



**Klohn Crippen Berger**

**Teck Coal Ltd.**

**Quintette Coal operations**

***Shikano North Tailings Dam***

***2014 Dam Safety Inspection***

***Revision 1***

November 26, 2014

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**Mr. Kevin Sharman, P.Ge**  
**Senior Geologist Supervisor**

Dear Mr. Sharman:

**Quintette Coal Operations**  
**Shikano North 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 Shikano North Tailings Dam.

Yours truly,

**KLOHN CRIPPEN BERGER LTD.**



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

RF: cd

# **Teck Coal Ltd.**

## **Quintette Coal operations**

### ***Shikano North Tailings Dam***

### ***2014 Dam Safety Inspection***

### ***Revision 1***

## EXECUTIVE SUMMARY

Klohn Crippen Berger Ltd. (KCB) were engaged by Teck Coal Ltd. (Teck) to complete a dam safety inspection (DSI) for the Shikano North Tailings Dam (SNTD) 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 "Guidelines for Annual Dam Safety Inspection Reports". The inspection was completed by Mr. Rick Friedel (P.Eng.) on July 22, 2014.

The SNTD is considered a Major Dam and a Major Impoundment under the Code. The SNTD has a "Significant" consequence category based on CDA (2007) as reported in the most recent Dam Safety Review (DSR) (KCB, 2014). The next DSR is due in 2023, every 10 years based on CDA (2007). MEM permit C-156 (June 2013) refers to the SNTD as a "High" consequence classification dam assuming active tailings deposition would resume with restart of QCO mining. However, a "Significant" consequence classification is appropriate for the "care and maintenance" status of the dam and there have been no changes to the downstream environment or operation of the structure that would require a revision to this classification. KCB is the Engineer of Record for the SNTD. The SNTD is constructed between two pit walls, with a 200 m long crest and maximum downstream slope height (crest to toe) of 45 m. Tailings deposition was suspended in 2000 before the impoundment reached capacity. There was no construction activity on the SNTD over the past 12 months. There is currently 32 m between the tailings level and dam crest. Surface runoff in the impoundment and catchment collects in a depression on the tailings beach to form a shallow pond which was approximately 70 m away from the dam during the inspection. A spillway is not required based on the large available storage capacity within the impoundment. The run-off from a probable maximum flood (PMF) event, 370,920 m<sup>3</sup>, would raise the pond level by approximately 6.1 m leaving nearly 26 m of freeboard.

The dam is a "flow-through" structure with a coarse rockfill downstream shell and upstream filters. Water seeps through the dam face and discharges to Sediment Pond S3 (S3 Pond) through a low level outlet which is buried in the downstream shell of the dam. A simplified water balance for the facility estimated an average seepage rate of 2 l/s through the dam between October, 2013 and September, 2014. A flow of approximately 5 l/s was observed during the inspection which is above average flow which is expected as seepage from the wet spring period is moving through the system and the average flow estimate includes the winter period when flows are likely zero.

No significant visual changes or indications of developing dam safety concerns were observed during the inspection. Documentation of geotechnical and environmental monitoring for the dam was resumed in 2014. 2014 piezometer readings were below design thresholds and no significant unexpected increases since the previous readings (in 1999) were noted.

Teck drafted an OMS manual and an EPP in 2013 for a recommissioned SNTD with active tailings discharge. The OMS manual needs to be revised to reflect the current "care and maintenance" status of the dam, and the 2013 draft EPP does not need to be finalized because an EPP is not required for "Significant" consequence classification structures such as the SNTD.

The SNTD visually appears in good condition. Comparison with available annual inspection reports indicates there has been no significant change to the condition of the structure since 2000. Recent



piezometer readings show a generally decreasing, favourable trend in pore pressures since mine closure. 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 <sup>(1)</sup> )	Deficiency/ Non-conformance	Regulation or OMS Reference	Recommended Action	Recommended Deadline (Status)
DSI-SN-01 (2013 – Priority 2)	OMS manual is not current.	HSRC Code	Update OMS manual for existing dam condition.	December, 2014 (Underway by Teck)
DSI-SN-02 (2013)	No EPP document.	HSRC Code	Develop EPP for the NSTD.	CLOSED. (EPP not required for “Significant” structure)
DSI-SN-03 (2012)	Incomplete monitoring records.	HSRC Code DSI reporting requirement	Confirm whether the found instrument cables are functional and if possible what instruments they are.	CLOSED. (Reported in this document.)
DSI-SN-04 (2012)	Insufficient monitoring instruments for recommissioning.	n/a	Prior to further tailings disposal, install piezometers and survey monuments to resume pore pressure and movement monitoring of the SNTD.	CLOSED. (existing instrumentation suitable for “care and maintenance” status)
DSI-SN-05 (2012)	No flow or water quality measurements of seepage.	HSRC Code DSI reporting requirement)	Monthly monitoring of flow rate and collect samples for water quality (total suspended solids) of the outflow from the low level outlet.	CLOSED. Recommendation now superseded by amended MOE permit.
DSI-SN-06 (2013)	Insufficient safety berms along SNTD access road.	HSRC Code	This is not a dam safety concern; however, it is recommended to upgrade the safety berms between the mine access road and the southeastern boundary of the impoundment.	CLOSED. Teck report this was completed in August, 2014.
DSI-SN-07 (New – Priority 4)	Undocumented visual monitoring records.	HSRC Code	Create a form or system to document visual inspections of NSTD during each water sample collection of S3 Pond.	May, 2015
DSI-SN-08 (New – Priority 3)	Incomplete monitoring record.	HSRC Code	Include piezometers at P95KC-2A/2B in annual monitoring.	Complete during 2015 instrument readings.
DSI-SN-09 (New – Priority 3)	Survey monitoring data	n/a	Complete 3 survey readings in 2015. Confirm whether current survey method can provide suitable accuracy for this purpose.	(1) before May 30, 2015 (2) between July and August, 2015 (3) between September and November, 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 selected dam structures on the Quintette Coal mine site. The Quintette Coal 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 Shikano North Tailings Dam (SNTD) which was completed by Mr. Rick Friedel (P.Eng.) on July 22, 2014 between 11:30 am and 2:30 pm. During the DSI the weather was cloudy with sunny periods and no precipitation. Refer to Figure 1 for an overview of the facility with inspection waypoints.

The inspection and this report were prepared 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 “Guidelines for Annual Dam Safety Inspection Reports” (Appendix III).

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

- 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).

Fine coal tailings from restart operations would be discharged into the Shikano North Tailings Storage Facility. However, as of late 2014, Teck has deferred the restart of operations at the Quintette site pending an improvement in market conditions.

The SNTD is considered a Major Dam and Major Impoundment under the Code. The SNTD has a “Significant” consequence category based on CDA (2007) as reported in the most recent Dam Safety Review (DSR) (KCB, 2014). MEM permit C-156 (June 2013) refers to the SNTD as a “High” consequence classification dam which was assigned assuming tailings deposition in the SNTD impoundment would resume with restart of QCO mining. The “High” consequence classification was appropriate because of the potential for increased downstream effects in the event of a SNTD failure with the tailings and pond volumes near ultimate capacity. However, a “Significant” consequence classification is appropriate for the “care and maintenance” status of the dam.

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

## 2 BACKGROUND AND RECENT ACTIVITY

The SNTD is located approximately 2 km north of the existing plantsite and gatehouse. The dam is constructed across the mined-out Shikano North Pit to form the impoundment for the Shikano North Tailings Storage Facility. The tailings dam is a “flow-through” rockfill embankment with internal granular filters and a non-woven geotextile filter fabric to restrict fine coal tailings passing through the dam. The maximum downstream slope height (toe to crest) of the structure is 45 m.

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

- Klohn Crippen (1996). “Shikano North Tailings Impoundment – Pervious Tailings Dam Option Design Report”, February 9.
- Klohn Crippen (1997). “Shikano North Tailings Impoundment – 1996 As-Built Report”, March 14.
- Klohn Crippen (1999a). “Shikano North Tailings Impoundment – 1999 Annual Review”, December 6.
- Klohn Crippen (1999b). “Shikano North Tailings Impoundment – Stage 2 As-built Report”, July 9.
- Klohn Crippen Berger (2012a). “Quintette Coal Project: Shikano North Tailings Storage Facility Expansion - March 2012 Feasibility Update” March 19.
- 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). “Shikano North Tailings Dam - 2013 Dam Safety Inspection Report” December 18.
- Klohn Crippen Berger (2014). “Quintette Dam Safety Review: Shikano North Tailings Storage Facility”, May 27.

The SNTD design was completed by Klohn Crippen Consultants Ltd (KC, 1996). Construction record reports were issued for Stage I raise (KC, 1997) and Stage II raise (KC, 1999b). The impoundment was commissioned in 1997 when the Plantsite tailings facility reached capacity. No significant construction or performance related issues were noted in the as-built document (KC, 1999b) or the 1999 DSI report of the dam (KC, 1999a) prior to suspension of operations in 2000. The design cross section of the Shikano North tailings dam is included in Appendix II. The current dam crest, measured from 2014 survey monument pins, is elevation 828 m and existing tailings level approximately elevation 796 m based on a 2010 LiDAR survey of the Quintette site (provided by Teck, survey completed by McElhanney Consulting Services Ltd.).

No construction has been completed on the dam since operations were suspended in 2000 and none are planned for the duration of the current “care and maintenance” status during which there will be no tailings discharge. If the restart operations proceed in the future, the downstream low-level outlet would be decommissioned and replaced with a network of pumping wells.

### 3 WATER MANAGEMENT

The catchment area for the SNTD impoundment is 78.5 ha including the tailings beach and pond area (15.4 Ha). During operations, tailings were discharged from the eastern edge of the impoundment which formed a tailings beach slope towards the embankment. Excess water would pond against the dam face and seep through the upstream filters. Post-operations consolidation of the tailings beach has created a shallow depression in the tailings beach surface where water ponds approximately 70 m offset from the dam (Photo I-12). The pond area and stored volume is less than during the 2012 or 2013 DSIs. An outflow channel in the tailings beach conveys water to the dam face where it seeps into the upstream rockfill shell (Photo I-17).

Seepage through the embankment accumulates in the coarse rockfill downstream shell of the dam. A 750 mm perforated corrugated steel pipe (CSP) was buried in the coarse rockfill (invert El. 777.9 m) and connected to a 750 mm solid pipe section which was buried beneath the haul road downstream and discharges into a channel that flows into Sedimentation Pond S3 (S3 Pond) (KC, 1996). SNTD seepages discharges to and flows through the S3 Pond before being released to the environment. Discharge from the S3 Pond is a monitoring location listed in the MOE Permit 6739 which includes quarterly water quality (suspended solids and metals) and weekly flow measurements between April and October of each year. There is no existing discharge from the SNTD to the M11/M15 Channel therefore no monitoring is required as specified in the MOE Permit 6739.

Precipitation data from October, 2013 to September, 2014 (367.7 mm) for the SNTD is summarized in Table 3.1. 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).

**Table 3.1 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. Oct 2013 to April 2014 - Not measured on site, interpreted from Chetwynd Airport climate station (ID: 1181508), with elevation correction from KCB (2012b).

Post-operations, inflows to the impoundment are predominately from surface water runoff with limited observed contribution from pit wall seepage. Outflows from the impoundment are predominately seepage through the “flow-through” embankment and evaporation from the pond. The size of the pond has been observed to change seasonally indicating there is some retention and attenuation capacity within the impoundment. However, total water that enters the impoundment either leaves the impoundment via evaporation or seepage.

A simplified water balance calculation for the SNTD impoundment for the period of October, 2013 to September, 2014 is summarized below:

- Inflows:
  - ◆ Precipitation on pond surface =  $5,663 \text{ m}^3$  (assumed pond surface on average is 10% of tailings beach); and
  - ◆ Runoff from tailings beach (excl. pond area) =  $20,385 \text{ m}^3$  (assumed average runoff coefficient of 0.4); and
  - ◆ Runoff from upstream catchment =  $90,454 \text{ m}^3$  (assumed average runoff coefficient of 0.4).
- Outflows:
  - ◆ Evaporation from pond surface =  $8,470 \text{ m}^3$  (evaporation rate for this site 550 mm/yr (KCB,2013a); and
  - ◆ Seepage losses from the impoundment =  $108,032 \text{ m}^3$  (the remainder of inflows minus evaporation).

The seepage losses from the impoundment are estimated at an average flow rate of 3.4 L/s over the 12 month period. The estimated flow rate during the DSI (5 L/s), Photo I-6 and Photo I-7, is above average flow which is expected as seepage from the wet spring period is moving through the system and the average flow estimate includes the winter period when flows are likely zero. The water balance is within the expected performance range for the “flow-through” design and there are no planned changes to surface water management that would alter this observation.

During flood events, the runoff accumulates in the basin and seeps through the embankment. The inflow design flood (IDF) for a “Significant” consequence dam is between the 100 year and 1000 year return period event (CDA, 2007). No spillway was constructed based on the large available storage capacity within the impoundment (currently approximately 32 m between the tailings surface and dam crest). The run-off from a probable maximum flood (PMF) event,  $370,920 \text{ m}^3$ , would raise the pond level by approximately 6.1 m leaving nearly 26 m of freeboard.

## 4 REVIEW OF MONITORING RECORDS AND DOCUMENTS

### 4.1 Monitoring Plan

Teck drafted an Operations, Maintenance and Surveillance (OMS) manual in 2013 for the SNTD (Teck, 2013) assuming the facility would be recommissioned and that tailings deposition would resume during 2014 or 2015. This document was prepared to comply with CDA (2007) and MAC (2011) requirements. However, the draft OMS manual is not appropriate for the current “care and maintenance” status of the dam and requires an update. Teck advised that the update is underway and will be available in December 2014. The updated document is still required to meet the requirements specified in CDA (2007) and KCB recommends following the format proposed in MAC (2011).

The current OMS document was not used when comparing compliance of monitoring records as the requirements are not appropriate for the “care and maintenance” status of the SNTD.

### 4.2 Inspections

Documented physical inspections of the SNTD are being completed annually (the DSI described in this report). Given the long performance history of the SNTD and the consequence classification (Significant), annual DSIs are sufficient for formal inspection requirements. The OMS should include an allowance for routine surveillance and “event-driven” inspections following flood or seismic events.

Site staff currently visit the SNTD area for periodic water sampling and flow monitoring at the S3 Pond (Section 4.5). KCB recommends that the OMS manual include documenting visual observations of the SNTD downstream area (eg. checklist) as part of the S3 Pond sampling routine.

### 4.3 Pore Pressures

Pore pressure measurements were collected on July 25, 2014 (during DSI) and October 8, 2014 from the piezometers installed in the dam. Figure 2 summarizes measurements and presents measured water levels on a cross section through the SNTD. The following observations are made based on the data:

- Instruments are accessible and functioning with the exception of:
  - ◆ P96-1 and P96-2 instrument leads were not accessible or the instruments have been removed from drill casing.
  - ◆ P96-4 instrument cable was noted as plugged in KC (1999a) and the instrument did not give an appropriate reading (+450 kPa), so it has been disregarded.
  - ◆ P98-1 and P98-2 were not found.
- P95KC-2A/2B drill casing was located but instruments not tested. These readings should be included in the next DSI site visit.



- All measured piezometers have lower pore pressure than the last reading from October, 1999 with the exception of P96-9 and P96-10 which are both recording pore pressures above the pond and tailings level.
- In general October 2014 readings were less than July 2014. Also, the variability between pore pressures measured in July 2014 for piezometers installed at the same elevation (e.g. P96-5 and P96-6), was not present in the October 2014 reading.
- The pore pressure measured for piezometers at the same elevation upstream of the filter zones show a downward gradient in the upstream rockfill zone. This behaviour was observed during operations (KC, 1999a) and is likely caused by migration of fine tailings into the upstream rockfill zone lowering the permeability of the material. The pore pressures are not considered to be connected to the more recent development of sinkholes in the tailings beach.
- The reason why the measured pressure for P96-9 and P96-10 is above the current pond and tailings level is not known. The October 2014 readings were also above the tailings level but P96-10 pore pressure was 1.7 m less than the July, 2014. There is no visible seepage from the upstream face indicating a raised water level in the dam and P96-3 indicates the water level in the dam fill is below tailings level. Instrument error or locally entrained water around the instrument tip are the most likely causes for the readings. No follow up action is recommended to resolve this issue.
- All measured piezometers are below the “threshold levels” reported in KC (1999a).

The piezometer readings indicate no change from historical performance and are below design threshold levels. KCB recommends annual piezometer readings during the “care and maintenance” period. Piezometer readings should be available for review during future DSIs.

#### 4.4 Survey Monument Pins

Surveying of the monuments along the SNTD dam crest was resumed in 2014 with surveys done on April 29<sup>th</sup> and October 10<sup>th</sup> (refer to Table 4.1). The most recent survey prior to 2014 was in 1999 (KC, 1999a). A review of the 2014 readings to the old surveys indicates a change in the survey datum so a comparison of the 1999 and 2014 Northing and Easting coordinates is not appropriate. Based on the 2014 survey, the elevations of the monitoring pins have lowered 1.1 m to 1.2 m (6 mm to 7 mm per month) since 1999. Available visual inspections made over that period, establish that no significant slope movements have occurred (eg. slumping, cracking, bulging at toe).

**Table 4.1 SNTD 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	626041.8	6095161	828.527	626041.8	6095161	828.494	-0.014	-0.006	0.033
CP2	626090.1	6095211	828.100	626090.1	6095211	828.055	-0.029	0.024	0.045
CP3	626119.2	6095241	828.147	626119.2	6095241	828.111	-0.032	0.021	0.036
CP4	626145.4	6095268	828.003	626145.4	6095268	827.946	-0.023	0.029	0.057



A comparison of the April and October survey data show higher than expected movements: 30 mm to 60 mm of settlement (6 mm to 10 mm per month); and up to 30 mm of horizontal movement. Such rates of movement are not typical for compacted rockfill embankments of this age and with no tailings deposition since 2000. 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 SNTD 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 SNTD monuments should be completed in 2015.

## 4.5 Water Quality

A water quality monitoring point included in MOE Permit No. 6739 is the outflow from S3 Pond downstream of the SNTD. Monitoring at S3 Pond which came into force with the July 9<sup>th</sup> permit amendment includes:

- Weekly: Flow rate (April 1 to October 31)
- Quarterly: Field turbidity; Lab turbidity and total suspended solids; 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. The water quality of the S3 Pond outflow is not representative of SNTD seepage because surface water from other catchments also report to S3 Pond. Teck confirm there have been no non-conformances and that monitoring frequency meets the permit requirements.

## 5 VISUAL OBSERVATIONS AND PHOTOGRAPHS

The following observations were made during the DSI:

- **Historic Slumping of Pit Wall:** a historic slumping failure is present on the eastern side of the impoundment (Photo I-5) in the old pit wall. No significant change was observed in the area since the 2012 DSI.
- **Dam Crest:** Good condition. No signs of lateral movement, significant differential settlement or cracking of the dam crest (Photo I-13).
- **Downstream Slope:** Good condition. No visible signs of significant erosion or displacement and no vegetation cover (Photo I-15).
- **Upstream Slope:** Good condition. No visible signs of significant erosion or displacement and no vegetation cover (Photo I-21).
- **West Abutment:** Good condition. No visible signs of significant erosion or displacement of the pit wall (Photo I-19 and Photo I-20).
- **East Abutment:** Good condition. No visible signs of significant erosion or displacement of the pit wall (Photo I-14 and Photo I-18).
- **Tailings Impoundment:** The impoundment area was sparsely vegetated near the pond and dam. Away from the pond the tailings surface is well drained and supports human traffic (Photo I-2 and Photo I-12). The pond volume was smaller than observed during the 2012 or 2013 DSIs. The pond was set back approximately 70 m from the upstream slope of the dam.
- **Sinkhole Depressions in Tailings Beach:** A cluster of three sinkholes were observed on the tailings beach (Photo I-16). These features have been noted since the 2010 DSIs but the time which they started to form is not known. There was a notable increase in size between the 2012 and 2013 DSIs but a less significant increase in size noted in 2014. The largest of the holes was approximately 7 m by 3 m and 1.5 m deep. The cause of these features is most likely migration of tailings into the upstream coarse rockfill shell which is upstream of the filters. This is a local condition and does not indicate piping through the internal filter zones in the dam. No action in addition to monitoring during ongoing DSIs is required at this time.
- **Erosion at southern edge of basin:** At the southeastern boundary of the impoundment, runoff flows into the impoundment through gaps in the roadside safety berms (Photo I-3). This has resulted in progressive erosion that is encroaching on the access road through this area (Photo I-4). The erosion features are approximately 4 m away from the road surface (same as noted during 2013 DSI). This does not pose a dam safety risk but additional safety berms or some other barrier between these erosion features and the roadway is recommended (Teck report this was completed in August, 2014).

## 6 ASSESSMENT OF DAM SAFETY

The consequence classification for the SNTD is “Significant” based on KCB(2014). There have been no changes to the downstream environment or operation of the structure since KCB (2014) that justify a revision to the consequence classification.

The dam safety management documents, specifically the OMS manual, for the SNTD needs to be updated to reflect the current “care and maintenance” status of the dam.

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

- **Overtopping:** Given the large freeboard available in the dam (approximately 26 m after a PMF event) and “flow-through” design, the probability of overtopping failure is considered to be negligible.
- **Internal Erosion and Piping:** The dam is a “flow-through” design with a rockfill core, two upstream filter zones and a geotextile. Filter performance has been demonstrated by clear seepage from the low level outlet and retention of fine tailings in the impoundment during operations and “care and maintenance” periods. Sinkholes observed in tailings beach will be monitored for changing conditions during annual DSIs. They are most likely a local condition where tailings are migrating into the upstream coarse rockfill shell, not the internal filters.
- **Slope Instability:** The dam is a coarse rockfill structure founded on bedrock at the base and abutments. The downstream slope of the dam is 2 horizontal to 1 vertical. Slope stability analysis in the design (KC, 1996) had safety factors greater than 1.6 under the full pond and tailings levels which complies with CDA (2007) recommendations for this type of structure. 2014 piezometer readings indicate that the pore pressures in the dam are below design threshold. The safety factor under the current tailings and pond levels will be greater than the ultimate design condition and the probability of failure due to slope instability is very low.
- **Foundation Irregularities:** The dam is constructed across an old open pit and is founded on rock. In the design, a risk of failure along weak planes in the abutment rock was identified and slope inclinometers were installed to monitor. No significant movement was observed in the inclinometers which were monitored until 1998. The probability of failure due to foundation irregularities is very low.
- **Surface Erosion:** Both the upstream and downstream slopes of the dam are covered with a coarse rockfill to protect against surface erosion. The probability of failure due to surface erosion is very low.
- **Earthquakes:** Stability of the dam under seismic loading was reviewed as part of the design (KC, 1996) for a seismic acceleration (0.15g) greater than the 2500 year return period acceleration based on the National Building Code of Canada (NBCC, 2005, 2010). The dam was noted to not be susceptible to failure or significant deformation during seismic events.

The SNTD visually appears in good working condition and the observed performance is consistent with the expected design conditions. Comparison of available annual inspection reports and piezometer measurements indicate there has been no significant change to the condition of the structure since 2000. 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 <sup>(1)</sup> )	Deficiency/ Non-conformance	Regulation or OMS Reference	Recommended Action	Recommended Deadline (Status)
DSI-SN-01 (2013 – Priority 2)	OMS manual is not current.	HSRC Code	Update OMS manual for existing dam condition.	December, 2014 (Underway by Teck)
DSI-SN-02 (2013)	No EPP document.	HSRC Code	Develop EPP for the NSTD.	CLOSED. (EPP not required for “Significant” structure)
DSI-SN-03 (2012)	Incomplete monitoring records.	HSRC Code DSI reporting requirement	Confirm whether the found instrument cables are functional and if possible what instruments they are.	CLOSED. (Reported in this document.)
DSI-SN-04 (2012)	Insufficient monitoring instruments for recommissioning.	n/a	Prior to further tailings disposal, install piezometers and survey monuments to resume pore pressure and movement monitoring of the SNTD.	CLOSED. (existing instrumentation suitable for “care and maintenance” status)
DSI-SN-05 (2012)	No flow or water quality measurements of seepage.	HSRC Code DSI reporting requirement	Monthly monitoring of flow rate and collect samples for water quality (total suspended solids) of the outflow from the low level outlet.	CLOSED. Recommendation now superseded by amended MOE permit.
DSI-SN-06 (2013)	Insufficient safety berms along SNTD access road.	HSRC Code	This is not a dam safety concern; however, it is recommended to upgrade the safety berms between the mine access road and the southeastern boundary of the impoundment.	CLOSED. Teck report this was completed in August, 2014.
DSI-SN-07 (New – Priority 4)	Undocumented visual monitoring records.	HSRC Code	Create a form or system to document visual inspections of NSTD during each water sample collection of S3 Pond.	May, 2015
DSI-SN-08 (New – Priority 3)	Incomplete monitoring record.	HSRC Code	Include piezometers at P95KC-2A/2B in annual monitoring.	Complete during 2015 instrument readings .
DSI-SN-09 (New – Priority 3)	Survey monitoring data	n/a	Complete 3 survey readings in 2015. Confirm whether current survey method can provide suitable accuracy for this purpose.	(1) before May 30, 2015 (2) between July and August, 2015 (3) between September and November, 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.

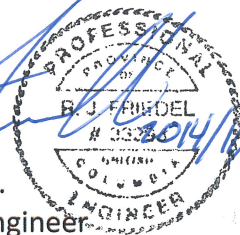
## 7 CLOSING

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 the 2014 Dam Safety Inspection. 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  
Manager, Engineering



## REFERENCES

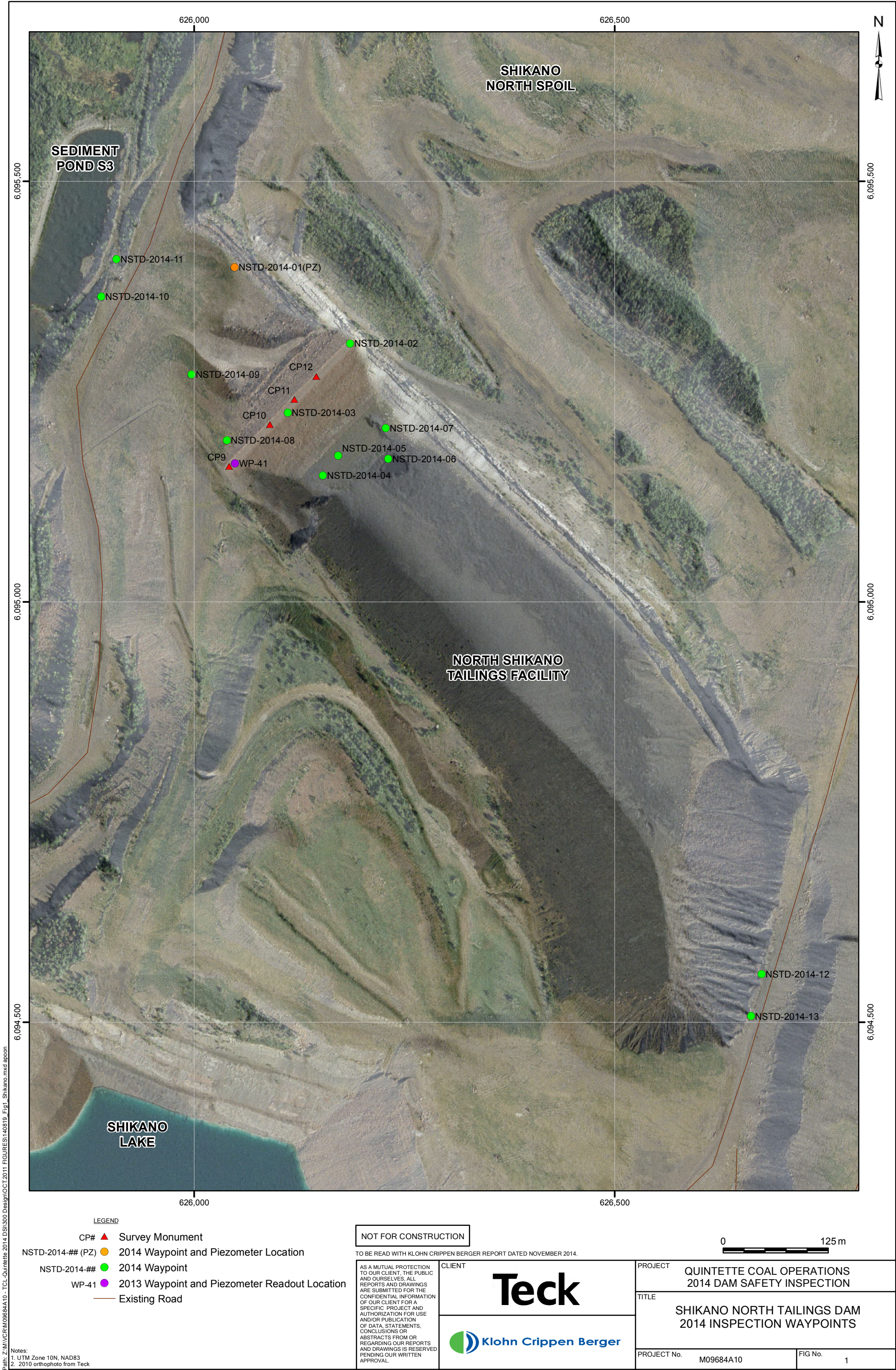
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## FIGURES

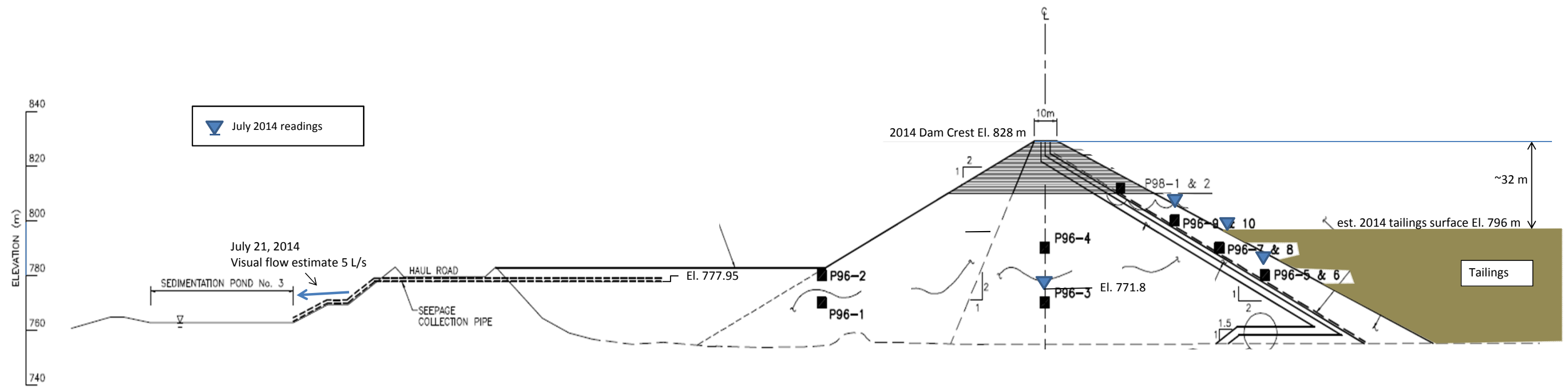
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- |          |  |
|----------|--|
| Figure 1 | Shikano North Tailings Dam 2014 Inspection Waypoints |
| Figure 2 | Shikano Tailings Dam Piezometer Readings             |









Instrument ID	Jul.2014 Reading (kPa)	Pressure		Threshold El. (m) (Note 5)	Tip El. (m)	Instrument Indicator	Previous Reading Oct.1999 (Note 4)	
		Head (m)	El. (m)				El. (m)	Change
P96-1	No 2014 measurement, surface casing found but no instrument cables present.							
P96-2	No 2014 measurement, surface casing found but no instrument cables present.							
P96-3	18	1.8	771.8	786	770	3 tape wraps near lead	780	-8.2
P96-4	No 2014 measurement, noted as plugged in historical readings.							
P96-5	3	0.3	780.3	790	780	5 tape wraps near lead	792	-11.7
P96-6	46	4.7	784.7	790	780	6 tape wraps near lead	788	-3.3
P96-7	34	3.5	793.6	800	790	7 tape wraps near lead	795	-1.4
P96-8	2	0.2	790.4	800	790	8 tape wraps near lead	794	-3.6
P96-9	2	0.2	800.2	805	800	9 tape wraps near lead	800	0.2
P96-10	20	2.0	802.0	805	800	10 tape wraps near lead	800	2.0
P98-1	No 2014 measurement, instrument not found.							
P98-2	No 2014 measurement, instrument not found.							

Instrument ID	Oct. 2014	Pressure		Threshold El. (m) (Note 5)	Tip El. (m)	Change from Jul. 2014 (m)
	Reading (kPa)	Head (m)	El. (m)			
P96-1	No 2014 measurement, surface casing found but no instrument cables present.					
P96-2	No 2014 measurement, surface casing found but no instrument cables present.					
P96-3	3	0.3	770.3	786	770	-1.5
P96-4	No 2014 measurement, noted as plugged in historical readings.					
P96-5	11	1.1	781.1	790	780	0.8
P96-6	12	1.2	781.2	790	780	-3.5
P96-7	1	0.1	790.2	800	790	-3.4
P96-8	1	0.1	790.3	800	790	-0.1
P96-9	5	0.5	800.5	805	800	0.3
P96-10	2.5	0.3	800.3	805	800	-1.8
P98-1	No 2014 measurement, instrument not found.					
P98-2	No 2014 measurement, instrument not found.					

#### Notes:

- Instrument leads are located on the west abutment crest inside of a protective tire, except for P96-1, P96-2 and P95KC-2A/2B. (Waypoint WP-41 on Figure 1)
- Dam cross section image and instrument locations were extracted from Section C of Drawing D-16003. A copy of the cross section with design details and labels is included in Appendix II.
- October, 2014 reading were collected by Teck staff and provided to KCB.
- October, 1999 readings were estimated from a hard copy graph in the 1999 inspection report (KC, 1999a).
- The SNTD design (KC, 1996) recommended a review and assessment of potential corrective actions be undertaken if a threshold value is exceeded.



PROJECT:			
Quintette Coal Operations 2014 Dam Safety Inspection			
TITLE:			
Shikano Tailings Dam Piezometer Readings			
PROJECT NO.	M09684A10	FIGURE	2

## **APPENDIX I**

### **Inspection Photos**

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## Appendix I Inspection Photos

### LEGEND:

- NSTD = North Shikano Tailings Dam.
- NSTD-2014-## refers to 2014 DSI waypoint shown on Figure 1.
- All photographs taken during inspection on July 22, 2014.



**Photo I-1      Overview of North Shikano Tailings Storage Facility. (NSTD-2014-12)**





**Photo I-2 Overview of NSTD upstream slope. (NSTD-2014-12)**



**Photo I-3 Erosion of the upslope crest of the Southern Basin Wall near the access road where flow is concentrated through openings in the roadside perimeter berms. No significant observed changes since 2013 DSI. (NSTD-2014-13)**





**Photo I-4** Erosion shown in Photo I-3 is encroaching on the access road (offset approximately 4 m). Safety berms constructed to the Code are recommended between the access road and erosion features. No significant observed changes since 2013 DSI. (NSTD-2014-13)



**Photo I-5** View of historic slumping failure on the Eastern Basin Wall. No significant observed changes since 2013 DSI. (NSTD-2014-13)





**Photo I-6** Seepage discharge from low level outlet downstream of dam. (NSTD-2014-11)



**Photo I-7** Overview of S3 Pond and pre-settlement pond. (NSTD-2014-10)





**Photo I-8 Overview of S3 Pond with outlet visible in the middle of the far embankment wall. (NSTD-2014-10)**



**Photo I-9 Slope between NSTD access road and S3 Pond. (NSTD-2014-10)**





**Photo I-10** P96-1 and P96-2 surface casing. No piezometer cables accessible in casing.



**Photo I-11** No Signs of recent movement or settling along the pit wall downstream of the NSTD or at the east abutment contact. (NSTD-2014-02)





**Photo I-12 Overview of pond and basin from dam crest. (NSTD-2014-02)**



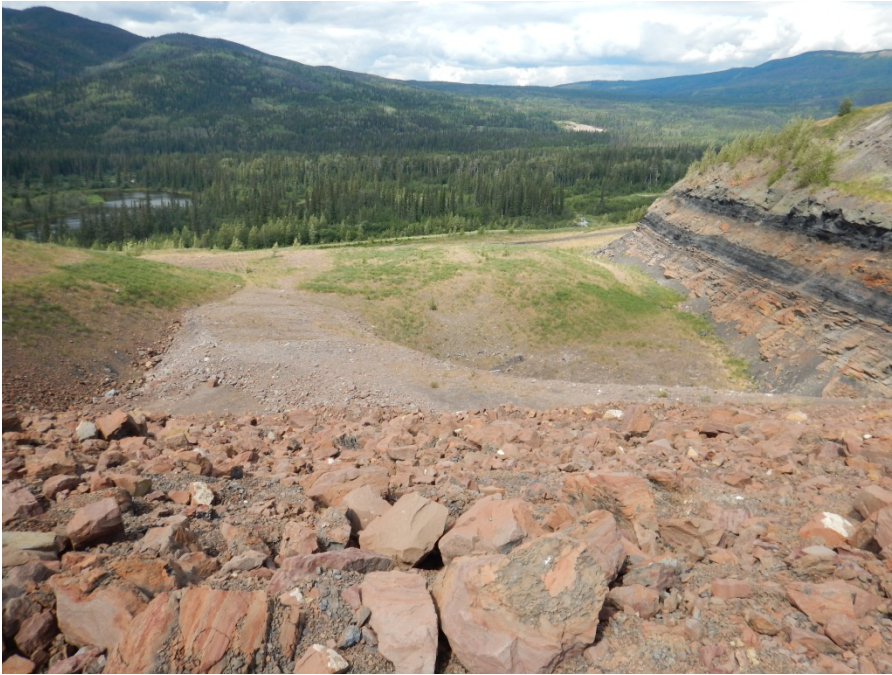
**Photo I-13 Overview of NSTD dam crest. No signs of movement or settling (e.g. sinkholes, cracks, slumping) observed. (NSTD-2014-02)**





**Photo I-14 Pit wall slope upstream of east abutment. (NSTD-2014-02)**





**Photo I-15** Downstream slope overview taken from mid-crest. (NSTD-2014-03)



**Photo I-16** Sinkholes observed on tailings beach, refer to Section 5 of main text. (NSTD-2014-05)





**Photo I-17**     **Drainage channel from the existing pond to the upstream face of the NSTD to promote seepage was unobstructed and dry. (NSTD-2014-07)**



**Photo I-18**     **Upstream contact of east abutment. (NSTD-2014-07)**





**Photo I-19** Upstream slope of dam and west abutment contact. (NSTD-2014-04)



**Photo I-20** Ravelling of the exposed rock face upstream of the west abutment caused by weathering of alternating beds of sandstone and shale. No significant change from 2013 DSI.



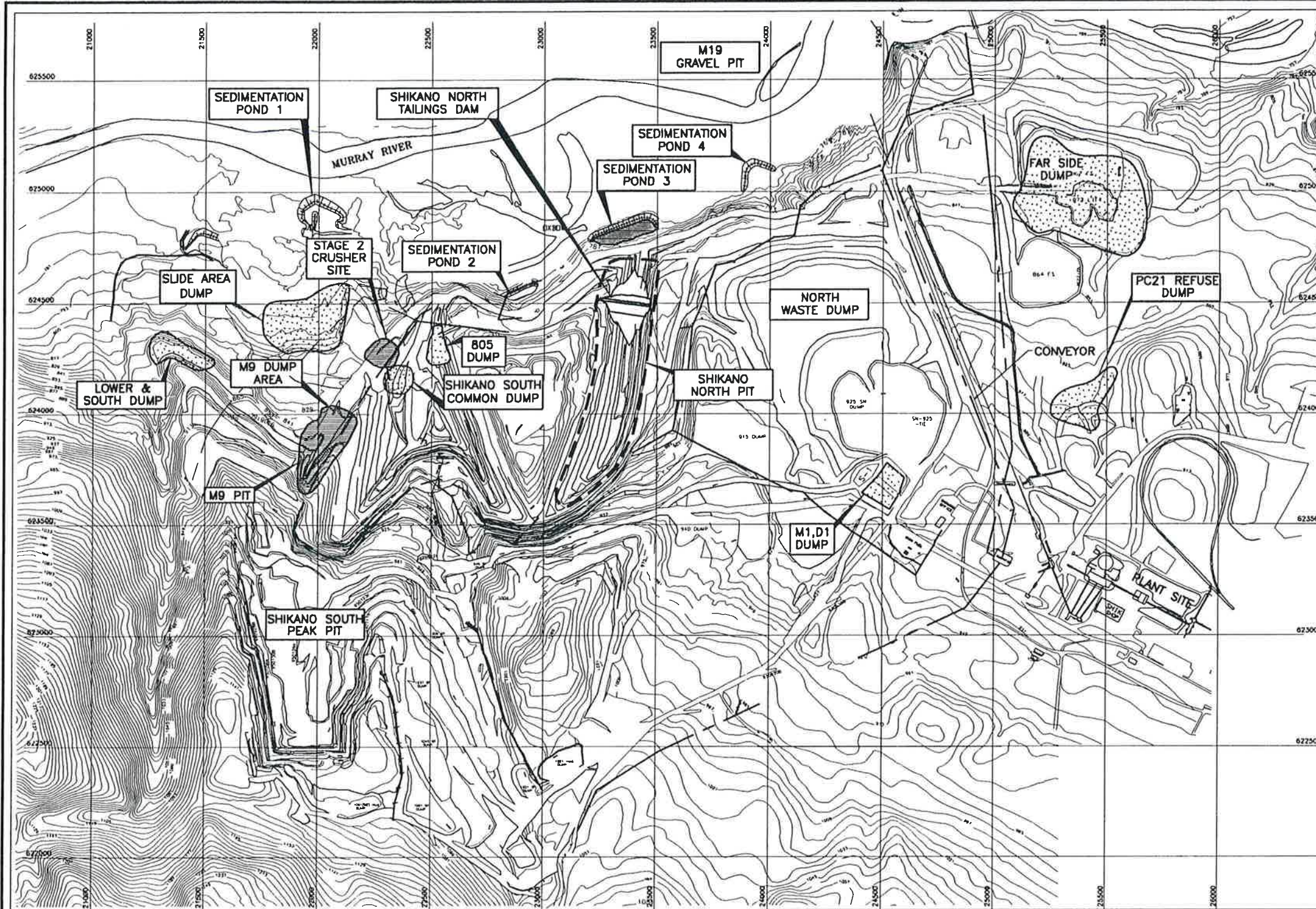
**Photo I-21**    **Overview of upstream dam slope.**

## **APPENDIX II**



### **Dam Design Drawings**

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**LEGEND**

-  SHIKANO NORTH PIT \ WORK AREA
-  DISPOSAL AREA

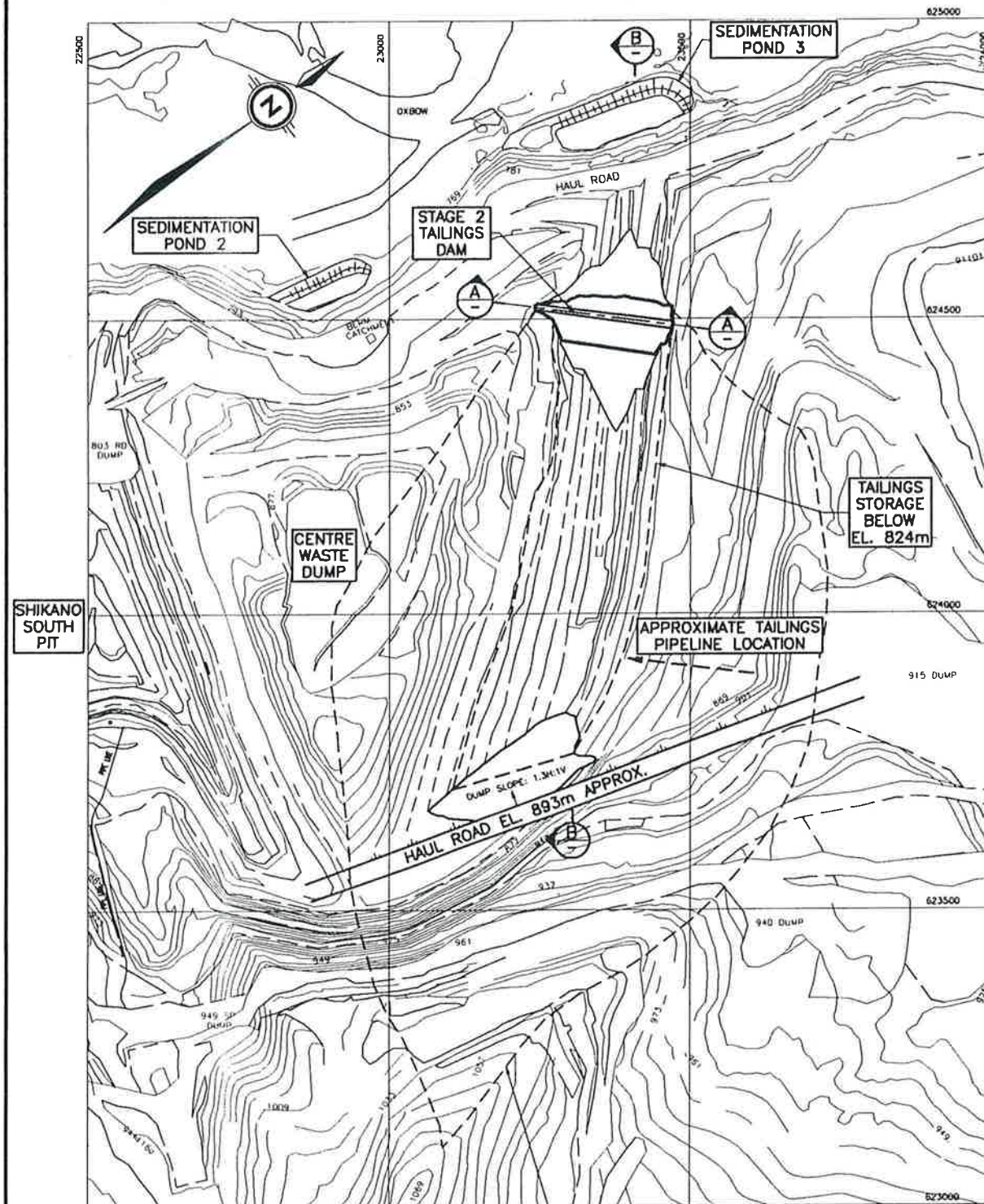
ISSUED FOR AS-BUILT



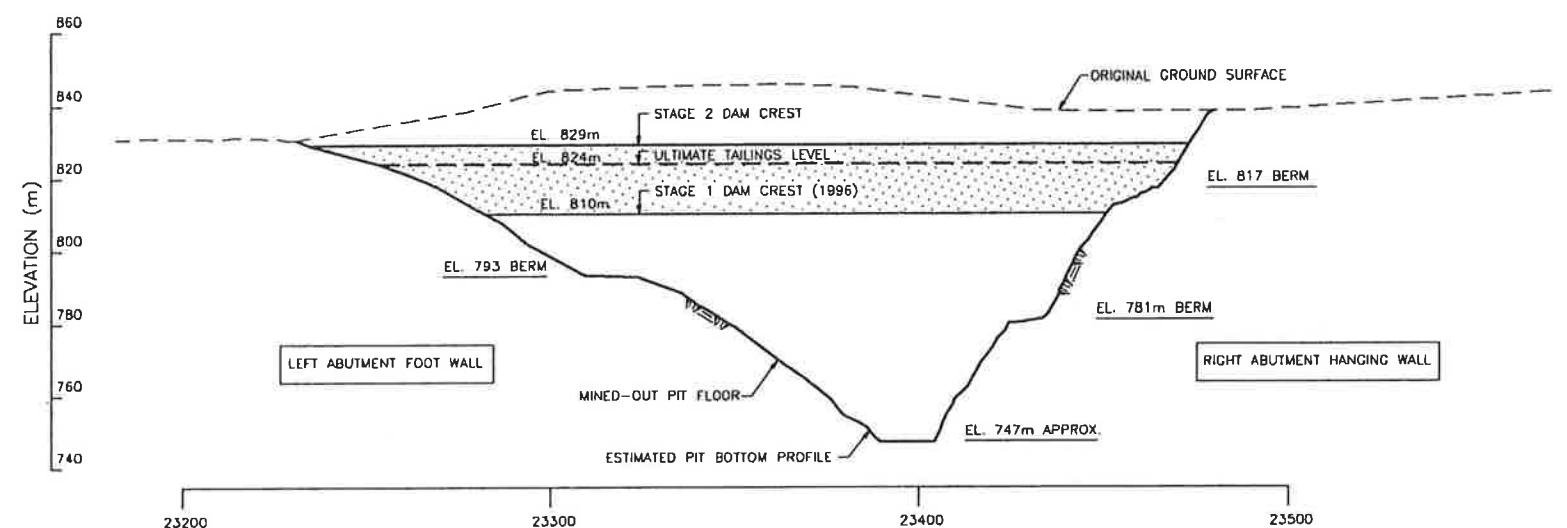
<p>SEAL</p> <p>AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICATION OF DATA STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR RECORDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL</p>	<p>CLIENT</p> <p> Quintette Operating Corp.</p> <p> KLOHN-CRIPPEN</p>	<p>PROJECT</p> <p>SHIKANO NORTH TAILINGS IMPOUNDMENT</p> <p>TITLE</p> <p>GENERAL SITE ARRANGEMENT</p>	<p>SCALE</p> <p>AS SHOWN</p> <p>PROJECT No.</p> <p>PM6970 16</p> <p>DWG. No.</p> <p>D-16000</p> <p>REV</p> <p>2</p>

DRAWING NO.	REFERENCE DRAWING	NO.	DATE	ISSUE / REVISION	DRAWN	CHECKED	DESIGN	APP'D
		2	JULY 99	ISSUED FOR AS-BUILT	ENL	TOP	HDP	<i>HDP</i>
		1	OCT 98	ISSUED FOR CONSTRUCTION	PSK	TOP	HDP	<i>PSK</i>
		0	OCT 98	ISSUED FOR TENDER	PSK	TOP	HDP	<i>PSK</i>



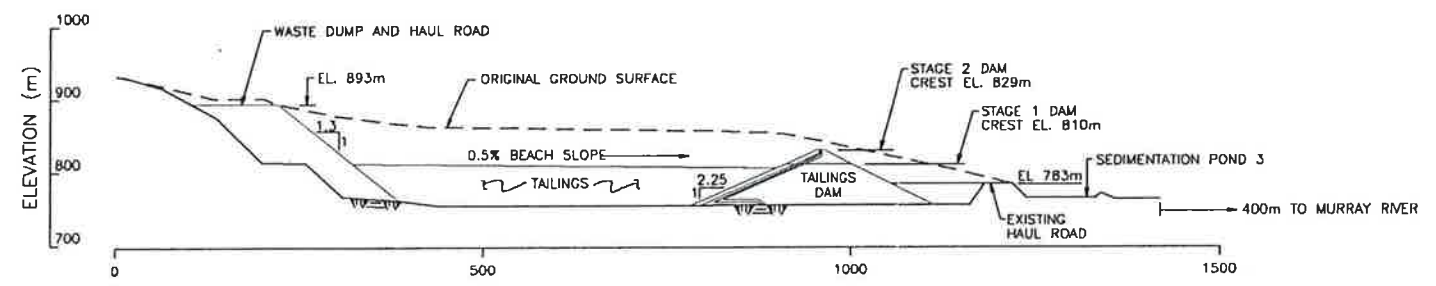


PLAN  
SCALE: A



SECTION A  
SCALE: B

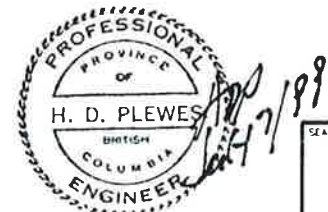
LEGEND:  
[Patterned box] STAGE 2 DAM RAISE



SECTION B  
SCALE: A

ISSUED FOR AS-BUILT

SCALE B: 20m 0 60m  
SCALE A: 100m 0 300m  
SCALE



2	JULY 99	ISSUED FOR AS-BUILT	ENL	TOP	HDP	HDP
1	OCT 98	ISSUED FOR CONSTRUCTION	PSK	TOP	HDP	HDP
0	OCT 98	ISSUED FOR TENDER	PSK	TOP	HDP	HDP
NO.	DATE	ISSUE / REVISION	DRAWN	CHK'D	DESIGN	APPROV'D

DRAWING NO. REFERENCE DRAWING

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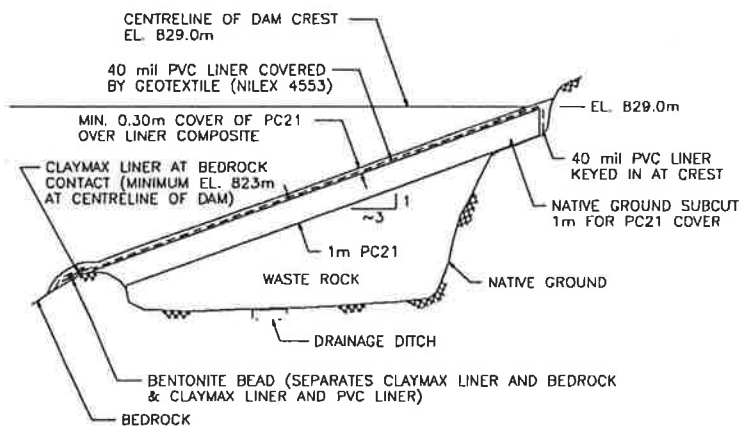
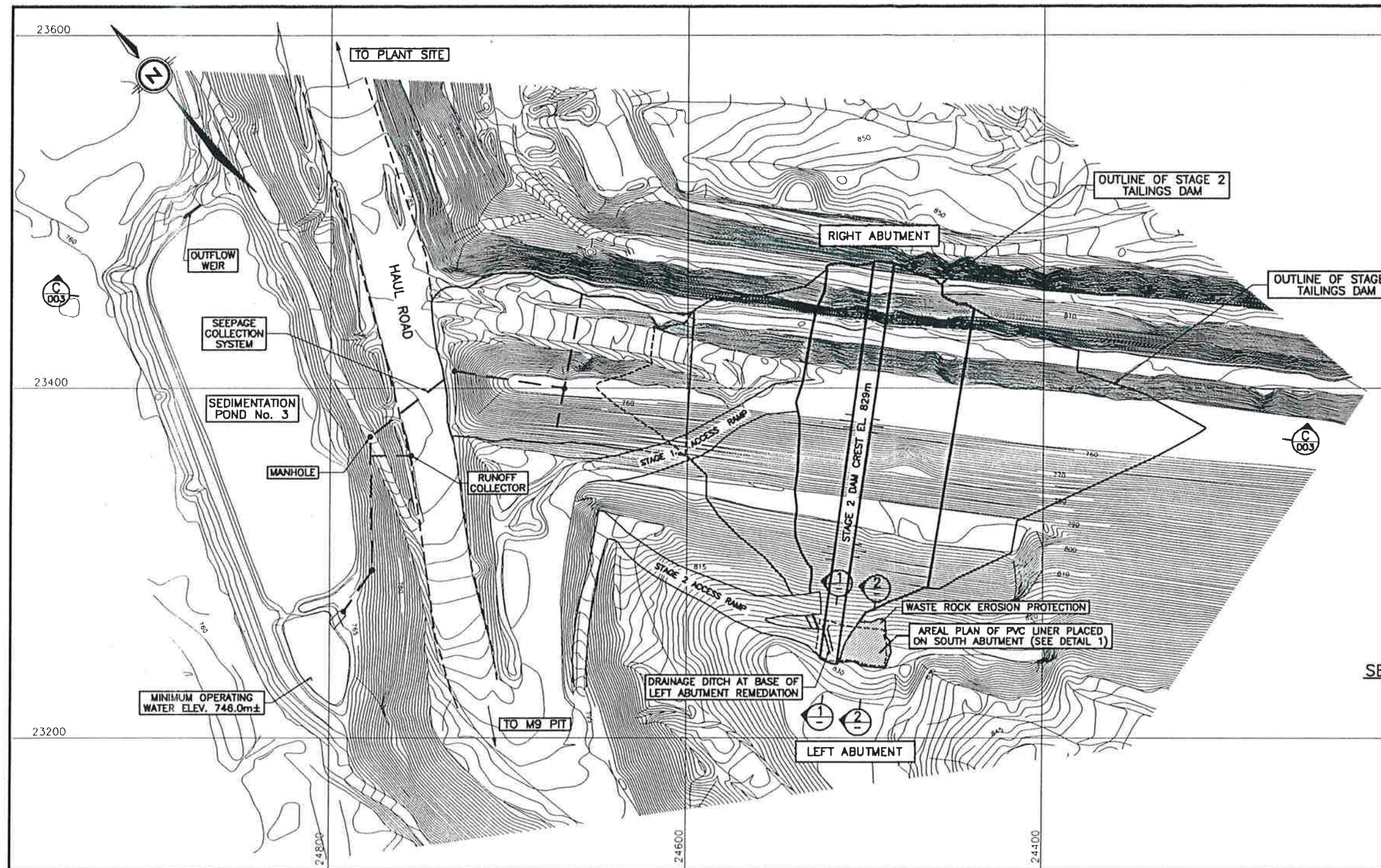
Quintette Operating Corp.

KLOHN-CRIPPEN

PROJECT	SHIKANO NORTH TAILINGS IMPOUNDMENT		
TITLE	ARRANGEMENT PLAN AND SECTIONS OF TAILINGS IMPOUNDMENT SITE		
SCALE	AS SHOWN	PROJECT No. PM6970 16	REV. 2
ENCLOSURE	D-16001		

CANCEL PRINTS BEARING PREVIOUS





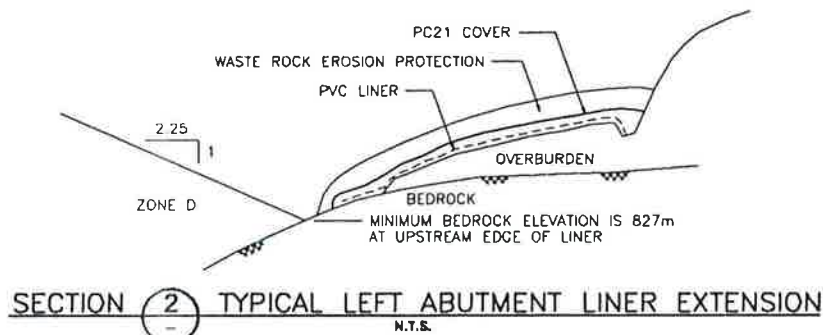
SECTION 1 TYPICAL LEFT ABUTMENT REMEDIATION  
N.T.S.

NOTES:

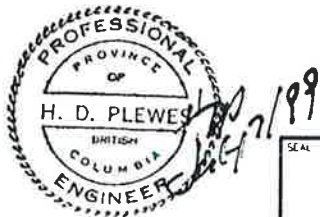
1. TOPOGRAPHY ACQUIRED FROM AERIAL PHOTOGRAPHY TAKEN SEPT. 8, 1995 AND SUPPLIED BY QUINTETTE OPERATING CORPORATION.
2. TOPOGRAPHY FOR LEFT ABUTMENT REMEDIATION SUPPLIED BY CONTRACTOR.

PLAN

ISSUED FOR AS-BUILT



SECTION 2 TYPICAL LEFT ABUTMENT LINER EXTENSION  
N.T.S.



SEAL

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Quintette Operating Corp.



KLOHN-CRIPPEN

SHIKANO NORTH TAILINGS IMPOUNDMENT

STAGES 1 AND 2 TAILINGS DAM PLAN

AS SHOWN

PROJECT No. PM6970 16

DATE: D-16002

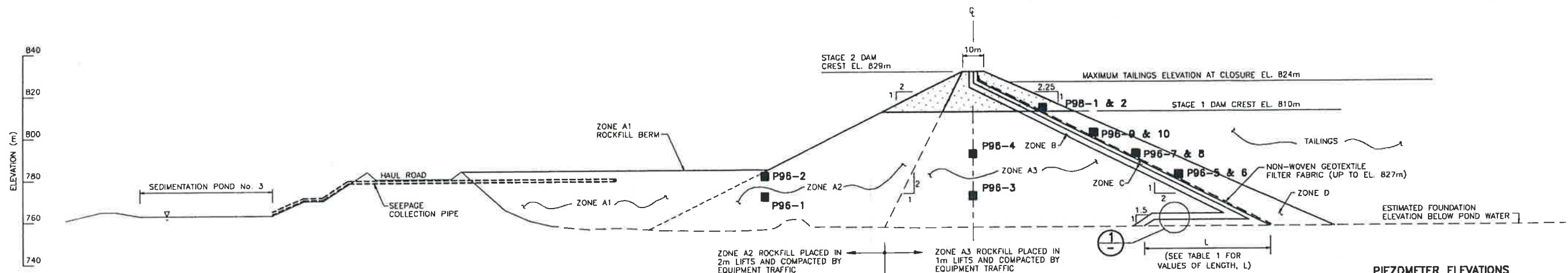
REV 2

NO	DATE	ISSUE / REVISION	DRAWN	CHK'D	DESIGN	APP'D
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1	OCT 98	ISSUED FOR CONSTRUCTION	PSA	TDP	HDP	XDP
0	OCT 98	ISSUED FOR TENDER	PSA	TDP	HDP	XDP

DRAWING NO. REFERENCE DRAWING

CANCEL PRINTS BEARING PREVIOUS





PIEZOMETER ELEVATIONS

PIEZOMETER	TIP ELEVATION (METRES)
P96-1	767.2
P96-2	777.2
P96-3	770.0
P96-4	780.1
P96-5	780.0
P96-6	780.0
P96-7	790.1
P96-8	790.2
P96-9	800.0
P96-10	800.0
P98-1	810.5
P98-2	810.5

LEGEND:

96-10  
PIEZOMETERS INSTALLED IN TAILINGS DAM

NOTES:

1. FILTER FABRIC LAID ON THE UPSTREAM SIDE OF ZONE C FINE FILTER. FILTER FABRIC OVERLAP > 0.3m ON DAM FACE, AND EXTENDS 1m UP DAM ABUTMENTS. FILTER FABRIC COVERED BY 0.3m OF ZONE C FINE FILTER.
2. PIEZOMETER LEADS FOR P96-3 AND 4 AND P98-1 AND 2 EXTENDED TO LOCATION OF PIEZOMETER LEADS FOR P96-5 TO 10.
3. PIEZOMETER LEADS FOR P96-3 TO P96-10 AND P98-1 AND 2 ARE EXTENDED IN A PVC CONDUIT UP THE LEFT ABUTMENT TO THE STAGE 2 DAM CREST.

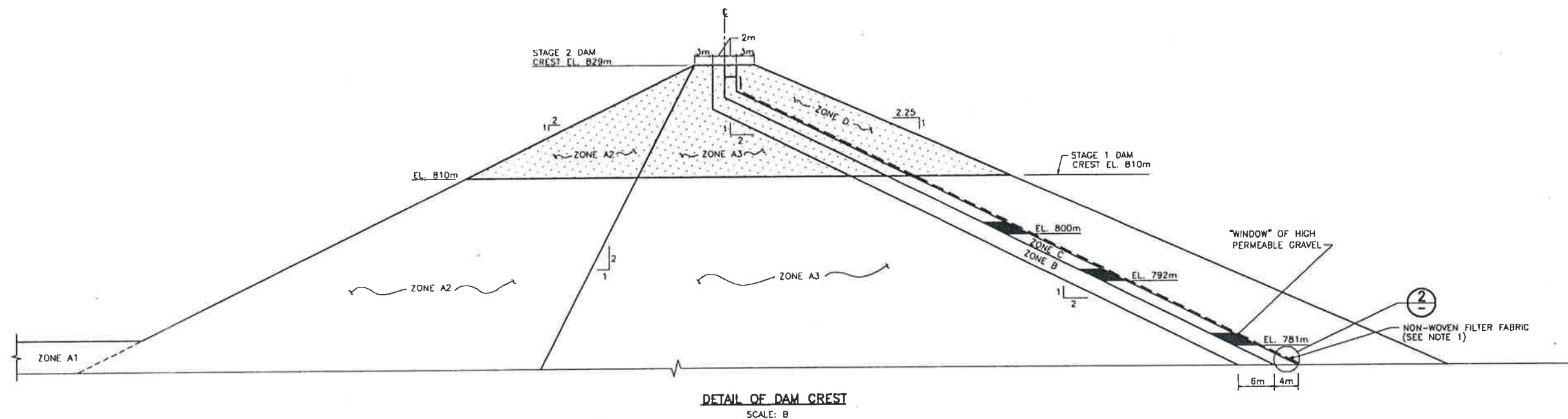


TABLE 1  
FILTER ARM EXTENSION LENGTHS

FOUNDATION ELEVATION (m)	LENGTH, L (METRES)	
	RIGHT ABUTMENT	LEFT ABUTMENT
810.0 - 815.5	30	20
815.5 - 816.5	28	20
816.5 - 817.5	26	20
817.5 - 818.5	24	20
818.5 - 819.5	22	20
819.5 - 820.5	20	20
820.5 - 821.5	18	18
821.5 - 821.6	15	15
821.6 - 822.5	13	13
822.5 - 823.5	11	11
823.5 - 824.5	9	9
824.5 - 825.5	9	9
825.5 - 825.6	7	7
825.6 - 826.5	7	7
826.5 - 827.5	7	7
827.5 - 828.5	7	7
828.5 - 829.0	6	6

TABLE 2  
FILTER ARM WIDTHS

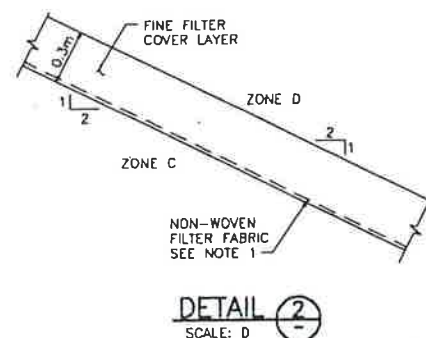
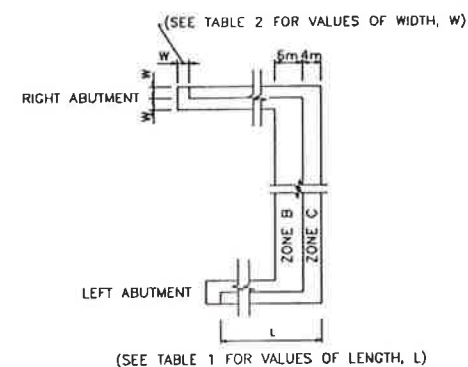
FOUNDATION ELEVATION (m)	WIDTH, W (METRES) *	
	LEFT ABUTMENT	RIGHT ABUTMENT
810.0 - 829.0	2.5	1.677

\* EQUIVALENT HORIZONTAL THICKNESS, PERPENDICULAR THICKNESS TO ABUTMENT WALL IS 1.5m

STAGE 2 DAM RAISE MATERIAL ZONES

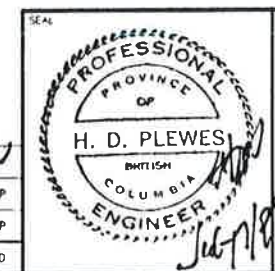
ZONE	DESCRIPTION	MATERIAL DESCRIPTION
A2	DOWNSTREAM SHELL	WASTE ROCK < 2m
A3	ROCKFILL SELECT	WASTE ROCK < 1m
B	COARSE FILTER	150mm MINUS
C	FINE FILTER	38mm MINUS
D	UPSTREAM SHELL	WASTE ROCK < 2m

ISSUED FOR AS-BUILT



GEOTEXTILE PROTECTIVE COVER

2	JULY 99	ISSUED FOR AS-BUILT	ENL	TDP	HDP	1/2
1	OCT 98	ISSUED FOR CONSTRUCTION	PSK	TDP	HDP	X2/P
0	OCT 98	ISSUED FOR TENDER	PSA	TDP	HDP	X2/P
NO	DATE	ISSUE / REVISION	DRAWN	CHK'D	DESIGN	APP'D



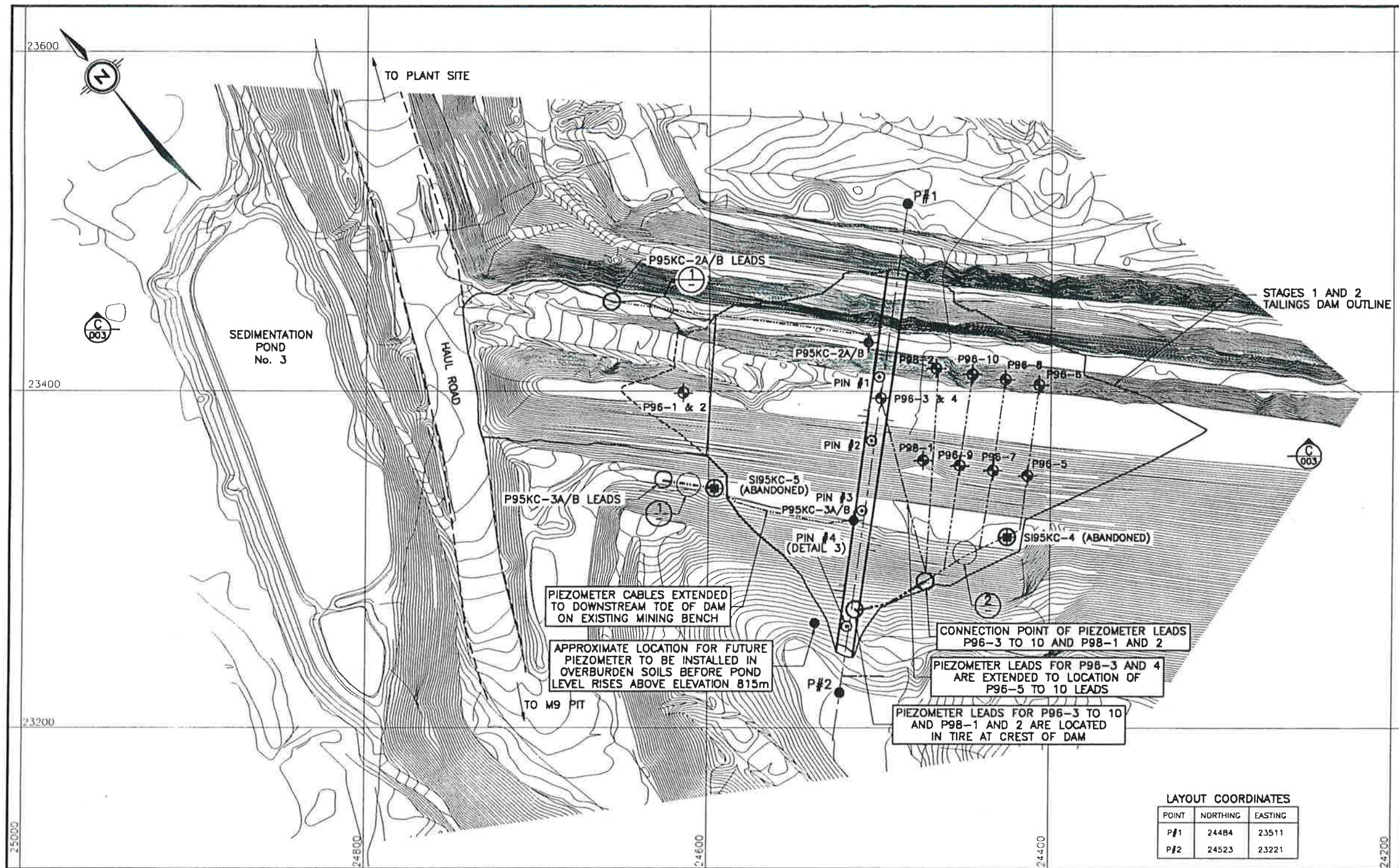
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CLIENT  
Quintette Operating Corp.  
KLOHN-CRIPPEN

PROJECT SHIKANO NORTH TAILINGS IMPOUNDMENT			
TITLE STAGES 1 AND 2 TAILINGS DAM SECTIONS AND DETAILS			
SCALE AS SHOWN	PROJECT No. PM6970 16	DMG No. D-16003	REV 2

CANCEL PRINTS BEARING PREVIOUS





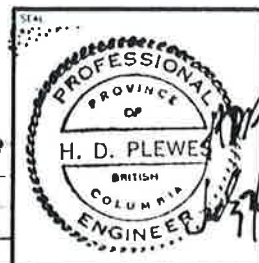
#### NOTES:

1. TOPOGRAPHY ACQUIRED FROM AERIAL PHOTOGRAPHY TAKEN SEPT. 8, 1995 AND SUPPLIED BY QUINTETTE OPERATING CORPORATION (QOC).
2. TOPOGRAPHY FOR LEFT ABUTMENT REMEDIATION SUPPLIED BY CONTRACTOR.

#### LEGEND:

- P96-5 LOCATION OF PIEZOMETERS INSTALLED IN STAGE 1
- EXISTING PIEZOMETERS P95KC-2A/B AND P95KC-3A/B
- EXISTING SLOPE INCLINOMETER SIK95-5
- TIRE LOCATIONS TO PROTECT END OF PIEZOMETER CABLES AND SLOPE INCLINOMETERS.
- PIEZOMETER CABLES
- PIEZOMETER CABLES ENCLOSED IN PVC
- DAM SETTLEMENT MONUMENTS SURVEY POINTS

2	JULY 99	ISSUED FOR AS-BUILT	ENL	TDP	HDP	
1	OCT 98	ISSUED FOR CONSTRUCTION	PSK	TDP	HDP	XDP
0	OCT 98	ISSUED FOR TENDER	PSK	TDP	HDP	XDP
NO	DATE	ISSUE / REVISION	DRAWN	CHK'D	DESIGN	APP'D



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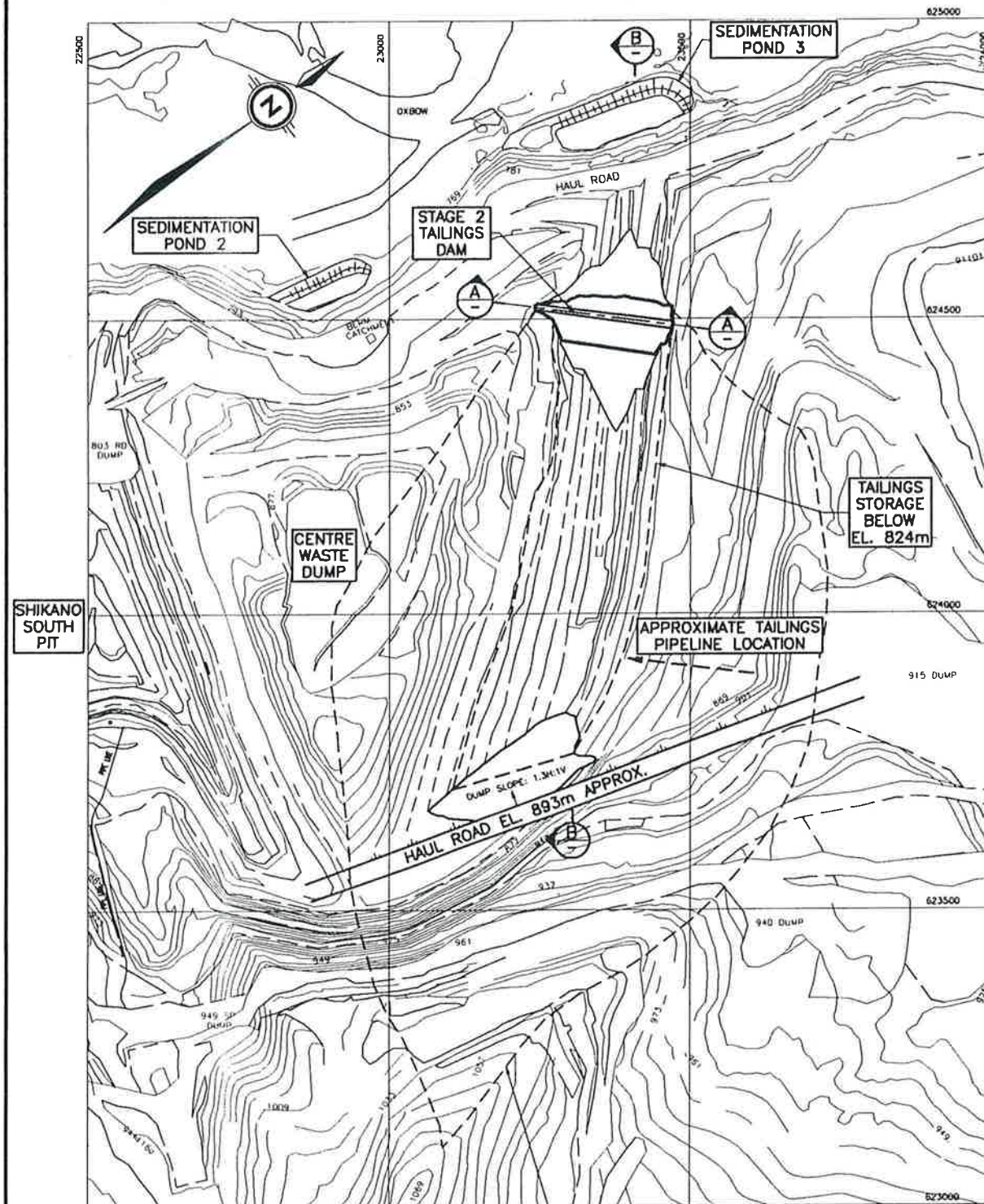


PROJECT	SHIKANO NORTH TAILINGS IMPOUNDMENT		
TITLE	STAGES 1 AND 2 TAILINGS DAM INSTRUMENTATION PLAN AND DETAILS		
SCALE	AS SHOWN	PROJECT No. PM6970 16	DMC No. D-16004
REV	2		

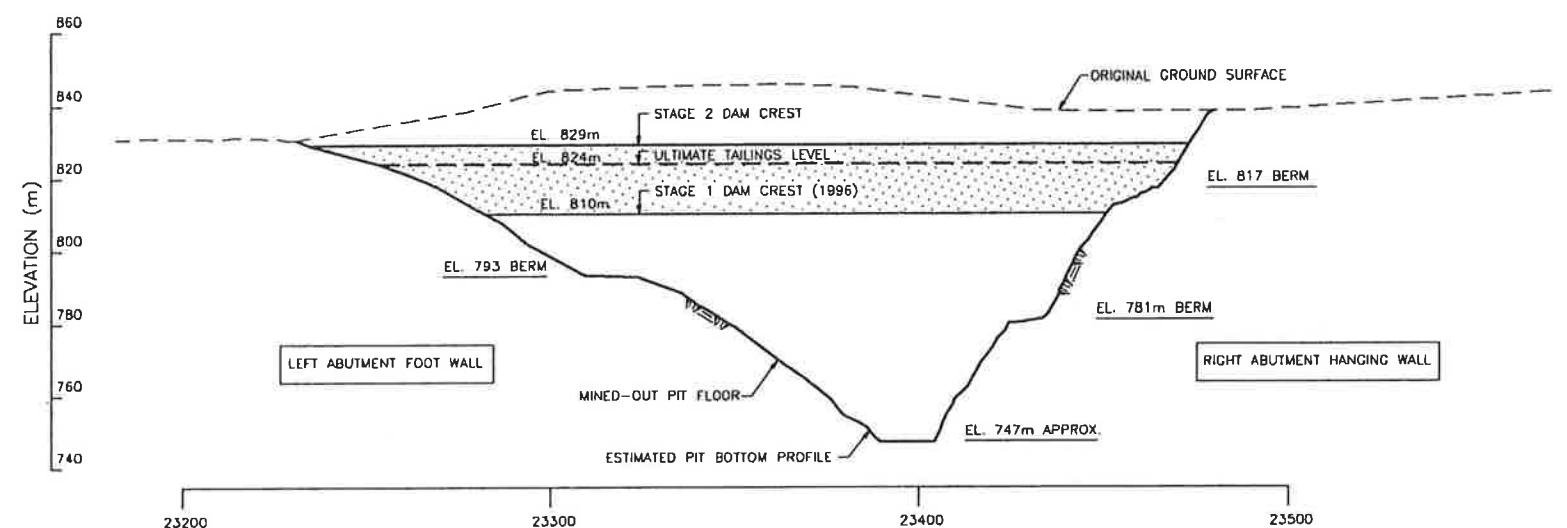
ISSUED FOR AS-BUILT





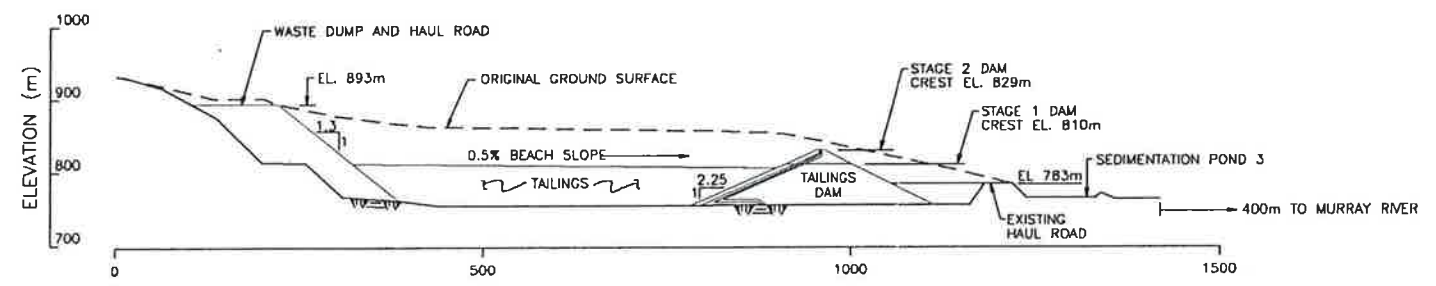


PLAN  
SCALE: A



SECTION A  
SCALE: B

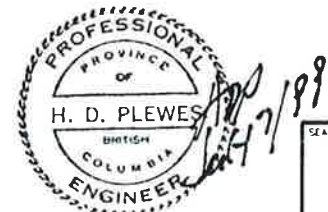
LEGEND:  
STAGE 2 DAM RAISE



SECTION B  
SCALE: A

ISSUED FOR AS-BUILT

SCALE B: 20m 0 60m  
SCALE A: 100m 0 300m  
SCALE



2	JULY 99	ISSUED FOR AS-BUILT	ENL	TOP	HDP	HDP
1	OCT 98	ISSUED FOR CONSTRUCTION	PSK	TOP	HDP	HDP
0	OCT 98	ISSUED FOR TENDER	PSK	TOP	HDP	HDP
NO.	DATE	ISSUE / REVISION	DRAWN	CHK'D	DESIGN	APPROD

DRAWING NO. REFERENCE DRAWING

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICATION OF DATA STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

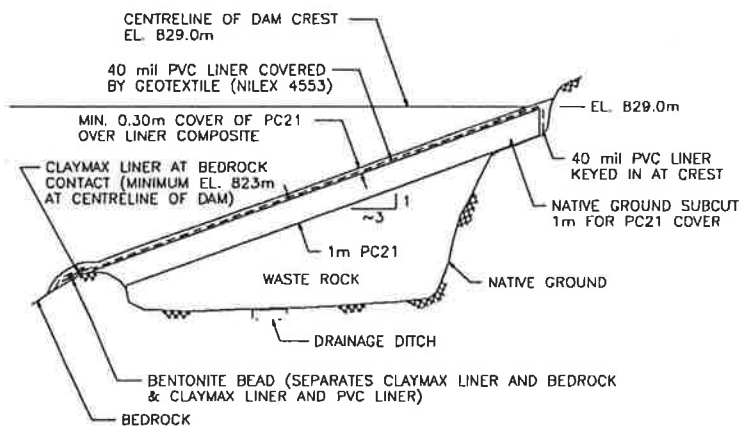
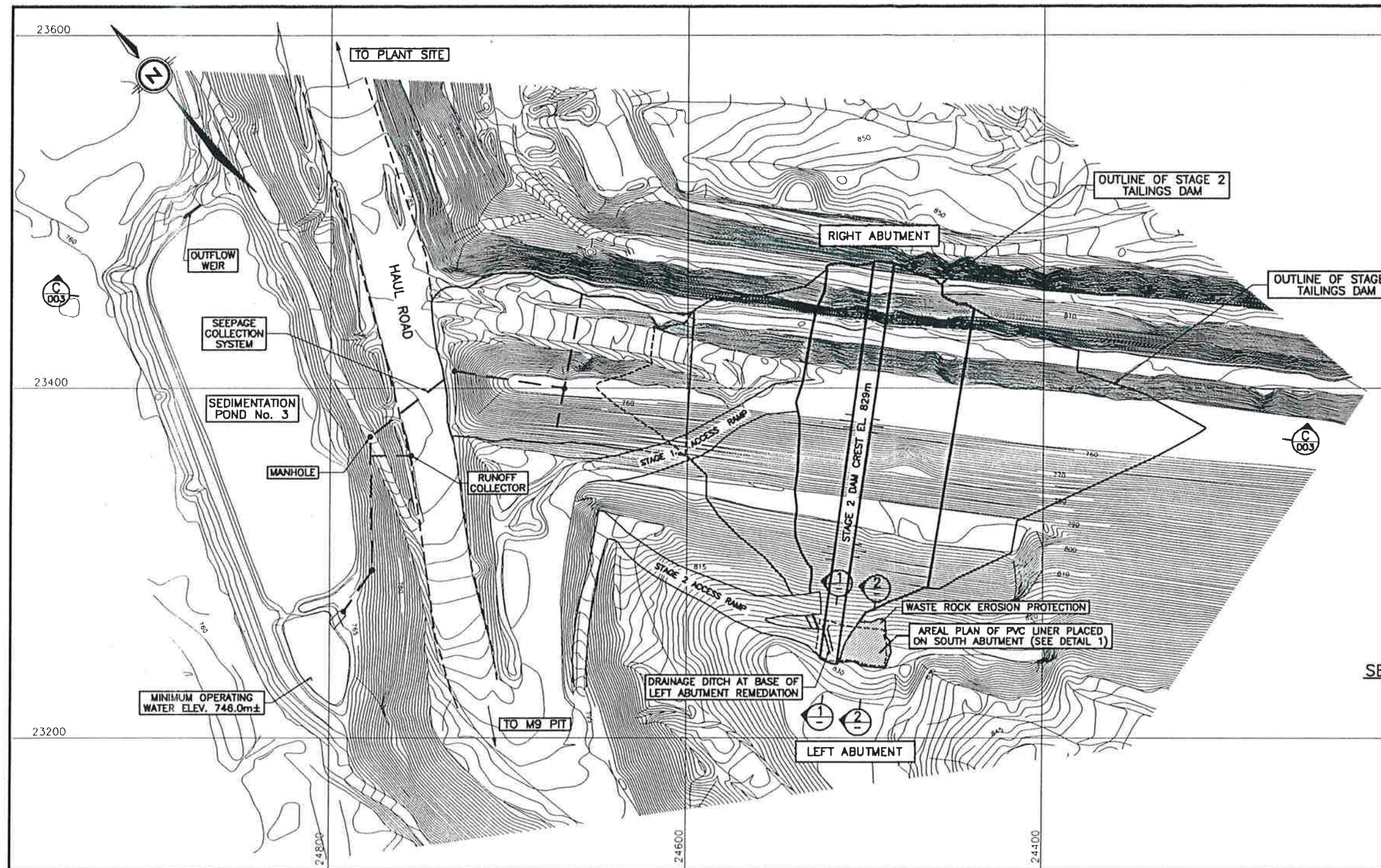
Quintette Operating Corp.

KLOHN-CRIPPEN

PROJECT	SHIKANO NORTH TAILINGS IMPOUNDMENT		
TITLE	ARRANGEMENT PLAN AND SECTIONS OF TAILINGS IMPOUNDMENT SITE		
SCALE	AS SHOWN	PROJECT No. PM6970 16	REV. 2
ENCLOSURE	D-16001		

CANCEL PRINTS BEARING PREVIOUS





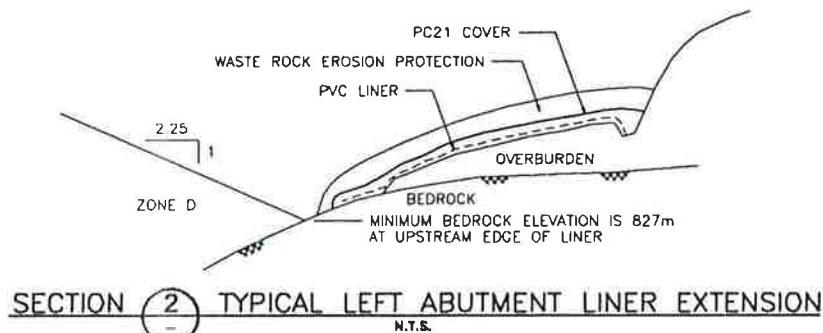
SECTION 1 TYPICAL LEFT ABUTMENT REMEDIATION  
N.T.S.

NOTES:

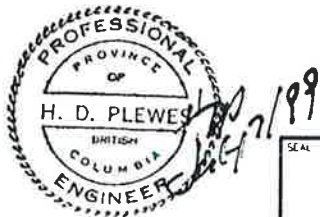
1. TOPOGRAPHY ACQUIRED FROM AERIAL PHOTOGRAPHY TAKEN SEPT. 8, 1995 AND SUPPLIED BY QUINTETTE OPERATING CORPORATION.
2. TOPOGRAPHY FOR LEFT ABUTMENT REMEDIATION SUPPLIED BY CONTRACTOR.

PLAN

ISSUED FOR AS-BUILT



SECTION 2 TYPICAL LEFT ABUTMENT LINER EXTENSION  
N.T.S.



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Quintette Operating Corp.

KLOHN-CRIPPEN

SHIKANO NORTH TAILINGS IMPOUNDMENT

STAGES 1 AND 2 TAILINGS DAM PLAN

AS SHOWN

PROJECT No. PM6970 16

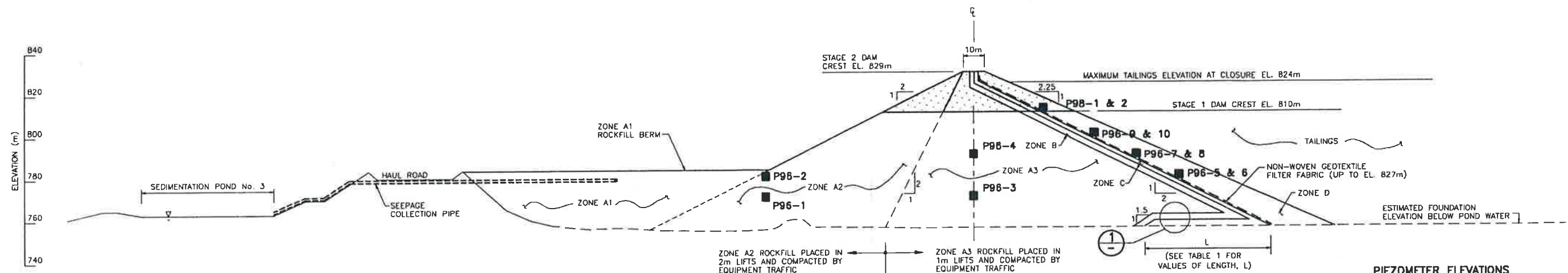
DATE: D-16002

REV 2

NO	DATE	ISSUE / REVISION	DRAWN	CHK'D	DESIGN	APP'D
2	JULY 99	ISSUED FOR AS-BUILT	ENL	TDP	HDP	HDP
1	OCT 98	ISSUED FOR CONSTRUCTION	PSA	TDP	HDP	XDP
0	OCT 98	ISSUED FOR TENDER	PSA	TDP	HDP	XDP

DRAWING NO. REFERENCE DRAWING





PIEZOMETER ELEVATIONS

PIEZOMETER	TIP ELEVATION (METRES)
P96-1	767.2
P96-2	777.2
P96-3	770.0
P96-4	780.1
P96-5	780.0
P96-6	780.0
P96-7	790.1
P96-8	790.2
P96-9	800.0
P96-10	800.0
P98-1	810.5
P98-2	810.5

LEGEND:

96-10  
PIEZOMETERS INSTALLED IN TAILINGS DAM

NOTES:

1. FILTER FABRIC LAID ON THE UPSTREAM SIDE OF ZONE C FINE FILTER. FILTER FABRIC OVERLAP > 0.3m ON DAM FACE, AND EXTENDS 1m UP DAM ABUTMENTS. FILTER FABRIC COVERED BY 0.3m OF ZONE C FINE FILTER.
2. PIEZOMETER LEADS FOR P96-3 AND 4 AND P98-1 AND 2 EXTENDED TO LOCATION OF PIEZOMETER LEADS FOR P96-5 TO 10.
3. PIEZOMETER LEADS FOR P96-3 TO P96-10 AND P98-1 AND 2 ARE EXTENDED IN A PVC CONDUIT UP THE LEFT ABUTMENT TO THE STAGE 2 DAM CREST.

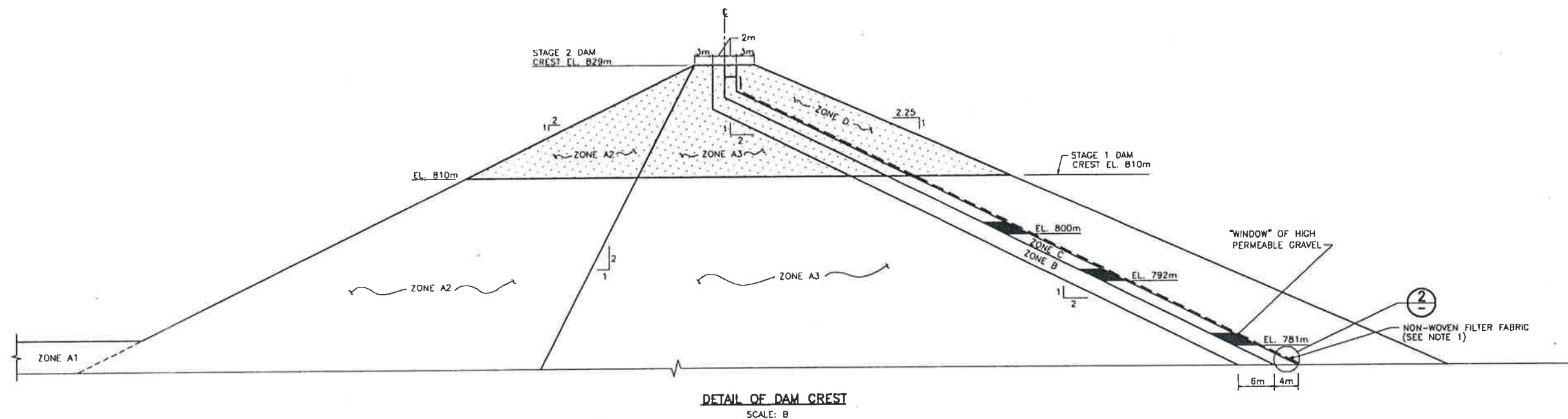


TABLE 1  
FILTER ARM EXTENSION LENGTHS

FOUNDATION ELEVATION (m)	LENGTH, L (METRES)	
	RIGHT ABUTMENT	LEFT ABUTMENT
810.0 - 815.5	30	20
815.5 - 816.5	28	20
816.5 - 817.5	26	20
817.5 - 818.5	24	20
818.5 - 819.5	22	20
819.5 - 820.5	20	20
820.5 - 821.5	18	18
821.5 - 821.6	15	15
821.6 - 822.5	13	13
822.5 - 823.5	11	11
823.5 - 824.5	9	9
824.5 - 825.5	9	9
825.5 - 825.6	7	7
825.6 - 826.5	7	7
826.5 - 827.5	7	7
827.5 - 828.5	7	7
828.5 - 829.0	6	6

TABLE 2  
FILTER ARM WIDTHS

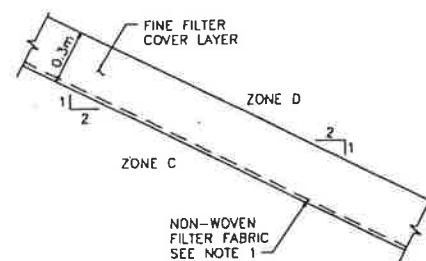
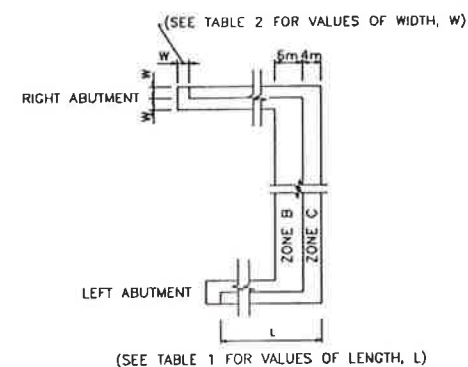
FOUNDATION ELEVATION (m)	WIDTH, W (METRES) *	
	LEFT ABUTMENT	RIGHT ABUTMENT
810.0 - 829.0	2.5	1.677

\* EQUIVALENT HORIZONTAL THICKNESS, PERPENDICULAR THICKNESS TO ABUTMENT WALL IS 1.5m

STAGE 2 DAM RAISE MATERIAL ZONES

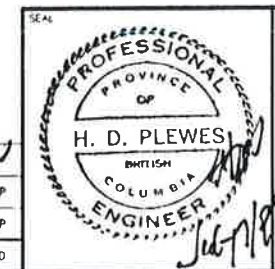
ZONE	DESCRIPTION	MATERIAL DESCRIPTION
A2	DOWNSTREAM SHELL	WASTE ROCK < 2m
A3	ROCKFILL SELECT	WASTE ROCK < 1m
B	COARSE FILTER	150mm MINUS
C	FINE FILTER	38mm MINUS
D	UPSTREAM SHELL	WASTE ROCK < 2m

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DETAIL 2  
SCALE: D  
GEOTEXTILE PROTECTIVE COVER

2	JULY 99	ISSUED FOR AS-BUILT	ENL	TDP	HDP	1/2
1	OCT 98	ISSUED FOR CONSTRUCTION	PSK	TDP	HDP	X2/P
0	OCT 98	ISSUED FOR TENDER	PSA	TDP	HDP	X2/P
NO	DATE	ISSUE / REVISION	DRAWN	CHK'D	DESIGN	APP'D



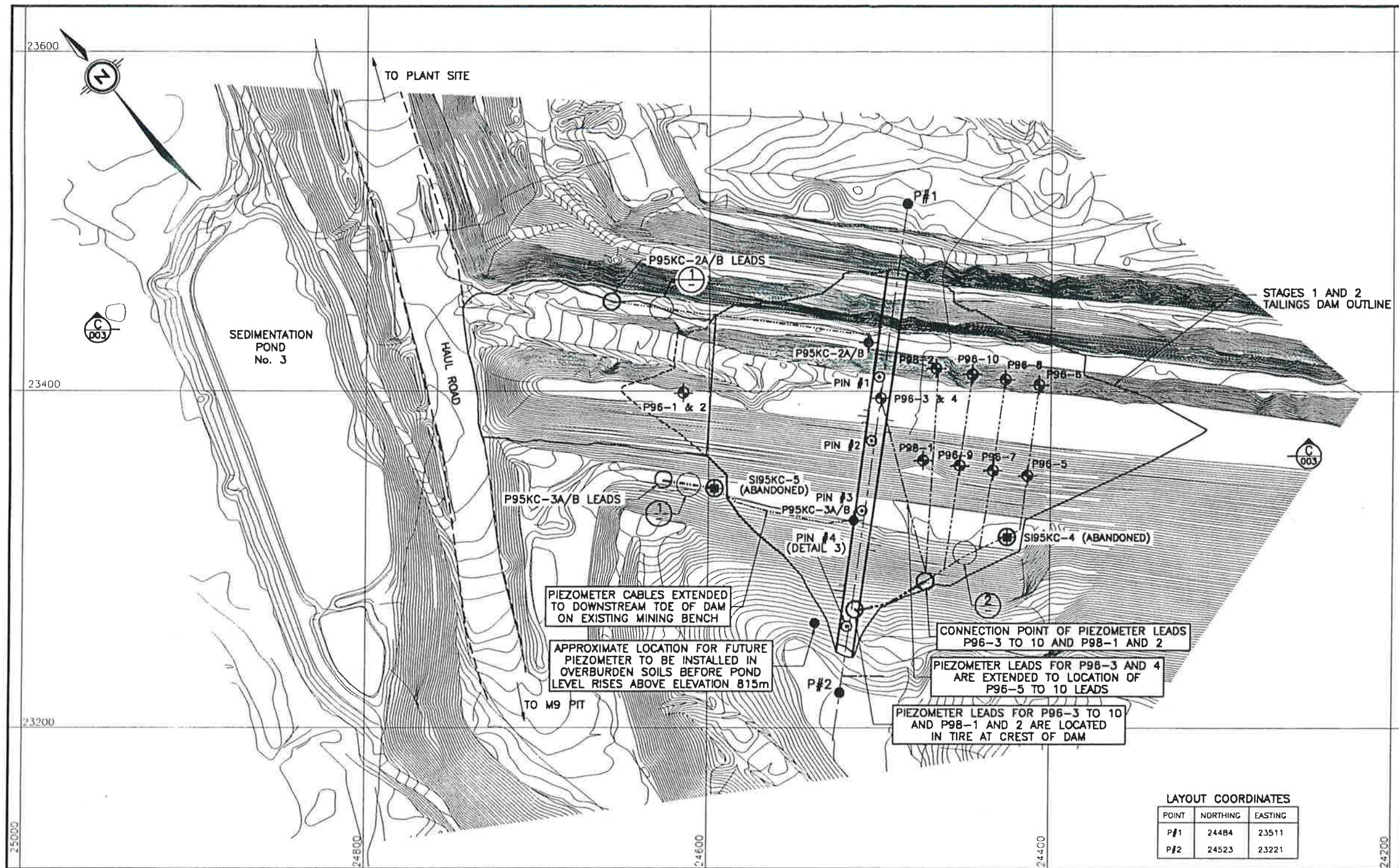
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CLIENT  
Quintette Operating Corp.  
KLOHN-CRIPPEN

PROJECT SHIKANO NORTH TAILINGS IMPOUNDMENT	
TITLE STAGES 1 AND 2 TAILINGS DAM SECTIONS AND DETAILS	
SCALE AS SHOWN	PROJECT No. PM6970 16
DATE D-16003	REV 2

CANCEL PRINTS BEARING PREVIOUS





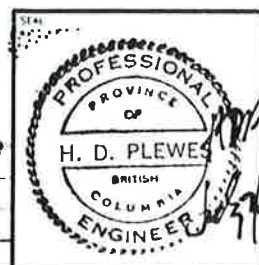
#### NOTES:

1. TOPOGRAPHY ACQUIRED FROM AERIAL PHOTOGRAPHY TAKEN SEPT. 8, 1995 AND SUPPLIED BY QUINTETTE OPERATING CORPORATION (QOC).
2. TOPOGRAPHY FOR LEFT ABUTMENT REMEDIATION SUPPLIED BY CONTRACTOR.

#### LEGEND:

- P96-5 LOCATION OF PIEZOMETERS INSTALLED IN STAGE 1
- EXISTING PIEZOMETERS P95KC-2A/B AND P95KC-3A/B
- EXISTING SLOPE INCLINOMETER SIK95-5
- TIRE LOCATIONS TO PROTECT END OF PIEZOMETER CABLES AND SLOPE INCLINOMETERS.
- PIEZOMETER CABLES
- PIEZOMETER CABLES ENCLOSED IN PVC
- DAM SETTLEMENT MONUMENTS SURVEY POINTS

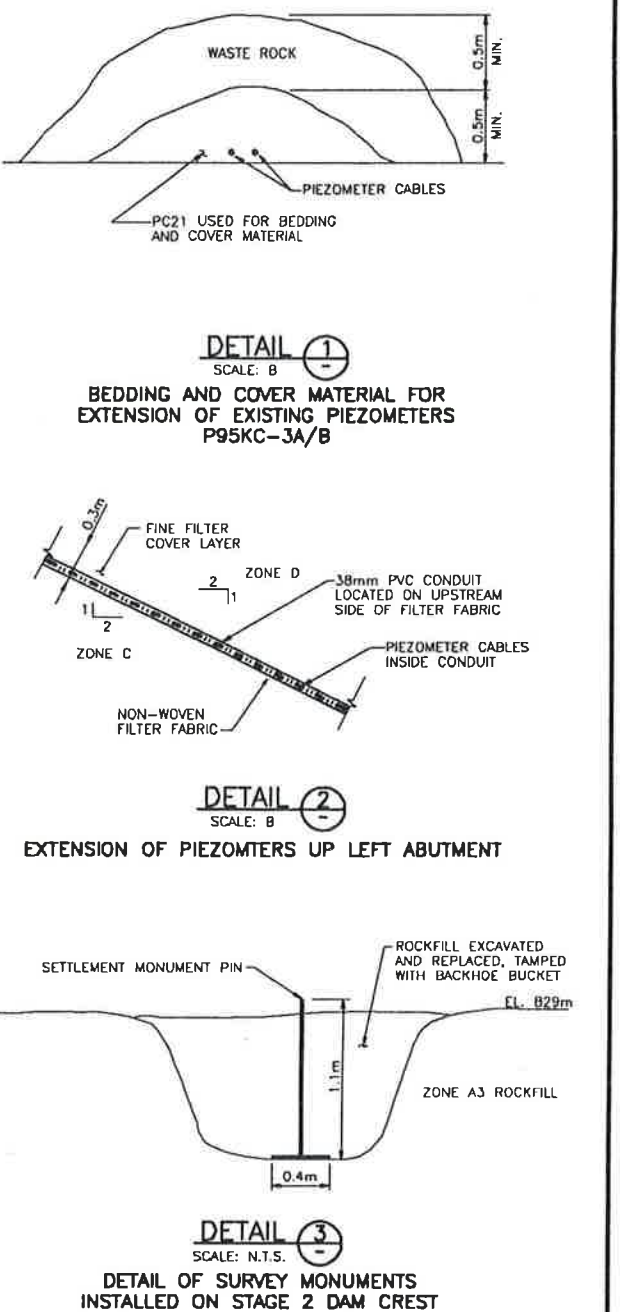
2	JULY 99	ISSUED FOR AS-BUILT	ENL	TDP	HDP	
1	OCT 98	ISSUED FOR CONSTRUCTION	PSK	TDP	HDP	XDP
0	OCT 98	ISSUED FOR TENDER	PSK	TDP	HDP	XDP
NO	DATE	ISSUE / REVISION	DRAWN	CHK'D	DESIGN	APP'D



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PROJECT	SHIKANO NORTH TAILINGS IMPOUNDMENT		
TITLE	STAGES 1 AND 2 TAILINGS DAM INSTRUMENTATION PLAN AND DETAILS		
SCALE	AS SHOWN	PROJECT No. PM6970 16	DMC No. D-16004
REV	2		



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## **APPENDIX III**

### **“Guidelines for Annual Dam Safety Inspection Reports”**

#### **Ministry of Energy and Mines**

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## 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.