Klohn Crippen Berger

Teck Coal Limited

Quintette Coal Operations

2017 Dam Safety Inspection

Shikano North Tailings Dam

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March 2018

Klohn Crippen Berger

March 16, 2018

Teck Coal Ltd.
P.O. Box 1500
23097 Murray Forest Service Rd.
Tumbler Ridge, British Columbia
V0C 2W0

Mr. Rob Muise
Site Lead, Care and Maintenance

Dear Mr. Muise:

Quintette Coal Operations
Shikano North Tailings Dam
2017 Dam Safety Inspection

We are pleased to submit the 2017 Dam Safety Inspection Report for the Shikano North Tailings Dam. Please contact us if you have any questions regarding this report.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

Robert W. Chambers, P.Eng.
Engineer of Record
Senior Geotechnical Engineer, Principal

OL/NG:jcp

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Teck Coal Limited

Quintette Coal Operations

2017 Dam Safety Inspection

Shikano North Tailings Dam

EXECUTIVE SUMMARY

Klohn Crippen Berger Ltd. (KCB) was engaged by Teck Coal Ltd. (Teck) to complete the 2017 Dam Safety Inspection (DSI) of the Shikano North Tailings Dam (SNTD) on the Quintette Coal Operations (QCO) mine site, to comply with Section 10.5.3 of the Health, Safety and Reclamation Code (HSRC) for Mines in British Columbia (the Code), revised in 2017. This report was prepared following:

- Ministry of Energy and Mines[1] (MEM), British Columbia (BC) Section 4.2 "Annual Tailings Facility and Dam Safety Inspection Report" of the 2016 HSRC Guidance Document; and
- MEM Guidelines for Annual Dam Safety Inspection Report.

The 2017 inspection was completed by the Engineer of Record, (EoR), Mr. Bob Chambers, P.Eng., as a representative of KCB between August 14th and 15th, 2017. Mr. Andrew Bidwell, P.Eng., of Teck is the Tailings Storage Facility (TSF) Qualified Person (as defined by the Code) for the SNTD.

Summary of Facility Description

QCO 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. During care and maintenance, Teck staff are onsite for environmental sampling, inspections and maintenance activities.

The SNTD is approximately 16 km south of the Municipality of Tumbler Ridge in northeastern BC. The SNTD is constructed across the mined-out Shikano North Pit. The SNTD crest is approximately 200 m long and was constructed to elevation 829 masl. The SNTD is has a maximum downstream slope height of 45 m (crest to toe) with 2H:1V downstream slope and 2.25H:1V upstream slope.

The dam was designed as a "flow-through" rockfill dam with internal granular filters and a non-woven geotextile to restrict fine coal tailings passing through the dam while allowing seepage through the dam. The seepage discharges to Sedimentation Pond S3 through a culvert in the downstream shell of the dam before being discharged to the environment which drains towards the Murray River (west of the SNTD). No construction has been carried out on the dam since 2000 and no construction is planned while the site remains in care and maintenance.

Summary of Key Hazards

Internal Erosion and Piping: Several sinkholes have been observed on the tailings beach sine 2010 DSI inspection but when they started to form is not known. They are most likely a local condition where tailings are migrating into the upstream coarse rockfill shell or into the "windows" of high permeability fill, but not through the internal filters. The "windows" of high permeability was a design modification introduced during the construction to encourage seepage flow through the dam as the fine filter had a permeability lower than expected. If piping of tailings were to occur, the probability of triggering a dam failure is very low.

[1] Ministry of Energy and Mines (MEM) is now Ministry of Energy, Mines and Petroleum Resources (MEMPR).

Other Hazards: such as overtopping, slope stability, foundation failure, surface erosion, and earthquakes are not considered "key hazards" for this facility and are discussed in the main text of this report.

Consequence Classification of Dam

The SNTD was classified as having "Significant" failure consequence (KCB 2014a), based on Canadian Dam Association (CDA) (2013). 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 mining. However, a "Significant" consequence classification is appropriate for the existing 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.

Significant Changes in Instrumentation and/or Visual Monitoring Records

No exceedance in instrument thresholds was recorded and no event-driven inspections were trigged in 2017.

The monitoring program (inspections and instrumentation) is sufficient to observe the performance of the SNTD during care and maintenance. The piezometers indicate a downward gradient upstream of the filters and a low water level in the rockfill dam. Overall piezometer readings are below historical levels during operations and there were no threshold exceedances in 2017. Therefore, the current piezometer reading frequency of once per year is sufficient under the current care and maintenance status with no active tailings deposition; no changes are recommended.

The survey measurements at the SNTD are currently taken three times per year (e.g., before May, between July and August, and between September and November). KCB recommends the reading frequency be reduced to once per year since no continuous downstream movement or settlement of the crest has been observed since their re-initiation in 2014. Piezometer reading and survey monument measurement frequency should be revised before tailings discharge resumes at the SNTD.

Routine inspections of the dam were completed by Teck's Dam Inspector in May 2017 and October 2017. Inspection details were documented using a standard checklist. The routine inspections and 2017 DSI observations do not indicate any significant change in the SNTD or dam safety issues.

Significant Changes to Dam Stability and/or Surface Water Control

There has been no change in dam stability or surface water control.

The catchment for the SNTD impoundment is 76.4 ha including the tailings beach and pond area (8.3 ha). During operations, tailings were discharged from the eastern edge of the impoundment which formed a tailings beach sloping towards the dam. Excess water would pond against the dam face and seep through the upstream filters.

Total precipitation from September 1st, 2016 to August 31st, 2017 was 435 mm, which is well below normal precipitation (1991 to 2000) of 560 mm. A simplified water balance for the facility estimated an average seepage rate of 5 L/s through the dam between September 1st, 2016 and August 31st,

2017, which matches the estimated flow of 5 L/s during the August 2017 inspection. Note: the average flow estimate includes the winter period when flows are likely zero.

Tailings deposition at SNTD was suspended in 2000 before the impoundment reached capacity. The tailings level is currently 32 m below dam crest level. Surface runoff in the impoundment and catchment collects in a depression on the tailings beach to form a seasonal, shallow pond which was approximately 30 m away from the dam during the inspection. A spillway is not required based on the large available storage capacity within the impoundment. Even during a probable maximum flood (PMF), there would be approximately 25 m of freeboard.

Operation, Maintenance, and Surveillance Manual

The Operation, Maintenance and Surveillance Manual (OMS) manual was updated in February 2018 as draft. The OMS manual includes monthly downstream slope inspections, and routine visual inspections three times per year, e.g., spring (after snowmelt), mid-summer, and fall (before first snowfall). Guidance on visual inspections and thresholds (i.e., Quantifiable Performance Objectives (QPOs)) for piezometers and survey monuments recommended in this report have been included in the document. If a threshold is exceeded, the OMS manual includes a response action and timeline to complete.

Emergency Preparedness and Response Plan

There is currently no Emergency Preparedness and Response Plan (EPRP) developed for the SNTD. Teck has indicated that the EPRP should be available by the end of 2018.

Dam Safety Review

The most recent DSR was completed in 2014. Teck has indicated that the next DSR should be completed by July 2021, which is 5 years from effective date of the Code requirement for DSRs to be performed at least every 5 years.

2017 DSI Observations and Recommendations

The SNTD 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 the facility was put onto care and maintenance status. Survey data collected in 2017 indicated no continuous crest movement or settlement.

Previous, outstanding recommendations regarding deficiencies, non-conformances and future work are summarized in Table 1. Recommendations for future work or items of concern for the dam resulting from the 2017 DSI site visit and review are summarized in Table 2. Closed recommendations are shown in italics and will be removed from the table in next year's DSI.

KCB has assigned priority to the various recommendations using the 2016 HSRC Guidance Document priority definitions, which are as follows:

- 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.

Table 1 Previous Deficiencies and Recommendations

ID Number	Deficiency or Non-Conformance	Applicable Regulation or OMS Manual Reference	Recommended Action	Priority	Recommended Deadline (Status)
SNTD-2014-01 (DSI-SN-07)	*Undocumented Visual Monitoring Records.*	*HSRC Code*	*Create a form or system to document visual inspections of SNTD during each water sample collection of S3 Pond.*	*4*	*CLOSED*
SNTD-2015-01 (DSI-SN-10)	*Survey Monitoring Requirements*	*n/a*	*After 2016 survey monument readings, review available data and define threshold values which should then be added to OMS manual.*	*3*	*CLOSED*
SNTD-2016-01	Sinkhole Monitoring Program	OMS Manual	Establish a monitoring program (i.e. stakes) for the sinkholes within the tailings beach to determine if new ones are forming and/or if current ones are getting larger. To be conducted by Teck during the visual inspections and procedure included in the OMS manual. KCB to provide guidance on monitoring program.	3	October 2017 (OPEN)
SNTD-2016-02	*Engineer of Record (EoR)*	*OMS Manual*	*Update the EoR currently listed in the OMS manual.*	*3*	*CLOSED*

Table 2 2017 Deficiencies and Recommendations

ID Number	Deficiency or Non-Conformance	Applicable Regulation or OMS Manual Reference	Recommended Action	Priority	Recommended Deadline (Status)
SNTD-2017-01	Lack of an Emergency Preparedness and Response Plan (EPRP)	HSRC Code	Prepare an EPRP for the SNTD.	3	December 2018 (OPEN)
SNTD-2017-02	Lack of QPOs for Freeboard Thresholds and Responses	OMS Manual	Install physical indicators during routine visual inspection at the SNTD in spring of 2018. The indictors should be installed at the contact between dam upstream rockfill zone and tailings beach. The physical indicator should have a minimum of 1.5 m stickup and has a 1 m distant above tailings beach clearly marked.	4	June 2018 (OPEN)

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1 INTRODUCTION

Klohn Crippen Berger Ltd. (KCB) was engaged by Teck Coal Ltd. (Teck) to complete the 2017 Dam Safety Inspection (DSI) of the Shikano North Tailings Dam (SNTD) on the Quintette Coal Operations (QCO) mine site. The inspection and this report were prepared to comply with Section 10.5.3 of the Health, Safety and Reclamation Code (HSRC) for Mines in British Columbia (the Code), revised in 2017. This report was prepared following:

- Ministry of Energy and Mines[1] (MEM), British Columbia (BC) Section 4.2 "Annual Tailings Facility and Dam Safety Inspection Report" of the 2016 HSRC Guidance Document; and
- MEM Guidelines for Annual Dam Safety Inspection Report.

A site visit was completed on August 14th and 15th, 2017 between 2:30 pm and 5:00 pm by the Engineer of Record (EoR), Mr. Bob Chambers, P.Eng., as a representative of KCB, along with Mr. Nat Gullayanon, P.Eng., of KCB, and Mr. Rob Muise and Mr. Ray Proulx of Teck. During the site visit, the weather was sunny with cloudy periods and no precipitation. Refer to Figure 1 for an overview of the facility and DSI inspection photograph locations. Inspection observations are summarized in the following sections of the report. DSI inspection photographs are provided in Appendix I.

Mr. Andrew Bidwell, P.Eng., of Teck is the Tailings Storage Facility (TSF) Qualified Person (as defined by the Code) for the SNTD.

QCO 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. During care and maintenance, Teck staff are onsite for environmental sampling, inspections and maintenance activities. Under this level of site presence, the SNTD is consistent with "Closure-Active Care" phase as defined by the Canadian Dam Association (CDA) Mining Dam Technical Bulletin: Application of Dam Safety Guidelines to Mining Dams (2014).

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. PE-06739 (amended July 9, 2014).

Fine coal tailings from restart operations would be discharged into the SNTD impoundment. However, Teck have deferred the restart of operations pending an improvement in market conditions. The 2014 MOE permit amendment for a restart of operations includes provisions for water quality monitoring of the SNTD that apply to care and maintenance as well as to restart operations.

The SNTD has a "Significant" consequence category based on CDA Dam Safety Guidelines (2013) as reported in the most recent Dam Safety Review (DSR) (KCB 2014a). The factors considered in the classification of the SNTD are listed in Table 1.1.

[1] Ministry of Energy and Mines is now Ministry of Energy, Mines and Petroleum Resources (MEMPR).

Table 1.1 Classification of SNTD Based on Consequence Category (KCB, 2014a)

Population at Risk	Loss of Life	Economic and Social Loss	Environmental and Cultural Losses
No Permanent Population	Significant	Low	Significant to Low

MEM permit C-156 (June 2013) refers to the SNTD as a "High" consequence classification dam. The "High" consequence classification in the permit 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 remains appropriate for the existing care and maintenance status of the dam.

The most recent DSR was completed in 2014. Teck has indicated that the next DSR should be completed by July 2021, which is 5 years from effective date of the Code requirement for DSRs to be performed at least every 5 years.

2 BACKGROUND AND RECENT ACTIVITY

2.1 Background Information

The SNTD is approximately 16 km south of the Municipality of Tumbler Ridge in northeastern BC and is approximately 2.5 km west of QCO plantsite and gatehouse. The dam is constructed across the mined-out Shikano North Pit to form the Shikano North Tailings Storage Facility. The SNTD is surrounded by Centre Waste Dump to the south, Seepage Collection Pond S3 and Murray River to the west, waste dump/natural slope to the east, and North East Dump to the north.

The facility was commissioned in 1997 when the Plantsite Tailings Storage Facility reached capacity. No construction has been carried out on the dam since operations were suspended in 2000 and none are planned while the site remains in care and maintenance. A summary of available SNTD key reference documents is included in Appendix V.

The SNTD was designed as a "flow-through" rockfill dam with internal granular filters and a non-woven geotextile filter fabric to restrict fine coal tailings passing through the dam while allowing seepage through the dam. "Windows" of high permeability gravel, upstream of the filters, were introduced as a design modification during construction to encourage seepage flow through the dam as the fine filter had a permeability lower than expected; each window was approximately 1 m thick (KC 1997) (see Figure 2). The seepage discharges to Sedimentation Pond S3 through a culvert in the downstream shell of the dam (Figure 1).

The SNTD has a maximum downstream slope height of 45 m (crest to toe) with 2H:1V downstream and 2.25H:1V upstream slope. The dam crest is 200 m long. The SNTD has a storage capacity of approximately 6 Mm^3 and has 2.8 Mm^3 of tailings and water stored to date (KCB 2014b).

The SNTD design was completed by Klohn Crippen Consultants Ltd. (KC) (1996). Select dam record drawings including cross sections of the SNTD are included in Appendix II. The SNTD was raised to the current crest elevation in two stages:

- Stage I (May to November 1996): crest elevation 810 masl.
- Stage II (December 1998 to March 1999): crest raised to elevation 829 masl.

Construction record reports were issued following each raise (KC 1997 and KC 1999b). No significant construction or performance related issues were noted in the as-built document (KC 1999b), the 1999 Annual Review (AR) (KC 1999a) and DSI reports from 2010 to 2016 (KCB). No recent construction was carried out at the SNTD since completion in 1999.

When mining operations were suspended in 2000, tailings stored in the impoundment were well below design capacity. The current dam crest elevation, measured from survey monument pins in 2016, is 828.5 masl (KCB 2016b), 0.5 m lower than reported elevation in the Stage II construction record report. The current tailings is approximately at elevation 796 masl based on a 2010 LiDAR

survey (provided by Teck, survey completed by McElhanney Consulting Services Ltd.) which is more than 32 m below the crest.

2.2 Recent Activity

The Operation, Maintenance, and Surveillance (OMS) manual specifies maintenance parameters that includes clearing of vegetation on the dam crest and slopes, maintenance of pneumatic piezometer cables and fittings, maintenance of dam access roads, and quarterly check of weather stations on site. Teck replaced 4 pneumatic piezometer fittings on August 14th, 2017; however, no documentation was made regarding which instruments were repaired.

3 WATER MANAGEMENT, CLIMATE AND WATER BALANCE

3.1 Overview

The SNTD is an inactive facility in care and maintenance and currently holds no surplus mine water. The catchment for the SNTD impoundment is 76.4 ha including the tailings beach and pond area (8.3 ha).

During operations, tailings were discharged from the eastern edge of the impoundment which formed a tailings beach sloping towards the dam. Excess water would pond against the dam face and seep through the upstream filters. Water currently ponds in a shallow depression on the tailings beach formed by post-operations tailings consolidation. At the time of the inspection the pond was approximately 30 m upstream of the dam face (Photos I-1, I-7, and I-10). An outflow channel in the tailings beach conveys water from the pond to the dam face where it seeps into the upstream rockfill shell (Photos I-10 and I-12). The pond area and stored volume appears to be similar to that observed in 2015 and 2016, but slightly more than during the 2012, 2013 and 2014 DSI site visits.

Seepage through the dam accumulates in the coarse rockfill downstream shell. A 750 mm perforated corrugated steel pipe (CSP) buried in the coarse rockfill (invert El. 778 m) is connected to a 750 mm solid pipe section buried beneath the haul road downstream and discharges into a channel that flows to S3 Pond (KC 1996) (Figure 1), before being released to the environment. Discharge from the S3 Pond is a monitoring location listed in the MOE Permit No. PE-06739 which requires quarterly water quality (suspended solids and metals) and weekly flow measurements between April and October of each year. There is no discharge from the SNTD to the M11/M15 Channel, therefore no monitoring is required as specified in the MOE Permit No. PE-06739.

3.2 Climate

Precipitation and temperature data at the site from September 1st, 2016, to August 31st, 2017 is summarized in Table 3.1. Climate data was measured at the Plantsite Tailings Dam (PTD) (Lower Met climate station, elevation 914 masl), 3.8 km north of the SNTD but at similar elevation. However, the rain gauge is not heated so winter precipitation results are not reliable. KCB suggests that Teck install a heated rain gauge to collect the winter climate data; however, it is not a dam safety concern and therefore no current action is required. As a result, data from October 2016 to April 2017 from the Environment Canada Chetwynd Airport climate station (station No. 1181508; elevation 610 masl; and 86 km north of QCO) was obtained and corrected for orographic effects using the elevation-rainfall relationship developed for the restart permit application (KCB 2012a). Climate normals (1991 to 2000), taken from 2013 Baseline Hydrology and Design Basis report (Teck 2013), are also summarized in Table 3.1 for comparison.

Seasonal snowpack depth is measured at the Plantsite station, but no conversion information of the data is available; therefore, snowpack data is not available for review. KCB suggests that Teck resolve this issue for on-going climate data recording; however, it is not a dam safety concern that requires immediate action.

Table 3.1 Precipitation and Temperature at Shikano North Tailings Dam

Month	1991-2000 Normals Precipitation[1] (mm)	2016-2017 Precipitation[2],[3] (mm)	1991-2000 Normals Average Temperature[4] (°C)	2016-2017 Daily Max. Temperature[5] (°C)	2016-2017 Daily Min. Temperature[5] (°C)	2016-2017 Daily Average Temperature[5] (°C)
September	42.3	34.7	10.1	14.0	4.3	9.3
October	53.8	81.8	3.6	2.5	-2.8	-0.2
November	55.5	42.3	-3.7	3.1	-3.9	-0.2
December	40.9	11.6	-6.8	-9.3	-16.5	-12.8
January	43.5	14.7	-10.7	-2.8	-8.9	-5.7
February	36.1	23.9	-5.4	-3.2	-11.9	-7.2
March	33.2	29.8	-2.1	-0.1	-10.2	-5.0
April	27.3	45.9	3.5	6.8	-1.6	2.6
May	31.5	48.7	8.3	16.0	4.1	10.4
June	71.0	49.3	12.3	18.6	6.6	13.0
July	74.6	27.6	14.5	21.3	9.1	15.3
August	49.8	24.9	13.9	22.0	9.1	15.6
Total	**559.5**	**435.2**				

Notes:

1. Monthly normal precipitation is based on the mean annual precipitation-elevation relationship and monthly distribution outlined in the 2013 Baseline Hydrology and Design Basis report (Teck 2013).
2. October 2016 to April 2017 precipitation values were interpreted from Chetwynd Airport climate station (station No. 1181508; elevation 610 masl; and 86 km north of QCO) data, with elevation correction from KCB (2012a).
3. September 2016, and May 2017 to August 2017 precipitation values were interpreted from Plantsite climate station data with elevation correction from KCB (2012a).
4. Average monthly temperatures for the Quintette Site are outlined in the 2013 Baseline Hydrology and Design Basis report (Teck 2013).
5. Daily maximum, minimum, and average temperatures are based on daily temperature readings that were taken at the Plantsite climate station.

The following observations are made based on the data from September 1st, 2016 to August 31st, 2017:

- Total precipitation during this period was 435 mm, which is well below the precipitation normals of 560 mm, and is approximately 85% of the precipitation measured in 2016 (512 mm).
- Average temperatures in September 2016, and between April and August 2017 (Spring and Summer) were similar to the normals. Temperatures between October 2016 and March 2017 (Fall and Winter) were lower than normals, by 2 °C to 6 °C, with the exception of November 2016 and January 2017 when temperatures were higher than normals by approximately 3 °C to 5 °C.
- No event-driven inspections were triggered between September 2016 and August 2017. Event-driven inspections are required after a 10-year and 50-year rainfall events (52 mm and 67 mm, respectively, in 24-hour duration (Teck 2018)).

3.3 Water Balance

Under existing conditions, inflows to the impoundment are predominantly from surface water runoff with limited observed contribution from pit wall seepage. Outflows from the impoundment are predominately seepage through the "flow-through" dam 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 and does not accumulate on an annual basis.

A simplified water balance calculation for the SNTD impoundment from September 2016 to August 2017 is summarized below:

- Inflows:
  - Precipitation on pond surface = 4,098 m^3 (assumed pond surface on average is 4% of tailings beach);
  - Runoff from tailings impoundment (including impoundment slopes and tailings beach, excluding pond area) = 60,418 m^3 (assumed average runoff coefficient of 0.6); and
  - Runoff from upstream catchment = 91,117 m^3 (assumed average runoff coefficient of 0.4).
- Outflows:
  - Evaporation from pond surface = 5,158 m^3 (evaporation rate for this site is 548 mm/yr (KCB 2013); and
  - Seepage losses from the impoundment = 150,474 m^3 (estimated from inflows minus evaporation).

The seepage losses from the impoundment are estimated at an average flow rate of 5 L/s over the 12-month period. The estimated flow rate during the DSI inspection was 5 L/s (Photo I-28 and Photo I-29) which matches the average flow. 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.

3.4 Flood Routing

During flood events, the runoff accumulates in the upstream depression and seeps through the dam. The SNTD requires a minimum freeboard of 1 m above the Inflow Design Flood (IDF). KCB hydrotechnical assessment adopted an IDF equivalent to $^1/_3$ between the 1000-year return period and Probable Maximum Flood (PMF) for a "Significant" consequence dam, assuming the dam is under "Closure-Passive Care" as defined by the CDA (2014), which exceeds the requirements in the Code, and concluded that SNTD has the capacity to store the PMF of 336,200 m^3 with approximately 25 m of freeboard (KCB 2016c). As a result, a spillway is not required.

4 REVIEW OF MONITORING RECORDS AND DOCUMENTS

4.1 Operations, Maintenance and Surveillance Manual

The Operations, Maintenance and Surveillance (OMS) manual was updated in February 2018 as draft. Recommended monitoring for the structure includes routine and event driven inspections and review of instrumentation readings (piezometers and survey monuments) are outlined in the OMS manual. The 2018 OMS manual identifies Mr. Bob Chambers, P.Eng., of KCB as the EoR for the SNTD.

Piezometer, survey monument and freeboard threshold values (i.e., Quantifiable Performance Objectives (QPOs)) and responses recommended in this report are included in the updated OMS manual.

4.2 Emergency Preparedness and Response Plan

There is currently no Emergency Preparedness and Response Plan (EPRP) developed for the SNTD. Teck has indicated that the EPRP should be available by the end of 2018.

4.3 Monitoring Program

Monitoring of the dam includes visual observations (routine and event driven) and review of instrumentation readings, i.e., piezometers and survey monuments.

4.3.1 Visual Inspections

The SNTD monitoring program includes the following inspections (Teck 2018):

- Annual DSI (this report) – completed by the EoR.
- Routine – monthly inspections of the downstream slope area when visiting the area for S3 Pond water sampling and flow monitoring. Inspections of the facility are completed three times per year by Teck's Dam Inspector, Mr. Rob Muise: spring (after snowmelt), mid-summer, and fall (before first snowfall). Routine inspections were completed three times in 2017 (May 31st, 2017, August 14th, 2017 and October 3rd, 2017). The DSI inspection was counted as the 2017 mid-summer inspection. Teck's routine inspection checklists (Appendix III) do not indicate any observed significant change in the SNTD or dam safety issues.
- Event-driven – completed by Teck staff following a 24-hour rainfall event either greater than the 10-year return period (52 mm) or the 50 year return period (67 mm) or an earthquake magnitude 5 or greater within 100 km of the site. The magnitude of the precipitation event determines the response time for the inspection of the facility. Follow up inspections are to occur within 36 hours for a 50-year return period event, or within 3 days for a 10-year return period event. No event-driven inspection was triggered in 2017. No earthquakes were recorded by the Geological Survey of Canada within 100 km of the site during 2017.

Given the long performance history of the SNTD, flow-through design and large freeboard, the inspection program is appropriate.

4.3.2 Instrumentation

Instrumentation at SNTD includes 16 pneumatic piezometers, and 4 survey monuments installed on the SNTD crest. Locations of the piezometers and the survey monuments are shown in Figure 1.

4.3.2.1 Piezometers

Of the 16 piezometers installed at SNTD, 10 are functional (shown on Figure 2). Annual readings of the functioning pneumatic piezometers are to be taken in July of each year by the Teck Dam Inspector. Pore pressure readings were collected on May 31st and August 14th (during the DSI), 2017. Figure 2 presents water levels on schematic cross sections through the SNTD. 2017 piezometer readings are also summarized in Table 4.1.

Threshold values (i.e., QPOs) for the piezometers were developed based on the expected normal seepage conditions through the dam during operations (KC 1996). Piezometric values measured since operations were suspended have not exceeded the current thresholds and with the SNTD currently inactive, there is no need to decrease the thresholds. Threshold Level 1 – "Warning Level" and are summarized in Table 4.1 and was recommended previously in KCB (2016c). Threshold Level – 2 "Alarming Level" is triggered if there are Threshold Level 1 exceedance of two or more piezometers in the same instrumentation section, or if there are two instrumentation sections with observed exceedance of one or more piezometers. Recommended threshold responses are summarized in Table 4.2. Teck has included these threshold values and responses in the 2018 OMS manual.

The existing piezometers and annual readings are sufficient for monitoring of the structure under care and maintenance.

Table 4.1 Piezometer Threshold Values and 2017 Piezometer Readings

Piezometer	Status	Tip Elevation (masl)	Threshold Level 1 "Warning Level" Elevation (masl)	May 31, 2017		August 14, 2017	
				Pressure Readings (psi)	Piezometric Level (masl)	Pressure Readings (psi)	Piezometric Level (masl)
P96-1	Not Functional	767.2	-	No measurement taken, noted as leaking in 2016.			
P96-2	Not Functional	777.2	-	No measurement taken, noted as plugged in historical readings.			
P96-3	Not Functional	770.0	786.0	34 psi measured; unable to stabilize.			
P96-4	Operational	780.1	-	0.2	780.2	0	780.1
P96-5	Operational	780.0	797.0	17.0	792.0	12.3	788.6
P96-6	Operational	780.0	797.0	3.6	782.5	2.9	782.0
P96-7	Operational	790.1	803.0	4.3	793.1	0.6	790.5
P96-8	Operational	790.2	803.0	6.6	794.8	3.8	792.9
P96-9	Operational	800.0	805.0	2.6	801.8	3.2	802.3
P96-10	Operational	800.0	805.0	1.0	800.7	0.9	800.6
P95KC-2A	Operational	755.4	790.0	0.2	755.5	0.3	755.6
P95KC-2B	Operational	776.2	790.0	0.5	776.6	2.0	777.6
P95KC-3A	Not Functional	762.8	790.0	Readings unable to stabilize, >35 psi			
P95KC-3B	Operational	781.3	795.0	0.7	781.8	0.9	781.9
P98-1	Unknown	810.5	-	Instrument has not been located.			
P98-2	Unknown	810.5	-	Instrument has not been located.			

Table 4.2 Piezometers Threshold Responses

Thresholds	Threshold Exceedance	Action
Level 1 "Warning Level"	Exceedance of a threshold in an individual piezometer	▪ Notify EoR within 24 hours upon verification of reading exceedance. ▪ EoR to evaluate data for reliability, and review piezometric data (and survey data if available) within the general vicinity of the individual piezometer in question. EoR may recommend repeat measurement and increased on-going monitoring frequency.
Level 2 "Alarming Level"	Trend of threshold exceedances in a group of piezometers	▪ Notify EoR within 24 hours upon verification of reading exceedance. ▪ Repeat reading within 1 week. ▪ EoR to assess dam integrity and may recommend stability analysis, site visit, or other action.

The following observations are made based on the 2017 piezometer readings:

- All piezometer readings are below the established threshold levels which were defined by KC (1999a). No significant change in established trends were observed.
- Instruments are accessible and functioning with the exception of:
  - P96-1 instrument was not read due to defective/leaking fitting.
  - P96-2 instrument cable was noted as plugged in KC (1999a).
  - P96-4 instrument cable was noted as plugged in KC (1999a) and the instrument continued to give unreasonable reading (+34 psi) in 2017, so it has been disregarded. P96-4 cable was suspected to have been switched with P96-3 in 2016 and in earlier years. P96-3 (before being relabelled to P96-4 in 2017) has been recording approximately 0.1 m of water head above the instrument tip (i.e., El. 770.1 masl), which appears to be lower than the perforated CSP seepage collection pipe (i.e., pipe El. 778 masl as shown in Figure 2). In addition, P96-4 reported tip elevation was incorrectly shown in the as-built drawing D-16003 (Appendix II), which shows the tip elevation at approximately 790 masl instead of installed El. 780.1 masl (KC 1999b). After the revision of P96-4's tip elevation and the labelling between P96-3 and P96-4, the 2017 water elevations recorded by P96-4 were between El. 780.1 m and 780.2 m (Figure 2), which are consistent with the CSP elevation. P96-3 is now being reported as "Unable to Stabilize" (Figure 2).
  - P95KC-3A was not found; Teck managed to find P95KC-3B after it has been reported as "not found" in previous DSI reports. The instrument location and its water levels are shown in Figure 2.
  - P98-1 and P98-2 were not found.
- P96-6 measured water level has been slightly lower than other upstream piezometers installed below the current tailings level, but has been consistent since 2014. This may be due to blockage in the instrument cable, or leakage in the instrument fitting.
- The reason why the measured pressure for P96-9 and P96-10 is above the current pond and tailings level is not known but has been consistent since 2013. There is no visible seepage from the upstream face of the dam and P96-4 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. This is not a dam safety concern and no follow up action is recommended to resolve this issue.
- In general, August 2017 readings were lower than May 2017 readings, likely due to spring freshet, but slightly higher than readings from October 2016.
- The pore pressure measured for piezometers at the same elevation upstream of the filter zones generally show a downward gradient in the upstream rockfill zone, as expected.

Based on the review of the available instrumentation data, the suite of instruments is sufficient for the SNTD. No follow up actions regarding any of the instrumentation is recommended. If the site was to be reactivated a further assessment of the existing instrumentation should be undertaken.

4.3.2.2 Survey Monument Pins

Monitoring pins were originally installed along the SNTD dam crest in 1999 for displacement monitoring and surveyed during operations until 1999. Monitoring of the pins was re-initiated in 2014 and the pins were surveyed 3 times during 2017 (Figure 3). The monuments consist of steel pins with plates attached to the base, buried 1 m below the crest surface (KC 1999b).

After the completion of the 2016 survey monument readings, threshold levels (i.e., QPOs) and threshold responses were established and have been included in the OMS manual. Threshold levels are summarized below:

- Threshold Level 1 – "Warning Level" was developed based on the maximum observed survey measurement to date plus 20%. The Threshold is exceeded if:
  - Horizontal movement ≥ 40 mm from the initial reading;
  - Vertical movement ≥ 70 mm from the initial reading; and
  - Vertical movement ≥ 80 mm between successive readings.
- Threshold Level 2 – "Alarming Level" is exceeded if:
  - There is a trend of threshold exceedances in the monitoring pins.

The responses for each of the threshold levels are summarized in Table 4.3.

Table 4.3 Survey Monument Threshold Response

Threshold Level	Exceedance Threshold	Action
1 "Warning Level"	Exceedance of established threshold in an individual survey pin	▪ Inspect the area around the pin. ▪ Measure again within 1 week and increase monitoring frequency to weekly. ▪ Notify EoR within 24 hours of second reading. ▪ EoR to evaluate data for reliability, and review survey data within the general vicinity of the individual survey pin in question.
2 "Alarming Level"	Common trend of threshold exceedances in a group of pins	▪ Increase monitoring frequency of the survey pins as needed based on assessment of common trend. ▪ EoR to assess stability, stability analysis may be initiated.

A comparison of the October 2016 measurements to the 2017 monitoring records are also summarized in Figure 3. The 2017 surveys were completed using the same method as 2016, using a GPS base station with portable rod mounted survey device and the same operator completed the surveys. The observed movements between readings in 2017 are plotted on Figures 4 and 5.

The horizontal accuracy of the GPS is approximately 0.005 m to 0.010 m and the vertical accuracy is 0.008 m to 0.015 m, as provided by Teck. Real time kinematic (RTK) GPS averaging of continuous

measurements (typically greater than 180 measurements) was used over a period ranging from 10 minutes to 30 minutes to achieve this accuracy.

From a review of the available data since 2014, none of the monuments indicates a trend in the downstream direction or significant crest settlement. There was no exceedance of thresholds during 2017 (Figures 4 and 5). Therefore, KCB recommend the survey monuments reading frequency be reduced to once per year. The current OMS has been updated to include the recommended survey reading frequency.

There are discrepancies between the historical and recent survey data of the SNTD:

- the as-built dam crest elevation was stated as 829 masl (KC 1999b);
- the 2010 LiDAR shows the dam crest elevation at 827.5 masl; and
- the crest ranges from 827.7 masl to 828.5 masl based on the most recent monitoring pin survey data (adjusting the data to account for stick-up).

As the SNTD is rockfill founded on bedrock and settlement is expected. The discrepancies in crest elevation could be the result of survey error, datum changes or settlement. This is not a dam safety concern given the large existing freeboard. Relative movements over time will be monitored using the existing monitoring pins and survey method.

4.3.3 Freeboard

Although the SNTD has significant flood storage, changes in pond size/level, which may indicate a change in dam condition/performance, should be monitored as required. The following are the recommended freeboard QPOs for on-going monitoring of SNTD under care and maintenance conditions:

- Threshold Level 1 – “Warning Level” is exceeded if the water level reaches the contact between dam upstream face and tailings beach. KCB recommends Teck to install a physical indicator (e.g., a staff gauge) during routine visual inspection at the SNTD in spring of 2018. The physical indicator should be installed where the tailings beach meets the upstream rock fill zone and must be installed with a minimum of 1.5 m stickup above tailings surface. A distant of 1 m above tailings surface must be clearly marked such that it is visible when looking from the top of the dam, or from the abutments.
- Threshold Level 2 – “Alarming Level” is exceeded if pond level reaches 1 m mark on the physical indicator.

The recommended responses for the Threshold Levels are summarized in Table 4.4.

Table 4.4 Response to Freeboard Threshold Exceedances

Response Level	Exceedance Threshold	Action
1 "Warning Level"	Pond level reaches the bottom of the Physical Indicator	▪ Notify EoR within 1 week upon verification of pond level exceedance. ▪ EoR may recommend increased monitoring of pond level.
2 "Alarming Level"	Pond level reaches 1 m mark on the Physical Indicator	▪ Notify EoR within 24 hours upon pond level exceedance. ▪ Increased monitoring frequency as directed by the EoR. ▪ EoR to investigate the increase of the pond level.

4.4 Water Quality

A water quality monitoring point included in MOE Permit No. PE-06739 is the outflow from S3 Pond downstream of the SNTD. Monitoring at S3 Pond includes:

- Weekly: Flow rate (April 1 to October 31); and
- Quarterly: Field turbidity; lab turbidity and total suspended solids; and metal and non-metal 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 2018. 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 has confirmed that there have been no non-conformances and that monitoring frequency meets permit requirements.

5 VISUAL OBSERVATIONS AND PHOTOGRAPHS

The following observations were made during the 2017 inspection:

- **Historic Slumping of Pit Wall:** A historic slumping failure is present on the eastern side of the impoundment (Photo I-31) in the old pit wall (approximately 480 m southeast from the upstream face of the dam). No significant change was observed in the area since the 2012 DSI.
- **Dam Crest**: Good condition. No sign of lateral movement, significant differential settlement or cracking of the dam crest (Photo I-3).
- **Downstream Slope**: Good condition. No sign of significant erosion or displacement and no vegetation cover (Photos I-5, I-6, and I-11).
- **Upstream Slope**: Good condition. No sign of significant erosion or displacement and no vegetation cover (Photos I-2, I-7, and I-9).
- **West Abutment**: 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 2014, 2015 or 2016 DSIs. No sign of displacement of the pit wall (Photo I-8). A small erosion gully was observed along the upstream slope and west abutment wall contact (Photo I-27), likely occurred during 2017 freshet. Otherwise, the abutment appears stable and in good condition. Ravelling is not a dam safety concern due to the large amount a freeboard within the reservoir; no action is required.
- **East Abutment**: Good condition. Minor ravelling of pit wall above the crest, appears predominantly surficial and stable. No sign of significant erosion or displacement of the pit wall (Photo I-4). Ravelling is not a dam safety concern due to the large amount a freeboard within the reservoir; no action is required.
- **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 (Photos I-1 and I-7). The pond area was bigger than observed during the 2016 but similar to the 2015 DSI's. The pond was set back approximately 30 m from the upstream slope of the dam (Photo I-10).
- **Sinkhole Depressions in Tailings Beach (refer for Figure 1 and Photo I-7 for sinkholes general location):** A cluster of sinkholes (Sinkhole 6) were observed on the tailings beach (Photo I-20). The largest of the sinkholes is approximately 7 m by 3.5 m and 2 m deep. These features have been noted since the 2010 DSI but when they started to form is not known. There was a notable increase in size between the 2012 and 2013, and between 2016 and 2017 DSIs but a less significant increase noted between 2014 and 2016. Sinkholes 2 and 3 were observed in 2015 in the tailings beach, which also appears to have slightly increased in size in 2017 (Photos I-16 and I-17). Sinkholes 1 and 9 were observed in 2016 in the tailings beach and only Sinkhole 1 appears to have slightly increased in size in 2017 (Photos I-15 and I-26). Sinkholes 4, 5, 7 and 8 were first observed during the 2017 inspection (Photo I-18, Photos I-19, I-24, and I-25). The cause of these features is most likely the migration of tailings into the upstream coarse rockfill shell and "windows" of high permeability gravel (Figure 2) which are upstream of the filters. Sinkholes are considered a local condition. A sinkhole monitoring program should be established and conducted in conjunction with the routine visual inspections at the SNTD. The sinkholes should be shown on a drawing for future reference.

6 ASSESSMENT OF DAM SAFETY

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

- **Overtopping:** Given the large freeboard available in the dam (approximately 25 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 inspections. They are most likely a local condition where tailings are migrating into the upstream coarse rockfill shell and "windows" of high permeability fill, not the internal filters. If some piping of tailings were to occur the probability of it triggering a dam failure is very low.

  The monitoring program of the sinkholes should include the installation of stakes or wooden posts along the outside of the sinkholes to determine if there is growth and the rate of the growth (KCB to provide further guidance). Alternatively, an aerial survey or LiDAR may be utilized to capture the development of the sinkholes. Currently the sinkholes are inspected during the annual DSI site visit.
- **Slope Instability:** The dam is a coarse rockfill structure founded on bedrock at the base and abutments. The downstream slope of the dam is 2H:1V. 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 the Code. 2017 piezometer readings indicate that the pore pressures in the dam are below design levels. 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 Failure:** 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 movement. No significant movement was observed in the inclinometers which were monitored until 1998. The probability of failure due to foundation failure is negligible.
- **Surface Erosion:** Both the upstream and downstream slopes of the dam are covered with a coarse rockfill to protect against surface erosion. A small erosion gully observed on the upstream slope and west abutment wall contact (Photo I-27), likely occurred during 2017 freshet, and is not a dam safety concern. 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 of 0.15g, which is greater than the Code's recommended earthquake design ground motion (EDGM), 2475-year return period event (i.e., 0.082g), based

on National Building Code of Canada (NBCC) (2015). The design analysis and lower EDGM relative to design assumptions indicate the probability of a failure during the EDGM is very low.

The SNTD appears in good condition and the observed performance is consistent with design requirements. Comparison of available annual inspection reports and piezometer measurements indicate there has been no significant change to the condition of the structure since 2000.

Deficiencies and non-conformances identified previously and during the 2017 DSI are given in Table 6.1 and Table 6.2. Closed items are shown in italic and will be removed from the table in the next DSI.

KCB has assigned priority to the various recommendations using the 2016 HSRC Guidance Document priority definitions, which are as follows:

- 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.

Table 6.1 Previous Deficiencies and Recommendations

ID Number	Deficiency or Non-Conformance	Applicable Regulation or OMS Manual Reference	Recommended Action	Priority	Recommended Deadline (Status)
SNTD-2014-01 (DSI-SN-07)	*Undocumented Visual Monitoring Records.*	*HSRC Code*	*Create a form or system to document visual inspections of SNTD during each water sample collection of S3 Pond.*	*4*	*CLOSED*
SNTD-2015-01 (DSI-SN-10)	*Survey Monitoring Requirements*	*n/a*	*After 2016 survey monument readings, review available data and define threshold values which should then be added to OMS manual.*	*3*	*CLOSED*
SNTD-2016-01	Sinkhole Monitoring Program	OMS Manual	Establish a monitoring program (i.e. stakes) for the sinkholes within the tailings beach to determine if new ones are forming and/or if current ones are getting larger. To be conducted by Teck during the visual inspections and procedure included in the OMS manual. KCB to provide guidance on monitoring program.	3	October 2017 (OPEN)
SNTD-2016-02	*Engineer of Record (EoR)*	*OMS Manual*	*Update the EoR currently listed in the OMS manual.*	*3*	*CLOSED*

Table 6.2 2017 Deficiencies and Recommendations

ID Number	Deficiency or Non-Conformance	Applicable Regulation or OMS Manual Reference	Recommended Action	Priority	Recommended Deadline (Status)
SNTD-2017-01	Lack of an Emergency Preparedness and Response Plan (EPRP)	HSRC Code	Prepare an EPRP for the SNTD.	3	December 2018 (OPEN)
SNTD-2017-02	Lack of QPOs for Freeboard Thresholds and Responses	OMS Manual	Install physical indicators during routine visual inspection at the SNTD in spring of 2018. The indictors should be installed at the contact between dam upstream rockfill zone and tailings beach. The physical indicator should have a minimum of 1.5 m stickup and has a 1 m distant above tailings beach clearly marked.	4	June 2018 (OPEN)

7 CLOSING

This report is an instrument of service of Klohn Crippen Berger Ltd. The report has been prepared for the exclusive use of Teck Coal Ltd. (Client) for the specific application to the 2017 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.

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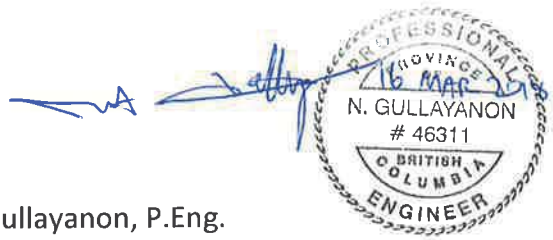

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Geotechnical Engineer

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Engineer of Record
Senior Geotechnical Engineer, Principal

REFERENCES

Canadian Dam Association (CDA). 2007. “Dam Safety Guidelines”, January.

Canadian Dam Association (CDA). 2013. “Dam Safety Guidelines” Including 2013 revision to Section 6, January.

Canadian Dam Association (CDA). 2014. “Technical Bulletin: Application of Dam Safety Guidelines to Mining Dams”.

Klohn Crippen Consultants Ltd. (KC). 1996. “Shikano North Tailings Impoundment – Pervious Tailings Dam Option Design Report” February.

Klohn Crippen Consultants Ltd. (KC). 1997. “Shikano North Tailings Impoundment – 1996 As-Built Report”, March.

Klohn Crippen Consultants Ltd. (KC). 1999a. “Shikano North Tailings Impoundment – 1999 Annual Review”, December.

Klohn Crippen Consultants Ltd. (KC). 1999b. “Shikano North Tailings Impoundment – Stage 2 As-built Report”, July.

Klohn Crippen Berger Ltd. (KCB). 2011. “Quintette 2010 Dam Safety Inspection and Consequence Classification”, March.

Klohn Crippen Berger Ltd. (KCB). 2012a. “Quintette Coal Project: Mines Act Permit Amendment Application Site Water Management Plan and Technical Data Report – Revision 1”, June.

Klohn Crippen Berger Ltd. (KCB). 2012b. “Quintette Coal Project: 2012 Dam Inspections: Plantsite Tailings Dam, M11 Diversion Dam, Shikano North Tailings Dam”, December.

Klohn Crippen Berger Ltd. (KCB). 2013. “Shikano North Tailings Dam - 2013 Dam Safety Inspection Report” December.

Klohn Crippen Berger Ltd. (KCB). 2014a. “Quintette Dam Safety Review: Shikano North Tailings Storage Facility”, May.

Klohn Crippen Berger Ltd. (KCB). 2014b. “Shikano North Tailings Dam – 2014 Dam Safety Inspection Report – Revision 1”,

Klohn Crippen Berger Ltd. (KCB). 2016a. “Shikano North Tailings Dam – 2015 Dam Safety Inspection Report”, March.

Klohn Crippen Berger Ltd. (KCB). 2016b. “Shikano North Tailings Dam – 2016 Dam Safety Inspection Report”, December.

Klohn Crippen Berger Ltd. (KCB). 2016c. “Quintette Coal Operations – Shikano North Tailings Dam Water Management, Water Balance and Quantifiable Performance Objectives”, December.

Ministry of Energy and Mines, British Columbia (MEM). 2016. “Health, Safety and Reclamation Code for Mines in British Columbia”.

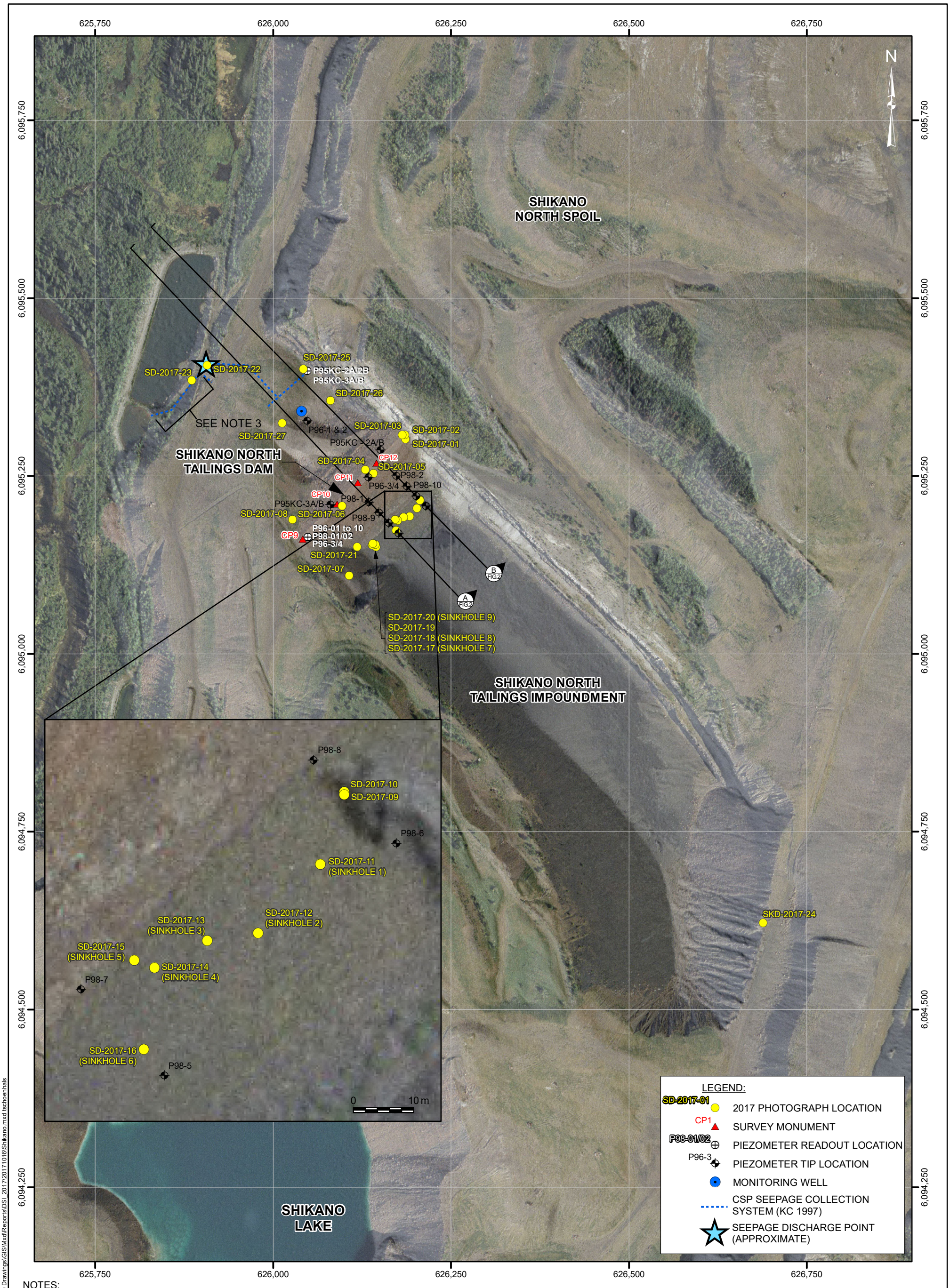
Mining Association of Canada (MAC). 2011. “Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities”.

Teck Coal Ltd. (Teck) 2013. “Baseline Hydrology and Design Basis”, January.

Teck Coal Ltd. (Teck). 2018. “Quintette Coal Operation Shikano North Tailings Operations, Maintenance, and Surveillance Manual - Draft”.

National Building Code of Canada (NBCC). 2015. National Research Council of Canada.

FIGURES



NOTES:
1. UTM ZONE 10N, NAD83.
2. 2010 ORTHOPHOTO PROVIDED BY TECK.
3. THIS PART OF SEEPAGE COLLECTION PIPE WAS LIKELY REPLACED WITH OPEN CHANNEL.

NOT FOR CONSTRUCTION

SCALE 0 150 m

CLIENT: Teck

Klohn Crippen Berger

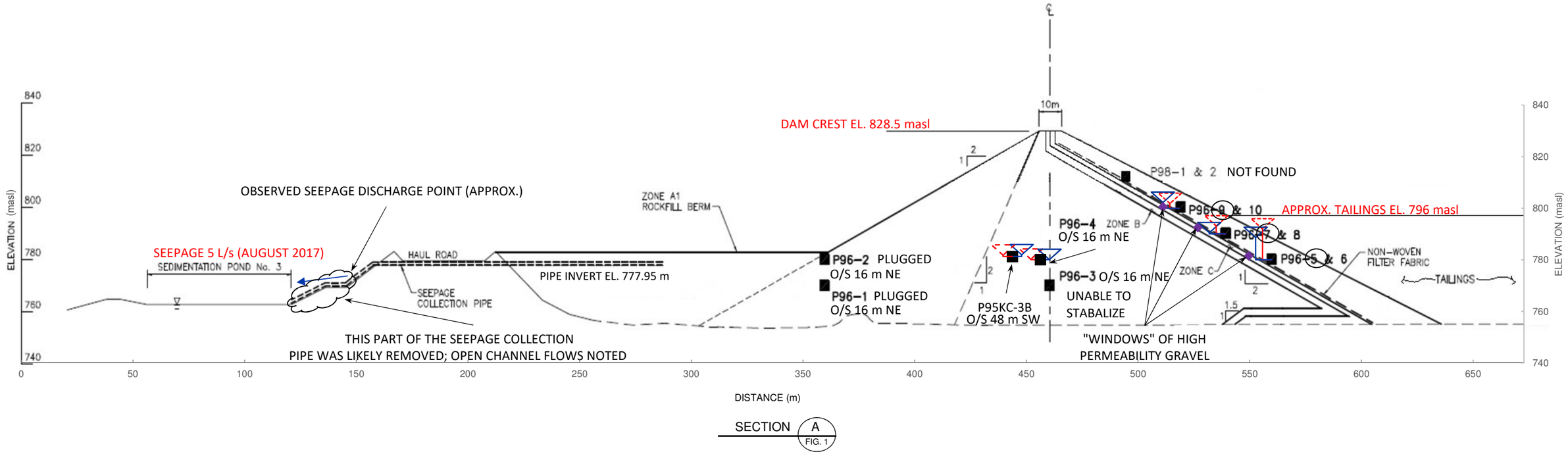
PROJECT: QUINTETTE COAL OPERATIONS
2017 DAM SAFETY INSPECTION

TITLE: SHIKANO NORTH TAILINGS DAM
GENERAL ARRANGEMENT

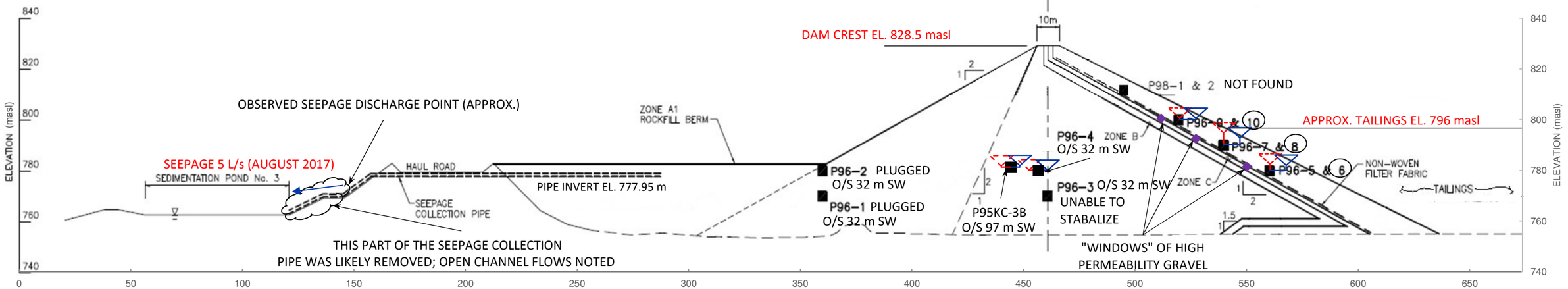
PROJECT No. M09684A14

FIG No. 1

Path: Z:\M\VCR\M09684A14 - TCL-Quintette 2017 DSI\400 Drawings\GIS\Mxd\Reports\DSI_2017\20171016\Shikano.mxd tschoenhals



SECTION A
FIG. 1



SECTION B
FIG. 1

NOTES:

1. TRESHOLD VALUES WERE ADJUSTED BASED ON RECOMMENDATIONS FROM 1990 ANNUAL REVIEW (KC 1990).

LEGEND:

MAY 31, 2017 WATER LEVEL

AUGUST 14, 2017 WATER LEVEL

NOT FOR CONSTRUCTION

CLIENT: Teck

Klohn Crippen Berger

PROJECT: QUINTETTE COAL OPERATIONS
2017 DAM SAFETY INSPECTION

TITLE: SHIKANO NORTH TAILINGS DAM
SCHEMATIC SECTIONS A AND B
WITH 2017 PIEZOMETER READINGS

PROJECT No. M09684A14

FIG. No. 2

Date & Time: 2018-02-24 13:45
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MONUMENT	OCTOBER 2016 READINGS	NORTHING (m)			CHANGES BETWEEN 2017 READINGS FROM OCTOBER 2016 (mm)		
	NORTHING (m)	May 23, 2017	August 10, 2017	October 4, 2017	May 23, 2017	August 10, 2017	October 4, 2017
CP9	6095161.127	6095161.121	6095161.139	6095161.136	-6	12	9
CP10	6095210.849	6095210.858	6095210.870	6095210.845	9	21	-4
CP11	6095240.672	6095240.678	6095240.683	6095240.668	6	11	-4
CP12	6095268.256	6095268.248	6095268.257	6095268.247	-8	1	-9

MONUMENT	OCTOBER 2016 READINGS	EASTING (m)			CHANGES BETWEEN 2017 READINGS FROM OCTOBER 2016 (mm)		
	EASTING (m)	May 23, 2017	August 10, 2017	October 4, 2017	May 23, 2017	August 10, 2017	October 4, 2017
CP9	626041.789	626041.794	626041.793	626041.801	5	4	12
CP10	626090.104	626090.111	626090.111	626090.116	6	7	12
CP11	626119.191	626119.204	626119.190	626119.195	13	-1	3
CP12	626145.425	626145.423	626145.417	626145.421	-2	-8	-5

MONUMENT	OCTOBER 2016 READINGS	ELEVATION (masl)			CHANGES BETWEEN 2017 READINGS FROM OCTOBER 2016 (mm)		
	ELEVATION (masl)	May 23, 2017	August 10, 2017	October 4, 2017	May 23, 2017	August 10, 2017	October 4, 2017
CP9	828.528	828.511	828.541	828.510	-18	13	-19
CP10	828.080	828.062	828.122	828.070	-19	41	-10
CP11	828.141	828.116	828.160	828.127	-25	19	-14
CP12	827.986	827.981	828.006	827.969	-5	20	-18

NOTES:

1. LATEST SURVEY DATA PROVIDED BY QUINTETTE COAL OPERATIONS ON OCTOBER 4, 2017.
2. SURVEYS COMPLETED USING A GPS BASE STATION WITH A PORTABLE ROD MOUNTED GLOBAL NAVIGATION SATELLITE SYSTEM ANTENNA.

SURVEY ACCURACY:
HORIZONTAL: +/- 5 mm to 10 mm
VERTICAL: +/- 8 mm to 15 mm

CLIENT: Teck

Klohn Crippen Berger

PROJECT: QUINTETTE COAL OPERATIONS
2017 DAM SAFETY INSPECTION

TITLE: SHIKANO NORTH TAILINGS DAM
2017 SURVEY MONUMENT DATA

PROJECT No. M09684A14

FIG. No. 3

Date & Time: 2017-12-07 22:45
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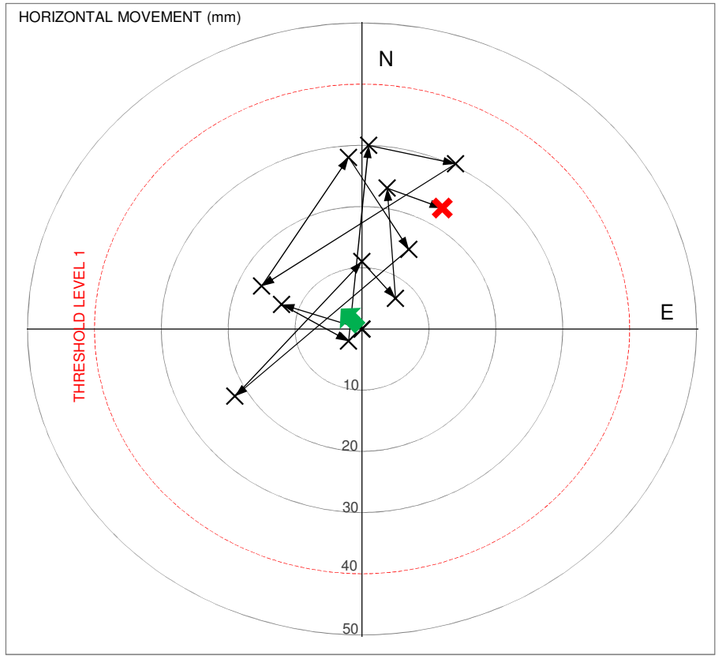
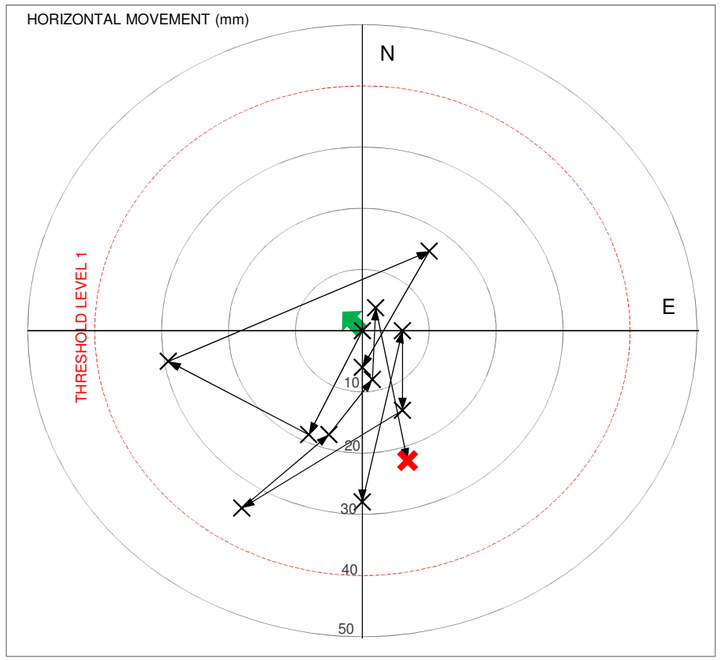
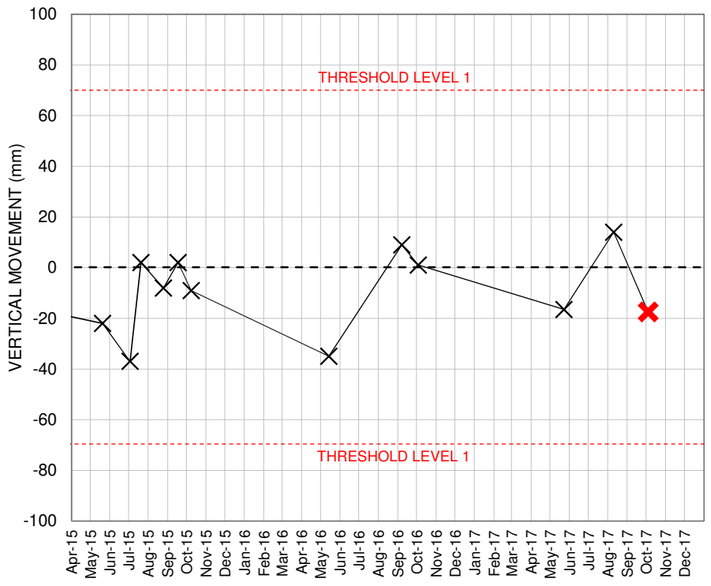
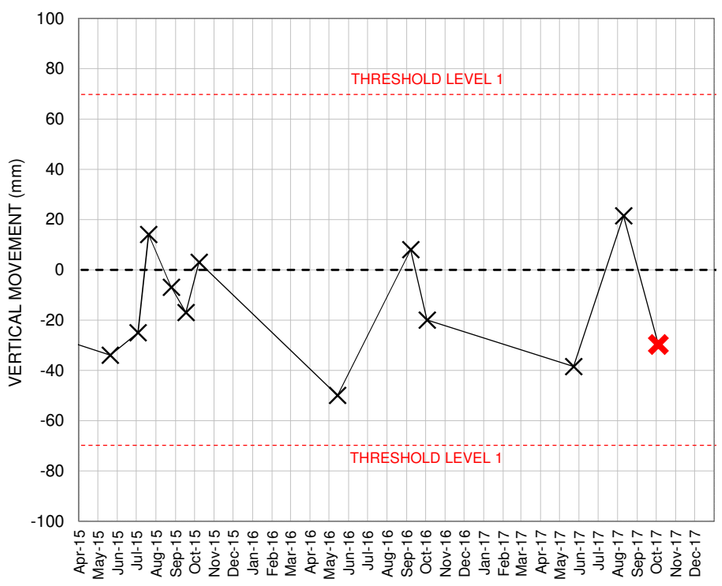






CP9 SURVEY RECORDS



CP10 SURVEY RECORDS

NOTES:

1. LATEST SURVEY DATA PROVIDED BY QUINTETTE COAL OPERATIONS ON OCTOBER 4, 2017.
2. SURVEYS COMPLETED USING A GPS BASE STATION WITH A PORTABLE ROD MOUNTED GLOBAL NAVIGATION SATELLITE SYSTEM ANTENNA.

LEGEND:

DOWNSTREAM DIRECTION

LATEST SURVEY READING

SURVEY ACCURACY:
HORIZONTAL: +/- 5 mm to 10 mm
VERTICAL: +/- 8 mm to 15 mm

THRESHOLD VALUES:
THRESHOLD LEVEL 1: ≥ 40 mm OF HORIZONTAL MOVEMENT FROM INITIAL READING;
≥ 70 mm OF VERTICAL MOVEMENT FROM INITIAL READING; OR
IF VERITICAL MOVEMENT ≥ 80 mm BETWEEN SUCCESSIVE READINGS
THRESHOLD LEVEL 2: IF THERE IS A TREND OF THRESHOLD EXEEDANCE IN THE MONITORING MONUMENTS.

CLIENT: Teck

Klohn Crippen Berger

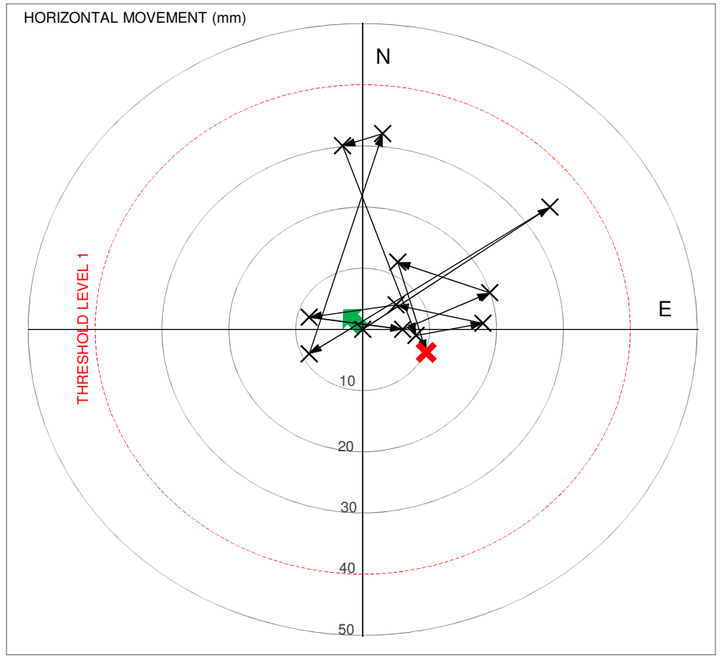
PROJECT: QUINTETTE COAL OPERATIONS
2017 DAM SAFETY INSPECTION

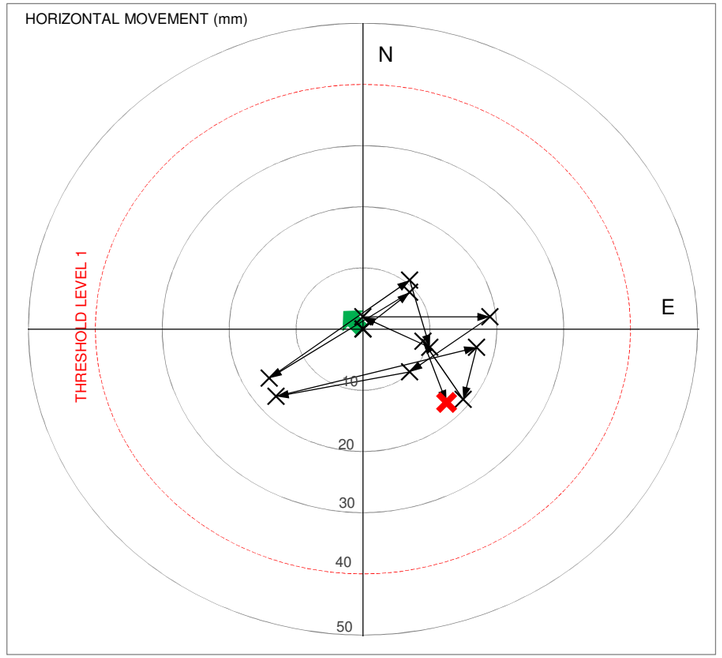
TITLE: SHIKANO NORTH TAILINGS DAM
2017 SURVEY MONUMENT PLOTS
CP9 AND CP10

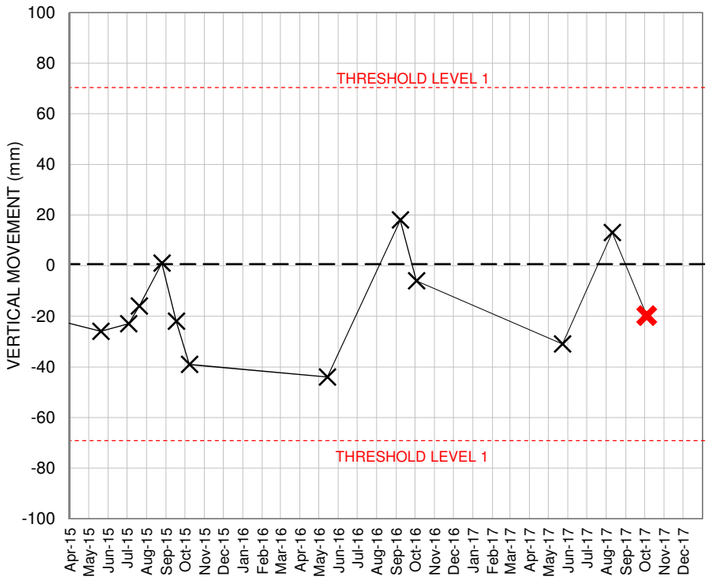
PROJECT No. M09684A14

FIG. No. 4

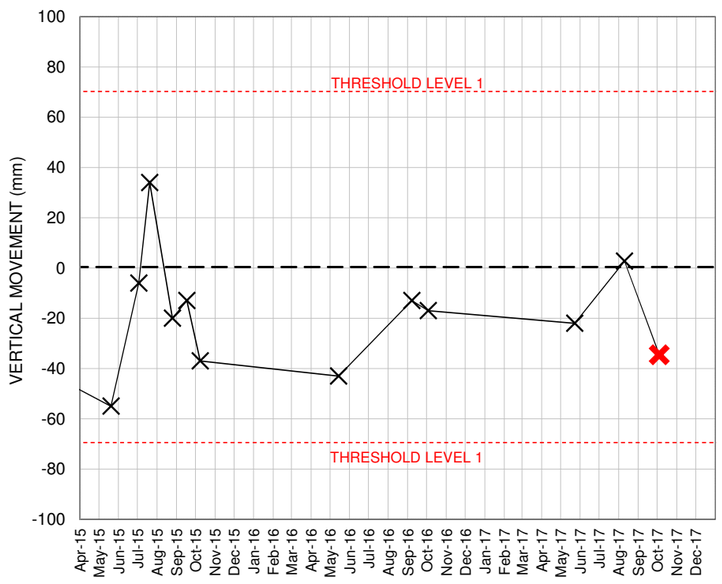
Date & Time: 2017-12-07 22:54
Figure File: Z:\M\VCR\M09684A14 - TCL-Quintette 2017 DSI\300 Design\340 Ph04-EngSupport\341 Instrumentation\SNTD Survey\[171207 Shikano Survey.xlsx]Figure C







CP11 SURVEY RECORDS



CP12 SURVEY RECORDS

NOTES:

1. LATEST SURVEY DATA PROVIDED BY QUINTETTE COAL OPERATIONS ON OCTOBER 4, 2017.
2. SURVEYS COMPLETED USING A GPS BASE STATION WITH A PORTABLE ROD MOUNTED GLOBAL NAVIGATION SATELLITE SYSTEM ANTENNA.

LEGEND:

DOWNSTREAM DIRECTION

LATEST SURVEY READING

SURVEY ACCURACY:
HORIZONTAL: +/- 5 mm to 10 mm
VERTICAL: +/- 8 mm to 15 mm

THRESHOLD VALUES:
THRESHOLD LEVEL 1: ≥ 40 mm OF HORIZONTAL MOVEMENT FROM INITIAL READING;
≥ 70 mm OF VERTICAL MOVEMENT FROM INITIAL READING; OR
IF VERITICAL MOVEMENT ≥ 80 mm BETWEEN SUCCESSIVE READINGS
THRESHOLD LEVEL 2: IF THERE IS A TREND OF THRESHOLD EXEEDANCE IN THE MONITORING MONUMENTS.

CLIENT: Teck

Klohn Crippen Berger

PROJECT: QUINTETTE COAL OPERATIONS
2017 DAM SAFETY INSPECTION

TITLE: SHIKANO NORTH TAILINGS DAM
2017 SURVEY MONUMENT PLOTS
CP11 AND CP12

PROJECT No. M09684A14

FIG. No. 5

Date & Time: 2017-12-07 22:54
Figure File: Z:\M\VCR\M09684A14 - TCL-Quintette 2017 DSI\300 Design\340 Ph04-EngSupport\341 Instrumentation\SNTD Survey\[171207 Shikano Survey.xlsx]Figure C

APPENDIX I

Inspection Photographs

Appendix I
Inspection Photographs

LEGEND:

- SNTD = Shikano North Tailings Dam.
- SNTD-2017-## refers to 2017 DSI photograph location, as shown on Figure 1.
- Photographs were taken during site inspection on August 14th and 15th, 2017.

Photo I-1 Pond and basin from the northeast abutment - looking upstream (south) (SNTD-2017-01)

Photo I-2 **Upstream slope – looking southwest. No sign of erosion or movement (SNTD-2017-01)**

Photo I-3 **Dam crest from east abutment – no sign of movement or settling (e.g., sinkholes, cracks, slumping) (SNTD-2017-02)**

Photo I-4 **East abutment – minor ravelling of material from slope above onto the crest – appears to be in the same condition as previous year (SNTD-2017-02)**

Photo I-5 **Downstream slope – looking southwest. No sign of erosion or significant movement (SNTD-2017-03)**

Photo I-6 **Downstream slope taken from mid-length of the crest – slope appears to be in good condition (SNTD-2017-04)**

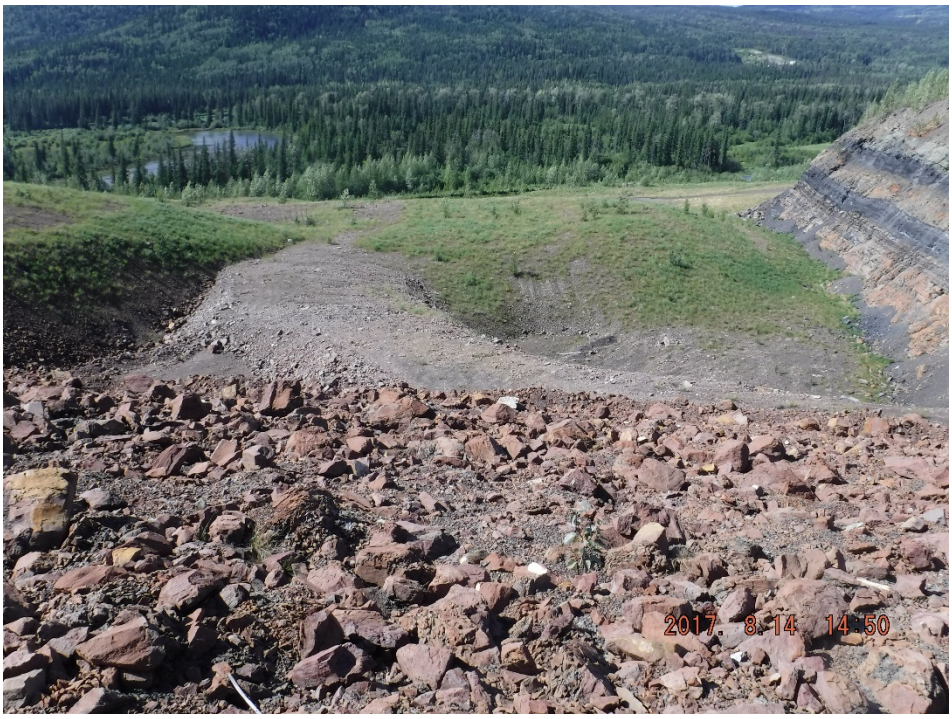


Photo I-7 **Upstream slope taken from mid-length of the crest – slope appears to be in good condition. General area where sinkholes are observed is shown in red box (SNTD-2017-05)**

Photo I-8 **West abutment, continued ravelling of shale slope upstream of abutment. No significant change from 2016 inspection (SNTD-2017-06)**

Photo I-9 **Upstream slope taken from the west abutment – looking northeast. Slope appears to be in good condition with no significant sign of erosion or movement (SNTD-2017-07)**

Photo I-10 **North abutment – looking northeast; erosion appears unchanged from previous years (SNTD-2017-07)**

Photo I-11 Downstream slope taken from west abutment – looking northeast; no sign of erosion or movement (SNTD-2015-08)

Photo I-12 Drainage channel inside the impoundment (SNTD-2017-09)

Photo I-13 **Offshoot of main drainage channel from the tailings pond to the upstream face of the SNTD; signs of slumping within tailings around the channel. (SNTD-2017-09)**

Photo I-14 **Offshoot of main drainage channel – closeup view of the slumping (SNTD-2017-10)**

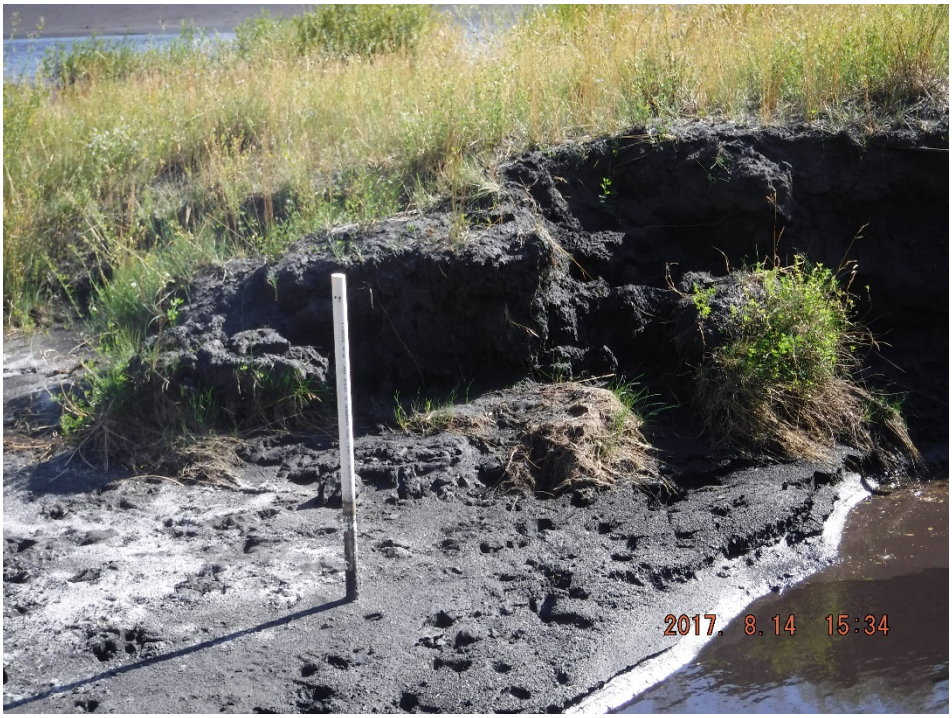


Photo I-15 Sinkhole 1 – first observed in 2016. Approximately 1.2 m x 1.9 m x 1.0 m deep (SNTD-2017-11)

Photo I-16 Sinkhole 2 – approximately 3.1 m x 2.8 m x 0.6 m deep (SNTD-2017-12)

Photo I-17 Sinkhole 3 – approximately 2.5 m x 2.3 m x 0.5 m deep (SNTD-2017-13)

Photo I-18 Sinkhole 4 – was not observed in 2016. Approximately 0.2 m x 0.1 m x 0.7 m deep (SNTD-2017-14)

Photo I-19 Sinkhole 5 – was not observed in 2016. Approximately 0.2 m x 0.1 m x 0.2 m deep (SNTD-2017-15)

Photo I-20 Sinkhole 6 - cluster of three sinkholes (STND-2017-16)

Photo I-21 **Sinkhole 6 - partial view of sinkhole cluster. Approximately 1.2 m x 1.3 m x 0.5 m deep (SNTD-2017-16)**

Photo I-22 **Sinkhole 6 - partial view of sinkhole cluster. Approximately 3.5 m x 6.7 m x 0.9 m deep (SNTD-2017-16)**

Photo I-23 Sinkhole 6 - partial view of sinkhole cluster. Approximately 1.9 m x 3.2 m x 1.9 m deep (SNTD-2017-16)

Photo I-24 **Sinkhole 7 – was not observed in 2016. Approximately 0.2 m x 0.2 m x 0.2 m deep (SNTD-2017-17)**

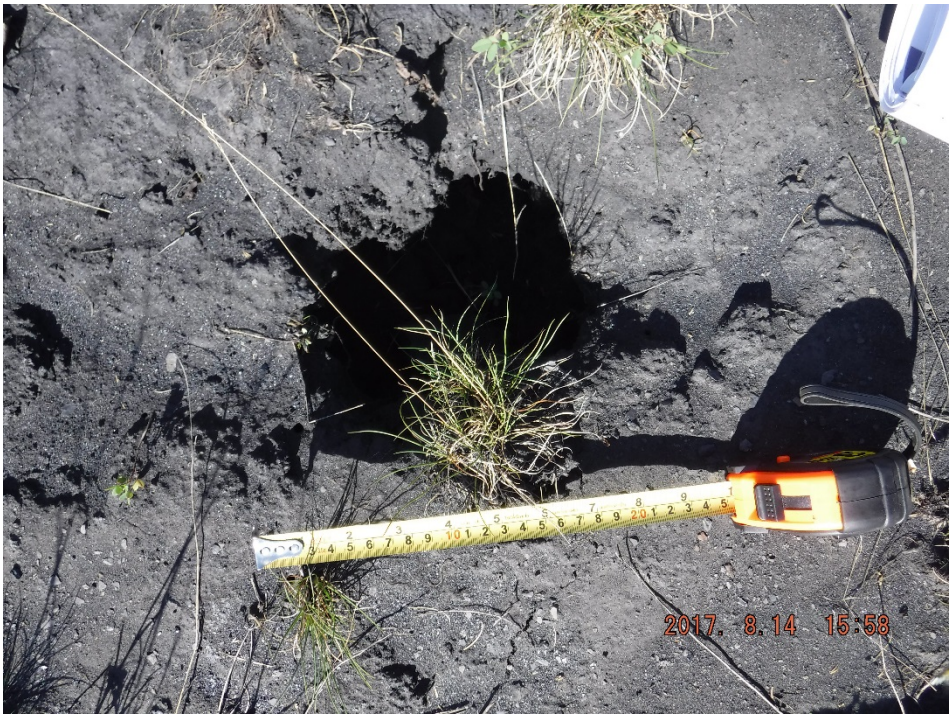


Photo I-25 **Sinkhole 8 – was not observed in 2016. Approximately 0.1 m x 0.2 m x 0.2 m deep (SNTD-2017-18)**

Photo I-26 Sinkhole 9 – first observed in 2016. Approximately 0.1 m x 0.1 m x 0.1 m deep (SNTD-2017-20)

Photo I-27 SNTD west abutment - upstream contact with the Shikano pit west wall – small erosion gully noted (SNTD-2017-21)

Photo I-28 Seepage from low level outlet downstream of the dam (SNTD-2017-22)

Photo I-29 Seepage channel, which flows into Sediment Pond S3 – flow estimate: 5 L/s (SNTD-2017-23)

Photo I-30 Sediment Pond S3 (SNTD-2017-23)

Photo I-31 Shikano North Tailings Dam – looking south. Historic slumping failure circled with red dash line. No significant change since 2012 (SNTD-2017-24)

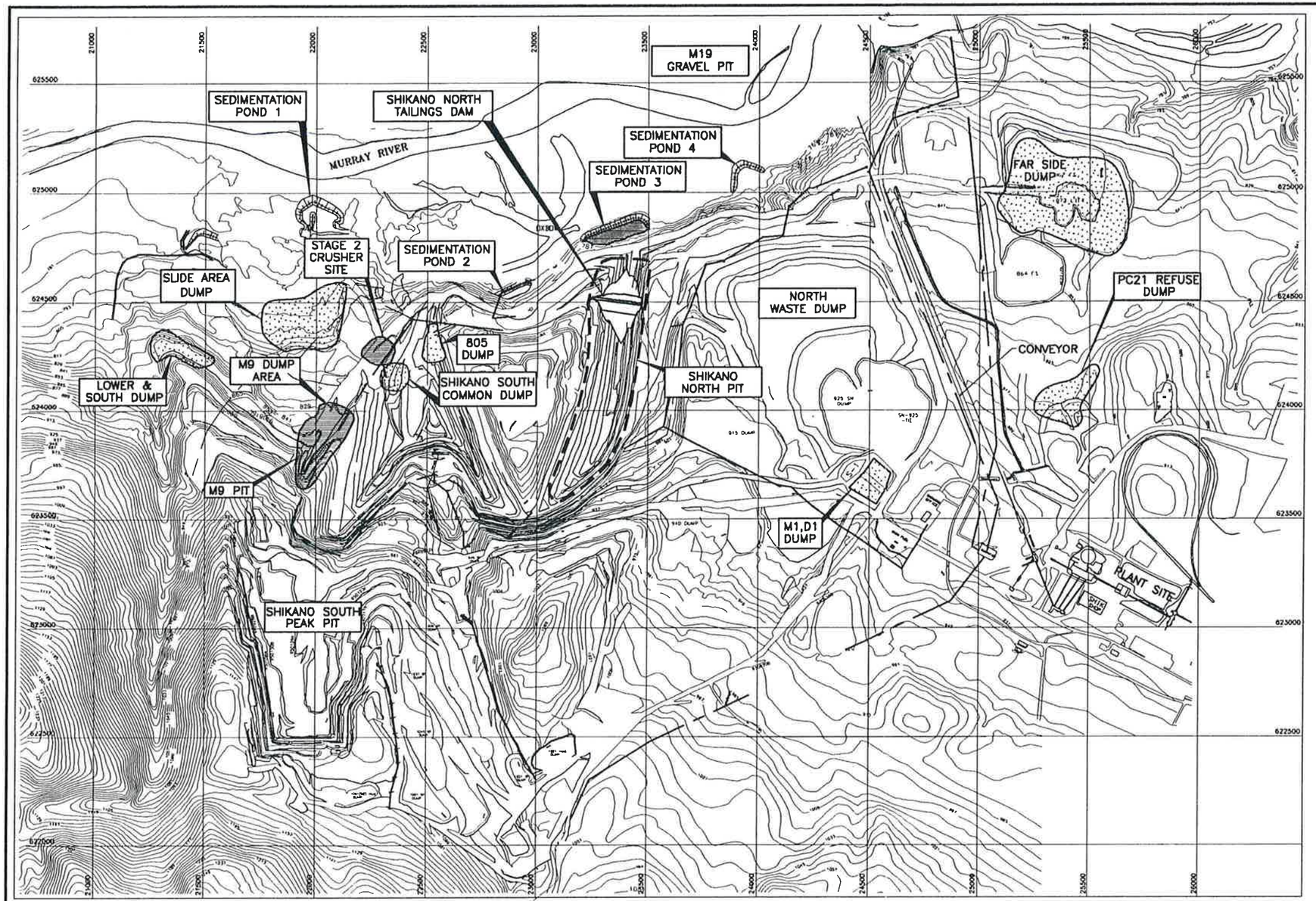
Photo I-32 Downstream east abutment – looking southeast. No change in condition from previous year (SNTD-2017-25)

Photo I-33 Downstream contact with east abutment – no change in condition from previous year (SNTD-2017-26)

Photo I-34 Downstream, access ramp and downstream slope – no significant sign of erosion or movement (SNTD-2017-27)

APPENDIX II

Select Dam Record Drawings



LEGEND

SHIKANO NORTH PIT \ WORK AREA

DISPOSAL AREA

ISSUED FOR AS-BUILT

200m 0 600m
SCALE

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
H. D. PLEWES
Sept 7/99

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	PSK	TDP	HDP	HDP
0	OCT 98	ISSUED FOR TENDER	PSK	TDP	HDP	HDP

DRAWING NO. | REFERENCE DRAWING

SEAL

CLIENT: Quintette Operating Corp.

KLOHN-CRIPPEN

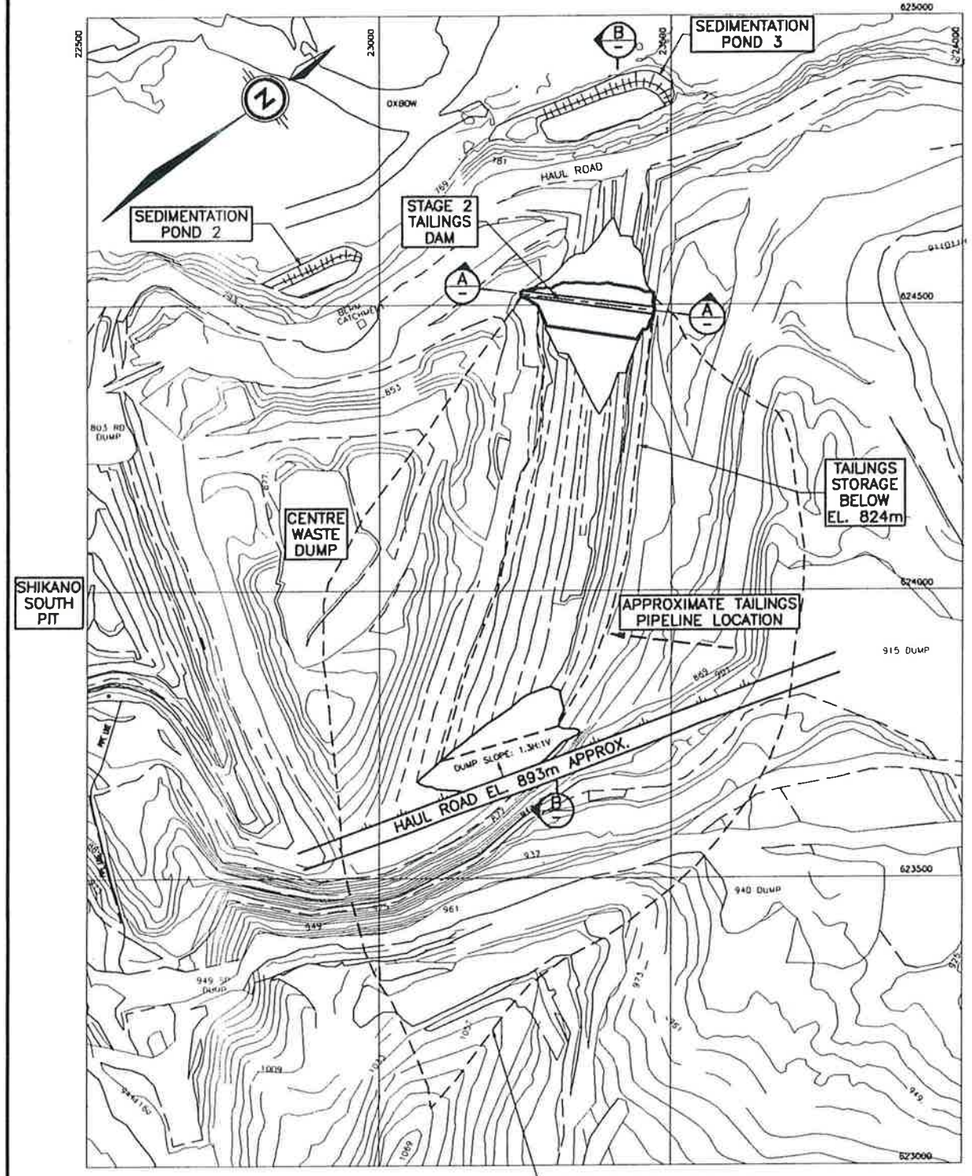
PROJECT: SHIKANO NORTH TAILINGS IMPOUNDMENT

TITLE: GENERAL SITE ARRANGEMENT

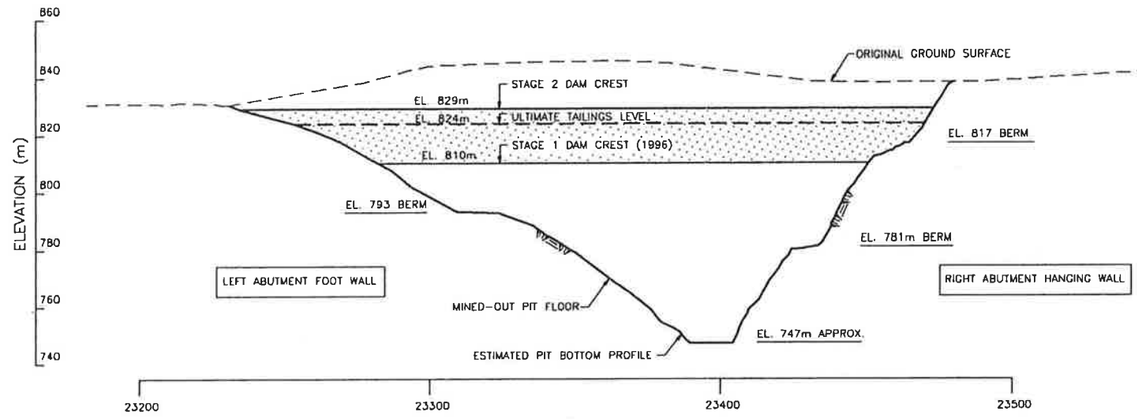
SCALE	PROJECT No.	DWG. No.	REV
AS SHOWN	PM6970 16	D-16000	2

CANCEL PRINTS BEARING PREVIOUS

KCC-A3



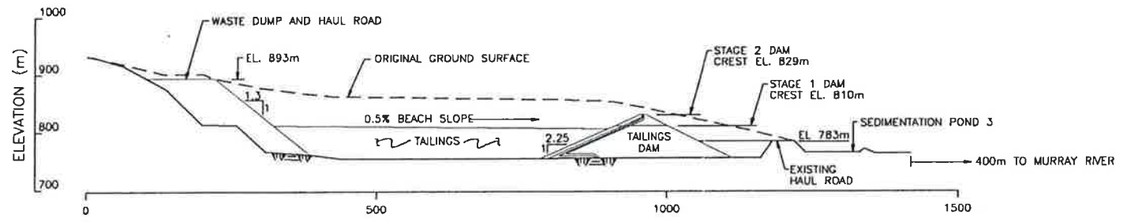
PLAN
SCALE: A



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

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA H. D. PLEWES 7/99

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	PSK	TDP	HDP	HDP
0	OCT 98	ISSUED FOR TENDER	PSK	TDP	HDP	HDP

DRAWING NO. | REFERENCE DRAWING

SEAL

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.

CLIENT: Quintette Operating Corp.

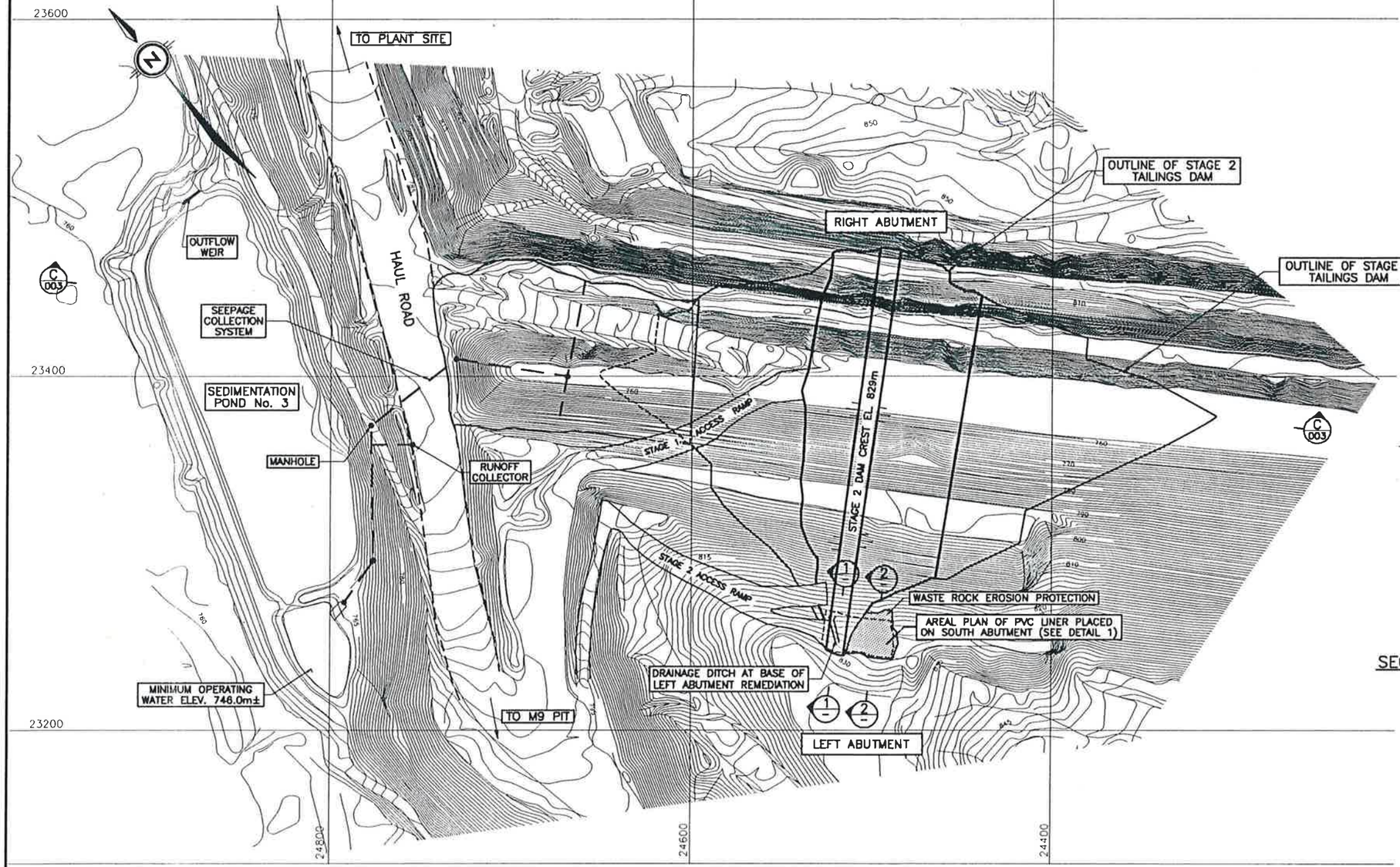
KLOHN-CRIPPEN

PROJECT: SHIKANO NORTH TAILINGS IMPOUNDMENT

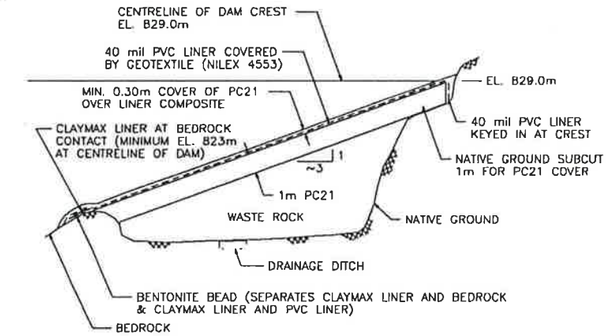
TITLE: ARRANGEMENT PLAN AND SECTIONS OF TAILINGS IMPOUNDMENT SITE

SCALE	PROJECT No.	DWG. No.	REV.
AS SHOWN	PM6970 16	D-16001	2

CANCEL PRINTS BEARING PREVIOUS



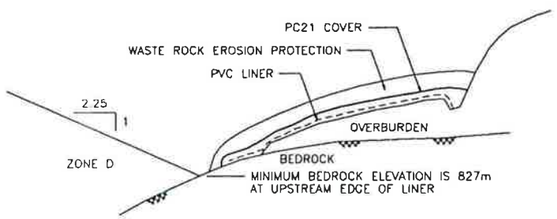
PLAN



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.



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

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — H. D. PLEWES — 7/99

ISSUED FOR AS-BUILT

0 100m
SCALE

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	PSK	TDP	HDP	KDP
0	OCT 98	ISSUED FOR TENDER	PSK	TDP	HDP	KDP

DRAWING NO. | REFERENCE DRAWING

SEAL

CLIENT: Quintette Operating Corp.

KLOHN-CRIPPEN

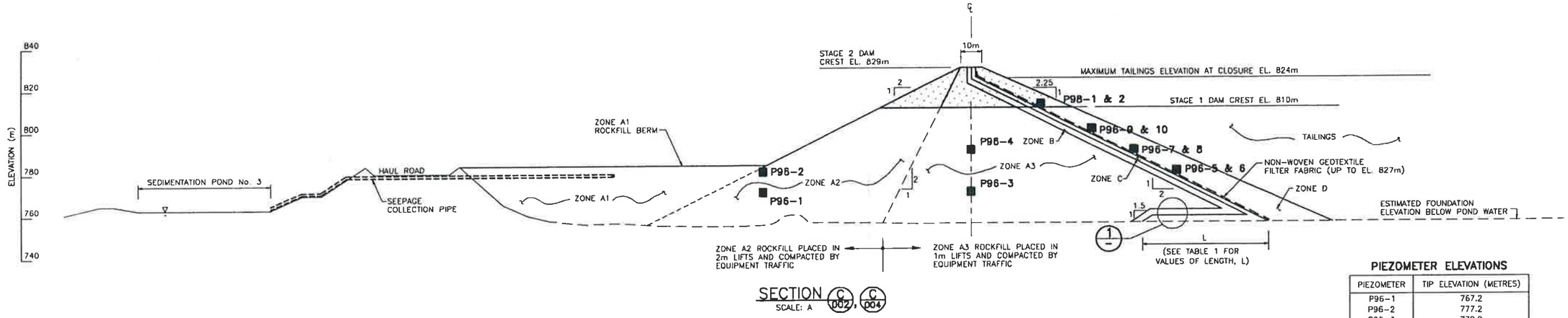
PROJECT: SHIKANO NORTH TAILINGS IMPOUNDMENT

TITLE: STAGES 1 AND 2 TAILINGS DAM PLAN

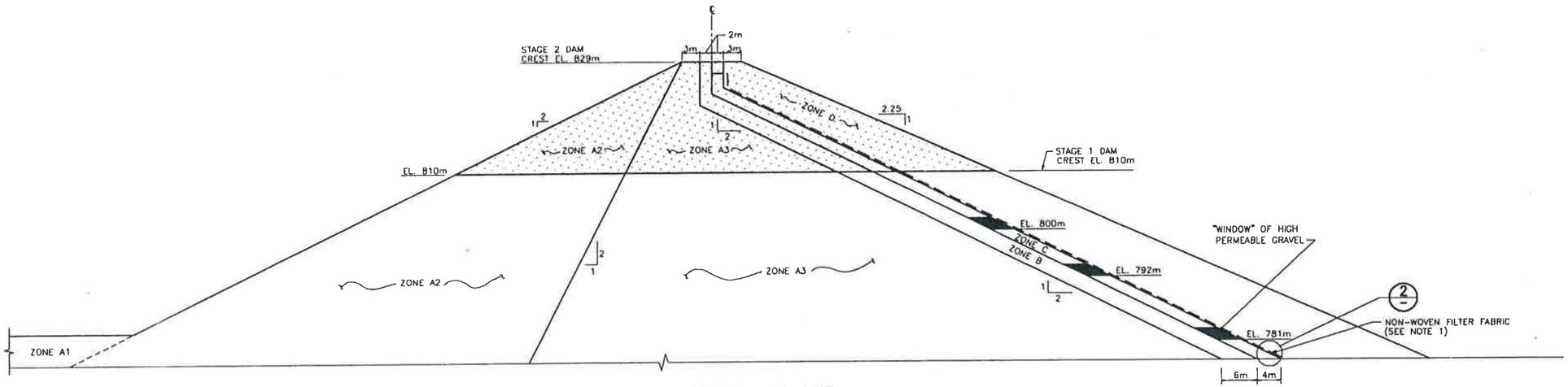
SCALE	PROJECT No.	DWG No.	REV
AS SHOWN	PM6970 16	D-16002	2

CANCEL PRINTS BEARING PREVIOUS

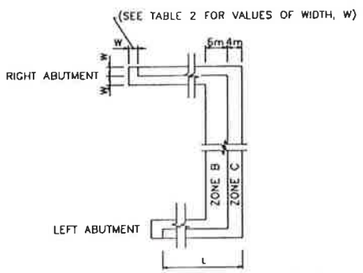
KCC-A3



SECTION (C/002), (C/004)
SCALE: A



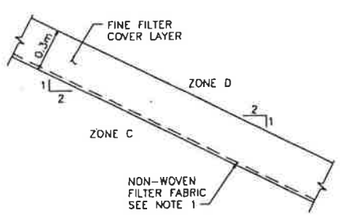
DETAIL OF DAM CREST
SCALE: B



(SEE TABLE 1 FOR VALUES OF LENGTH, L)

DETAIL (1/-)
SCALE: C

PLAN VIEW OF FILTER ZONES AGAINST ABUTMENT WALLS



DETAIL (2/-)
SCALE: D

GEOTEXTILE PROTECTIVE COVER

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

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.

ISSUED FOR AS-BUILT

SCALE D: 0 2m
SCALE C: 0 80m
SCALE B: 0 40m
SCALE A: 0 100m
SCALE

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

DRAWING NO. | REFERENCE DRAWING

SEAL: PROFESSIONAL ENGINEER, PROVINCE OF BRITISH COLUMBIA, H. D. PLEWES

CLIENT: Quintette Operating Corp.

KLOHN-CRIPPEN

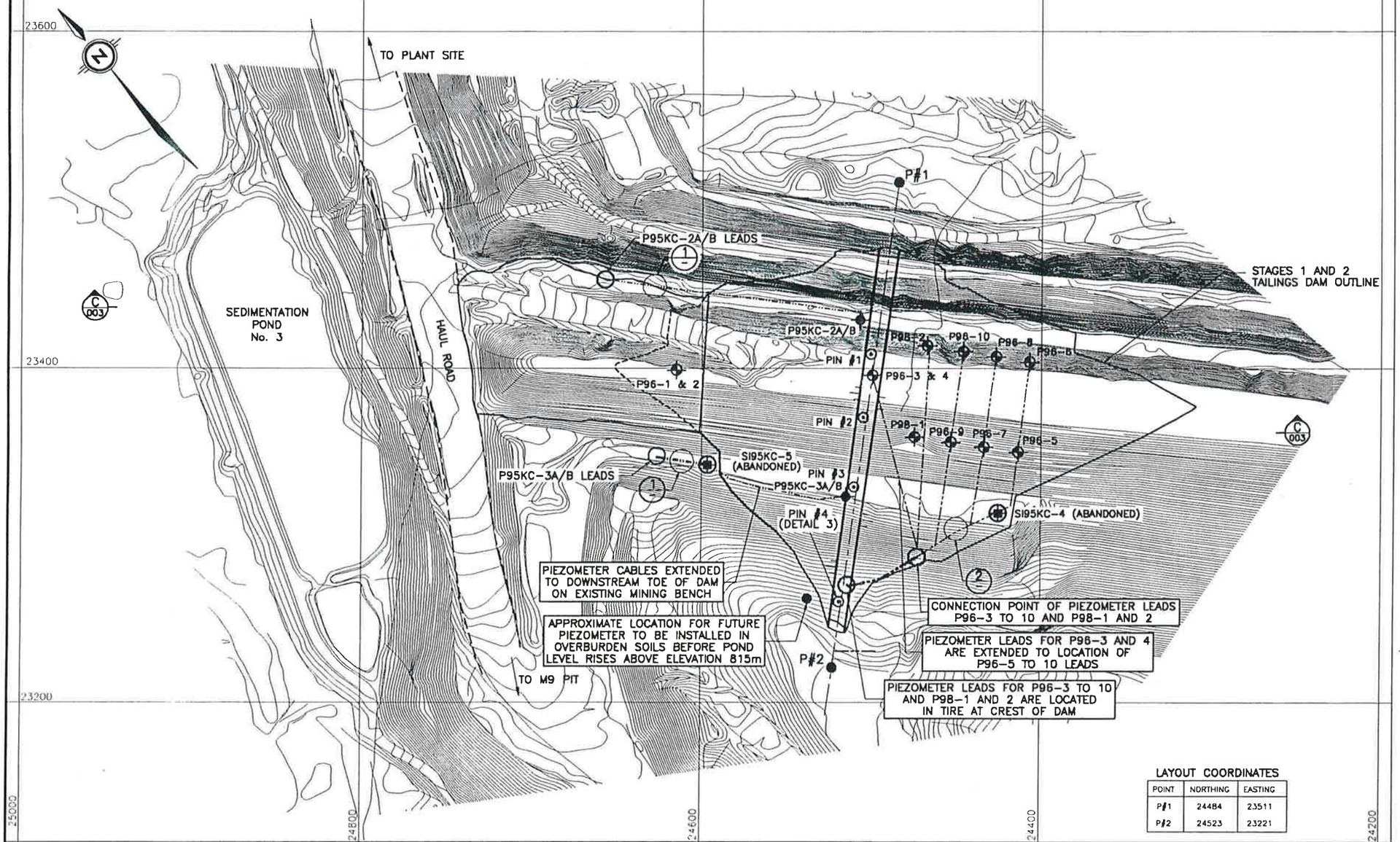
PROJECT: SHIKANO NORTH TAILINGS IMPOUNDMENT

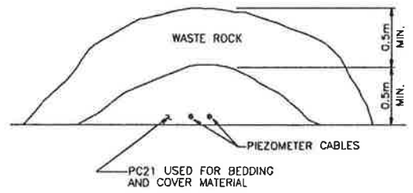
TITLE: STAGES 1 AND 2 TAILINGS DAM SECTIONS AND DETAILS

SCALE	PROJECT No.	DWG No.	REV
AS SHOWN	PM6970 16	D-16003	2

CANCEL PRINTS BEARING PREVIOUS

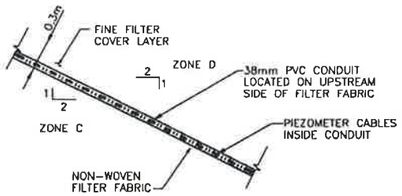
ACC-A3





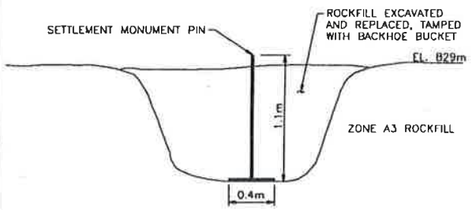
DETAIL 1
SCALE: B

BEDDING AND COVER MATERIAL FOR EXTENSION OF EXISTING PIEZOMETERS P95KC-3A/B



DETAIL 2
SCALE: B

EXTENSION OF PIEZOMTERS UP LEFT ABUTMENT



DETAIL 3
SCALE: N.T.S.

DETAIL OF SURVEY MONUMENTS INSTALLED ON STAGE 2 DAM CREST

LAYOUT COORDINATES

POINT	NORTHING	EASTING
P#1	24484	23511
P#2	24523	23221

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 SIKC95-5
- TIRE LOCATIONS TO PROTECT END OF PIEZOMETER CABLES AND SLOPE INCLINOMETERS.
- PIEZOMETER CABLES
- PIEZOMETER CABLES ENCLOSED IN PVC
- PIN #1 — DAM SETTLEMENT MONUMENTS SURVEY POINTS

ISSUED FOR AS-BUILT

SCALE B: 0 2m
SCALE A: 0 100m
SCALE

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	PSK	TDP	HDP	HDP
0	OCT 98	ISSUED FOR TENDER	PSK	TDP	HDP	HDP

DRAWING NO. | REFERENCE DRAWING

SEAL: PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — H. D. PLEWES

CLIENT: Quintette Operating Corp.

KLOHN-CRIPPEN

PROJECT: SHIKANO NORTH TAILINGS IMPOUNDMENT

TITLE: STAGES 1 AND 2 TAILINGS DAM INSTRUMENTATION PLAN AND DETAILS

SCALE	PROJECT No.	DWG. No.	REV.
AS SHOWN	PM6970 16	D-16004	2

CANCEL PRINTS BEARING PREVIOUS

APPENDIX III

Teck's Shikano North Tailings Dam
2017 Routine Inspection Checklists

Shikano North Tailings Dam – Downstream Slope Visual Inspection

		Date:	
Property:	Quintette Coal Operations (QCO)		
Structure:	Shikano North Tailings Dam		
Function (tailings, water, etc.):	Tailings storage facility		
Consequence Classification:	Significant		
Inspection Performed By:	Rob Muise		
Inspection Type (circle one):	Routine ✓	Event-Driven (Rainfall)	Event-Driven (Earthquake)

Conditions at Time of Inspection			
Conditions	☐Sunny ☐Scattered Clouds ☐Overcast ☑Raining ☐Snowing Comments:		
Temperature	4°C		
Winds	☐None ☑Light ☐Moderate ☐High	From:	

Downstream Slope Condition	
Snow Cover	☑None ☐Slight ☐Drifts ☐Melting Comments:
Vegetation	Any vegetation growth? NONE
Condition	Visible signs of erosion, tension cracking, bulging or movement of the rock fill face? NONE
Seepage	If seepage observed, note location, approximate elevation, clarity/turbidity, approximate rate. NONE
Animal Burrows	Small burrowing adjacent Pond Area
Other	Other comments or unusual conditions.

Shikano North Tailings Dam – Overall Visual Inspection

	Date: May 16/2017
Property:	Quintette Coal Operations (QCO)
Structure:	Shikano North Tailings Dam
Function (tailings, water, etc.):	Tailings storage facility
Consequence Classification:	Significant
Inspection Performed By:	Rob Muise
Inspection Type (circle one):	(Routine) Event-Driven (Rainfall) Event-Driven (Earthquake)

Conditions at Time of Inspection		
Conditions	☐Sunny ☐Scattered Clouds ☐Overcast ☑Raining ☐Snowing Comments:	
Temperature	4°C	
Winds	☐None ☑Light ☐Moderate ☐High	From:
Snow Cover	☑None ☐Slight ☐Drifts ☐Melting Comments:	
Pond	☐None ☑Open Water ☐Partially Frozen ☐Frozen ☐High Turbidity Comments:	
Wave Action:	☑None ☐Light ☐Moderate ☐High ☐Causing Erosion Comments:	

Shikano North Tailings Dam – Overall Visual Inspection

DAM STRUCTURE	Visible for Inspection	Cracks	Settlement	Sloughing, Slides or Sinkholes	Surficial Erosion or Rutting	Seepage Breakout, Turbidity or Discoloration	Excessive Vegetation	Excessive Debris	Animal Burrows
Crest	Yes ☑ No ☐	Yes ☐ No ☑	Yes ☐ No ☑	Yes ☐ No ☑	Yes ☐ No ☑		Yes ☐ No ☑		Yes ☐ No ☑
	Comments or Unusual Conditions:								
Upstream Slope	Yes ☑ No ☐	Yes ☐ No ☑	Yes ☐ No ☑	Yes ☐ No ☑	Yes ☐ No ☑		Yes ☐ No ☑		Yes ☐ No ☑
	Comments or Unusual Conditions:								
Downstream Slope	Yes ☑ No ☐	Yes ☐ No ☑	Yes ☐ No ☑	Yes ☐ No ☑	Yes ☐ No ☑	Yes ☐ No ☑	Yes ☐ No ☑		Yes ☐ No ☑
	Comments or Unusual Conditions:								
Tailings Beach	Yes ☑ No ☐	Yes ☐ No ☑	Yes ☐ No ☑	Yes ☑ No ☐	Yes ☐ No ☑	Yes ☐ No ☑	Yes ☐ No ☑	Yes ☐ No ☑	Yes ☑ No ☐
	Comments or Unusual Conditions: Several sinkholes → same as previous year. Small burrows								
Downstream Toe & Area	Yes ☑ No ☐	Yes ☐ No ☑	Yes ☐ No ☑	Yes ☐ No ☑	Yes ☐ No ☑	Yes ☐ No ☑	Yes ☐ No ☑	Yes ☐ No ☑	Yes ☐ No ☑
	Comments or Unusual Conditions:								
Seepage Collection Pipe Outlet	Yes ☑ No ☐	Yes ☐ No ☑	Yes ☐ No ☑	Yes ☐ No ☑	Yes ☐ No ☑	Yes ☐ No ☑	Yes ☐ No ☑	Yes ☐ No ☑	Yes ☐ No ☑
	Approximate flow rate and clarity of discharge: Strong sulfur odor								
Other	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐
	Comments or Unusual Conditions:								

Shikano North Tailings Dam – Overall Visual Inspection

	Date: Oct 3/2017
Property:	Quintette Coal Operations (QCO)
Structure:	Shikano North Tailings Dam
Function (tailings, water, etc.):	Tailings storage facility
Consequence Classification:	Significant
Inspection Performed By:	Rob Muise
Inspection Type (circle one):	(Routine) Event-Driven (Rainfall) Event-Driven (Earthquake)

Conditions at Time of Inspection		
Conditions	☑Sunny ☐Scattered Clouds ☐Overcast ☐Raining ☐Snowing Comments:	
Temperature	8°C	
Winds	☐None ☐Light ☐Moderate ☑High	From: SW
Snow Cover	☒None ☐Slight ☐Drifts ☐Melting Comments:	
Pond	☐None ☒Open Water ☐Partially Frozen ☐Frozen ☐High Turbidity Comments:	
Wave Action:	☐None ☐Light ☒Moderate ☐High ☐Causing Erosion Comments:	

Shikano North Tailings Dam – Overall Visual Inspection

DAM STRUCTURE	Visible for Inspection	Cracks	Settlement	Sloughing, Slides or Sinkholes	Surficial Erosion or Rutting	Seepage Breakout, Turbidity or Discoloration	Excessive Vegetation	Excessive Debris	Animal Burrows
Crest	Yes ☒ No ☐	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒		Yes ☐ No ☒		Yes ☐ No ☒
	Comments or Unusual Conditions:								
Upstream Slope	Yes ☒ No ☐	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒		Yes ☐ No ☒		Yes ☐ No ☒
	Comments or Unusual Conditions:								
Downstream Slope	Yes ☒ No ☐	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒		Yes ☐ No ☒
	Comments or Unusual Conditions:								
Tailings Beach	Yes ☒ No ☐	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☒ No ☐	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒
	Comments or Unusual Conditions: Same sinkholes → NOT Propagating								
Downstream Toe & Area	Yes ☒ No ☐	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒
	Comments or Unusual Conditions:								
Seepage Collection Pipe Outlet	Yes ☒ No ☐	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☒ No ☐	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒
	Approximate flow rate and clarity of discharge: 3.88 L/sec								
Other	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐
	Comments or Unusual Conditions:								

APPENDIX IV

Register of Reference Documents

Appendix IV
Register of Reference Documents

Document Title	Author	Date of Issue
Shikano Geological Report Text	Quintette Coal Limited	May-85
Shikano North Tailings Impoundment - Design Report	Klohn Crippen	23-Jun-95
Shikano North Tailings Impoundment - Pervious Tailings Dam Option - Design Report	Klohn Crippen	09-Feb-96
Shikano North Tailings Impoundment - 1995 Geotechnical Investigations, Data Report	Klohn Crippen	09-Feb-96
Shikano North Tailings Impoundment 1996 As-Built Report	Klohn Crippen	14-Mar-97
Shikano North Tailings Impoundment 1997 Annual Review	Klohn Crippen	20-Feb-88
Shikano North Tailings Impoundment 1998 Annual Review	Klohn Crippen	05-Mar-99
Shikano North Tailings Impoundment - Stage 2 As-Built Report	Klohn Crippen	09-Jul-99
Shikano North Tailings Impoundment 1999 Annual Review	Klohn Crippen	06-Dec-99
Quintette Project - Baseline Climate & Hydrology Conditions	Clearwater Consultants Ltd.	17-Aug-11
Quintette Coal Project: 2012 Dam Inspections: Plantsite Tailings Dam, M11 Diversion Dam, Shikano North Tailings Dam	Klohn Crippen Berger Ltd.	December 2012
Tailings Water Balance, Seepage Rates and Preliminary Seepage Reclaim Design	Klohn Crippen Berger Ltd.	30-Apr-13
Shikano North Tailings Dam - 2013 Dam Safety Inspection Report	Klohn Crippen Berger Ltd.	09-Dec-13
Quintette Dam Safety Review Shikano North Tailings Storage Facility	Klohn Crippen Berger Ltd.	27-May-14
Shikano North Tailings Dam – 2014 Dam Safety Inspection Report – Revision 1	Klohn Crippen Berger Ltd.	26-Nov-14
Shikano North Tailings Dam - Response to February 3, 2014 MEM Memorandum	Klohn Crippen Berger Ltd.	29-Jun-15
Shikano North Tailings Dam – 2015 Dam Safety Inspection Report	Klohn Crippen Berger Ltd.	04-Mar-16
Shikano North Tailings Storage Facility Engineer of Record	Klohn Crippen Berger Ltd.	23-Sep-16
Quintette Coal Operations – Shikano North Tailings Dam Water Management, Water Balance and Quantifiable Performance Objectives	Klohn Crippen Berger Ltd.	22-Dec-16
Shikano North Tailings Dam – 2016 Dam Safety Inspection Report	Klohn Crippen Berger Ltd.	22-Dec-16