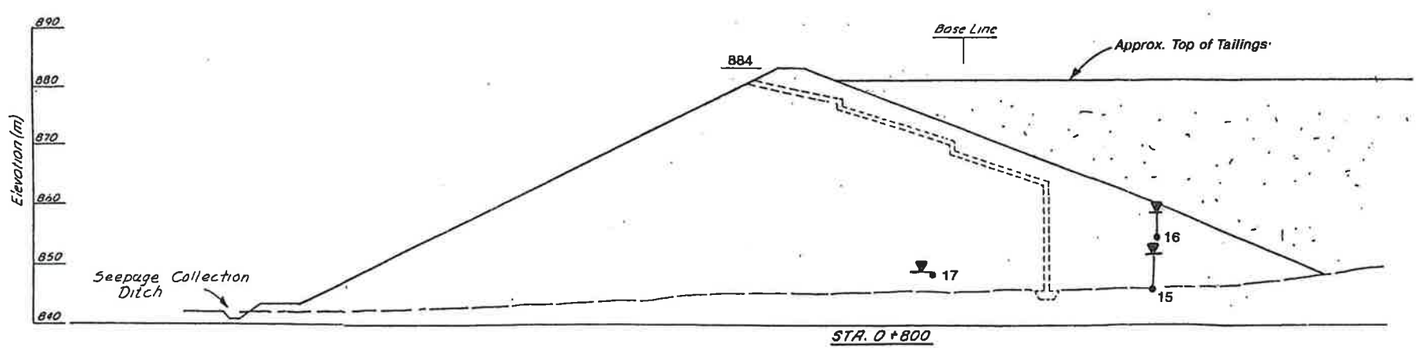
Golder Associates

QOC – NORTH TAILINGS DAM
PIEZOMETER DATA – STATION 0 + 700

Figure **B-5**





STATION 0+800

The piezometers at Station 0+800 are located within a vertical plane at horizontal distances of approximately 25 metres from the adjacent finger drains on either side of the plane.

Piezometers 15 and 16 are located on the upstream (pond) side of the Chimney/Core drain. Piezometer 15 is located at shallow depth below the embankment fill/foundation interface. Piezometer 16 is located within the compacted glacial till fill (impervious zone) on the upstream side of the chimney drain.

Piezometer No. 17 is located within the compacted Coarse Reject fill, at a modest height about the foundation/fill surface of contact.

The piezometric pressures that have been recorded over the past decade indicate that significant head loss occurs as the seepage water passes through the settled tails and through the zone of compacted glacial till fill (the impervious zone) on the upstream side of the chimney drain.

The piezometer data show that the bulk of the section remains well drained. The low piezometric levels contribute to the stability of the embankment section.

NOTES

1. Location of section is shown on Figure B1 of this Appendix.
2. 1 (one) psi of pressure is equivalent to a head of 0.704 metres of water. Plotted piezometric heights above piezometer tips are to scale.
3. Occasional zero readings at a piezometer are an indication that the piezometer leads were frozen or otherwise blocked at the time of the readings.

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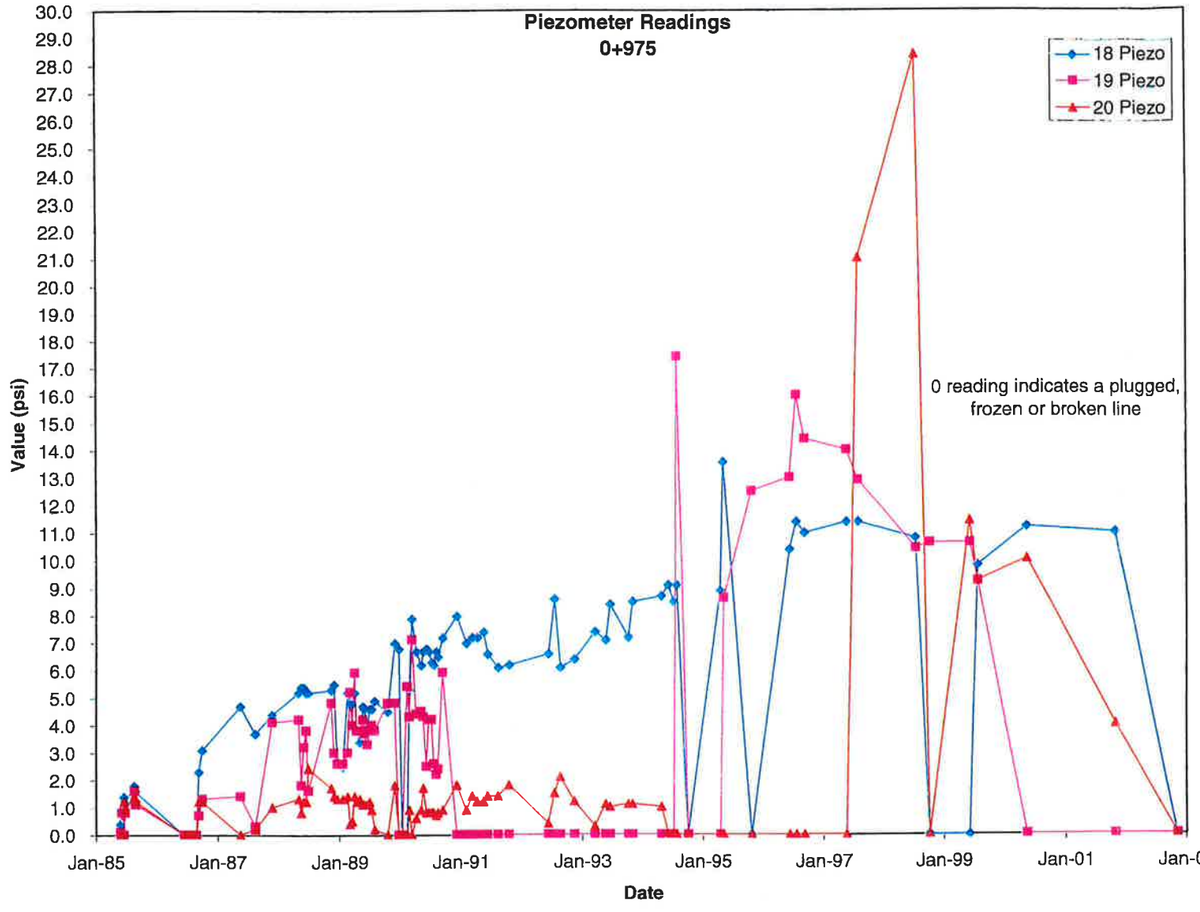
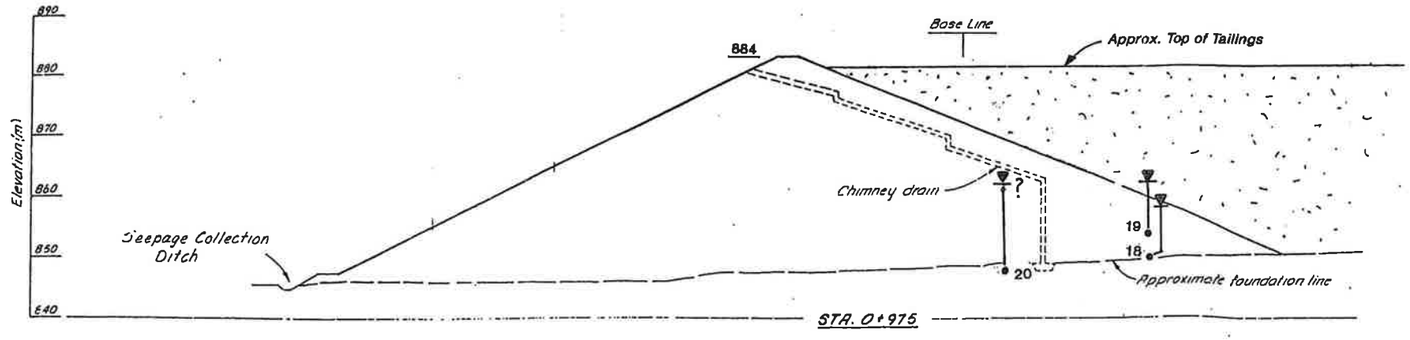
QOC – NORTH TAILINGS DAM
PIEZOMETER DATA – STATION 0 + 800

Figure **B-6**





STATION 0+975

The piezometers at Station 0+975 are located within a vertical plane which is approximately 25 metres horizontally from the adjacent finger drains on either side of the plane.

Piezometers 18 and 19 are located on the upstream (pond) side of the Chimney/Core drain. Piezometer 18 is located at shallow depth below the embankment fill/foundation interface, and piezometer No. 19 is located within the compacted glacial till fill (impervious zone) on the upstream side of the chimney drain.

Piezometer No. 20 is located within the in situ foundation soils, at shallow depth below the base of the compacted embankment fill.

The piezometer data show that the bulk of the section remains well drained. These low piezometric levels contribute to the stability of the embankment section.

NOTES

1. Location of section is shown on Figure B1 of this Appendix.
2. 1 (one) psi of pressure is equivalent to a head of 0.704 metres of water. Plotted piezometric heights above piezometer tips are to scale.
3. Occasional zero readings at a piezometer are an indication that the piezometer leads were frozen or otherwise blocked at the time of the readings.

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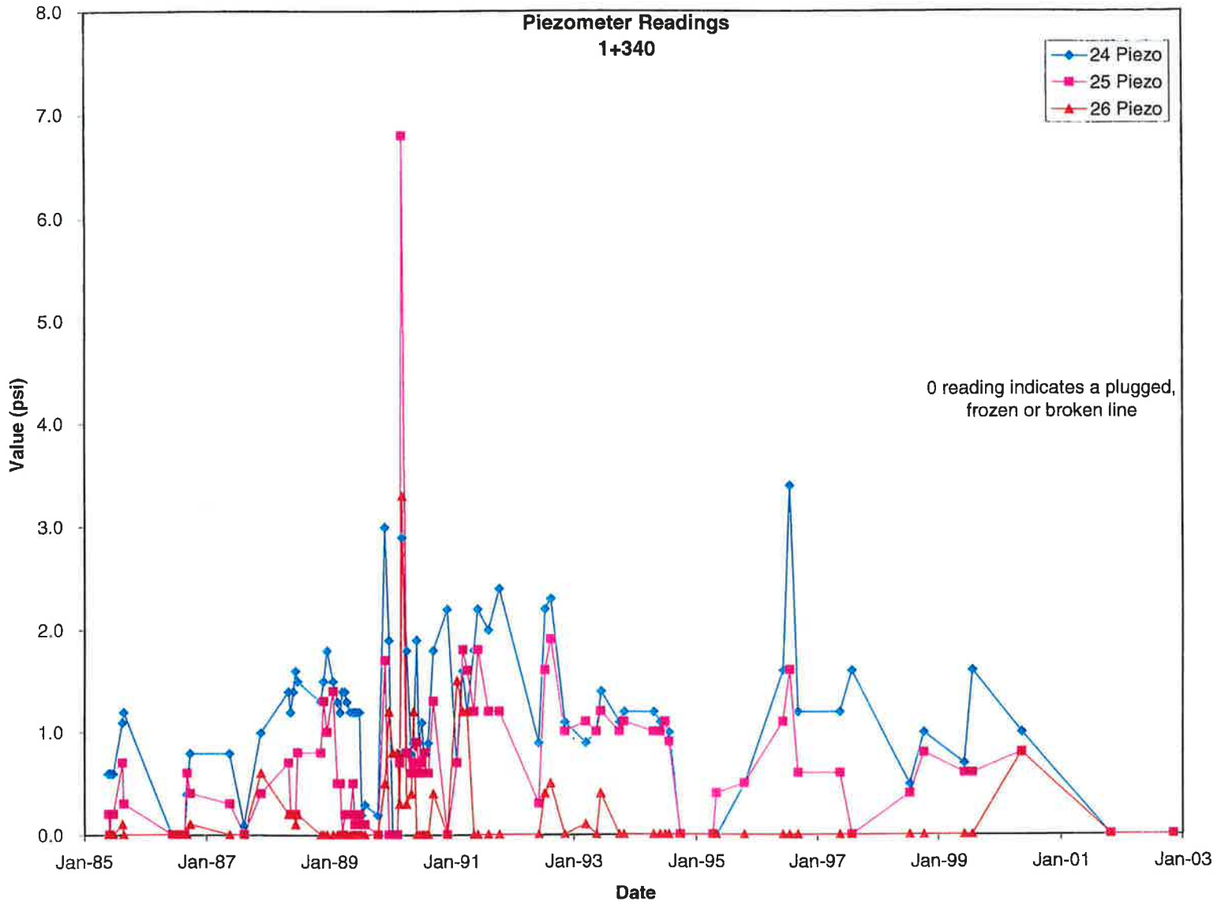
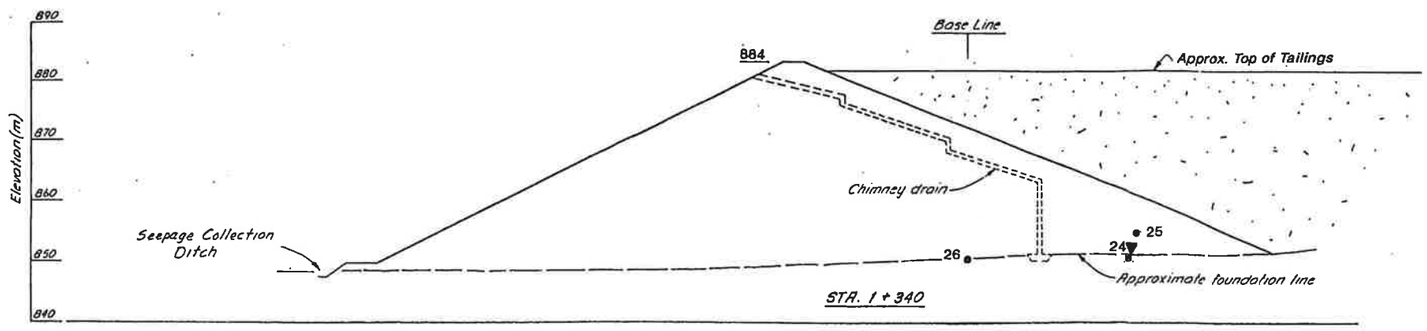
QOC – NORTH TAILINGS DAM
PIEZOMETER DATA – STATION 0 + 975

Figure **B–7**





STATION 1+340

The piezometers at Station 1+340 are located within a vertical plane that is approximately 25 metres from the adjacent finger drains on either side of the plane.

Piezometers 24 and 25 are located on the upstream (pond) side of the Chimney/Core drain. Piezometer 24 communicates with the in situ foundation soils at shallow depth below the embankment fill/foundation interface. Piezometer 25 is located within the compacted glacial till fill (impervious zone) on the upstream side of the chimney drain.

Piezometer 26 is located shallow depth below the fill/foundation surface of contact, on the downstream side of the core drain. This piezometer has not been functional for several years.

NOTES

1. Location of section is shown on Figure B1 of this Appendix.
2. 1 (one) psi of pressure is equivalent to a head of 0.704 metres of water. Plotted piezometric heights above piezometer tips are to scale.
3. Occasional zero readings at a piezometer are an indication that the piezometer leads were frozen or otherwise blocked at the time of the readings.

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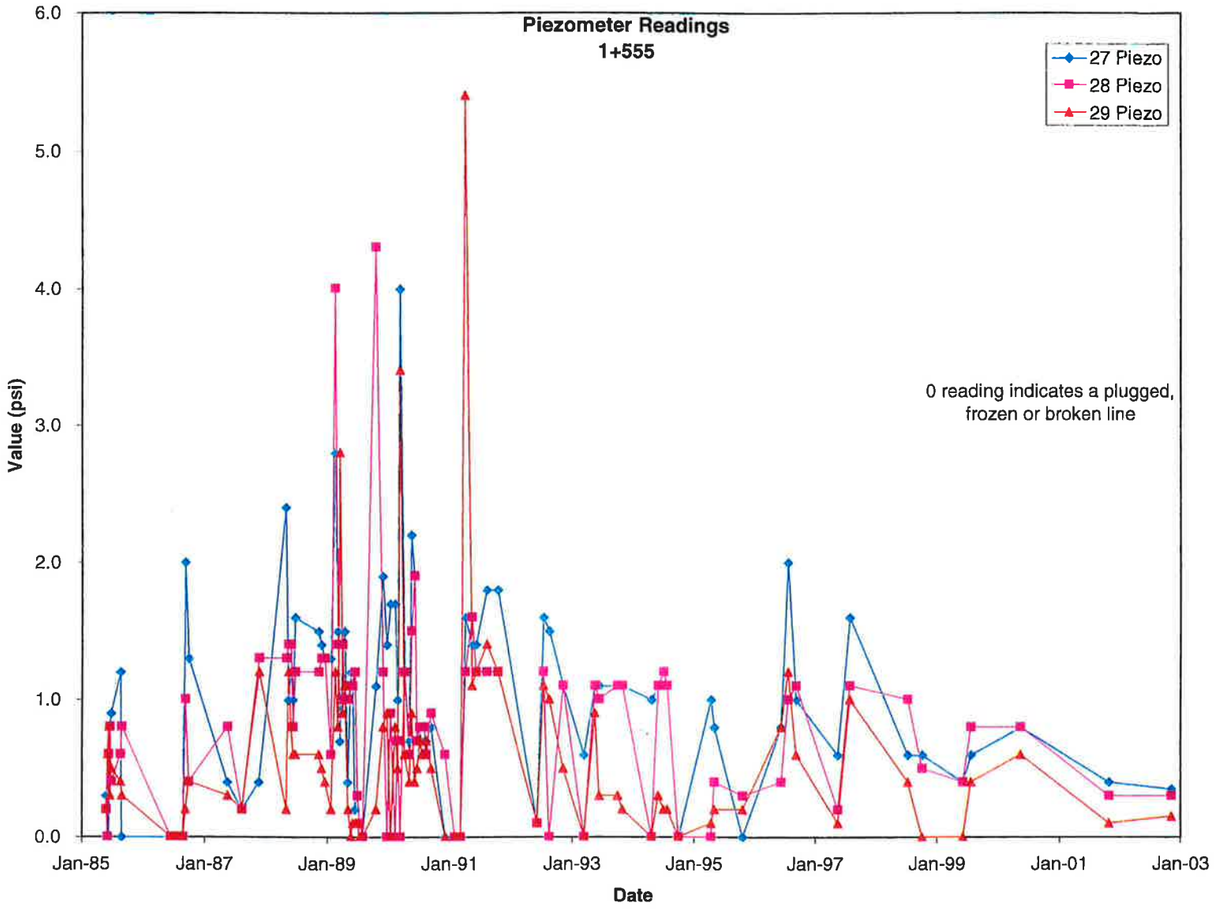
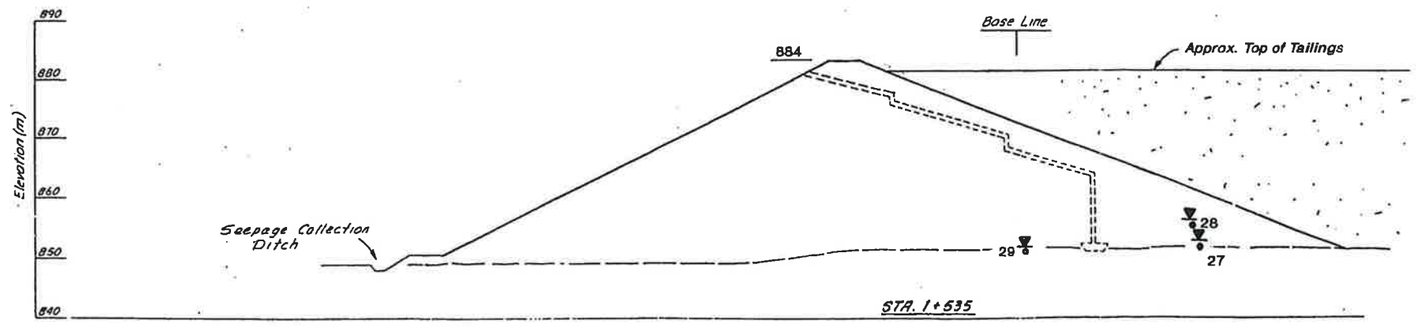
QOC – NORTH TAILINGS DAM
PIEZOMETER DATA – STATION 1 + 340

Figure **B–9**





STATION 1+555

The piezometers at Station 1+535 are located within a vertical plane at horizontal distances of approximately 25 metres from the adjacent finger drains on either side of the plane.

Piezometers 27 and 28 are located on the upstream (pond) side of the Chimney/Core drain. Piezometer 27 communicates with the in situ foundation soils at shallow depth below the embankment fill/foundation interface. Piezometer 28 is located within the compacted glacial till fill (impervious zone) on the upstream side of the chimney drain. Piezometer 29 is lcoated within the foundation soils, on the downstream side of the core drain.

The piezometer data show that the bulk of the section remains well drained. The low piezometric levels contribute to the stability of the embankment section.

NOTES

1. Location of section is shown on Figure B1 of this Appendix.
2. 1 (one) psi of pressure is equivalent to a head of 0.704 metres of water. Plotted piezometric heights above piezometer tips are to scale.
3. Occasional zero readings at a piezometer are an indication that the piezometer leads were frozen or otherwise blocked at the time of the readings.

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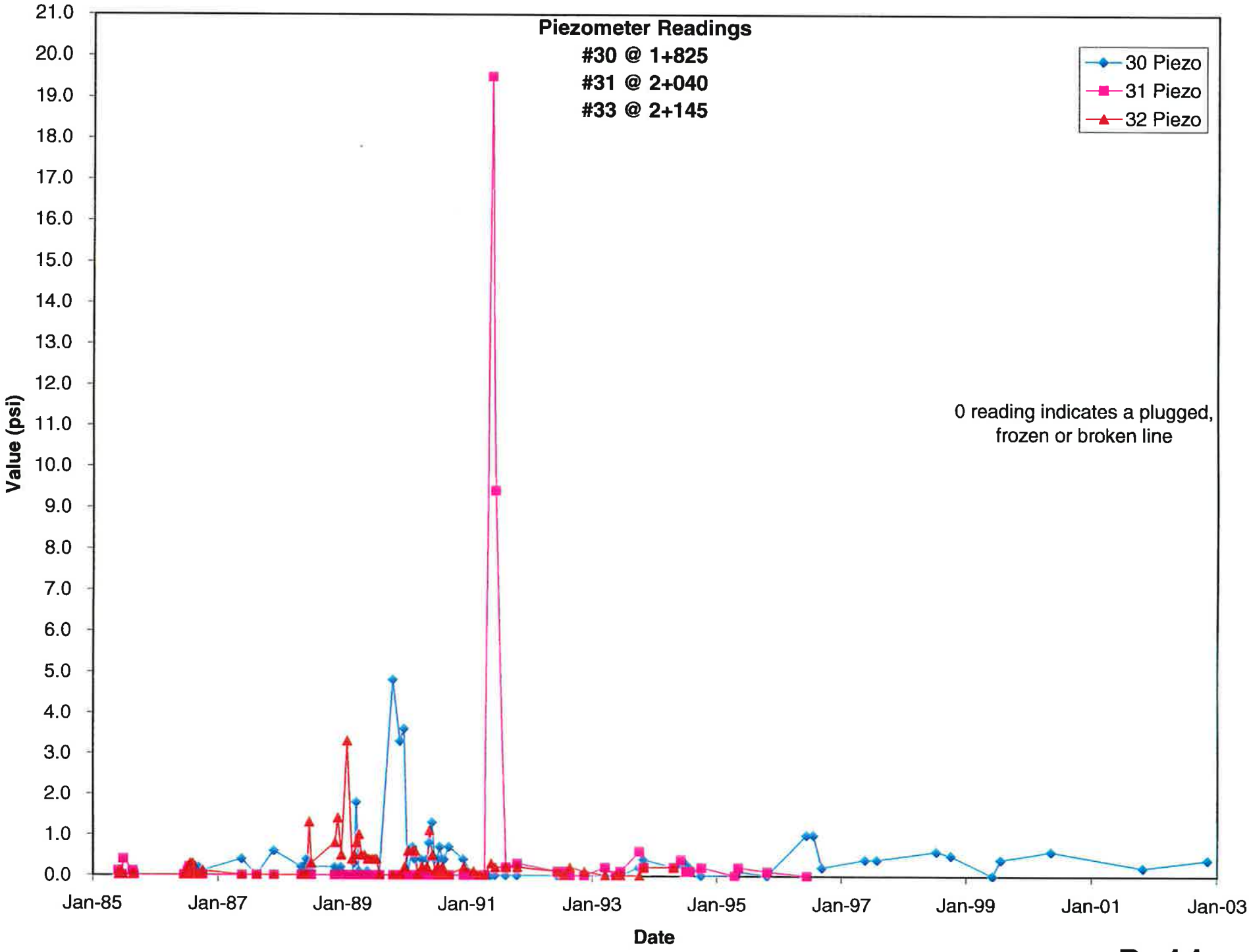
QOC – NORTH TAILINGS DAM
PIEZOMETER DATA – STATION 1 + 555

Figure **B–10**


Piezometer Readings
#30 @ 1+825
#31 @ 2+040
#33 @ 2+145
30 Piezo
31 Piezo
32 Piezo
0 reading indicates a plugged, frozen or broken line
Value (psi)
21.0
20.0
19.0
18.0
17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Date

APPENDIX IV

"Guidelines for Annual Dam Safety Inspection Reports"

Ministry of Energy and Mines

Ministry of Energy & Mines

GUIDELINES FOR ANNUAL DAM SAFETY INSPECTION REPORTS

Reference:

Health, Safety and Reclamation Code for Mines in British Columbia (Code) Section 10.5.3: *The manager shall submit an annual dam safety inspection report prepared by a professional engineer on the operation, maintenance and surveillance of the tailings and water management facilities and associated dams to the chief inspector.*

This Code reference applies to every operating and closed mine in BC.

The report shall provide the following information:

1. Executive Summary

   (a) Classification of the dam(s) in terms of Consequence of Failure in accordance with Table 2-1 of the CDA Dam Safety Guidelines (2007).

   (b) Significant changes in instrumentation and/or visual monitoring records.

   (c) Significant changes to dam stability and/or surface water control.

   (d) For major impoundments, as defined in Part 10 of the Code, a current Operation, Maintenance and Surveillance (OMS) Manual is required. The annual report shall indicate the latest revision date of the OMS manual.

   (e) For tailings dams classified as High, Very High, or Extreme Consequence, an Emergency Preparedness Plan (EPP) is required. The annual report shall indicate the latest revision date of the EPP document.

   (f) Scheduled date for the next formal Dam Safety Review in accordance with Table 5-1 of the CDA Dam Safety Guidelines (2007). Formal Dam Safety Reviews are required every 5 to 10 years (depending on consequence classification) and differ from annual dam safety inspections. The requirements for Dam Safety Reviews are included in Section 5 of the CDA Dam Safety Guidelines. Dam Safety Reviews may be conducted by the Engineer of Record with third party review, or by an independent third party with involvement of the Engineer of Record.

2. Summary of past years' construction (if any) with a description of any problems and stabilization.

3. Plan and representative cross sections.

4. Site photographs.

5. Review of climate data.

6. Water balance review.

7. Freeboard and storage availability (in excess of the design flood).

8. Water discharge system, volumes, and quality.

9. Seepage occurrence and water quality.

10. Surface water control and surface erosion.

11. Instrumentation review including:

    (a) Phreatic surfaces and piezometric data.

    (b) Settlement.

    (c) Lateral movement.

The report shall be submitted by a qualified geotechnical engineer registered as a Professional Engineer (P.Eng.) in British Columbia. The professional engineer will be deemed the Engineer of Record for the facility unless another engineer is identified within the Dam Safety Inspection report as having this responsibility.

Note, this document modified from the original by George Warnock, P.Eng. (Manager, Geotechnical Engineering) in August 2013. Original prepared by Chris Carr, P.Eng. (former Manager) in February 2002.