March 30, 2016

2015 ANNUAL DAM SAFETY INSPECTION

2-North Pit Tailings Disposal Facility

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REPORT

Reference Number: 1528261-003-R-Rev0-1000

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Executive Summary

The Quinsam Mine (Quinsam) is an underground coal mine operation owned by Hillsborough Resources Limited (Hillsborough), located approximately 15 kilometres west of the town of Campbell River on Vancouver Island, British Columbia. The mine produced coal in 2015. Quinsam staff have reported a cease in coal mining in early 2016, with the intent to enter a state of active care and maintenance.

The 2-North Pit Tailings Storage Facility at Quinsam includes four dams, namely the North, East, West, and South Embankments. This annual dam safety inspection report was prepared based on a site visit carried out on May 26, 2015, and a review of data provided by Hillsborough.

Dam Classification

Following the Canadian Dam Association (CDA) *Dam Safety Guidelines* (CDA 2013), the North Embankment is classified as a Very High consequence structure, the South and West Embankments are classified as High consequence structures, and the East Embankment is classified as a Low consequence structure. The classification remains unchanged from 2014.

Operations, Maintenance and Surveillance Manual, Emergency Preparedness Plan, and Dam Safety Review

The *Operations, Maintenance and Surveillance (OMS) Manual for the 2-North Pit Tailings Disposal Facility and South Dam* (Quinsam 2014) was updated on August 31, 2014. The Emergency Preparedness Plan is incorporated as Section 10 of the OMS manual. Additionally, an updated version of the OMS manual has been prepared for care and maintenance (Quinsam 2016).

A Dam Safety Review was completed for the 2-North Pit Tailings Disposal Facility in 2013, and is reported by Thurber (2014). The next Dam Safety Review for the facility should be scheduled for 2018 or earlier.

2015 Annual Dam Safety Inspection

The 2015 annual dam safety inspection indicates that the facility has generally performed as expected, with a stable configuration and sufficient flood storage capacity. No significant changes in instrumentation, visual monitoring records, dam stability, or surface water control were noted.

- Approximately 3,900 tonnes (t) of tailings were deposited in the facility throughout 2015. Annual tailings deposition decreased from 10,850 t in 2014, 22,500 t in 2013 (Golder 2014a), and 85,000 t in 2012 (Golder, 2013). Hillsborough estimates the total quantity of tailings stored in the 2-North Pit Disposal Facility is 1,564,700 t.
- The highest recorded water elevation in the pond was 352.1 m on March 12, 2015, corresponding to a freeboard of 2.0 m to the low point in the dam crest at elevation 354.1 m. Freeboard during the operating period therefore met the design criteria minimum of 1.25 m.

- At the time of the site inspection, there was no construction carried out on the embankments. Between June and September 2015 the West embankment was raised from El. 354.3 to 355.0 m. In-situ density and moisture contents tests were completed on the till at the crest.
- The downstream face of the West Embankment was re-sloped to meet long-term stability design criteria, as recommended in previous dam safety inspections.
- No significant other changes to the embankments were noted in monitoring records.
- No significant changes in measurements from instrumentation installed in the North Embankment were noted.
- No significant changes in stability were noted.
- Seepage was noted at the downstream toes of the North Embankment, South Embankment, and on the road on the West Embankment downstream slope, at similar locations and flow rates to previous years.
- Recommended actions from the 2014 annual inspection were addressed by the following actions.
  - A pipeline was relocated off of the North Embankment downstream slope.
  - On May 20, 2015, herbicide was sprayed on the embankments (estimated 95% successful), with vegetation scraped from the downstream slope of the West Embankment prior to re-sloping construction.
  - Organic material was removed from the till on the crest of the East Embankment.
  - A staff gage was installed to monitor freeboard near the intersection of the North and East Embankments.
  - A weir was installed to measure seepage flows downstream of the North Embankment.

Recommended Actions

Recommended actions include the following items.

- Maintain upstream and downstream slopes and crests of the embankments free of vegetation.
- Continue to inspect the embankments for signs of movement, instability, and erosion on a weekly basis.
- Continue to measure and record seepage rates on a weekly basis, noting any fluctuations.
- Record the water level in the pond on a weekly basis as an elevation, noting any fluctuations.
- Carry out detailed inspections following seismic events and following significant precipitation events. Should any change to the dams occur, then the Design Engineer (Golder) should be notified immediately, as per the OMS manual. Otherwise, documentation of inspections following seismic events and significant precipitation events should be sent to the Design Engineer within a week of each event. Documentation should include photographs.

- Quinsam has notified Golder of the intent to change from operations to a phase of active care and maintenance in 2016. The following are recommended related to this change.
  - The consequence classification of the embankments should be reviewed and updated to reflect the change from mine operation to active care and maintenance in 2016.
  - The frequency of review of inspection and collection of monitoring data, and for reporting of the same inspections and data to the Design Engineer for review should be confirmed.
    - Actions or changes resulting from the change to care and maintenance should be captured in an update to the OMS manual.
  - The Design Engineer should review the updated OMS manual in 2016, and any subsequent changes.
  - The Design Engineer should be notified in advance of any plan to re-start operations or implement closure works that would impact or change the 2N-Pit Tailings Disposal Facility, including plans to:
    - discharge tailings or water to the facility;
    - remove tailings or water from the facility;
    - complete any earthworks with the potential to impact the dams;
    - flood or dewater of the toe areas, such as
      - the sump at the 2 North Portal below the North Embankment; and
      - the pond at the South Embankment.

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1.0 INTRODUCTION

The Quinsam Mine (Quinsam) is an underground coal mine operation owned by Hillsborough Resources Limited (Hillsborough), located approximately 15 kilometres west of the town of Campbell River on Vancouver Island, British Columbia. The mine produced coal in 2015, and Quinsam staff have reported a cease in coal mining in early 2016, with the intent to enter a state of active care and maintenance.

At the request of Hillsborough, Golder Associates Ltd. (Golder) has completed an annual dam safety inspection at Quinsam. This report presents results of the dam safety inspection for the operating period of 2015 for the dams of the 2-North Pit Tailing Disposal Facility, namely:

- North Embankment;
- East Embankment;
- West Embankment; and
- South Embankment.

This dam safety inspection report has been prepared in accordance with Part 10.5.3 of the *Health, Safety and Reclamation Code for Mines in British Columbia* (BC MEM 2008), and it is understood that this report will be submitted by Hillsborough to the Chief Mines Inspector. The guidelines for annual dam safety inspection reports by British Columbia Ministry of Energy and Mines (BC MEM 2013) were followed during the preparation of this report.

The report is based on a site visit carried out on May 26, 2015, discussion with Quinsam staff, and review of data provided by Hillsborough, and consists of the following.

- Site conditions and background information of the facility.
- A summary of the construction, operating and/or repair activities for the 2015 period.
- Dam classification and required operational documents review.
- Site photographs and records of dam inspection.
- A review of:
  - previous annual dam inspection reports;
  - instrumentation monitoring data;
  - climate data; and
  - water balance.
- Recommendations for future operation, monitoring and inspection.

The previous annual dam safety inspection for the facility was carried out in August 2014, and is reported in Golder (2014b).

2.0 METHOD

2.1 2015 Site Visit

A site inspection was carried out on May 26, 2015 by Ben Wickland, P.Eng., and Erin Thomas of Golder, accompanied by Mauricio Figueroa of Hillsborough. The temperature during the visit was approximately 21ºC (degrees Celsius). The weather was sunny during the site inspection.

2.2 Review of Background Information

Hillsborough provided the following information for this dam safety inspection:

- Survey data of the embankments;
- Site climate data from January to December 2015;
- Vibrating wire (VW) piezometer data from January to December 2015;
- 2015 water balance data for the 2-North Pit Tailing Disposal Facility;
- An estimate of the total tonnage of tailings deposited in the facility in 2014 and 2015;
- Records of construction, operating and/or repair activities for the 2015 period.
- Record of a post-earthquake inspection carried out on April 24, 2014;
- Weekly visual inspection records from January to December 2015; and
- The *Operation, Maintenance, and Surveillance Manual and Emergency Preparedness Plan of 2-North Pit Tailing Disposal Facility and South Dam Revision 2016-1*, (Quinsam 2016). The updated OMS provided to Golder is intended for care and maintenance conditions.

3.0 BACKGROUND

3.1 Site History

The Quinsam Mine (Quinsam) began operations in 1986 and has historically produced approximately 500,000 tonnes of thermal coal per year.

3.2 Overview of Design and Previous Operation

Quinsam originally developed the 2-North Pit as an open pit, mining an approximately 3 to 4 metre (m) thick coal seam. The operation then continued by underground mining to the east of the 2-North Pit through two portals located at the bottom of the east high wall, near the middle of the pit. Between 1986 and 1994, the fine refuse (tailings) that were generated from the coal wash plant were deposited in the Old Tailings Facility, located in the northern portion of the pit. Starting in 1994, tailings were deposited in the 2-North Pit Tailings Disposal Facility, located in the south end of the pit.

The 2-North Pit Tailings Disposal Facility is contained by the North, East, South and West Embankments, shown in plan in Figure 1 and in the photographs in Appendix A. The North Embankment is operated as a flow-through structure, and the other embankments include a low permeability element of till on the upstream slope to limit seepage. Tailings have been discharged into the 2-North Pit Tailings Disposal Facility via a pipeline from a central location on the West Embankment. The catchment area for the 2-North Pit Tailings Disposal Facility is limited to the area within the embankment crests. Water from external drainage features does not enter the 2-North Pit Tailings Disposal Facility.

Construction of the 2-North Pit Tailings Disposal Facility began in 1994 by placing two east-west trending confining embankments across the exposed footwall at the north and south ends of the 2-North Pit. The major recoverable coal seam that was mined from the pit originally outcropped on the surface and dipped to the east at an average inclination of approximately 5 to 10 degrees. The coal was mined down the footwall of the seam, from west to east, and a 35 m high highwall was excavated along the east side of the north-south trending pit. The width of the pit was approximately 200 m from the crest of the footwall to the crest of the highwall.

Soils (till) and waste rock that were stripped from the pit footprint were placed at the footwall on the west side of the pit. Towards the end of mining in the pit, a cast blast was carried out along the north side of the highwall, in the vicinity of the existing North Embankment. The purpose of the cast blast was to throw the overburden rock from the highwall across the pit onto the footwall, and thereby reduce the volume of material to be removed by conventional stripping methods. The cast blast did not work as planned, and the majority of the rock was not cast across the pit. Rather, the rock was fragmented and heaved in place, resulting in a highly fractured rock mass.

Following the completion of open pit mining, recovery of the coal seam continued down-dip to the east of the 2-North Pit highwall by underground room and pillar mining methods. The extent of underground mining near the pit is shown in plan in Figure 7. The pillars were recovered from the rooms adjacent to the highwall and the backs of the rooms reportedly caved. Some subsidence and surface cracking has occurred above these rooms. The cracks were deemed not to have an adverse impact on the development of the 2-North Pit Tailings Disposal Facility, nor was the development of the 2-North Pit Tailings Disposal Facility deemed to have an adverse impact on the underground mining operations. This is discussed in further detail in the design report for the expansion of the in-pit tailings disposal facility (Golder 1997b).

The 2-North Pit Tailings Disposal Facility is currently permitted to be raised to elevation 355 m, and the embankments are at or near the permitted elevation. The embankments have typically been raised each summer by the downstream method, whereby the crest and downstream toe move in the downstream direction as the crest is raised. The construction history of the embankments and the operation of the facility are discussed in further detail in the following sections. The embankments were constructed using coarse coal rejects, waste rock, and till. Coarse coal rejects are a gravel sized bi-product of cleaning the coal. Waste rock is rock without economically recoverable coal content that is moved to allow coal recovery. Till is a glacial deposit consisting of clay, silt, sand and gravel particle sizes.

A large beach of coarse tailings has built up against the West Embankment, in front of the tailings discharge pipe. The finer fraction of the tailings has been carried to the extremities of the pond and deposited against the upstream slopes of the embankments.

Quinsam had considered selling or re-processing the tailings from the Tailings Disposal Facility. To enable potential removal of tailings, Quinsam built a tailings berm from the West Embankment extending east onto the beach in August to September 2013. Quinsam planned to divide the facility into two cells, with ongoing deposition in one cell and tailings removal in the other. There has been no further development with regards to this undertaking.

In 2013, Quinsam started underground deposition of tailings from coal from the 7-South underground mine. The tailings from washing 7-South coal are deposited in the 2-North underground mine. The tailings from washing the 2-North underground mine coal continue to be deposited to the Tailings Disposal Facility, at a decreased rate.

3.2.1 North Embankment

The North Embankment is shown in plan in Figure 1 and in section in Figures 2 and 3. The North Embankment is also pictured in Photographs 1 to 8 (Appendix A), taken during the May 26, 2015 inspection.

The east portion of the North Embankment foundation contains intact bedrock in the pit highwall and fragmented cast blast rock, while the west abutment is founded against the waste materials placed at the west side of the footwall. The loose surficial material along the west side of the embankment was excavated in order to key the embankment into competent waste materials.

The cast blast material along the northeast side of the pit was recovered and used to construct the original embankment to elevation 330 m during the summers of 1995 and 1996. The coarser cast blast material was placed in the downstream portion of the embankment, while the finer material was placed upstream.

Due to the presence of large voids in the cast blast material along the east abutment of the North Embankment, seepage and piping of tailings has previously occurred through the embankment. A secondary embankment of coarse rejects was constructed immediately upstream of the cast blast embankment in 1997 in order to reduce the piping of tailings through the cast blast material. Coarse rejects with geotextile filter fabric were also placed on the upstream slope of the cast blast embankment (as shown in Figure 3). Sufficient coarse rejects have been placed between these embankments so that a single embankment has been formed.

The secondary embankment was partially successful in reducing the amount of tailings carried through the North Embankment. However, in 2001 it was identified that some fines were still migrating through the coarse rejects. A toe filter including geotextile material was constructed downstream of the cast blast material to further reduce the flow of fines from the 2-North Pit, and is shown in Figure 3.

Geotextile filter fabric has also been placed on the upstream (south) slope of the North Embankment since 2003 (elevation 337 m) to minimize the migration of tailings through the coarse rejects. The geotextile is covered with coarse rejects to prevent degradation.

Vibrating-wire piezometers were installed in the North Embankment in October 2003. Four piezometers were installed in shallow excavations within the toe berm. Two piezometers were installed by others in boreholes drilled from the crest of the North Embankment. The instrument locations are shown in Figures 1 and 3. In February 2011 an additional piezometer was installed from a road on the downstream crest of the North Embankment to replace a malfunctioning instrument (Golder 2012).

3.2.2 East Embankment

The East Embankment is shown in plan in Figure 1 and in cross-section in Figure 6. The East Embankment is also pictured in Photographs 9 to 14 (Appendix A), taken during the May 26, 2015 inspection.

The East Embankment is founded on the 2-North Pit highwall. The highwall is at approximately elevation 336.3 m near the North Embankment and elevation 342.8 m near the South Embankment. The portion of the East Embankment above the crest of the highwall was constructed with coarse rejects with an upstream low-permeability blanket of compacted fine-grained till to reduce the seepage losses through the embankment.

Settlement around the underground workings has previously caused some surface cracking within the footprint of the East Embankment. The plan extent of underground workings is shown in Figure 7. During foundation preparation for the East Embankment, exposed subsidence cracks were filled with coarse rejects and then covered with a layer of geotextile fabric to prevent the migration of embankment materials into the cracks. The geotextile was covered with a 0.25 to 0.5 m thickness of coarse rejects. This procedure was used for the treatment of all subsidence cracks encountered during the construction of the existing embankments.

In 2015 eight survey stations were installed at the south end of the embankment crest to measure and monitor settlement and deformation following earthquake events.

3.2.3 South Embankment

The South Embankment is shown in plan in Figure 1, and in section in Figures 4 and 5. The South Embankment is also pictured in Photographs 15 to 21 (Appendix A), taken during the May 26, 2015 inspection.

The east side of the South Embankment is founded on the intact footwall at the bottom of the pit with the east abutment against the intact highwall slope. The footwall and highwall of the east side of the pit were cleaned of fines and loose rock prior to the placement of embankment fills. The west side of the South Embankment is founded on mixed waste rock and soil placed to the west side of the footwall. Loose surficial material along the west abutment was excavated in order to key the embankment into the waste material.

Cast blast materials were used to construct the downstream shell of the embankment to approximately elevation 340 m. A low-permeability blanket of compacted fine-grained till was placed on the upstream slope of the embankment to reduce seepage losses. A transition layer of coarse rejects was used between the till and the cast blast material between elevations of 330 and 340 m. The embankment is constructed of compacted till and coarse rejects above elevation 340 m.

Seepage was observed at the downstream toe of the South Embankment during a site visit in June 2002. Tailings were not observed to be migrating with the seepage. However, a toe filter berm was constructed that incorporated a layer of geotextile filter fabric to reduce the potential for tailings to migrate through the embankment in the future. The toe filter is shown in Figure 5. The seepage that was observed in 2002 now reports directly to the seepage collection pond that is located downstream of the toe of the South Embankment.

The South Embankment has no instrumentation.

3.2.4 West Embankment

The West Embankment is shown in plan in Figure 1 and in cross-section in Figure 6. The West Embankment is also pictured in Photographs 22 to 30 (Appendix A), taken during the May 26, 2015 inspection.

Construction materials for the West Embankment initially included stripping and overburden from the 2-North Pit development. As such, the embankment includes both soil and cobbles/boulders of rock to approximately elevation 345 m. The remainder of the embankment has been raised using compacted coarse rejects and an upstream low-permeability blanket of compacted fine-grained till to reduce the seepage losses through the embankment.

The West Embankment has no instrumentation.

3.3 Previous Issues of Concern

The following concerns were noted in the previous dam safety inspection (Golder 2014):

- Downstream slopes of the south portion of the West Embankment are steeper than design and may result in reduced downstream dam stability.
- The pipeline on North Embankment could cause preferential erosion along length of pipe. In the event that the pipe ruptured, it could contribute to failure of the dam.
- Out of specification material in till was identified on the East Embankment. Organic material in the till may result in increased permeability and formation of preferential flow paths.
- Design analyses update is required to assess dam stability and flood storage capacity.
- Bushes located on the embankments should be cut flush with the ground surface.

These issues are reviewed in Section 7.3.

4.0 OPERATION AND CONSTRUCTION DURING 2014/2015

Coal production at the Quinsam mine in 2015 was reduced to 130,000 t (tonnes). Tailings produced in 2015 from washing coal from the 2-North underground mine were deposited in the 2-North Pit Tailings Disposal Facility and tailings produced from washing coal from the 7-South underground mine were deposited in the 2-North underground mine.

The following sections summarize construction of 2-North Pit Tailings Disposal Facility in 2015 based on data and information provided by Hillsborough.

4.1 North Embankment

The North Embankment is pictured in Photographs 1 to 8 in Appendix A.

No dam construction was performed on the North Embankment during 2015. The October 20, 2015 survey indicates that the North Embankment crest elevation range was between 354.9 m and 355.9 m. The crest width was approximately 20 m at the east end and 40 m at the west end. The tailings pipeline along the slope of the embankment was removed in December 2014 as recommended by Golder (2014b).

Five piezometers installed in the North Embankment were functioning as of December 2015. Vibrating wire piezometer VW0583 in the North Embankment measures pressure but is unable to measure temperature. The last temperature reading was taken on April 21, 2014. The calculated head at each piezometer was within the operating range specified in the OMS manual. In 2014 a weir was installed at the downstream seep discharge location to calculate and monitor flow rates. The height of water is measured and the calculated flow rate is recorded each week in the weekly inspection reports. The piezometer, thermistor and seepage flow rate data are summarized in Appendix C.

4.2 East Embankment

The East Embankment is pictured in Photographs 9 to 14 in Appendix A.

The October 2015 survey indicates a (till) crest elevation between 354.1 m at a low point, around Station 10+750, and 355.0 m. Survey data indicates that the till had an approximate width of 5 m, and that the total crest width of the East Embankment varies between approximately 18 and 25 m.

Sticks embedded in the till along the south portion of the East Embankment were removed during the May 26, 2015 inspection, as recommended by Golder (2014b). The till in the East Embankment was tested for density and moisture in September 2015. The design indicates till should be compacted to a minimum 95% of the Maximum Dry Density for Standard Compaction Effort at moisture contents between 1% below Standard Optimum Moisture Content (OMC) and 3% above Standard OMC (Golder 2002). Table 1 includes a summary of the laboratory moisture-density relation tests competed on the till used for construction of the tailings embankments since 1994. The results of moisture-density field testing completed in 2015 are summarized in Table 2 and the field test records are provided in Appendix D. Test results in Table 2 for the East Embankment indicated till density and moisture content met design specifications.

Table 1: Results of Moisture Density Relationship for Standard Proctor Compaction Tests on Till

Sampling Date	Maximum Dry Density (kg/m^3)	Optimum Moisture Content (%)
1994	2115	7.5
1997	2035	9.7
1998	2053	10.1
2001	2125	10.1
August 1, 2002	2040	10.4
August 1, 2002	2070	10.2
September 14, 2002	2040	10.7
July 23, 2004	2040	10.9
August 01, 2005	2110	8.6
July 14, 2008[(a)]	2175	9.2
July 8, 2009	2058	10.8
December 18, 2012	2074	9.2
June 27, 2015[(b)]	2027	10.7
Average	***2074***	***9.9***

Notes: a) Rock corrected density and moisture content, b) Taken from field result test sheet, moisture density relation test laboratory data sheets not provided.

Table 2: Field Density Test Data for Till

Test	Date	Location	Estimated Oversize (%)	Percent Maximum Dry Density (%)	Moisture Content (%)	Design Content Moisture Range (%)
1	30-Jun-15	South Embankment	28	96.2	7.6	9.7 to 13.7
2	30-Jun-15	West Embankment	28	96.8	7.8	9.7 to 13.7
3	30-Jun-15	West Embankment	28	97.1	6.3	9.7 to 13.7
4	30-Jun-15	West Embankment	28	97.2	7.9	9.7 to 13.7
5	30-Jun-15	West Embankment	28	102.6	6.5	9.7 to 13.7
6	30-Jun-15	West Embankment	28	99.1	8.2	9.7 to 13.7
1	24-Sep-15	East Embankment	28	95.6	12.9	9.7 to 13.7
2	24-Sep-15	East Embankment	28	95.2	12.4	9.7 to 13.7
3	24-Sep-15	East Embankment	28	96.5	11.5	9.7 to 13.7
4	24-Sep-15	East Embankment	28	98.9	10.7	9.7 to 13.7
5	24-Sep-15	East Embankment	28	97.9	10.5	9.7 to 13.7
6	24-Sep-15	East Embankment	28	96.2	13.5	9.7 to 13.7

A staff gage was installed in March 2015 at the north end of the East Embankment to measure available freeboard (Photograph 11). The freeboard is measured and recorded during the weekly inspections.

A pond has been noted periodically near the downstream toe of the East Embankment, north end (Photograph 14). The pond size varies with rainfall, and is therefore attributed to the collection of precipitation, rather than seepage from the impoundment. Weekly inspections indicate the pond dried up by May 21, 2015. The area appeared to be filled with coarse coal rejects during the May 26, 2015 site inspection.

Minor erosion on the upstream slope of the East Embankment was noted during the May 26, 2015 inspection, and was attributed to the action of the former water line. Vegetation was observed on the upstream slope and on the downstream slope toe of the East Embankment.

4.3 South Embankment

The South Embankment is pictured in Photographs 15 to 21 in Appendix A.

No construction was performed on the South Embankment during 2015. One density and moisture content test were performed in the till on June 30, 2015 (Test No. 1). The test results are summarized in Table 2 and are presented in Appendix D. Testing in 2015 indicated the till met design criteria for density, but was dry of the specified range for compaction.

The October 2015 survey indicates that the South Embankment crest elevation remained at about 354.1 to 355.0 m, the total crest width varied between 17 and 22 m, and the till had an approximate width of 5 to 6 m.

Minor erosion and exposed cobbles were observed on the upstream till slope during the May 26, 2015 inspection, attributed to the action of the former water line. Vegetation was present on the upstream slope along the length of the embankment and on the crest of the till (Photograph 16). A damp area was identified in the drainage ditch at the toe of the embankment. Water has been observed at this location during previous inspections (Photograph 17). There were no signs of flowing seepage at the time of the May 26, 2015 inspection. Dry, white salt stains were visible on the downstream slope near the access road about 2 m above the toe (Photograph 19b).

4.4 West Embankment

The West Embankment is pictured in Photographs 22 through 30 in Appendix A.

The October 2015 survey indicates that the West Embankment total crest width varied between 8 and 18 m, and the till has an approximate width of 5 to 6 m. The north section of the embankment crest remains at an elevation between 354.1 and 354.4 m.

In 2015, the till crest was raised to approximately 355.0 m for the portion of the embankment located to the south of the tailings road. In-situ density and moisture content tests were performed on the till on June 30, 2015 and the results are presented in Appendix D (Tests 2 to 6) and summarized in Table 2. Results indicate the till met criteria for density but was dry of the specified range for compaction.

The downstream slope of the southern portion of the West Embankment was re-sloped in 2015 to improve stability. Construction details are presented in Section 4.4.1 and in Appendix E.

Minor erosion and exposed cobbles were observed on the upstream till slope during the May 26, 2015 inspection, attributed to the action of the former water line. Vegetation was observed on the upstream till slope and along the downstream toe. Vegetation was removed from the downstream slope and foundation prior to re-sloping construction.

The interior tailings berm that extends from the mid-point of the West Embankment to the centre of the facility was not raised. The berm is about one to two m high and is shown in Photograph 28 and 30, and in Figure 1. Trial excavations into the tailings surface at the south end of the berm by Hillsborough indicated low strength.

4.4.1 West Embankment Re-Sloping

The southern portion of the West Embankment downstream slope was re-sloped from angle of repose to 2H:1V as recommended by Golder (2015b).

No construction report was provided to Golder. Quinsam provided survey data, photographs taken during the construction and the following information.

- Construction was completed from August 17 to September 30, 2015.
- Weather:
  - Sunny (August 17-28, Sept 4-6, Sept 9-18, Sept 21-22, Sept 25-30)
  - Rain (August 29-Sept 3, Sept 7-8, Sept 19-20, Sept 23-24)
- Contractor Ben Van Dyke (Van Dyke Excavating)
  - Equipment: Komatsu PC228 excavator, an 11 ton taper pad roller, and a Cat D8 dozer.
- Methods
  - Vegetation was removed using the excavator.
  - Coarse Coal Rejects were excavated from downstream slope at dam crest in areas with overbuilt crest width, then
    - placed at toe of dam in one meter lifts;
    - compacted with four passes by 11 ton taper pad roller compactor;
    - sloped at 2H:1V with the Komatsu PC228; and
    - both sides of the re-slope were tied into existing areas.

No seepage was observed during the construction period.

Refer to Appendix E for photographs of the West Embankment re-sloping construction.

4.5 Pond Level and Tailings Quantity

Quinsam reported the highest pond water elevation on March 12, 2015 at 352.1 m, dropping to 351.7 m in May, and then to 351.4 m in October.

During the May 26, 2015 inspection the tailings pond was located against the North, East and South Embankments and West Embankments, with a beach against the majority of the West Embankment. The tailings beach is pictured in Photographs 24, 25, 28, 29 and 30 in Appendix A. Survey data from October 2015 indicated the tailings beach next to the discharge point on the West Embankment was at approximately elevation 353.1 m, about 1.6 m lower than the adjacent till crest of the West Embankment.

Approximately 3,900 t of tailings were deposited in the facility between January and December 2015. The quantity of deposited tailings decreased from the annual total of 10,850 t in 2014 and 22,500 in 2013 (Golder, 2014a). The decrease of the tailings deposition to the facility is due to the underground tailings discharge and reduced coal production tonnage. The total quantity of tailings stored in the facility is estimated by Quinsam at approximately 1,564,700 t.

5.0 REVIEW OF CLIMATE DATA AND WATER BALANCE

5.1 Review of Climatic Information

Quinsam operates a weather station on the mine site that records the local climatic conditions. Monthly precipitation and temperature data from this weather station are provided in Table 2. Temperatures measured with thermistors in the piezometers in the North Embankment and precipitation data are plotted with site instrumentation data in Appendix C.

Table 3: Climate Data

Month	Year	Total Precipitation (mm)	Average Temperature (degrees Celsius)
January	2015	109.0	4.0
February	2015	126.0	6.2
March	2015	113.0	7.0
April	2015	33.0	7.6
May	2015	3.0	13.9
June	2015	20.0	16.9
July	2015	41.0	18.7
August	2015	89.0	16.7
September	2015	76.8	11.9
October	2015	98.2	10.4
November	2015	112.6	2.0
December	2015	263.9	1.1
	Average	90.5	9.7
	Total	1085.4	Not applicable

mm = millimetres

For comparison, the climate normals provided by Environment Canada for the Campbell River Airport weather station for the period of 1981 to 2010 had an average annual temperature of 9.0 degrees Celsius, and annual precipitation of 1,489 mm (millimetres).

5.2 Water Balance

The 2-North Pit Tailings Disposal Facility is composed of embankments that are higher in elevation than the surrounding topography. Therefore, no surface water controls are required to divert water from the facility.

The 2-North Pit Tailings Disposal Facility does not have a water discharge system. The water level within the 2-North Pit Tailings Disposal Facility is controlled by seepage (primarily through the North Embankment), evaporation, and by the rate of discharge to the facility through the tailings pipeline and wash plant pipeline.

A preliminary annual water balance estimate for the 2-North Pit Tailings Disposal Facility for 2015 is presented in Table 4. Inputs to the 2-North Pit Tailings Disposal Facility include transport water pumped with the tailings, pumping from the collection box, which is a combination of the wash plant effluent and rainfall runoff from the area (8.7 hectares) around the wash plant with an estimated run-off coefficient of 0.85, and direct precipitation falling on the 2-North Pit Tailings Disposal Facility (Hillsborough 2010). Hillsborough has indicated that the wash plant pipeline started discharge to the 2-North Pit Tailings Disposal Facility in fall 2010. The discharge was in operation at the time of the May 26, 2015 site inspection into the southwest area of the facility. The tailings effluent in 2015 is estimated and prorated based on the 2014 and 2015 tonnages. The outputs from the 2-North Pit Tailings Disposal Facility include seepage, evaporation, and retained water in the tailings voids. The values presented in Table 4 were provided by Hillsborough.

Table 4: Water Balance from January 2015 to December 2015

Input ($M m^3$)				Output ($M m^3$)				Balance ($M m^3$)
Tailings Effluent	Wash Plant Collection Box	Precipitation	Total	Seepage (Derived)	Evaporation	Retained in Tailings Voids	Total	
0.052	0.028	0.055	0.135	0.111	0.026	0.003	0.140	(0.012)

$M m^3$ = millions of cubic metres.

The water balance indicates reduced tailings discharge to the impoundment in 2015, corresponding to reduced quantity of deposited tailings. The reduced input has resulted in reduced pond levels and reduced seepage quantity from the facility. The estimated seepage rate from the water balance is approximately 210 litres per minute on average in 2015. The result implies seepage loss from the facility in areas other than the observed seeps, such as through the North Embankment and into the underground workings located to the east of the facility. The seepage rate continues to decrease from 2012 when the rate was estimated to be over 1,200 litres per minute (Golder 2013). The seepage rate in 2014 was estimated to be 360 litres per minute (Golder, 2014b).

6.0 DAM CONSEQUENCE CLASSIFICATION

Guidelines for the classification of dams are presented in the Canadian Dam Association (CDA) *Dam Safety Guidelines* (2013). Tailings dams in British Columbia are regulated under the *Health, Safety and Reclamation Code for Mines in British Columbia* (BC MEM 2008), which uses the same dam consequence classifications as CDA (2013).

Consequence categories are based on the incremental losses that a failure of the dam might inflict on downstream or upstream areas or at the dam location itself. Incremental losses are those over and above losses that might have occurred in the same natural event or condition had the dam not failed. The classification assigned to a dam is the highest rank determined among the four loss categories.

Table 3 presents the dam classification criteria by CDA (2013).

Table 5: Dam Classification in Terms of Consequences of Failure

Dam Class	Population at Risk [a]	Incremental Losses		
		Loss of Life[b]	Environmental and Cultural Values	Infrastructure and Economics
Low	None	0	Minimal short term loss. No long term loss.	Low economic losses; area contains limited infrastructure or service.
Significant	Temporary Only	Unspecified	No significant loss or deterioration of fish or wildlife habitat. Loss of marginal habitat only. Restoration or compensation in kind highly possible.	Losses to recreational facilities, seasonal workplaces, and infrequently used transport routes.
High	Permanent	10 of fewer	Significant loss or deterioration of important fish or wildlife habitat. Restoration or compensation in kind highly possible.	High economic losses affecting infrastructure, public transport, and commercial facilities.
Very High	Permanent	100 of fewer	Significant loss or deterioration of critical fish or wildlife habitat. Restoration or compensation in kind possible but impractical.	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances).
Extreme	Permanent	More than 100	Major loss of critical fish or wildlife habitat. Restoration or compensation in kind impossible.	Extreme losses affecting critical infrastructure or services (e.g., hospital, major industrial complex, major storage facilities for dangerous substances).

Source: CDA (2013)

Notes: [a] Definition for population at risk:
None – There is no identifiable population at risk, so there is no possibility of loss of life other than through unforeseeable misadventure.
Temporary – People are only temporarily in the dam-breach inundation zone (e.g., seasonal cottage use, passing through on transportation routes, participating in recreational activities).
Permanent – The population at risk is ordinarily located in the dam-breach inundation zone (e.g., as permanent residents); three consequence classes (high, very high, extreme) are proposed to allow for more detailed estimates of potential loss of life (to assist in decision-making if the appropriate analysis is carried out).

[b] Implications for loss of life:
Unspecified – The appropriate level of safety required a dam where people are temporarily at risk depends on the number of people, the exposure time, the nature of their activity, and other conditions. A higher class could be appropriate, depending on the requirements. However, the design flood requirement, for example, might not be higher if the temporary population is not likely to be present during the flood season.

An inundation study of overtopping and piping failure modes of the 2-North Pit Tailings Disposal Facility dams was prepared in 2014 (Golder, 2014c). Results from the inundation study have been used to review the classification of the embankments, which is summarized in Table 4.

Table 6: Classification of Embankments of 2-North Tailings Disposal Facility

Embankment	Classification	Incremental Losses		
		Loss of Life[b]	Environmental and Cultural Values	Infrastructure and Economics
North	Very High	**Very High** (less than 100 staff in area)	Significant (some potential for impact to Middle Quinsam Lake)	High (mine and process plant)
East	Low	**Low** (no population at risk)	**Low** (no significant loss of habitat)	**Low** (no infrastructure at risk)
West	High	Significant (temporary risk)	**High** (Significant loss or deterioration of "good" fish habitat)	Low (road at risk)
South	High	Significant (temporary risk)	**High** (Significant loss or deterioration of "good" fish habitat)	Low (road at risk)

Failure of the North Embankment could result in flow of tailings and water into the 2-North Pit to the north of the dam, with potential for flow across the office and process plant yard. The North Embankment is located immediately upstream and above the access portals to the underground workings for the mine. It is expected that more than 10 but less than 100 workers could be underground for each shift during mine operation. Therefore, failure of the North Embankment has the potential to cause fatalities and significant financial loss. Additionally, tailings and water will fill and overflow the pit, resulting in a potential for impact to Middle Quinsam Lake. As such, the North Embankment is classified as a Very High consequence dam.

The West and South Embankments are located above a road that takes regular traffic to and from the 7-South mine, four days per week during mine operation. The South Embankment is also above a laydown area that is occasionally used, with no permanent buildings or staff present. The failure of either the West or South Embankments would be expected to impact the road, and Middle Quinsam Lake. Fish habitat in Middle Quinsam lake is considered to be "good" (Golder 2011). The West and South Embankments are therefore classified as High consequence structures.

The East Embankment is not located above any critical facilities or habitat. It is likely that debris from the failure of the East Embankment would be contained on site. The East Embankment is therefore classified as a Low consequence structure.

The status of the mine has changed as of early 2016 from operations to care and maintenance. Recommendations on update to the classification of the dams are presented in Section 8.0.

7.0 DAM SAFETY ANALYSIS

This section presents the dam safety analysis for the 2-North Pit Tailings Disposal Facility dams based on the observations and data review for each of the failure modes that are most relevant to these types of dams. Photographs are presented in Appendix A. Records of inspection for each of the dams are shown in Appendix B.

7.1 Potential Failure Modes

7.1.1 Piping

Piping occurs due to the development of erosion to the extent that a hole develops through the embankment with rapid loss of water from the storage pond.

Design Basis

The embankments are intended to retain tailings solids. Filter compatibility between the tailings, coarse rejects, till, and cast blast materials was assessed by Golder (1997b and 2001) and is summarized in Table 7.

Table 7: Summary of Filter Compatibility between Construction Materials

Material 1	Material 2	Filter Compatible	Comments
Tailings	Coarse Rejects	No	Filter fabric required.
Tailings	Cast Blast	No	Use till OR coarse rejects and filter fabric as transition.
Tailings	Till	Yes	
Till	Coarse Rejects	Yes	
Till	Cast Blast	No (Fine portion only)	Use coarse rejects as transition as only the fine fraction of cast blast provides a filter and the material is variable.
Coarse Rejects	Cast Blast	Yes	

The filter compatibility for the construction materials has previously been checked based on gradation test results from 2009 to 2013. Results of the check are consistent with the results presented in Table 7. Gradation results have not been provided to Golder since 2013.

Observed Performance

In-situ density and moisture tests were carried out on the till on the South and West Embankments on June 30 and September 24, 2015. Results indicate that the till was compacted to within 95% of the maximum dry density. The performance of the dams was also assessed based on the observations from the site visit and the 2015 weekly inspection notes from Quinsam staff.

Historically, seepage has occurred through the east and west abutment walls along the downstream side of the North Embankment. This seepage was observed to have exited through the bedrock, and not through the dam fills. During the May 26, 2015 inspection, the seep exiting the bedrock near the west end of the North Embankment foundation was observed to be clear, and flowing at a measured rate of 0.6 litres per second. The seep is pictured in Photograph 6 in Appendix A. The seep from the North Embankment does not appear to indicate piping, since it was observed to be free of fine materials and exited through the bedrock. The flow from the seep is measured during the weekly inspections by Quinsam at a weir installed below the seep. The flow rate varied between 0.3 and 0.7 L/s in 2015, with seepage flow rates presented in Figure C-3 in Appendix C.

Flowing water was audible at the well casing for VW 16734 on the North Embankment face during the May 26, 2015 inspection (see Figure 1 for location).

No seepage was visible from the North Embankment east abutment during the May 26, 2015 inspection. The east abutment is pictured in Photograph 8 in Appendix A. Seepage from the east abutment was last observed during the April 2007 site visit but has since been covered with filter fabric and coarse rejects. The details regarding this seep are available in Golder (2006).

Seepage was not observed from the East Embankment during the May 26, 2015 inspection. The Quinsam weekly inspection reports indicate that water from precipitation and run-off collected and ponded at the downstream toe between January and May 2015. The pond dried up by May 21, 2015. The downstream slope and toe of the East Embankment is pictured in Photographs 12 to 14 in Appendix A. Seepage from the embankment has not been observed during the site inspections in 2007 through 2015. The underground workings below and to the east of the East Embankment were not inspected by Golder. Quinsam indicated that the underground area has caved, and measurement of seepage and evaluation of seepage quality is not possible.

Seepage flows were not observed from the downstream slope or toe of the South Embankment during the May 26, 2015 inspection. The downstream slope of the South Embankment is pictured in Photographs 17 to 21 in Appendix A. A damp area with salt stains was observed at the toe (Photograph 17), indicating seepage, but no flowing or ponded water was observed. Minor seepage had been observed for a number of years at the interface between the east highwall abutment and the downstream slope of the South Embankment. No seepage was observed from the east highwall abutment during the May 26, 2015 inspection (Photograph 21 in Appendix A). No evidence of suspended particles has been observed to date in the seepage from the South Embankment. Inspection of the pond at the toe of the South Embankment during the May 26, 2015 site visit did not indicate evidence of piping such as seeps, sediment or particles in the pond area.

The West Embankment is constructed from open pit overburden and has been raised using coarse rejects and an upstream blanket of till. Filter compatibility exists between the tailings and the till and hence piping within this portion of the embankment is unlikely. Filter compatibility does not exist for the lower portion of the slope constructed with cast blast material. Minor seepage, of less than 1 litre per minute, has been observed along the access ramp on the West Embankment since early September 2012 to 2014. The area was soft and damp with salt staining, but no flow was observed at this location during the May 26, 2015 inspection. The location is shown in Photograph 26 in Appendix A.

Vegetation was observed on the upstream till slopes of the West, South and East Embankments during the May 26, 2015 inspection.

7.1.2 Instability

Instability occurs due to imbalance of forces resulting in movement of a part of the dam with possible loss of integrity of the dam.

Design Basis

The dams are designed to provide Factors-of-Safety that meet or exceed the criteria of CDA (2013). A minimum Factor of Safety of 1.5 under normal operating conditions, and a minimum Factor of Safety of 1.0 under seismic conditions is required for the embankments. Golder reassessed the seismic hazard (Golder 2015c) to align with the recent update in the National Building Code of Canada (2015 NBCC) that represented a significant change in the design-level ground motions throughout Canada. The reassessment concluded that the PGA for an annual exceedance probability of 1/2475 was increased from 0.281 g to 0.320 g. The assumed materials properties are presented in Table 8 and the design geometry is presented in Table 9. A review of dam stability considering a revised seismic hazard assessment for the site and was in progress during the preparation of this report.

Table 8: Design Material Properties

Material	Unit Weight (kN/m^3)		Cohesion (kPa)	Friction Angle (degrees)
	Dry	Wet		
Cast Blast Spoil	19	20	0	37
Coarse Rejects	18	19	0	37
Till	20	21	10	30
Tailings	13.2	14.1	0	30

Source: Golder (2002), kN/m^3 = kilonewtons per cubic metre, kPa = kilopascals

Table 9: Design Geometry for Elevation 355 M Raise Embankments

Embankment	Crest Width (m)	Upstream Slope	Downstream Slope
North	10	1.3 horizontal (H): 1 vertical (V)	2H:1V
East	5	2H:1V	2H:1V
South	10	2H:1V	2H:1V
West	5	2H:1V	2H:1V

Source: Golder (2002)

Instrumentation

Measurements of piezometric heads and temperatures from vibrating wire piezometers in the North Embankment are presented in Figures C-1 and C-2 in Appendix C. Piezometer identification and tip elevations are summarized in Table 10.

Table 10: Piezometer Data Parameters

Serial Number	Tip Elevation (m)	Operational Comments
VW 0582	316.00	-
VW 0583	314.10	-
VW 0584	315.96	-
VW 0585	315.78	Malfunctioned in 2009
VW 0586	316.24	-
VW 0587	316.77	Malfunctioned in 2010
VW 16734	319.90	Installed in February 2011

The piezometer levels typically peak in August to September and are lowest from around December to April. Precipitation data from August 2009 to December 2015 are presented in Figure C-1 of Appendix C. Average daily ambient temperatures from February 2010 to December 2015 are presented in Figure C-2 of Appendix C with data from thermistors in the piezometer tips.

Historical data for piezometers VW 0582 and VW 0583 indicate that the tips are generally dry, with some seasonal variation. These two piezometers appeared to be dry in 2015.

The data for piezometer VW 0584 indicated a phreatic surface approximately 0.09 to 0.69 m above the elevation of the piezometer tip during 2015 with the maximum of 0.69 m occurring in February.

Readings from VW 0585 have been not available since July 2009. Golder recommended that replacing VW 0585 was not necessary due to its historical pressure readings and the proximity of VW 0584 and VW 0586 (Golder 2009b).

The 2015 data for piezometer VW 0586 indicated a phreatic surface was up to 0.08 m above the piezometer tip elevation. The phreatic surface was highest in January.

Piezometer VW 0587 malfunctioned in 2010. VW 16734 was installed in February 2011 to replace VW 0587. The piezometer locations are shown in plan in Figure 1 and in cross-section in Figure 3. Data since February 2011 from piezometer VW 16734 indicated higher water levels than other piezometers and was typically dry between June and October. Data for 2015 indicated that the water level was up to 0.27 m above the piezometer tip in February).

The piezometer readings for the year of 2015 are comparable to those of previous years. Based on the available piezometer data, the phreatic surfaces are not considered to present a concern for the stability of the North Embankment.

Observed Performance

The embankments were monitored by weekly visual inspections and annual surveys. The North, South, East, and West Embankments were examined for signs of instability during the May 26, 2015 inspection. Additionally, inspections following earthquakes were completed by Quinsam staff on April 24, 2014, March 25 and September 24, 2015, where no signs of instability were noted.

Minor erosion was observed on the downstream slope of the North, East, West, and South Embankments, and is not considered to be significant to embankment stability. A small gulley had formed by the access road by the southern corner of the West Embankment. Minor erosion was also observed of the till on the upstream slopes of the East, West, and South Embankments during the May 26, 2015 inspection, but does not represent a concern to stability.

The design downstream slope angle for all the dams is 2 horizontal: 1 vertical (2H:1V), though some areas along the downstream slopes of the North, East, and West Embankments are at angle of repose, near 1.3H:1V to 1.4H:1V. The upper two benches of the North Embankment are steeper than 2H:1V, with the upper bench supporting an access road. However, no significant signs of instability were observed during the inspection.

At the time of the inspection the downstream slope of the southern portion of the West Embankment was near 1.5H:1V, and steeper than the design slope of 2H:1V. Quinsam re-sloped this area to 2H:1V between August and September 2015, as discussed in Section 4.4.1.

Assessments of the abandoned underground workings (Golder 1997a) adjacent the eastern side of the facility suggest that the voids are likely to have filled with caved material, and hence the potential for future settlements is considered to be limited. The subsidence cracks near the pit highwall are therefore not considered to be adverse to the stability of the East Embankment.

The impact of underground tailings deposition on underground stability has not been assessed by Golder during this dam safety inspection and is outside the scope of this report.

During the 2015 inspection, the embankments did not exhibit any evidence of instability such as cracks at the crest, or slumps, bulges or sinkholes on either the crest, downstream slopes, or at the toes of the embankments.

7.1.3 Overtopping

Overtopping occurs when the pond level rises above the dam crest level, resulting in flow over the dam that may result in progressive erosion of the dam and loss of the pond.

Design Basis

The maximum allowable pond levels for the 2-North Pit Tailing Disposal Facility are presented in Table 11.

Table 11: Maximum Allowable Pond Levels

Item	Value (m)
Minimum required freeboard	1.25
Lowest elevation on 2-North Pit Tailing Disposal Facility crest	354.1
Maximum allowable pond elevation (calculated)	352.85

The design minimum operating freeboard (crest to pond) is 1.25 m to provide a minimum 1 m freeboard under the design flood event (Golder 2002). The design freeboard was set in 2002 based on an inflow design flood of 1/3 between 1-in-1,000 year flood and the Probable Maximum Flood of 0.14 m over the catchment area of the facility. An updated Inflow Design Flood (IDF) was established in 2010 by Lorax Environmental. The updated IDF value has been estimated as 310 mm of rainfall occurring over a 24-hour period. During such an event, the freeboard may fall slightly below 1.0 m for a period of time. However, the remaining freeboard would exceed 0.9 m and is expected to be adequate for wave run-up. A review of the flood storage and freeboard requirement was in progress during the preparation of this report.

Instrumentation Data

No instrumentation for measurement of settlement is currently in place at the facility, with the exception of survey monuments installed on the East Embankment. The embankments are inspected on a weekly basis for settlement, and surveyed on a yearly basis for dam crest elevation and pond water elevation. Freeboard is also measured on a weekly basis at a staff gage at the north east corner of the impoundment.

Observed Performance

Table 12 presents a summary of surveyed pond elevations from May 2006 to October 2015.

Table 12: Historic Pond Elevations

Survey Date	Pond Elevation (metres above sea level)
May 24, 2006	343.3
February 26, 2008	345.4
April 7, 2009	347.8
December 10, 2010	349.5
November, 2011	350.7
October 15, 2012	351.8
November 4, 2013	352.1
August 20, 2014	351.7
March 12, 2015	352.1
October 20, 2015	351.4

The maximum recorded pond elevation in 2015 was 352.1 m in March. The minimum freeboard was therefore about 2.0 m, which is greater than the design minimum requirement of 1.25 m.

7.2 Operational Documents

7.2.1 Operation, Maintenance and Surveillance Manual

The Operations, Maintenance and Surveillance (OMS) Manual for the 2-North Pit Tailings Disposal Facility and South Dam (Quinsam 2014) was updated on August 31, 2014.

Additionally, an updated version of the OMS manual has been prepared for care and maintenance (Quinsam 2016).

7.2.2 Emergency Preparedness Plan

The Emergency Preparedness Plan (EPP) is incorporated as Section 10 of the OMS manual (Quinsam 2014). Additionally, a version of the EPP manual is included in Quinsam (2016).

7.3 Comments on Previous Issues

Comments of previous issues of concern from Golder (2014b) presented in Section 3.3 are provided in Table 13.

Table 13: Summary of Comments on Previous Issues

Issue	Comment
The downstream slope of the West Embankment is steeper than design and should be flattened to 2 horizontal: 1 vertical to satisfy design criteria for stability for the elevation 355 m raise design (Golder 2002).	The West Embankment was re-sloped in 2015. See Section 4.4.1.
Relocate pipeline beyond footprint of the dam.	The pipeline was relocated beyond footprint of the dam.
Bushes on the embankments should be cut flush with the ground.	The upstream slopes of the embankments were sprayed with herbicide on May 20, 2015 and vegetation was mechanically removed from the downstream toe of the West Embankment prior to re-slope construction.
Organic material embedded in till on East Embankment.	Organics materials were removed.
Design analyses update	Stability analyses considering the updated seismic peak ground acceleration value and re-sloping construction were in progress during the preparation of this report.
Improve quality of weekly inspections	A staff gage was installed to allow efficient monitoring of the pond level. A weir was also installed at the toe of the North Embankment to quantify seepage rate.

8.0 FINDINGS AND RECOMMENDED ACTIONS

The 2-North Pit Tailings Disposal Facility was observed to be in generally good condition at the time of the 2015 site visit. The West Embankment was re-sloped to improve dam stability. No other significant changes with respect to dam stability and surface water control were noted based on instrumentation and visual monitoring records. The 2015 Dam Safety Inspection key issues and recommended actions for the 2-North Pit Tailings Disposal Facility are as follows:

- Maintain upstream and downstream slopes and crests of the embankments free of vegetation.
- Continue to inspect the embankments for signs of movement, instability, and erosion on a weekly basis.
- Continue to measure and record seepage rates on a weekly basis, noting any fluctuations.
- Record the water level in the pond on a weekly basis as an elevation, noting any fluctuations.
- Carry out detailed inspections following seismic events and following significant precipitation events. Should any change to the dams occur, then the Design Engineer (Golder) should be notified immediately, as per the OMS manual. Otherwise, documentation of inspections following seismic events and significant precipitation events should be sent to the Design Engineer within a week of each event. Documentation should include photographs.
- Quinsam has notified Golder of the intent to change from operations to a phase of active care and maintenance in 2016. The following are recommended related to this change.
  - The consequence classification of the embankments should be reviewed and updated to reflect the change from mine operation to active care and maintenance in 2016.
  - The frequency of review of inspection and collection of monitoring data, and for reporting of the same inspections and data to the Design Engineer for review should be confirmed.
    - Actions or changes resulting from the change to care and maintenance should be captured in an update to the OMS manual.
  - The Design Engineer should review the updated OMS manual in 2016, and any subsequent changes.
  - The Design Engineer should be notified in advance of any plan to re-start operations or implement closure works that would impact or change the 2N-Pit Tailings Disposal Facility, including plans to:
    - discharge tailings or water to the facility;
    - remove tailings or water from the facility;
    - complete any earthworks with the potential to impact the dams;
    - flood or dewater of the toe areas, such as
      - the sump at the 2 North Portal below the North Embankment; and
      - the pond at the South Embankment.

Table 14 summarizes the date of the last Dam Safety Review, guidelines for frequency, and schedule for next Dam Safety Review for each structure.

Table 14: Schedule for Next Dam Safety Review

Structure	Date of Last Dam Safety Review*	Dam Safety Review Frequency by CDA[(a)]	Suggested Schedule for Next Dam Safety Review
North Embankment	2013	5 years	2018 or earlier
West Embankment	2013	7 years	2020 or earlier
South Embankment	2013	7 years	2020 or earlier

a) CDA (2013). CDA = Canadian Dam Association

9.0 CLOSURE

The reader is referred to the Study Limitations, which follows the text and forms an integral part of this report.

We trust that this report meets your present requirements. If you have any questions, please contact the undersigned.

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Thurber (Thurber Engineering Ltd.). 2014. *Quinsam Coal Mine, 2013 Dam Safety Review, Tailings Disposal Facilities at the 2-North Pit*. Report to Quinsam Coal Corporation. File:17-770-1. January 7, 2014.

STUDY LIMITATIONS

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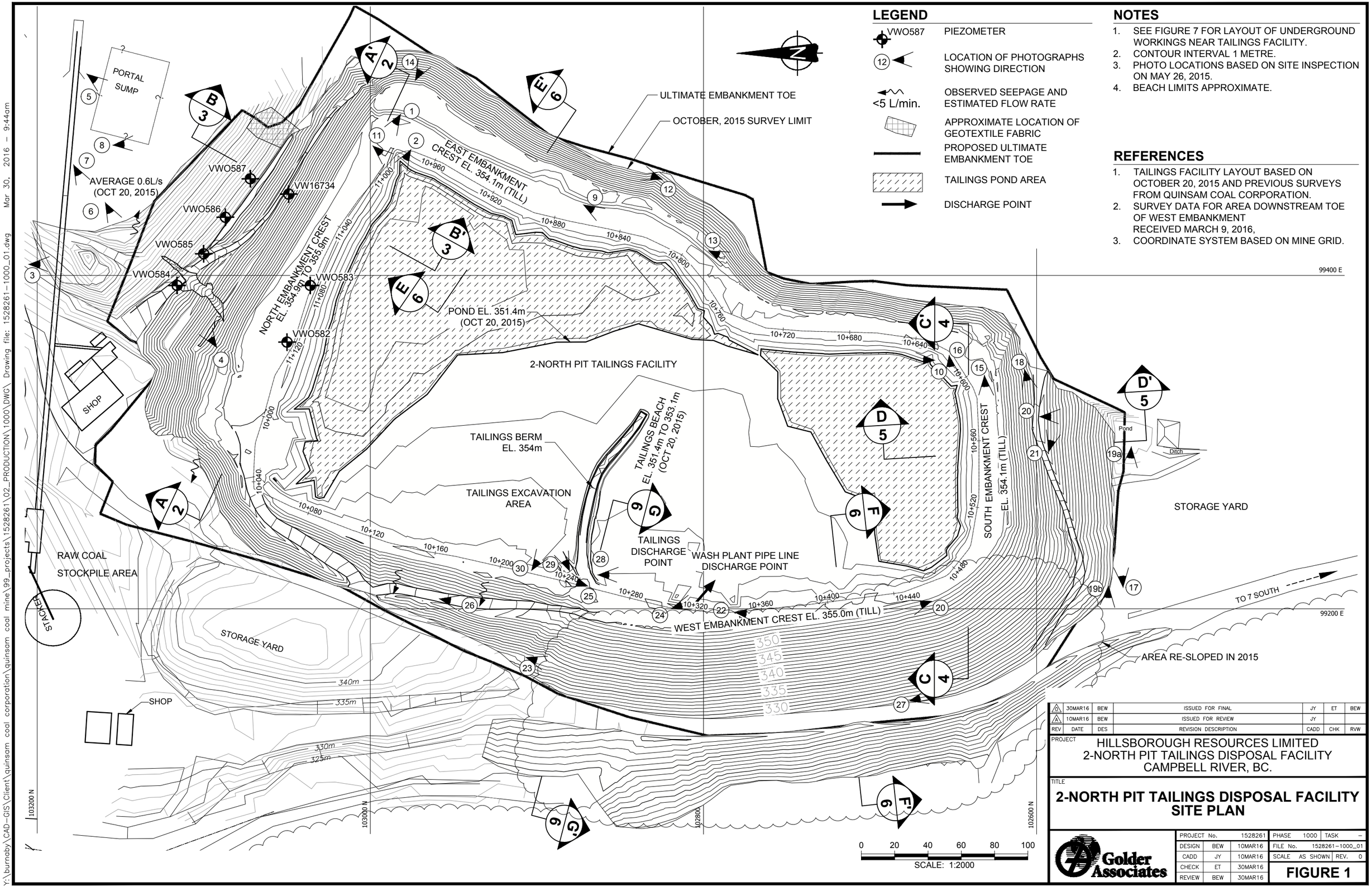


REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
2	30MAR16	BEW	ISSUED FOR FINAL	JY	ET	BEW
1	10MAR16	BEW	ISSUED FOR REVIEW	JY		

PROJECT
HILLSBOROUGH RESOURCES LIMITED
2-NORTH PIT TAILINGS DISPOSAL FACILITY
CAMPBELL RIVER, BC.

TITLE
2-NORTH PIT TAILINGS DISPOSAL FACILITY SITE PLAN

Golder Associates

PROJECT No.		1528261	PHASE	1000	TASK –
DESIGN	BEW	10MAR16	FILE No.	1528261-1000_01	
CADD	JY	10MAR16	SCALE	AS SHOWN	REV. 0
CHECK	ET	30MAR16			
REVIEW	BEW	30MAR16			

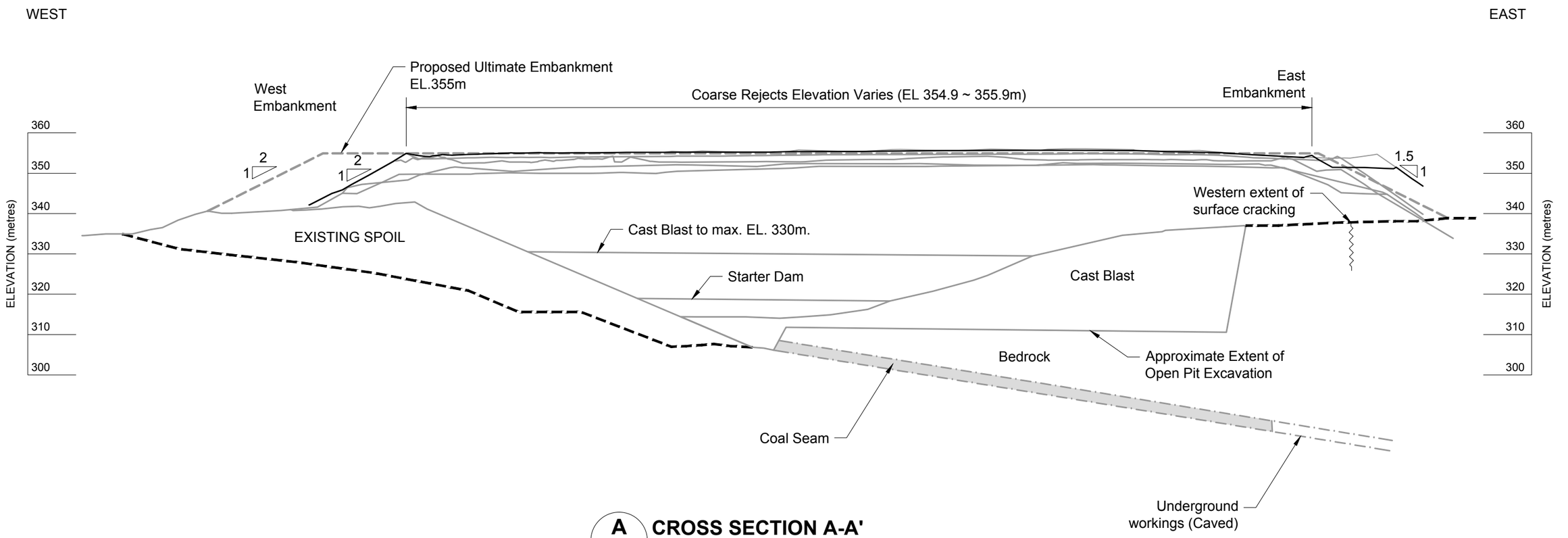
FIGURE 1

LEGEND

- PREVIOUS EMBANKMENT CONSTRUCTION
- EXISTING SURFACE (OCTOBER 20, 2015)
- PROPOSED ULTIMATE EMBANKMENT
- INFERRED ORIGINAL GROUND SURFACE

NOTES

1. EXISTING ELEVATIONS REFER TO OCTOBER 20, 2015 SURVEY DATA FROM QUINSAM COAL CORPORATION.
2. LOCATION OF CAST BLAST, COARSE REJECTS AND SPOILS PLACED PRIOR TO 2006 (BELOW ELEV. 346.50m) ARE APPROXIMATE.



A/1 CROSS SECTION A-A'
SCALE: 1:1000

0 10 20 30 40 50
SCALE: 1:1000

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
1	30MAR16	BEW	ISSUED FOR FINAL	JD	ET	BEW
A	07JAN16	BEW	ISSUED FOR REVIEW	JD		

PROJECT
HILLSBOROUGH RESOURCES LIMITED
2-NORTH PIT TAILINGS DISPOSAL FACILITY
CAMPBELL RIVER, BC.

TITLE
NORTH EMBANKMENT LONGITUDINAL SECTION

Golder Associates

PROJECT No.	1411846		PHASE	1000	TASK –
DESIGN	BEW	05JAN16	FILE No.	1528261–1000_02	
CADD	JD	05JAN16	SCALE	AS SHOWN	REV. 0
CHECK	ET	30MAR16			
REVIEW	BEW	30MAR16			

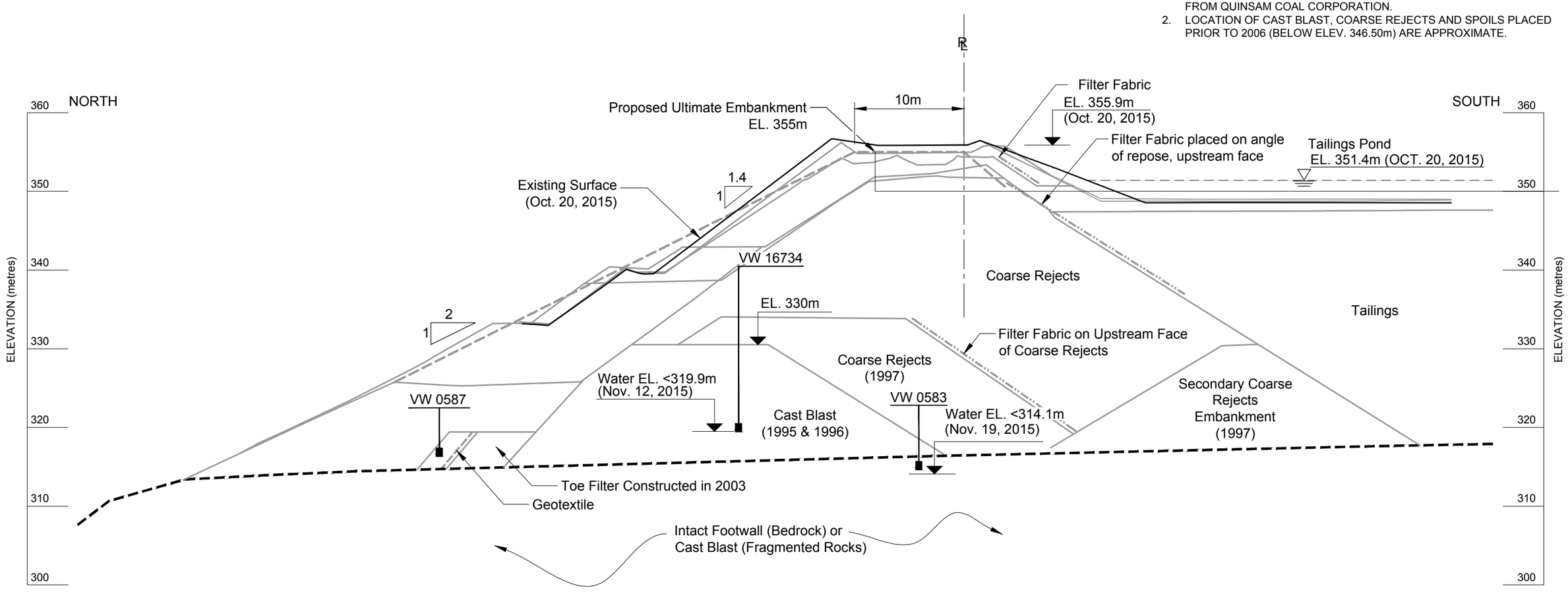
FIGURE 2

LEGEND

- PREVIOUS EMBANKMENT CONSTRUCTION
- EXISTING SURFACE (OCTOBER 20, 2015)
- PROPOSED ULTIMATE EMBANKMENT
- INFERRED ORIGINAL GROUND SURFACE
- VWO584 — PIEZOMETER
- POND ELEVATION

NOTES

1. EXISTING ELEVATIONS REFER TO OCTOBER 20, 2015 SURVEY DATA FROM QUINSAM COAL CORPORATION.
2. LOCATION OF CAST BLAST, COARSE REJECTS AND SPOILS PLACED PRIOR TO 2006 (BELOW ELEV. 346.50m) ARE APPROXIMATE.



B-1 CROSS SECTION B-B'
SCALE: 1:500

0 5 10 15 20 25
SCALE: 1:500

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
2	30MAR16	BEW	ISSUED FOR FINAL	JD	ET	BEW
1	07JAN16	BEW	ISSUED FOR REVIEW	JD		

PROJECT
HILLSBOROUGH RESOURCES LIMITED
2-NORTH PIT TAILINGS DISPOSAL FACILITY
CAMPBELL RIVER, BC.

TITLE
NORTH EMBANKMENT CROSS SECTION

Golder Associates

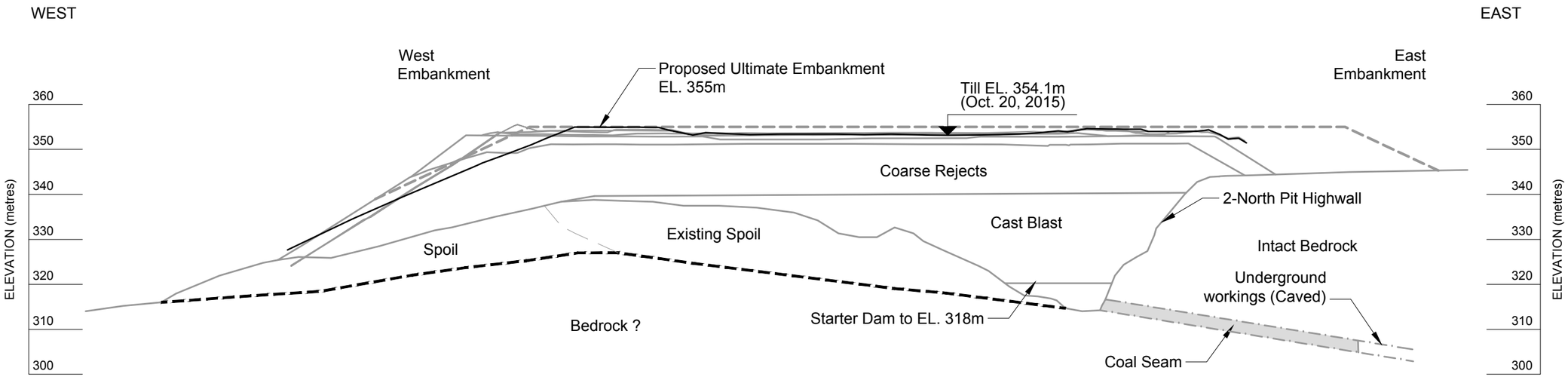
PROJECT No.		1528261	PHASE	1000	TASK –
DESIGN	BEW	05JAN16	FILE No.	1528261-1000_03	
CADD	JD	05JAN16	SCALE	AS SHOWN	REV. 0
CHECK	ET	30MAR16	**FIGURE 3**		
REVIEW	BEW	30MAR16			

LEGEND

- PREVIOUS EMBANKMENT CONSTRUCTION
- EXISTING SURFACE (OCTOBER 20, 2015)
- PROPOSED ULTIMATE EMBANKMENT
- INFERRED ORIGINAL GROUND SURFACE

NOTES

1. EXISTING ELEVATIONS REFER TO OCTOBER 20, 2015 SURVEY DATA FROM QUINSAM COAL CORPORATION.
2. LOCATION OF CAST BLAST, COARSE REJECTS AND SPOILS PLACED PRIOR TO 2006 (BELOW ELEV. 348.5m) ARE APPROXIMATE.



C-1 CROSS SECTION C-C'
SCALE: 1:1000

0 10 20 30 40 50
SCALE: 1:1000

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
2	30MAR16	BEW	ISSUED FOR FINAL	JD	ET	BEW
1	07JAN16	BEW	ISSUED FOR REVIEW	JD		

PROJECT
HILLSBOROUGH RESOURCES LIMITED
2-NORTH PIT TAILINGS DISPOSAL FACILITY
CAMPBELL RIVER, BC.

TITLE
SOUTH EMBANKMENT LONGITUDINAL SECTION

Golder Associates

PROJECT No.		1528261	PHASE	1000	TASK –
DESIGN	BEW	05JAN16	FILE No.	1528261-1000_04	
CADD	JD	05JAN16	SCALE	AS SHOWN	REV. 0
CHECK	ET	30MAR16			
REVIEW	BEW	30MAR16			

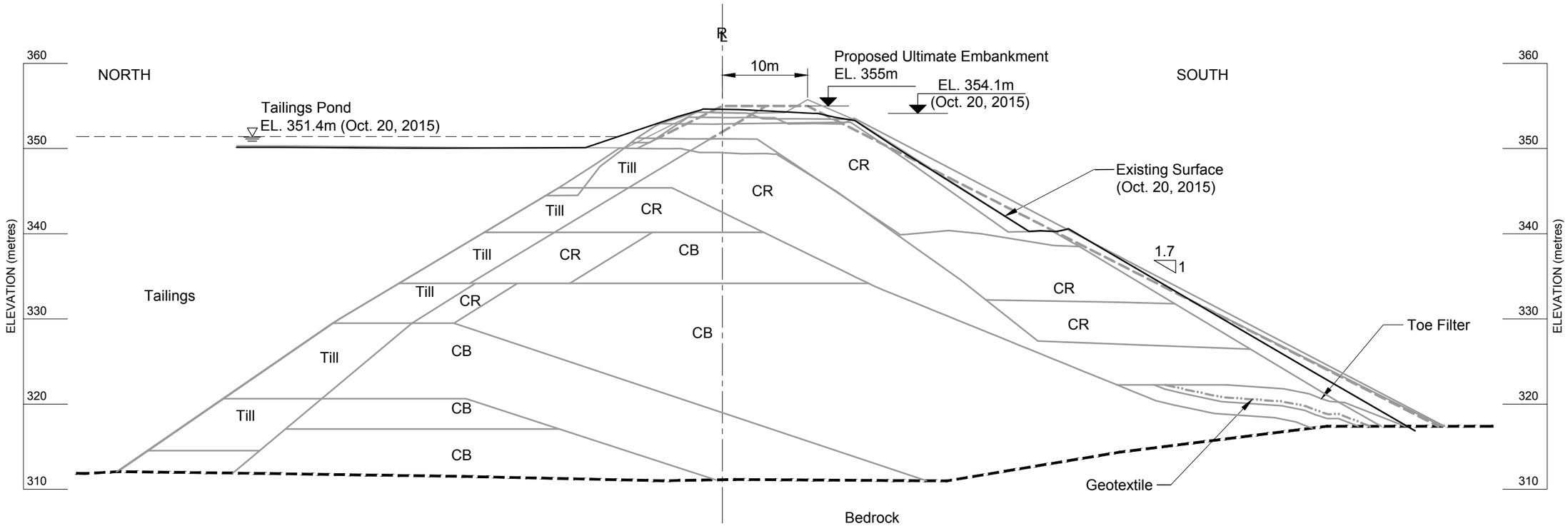
FIGURE 4

LEGEND

- PREVIOUS EMBANKMENT CONSTRUCTION
- EXISTING SURFACE (OCTOBER 20, 2015)
- PROPOSED ULTIMATE EMBANKMENT
- INFERRED ORIGINAL GROUND SURFACE
- POND ELEVATION

NOTES

1. EXISTING ELEVATIONS REFER TO OCTOBER 20, 2015 SURVEY DATA FROM QUINSAM COAL CORPORATION.
2. LOCATION OF CAST BLAST, COARSE REJECTS AND SPOILS PLACED PRIOR TO 2006 (BELOW ELEV. 348.5m) ARE APPROXIMATE.



CR - Coarse Rejects
CB - Cast Blast

D/1 CROSS SECTION D-D'

SCALE: 1:500

0 5 10 15 20 25
SCALE: 1:500

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
2	30MAR16	BEW	ISSUED FOR FINAL	JD	ET	BEW
1	07JAN16	BEW	ISSUED FOR REVIEW	JD		

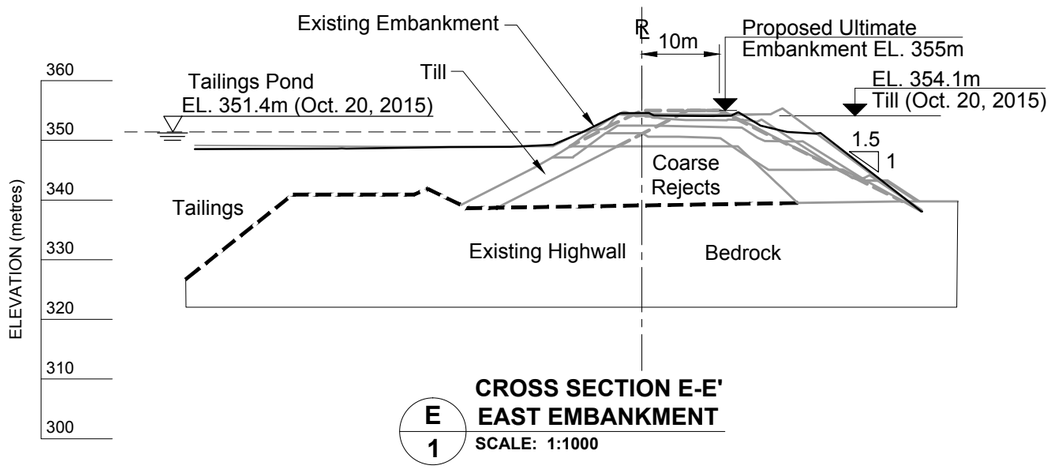
PROJECT
HILLSBOROUGH RESOURCES LIMITED
2-NORTH PIT TAILINGS DISPOSAL FACILITY
CAMPBELL RIVER, BC.

TITLE
SOUTH EMBANKMENT CROSS SECTION

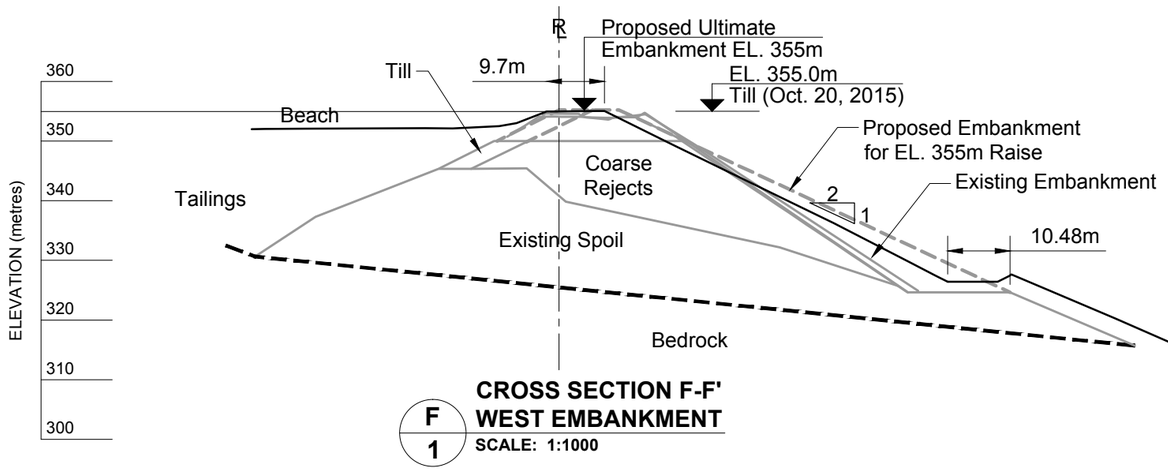
Golder Associates

PROJECT No.		1528261	PHASE	1000	TASK –
DESIGN	BEW	05JAN16	FILE No.	1528261-1000_05	
CADD	JD	05JAN16	SCALE	AS SHOWN	REV. 0
CHECK	ET	30MAR16			
REVIEW	BEW	30MAR16			

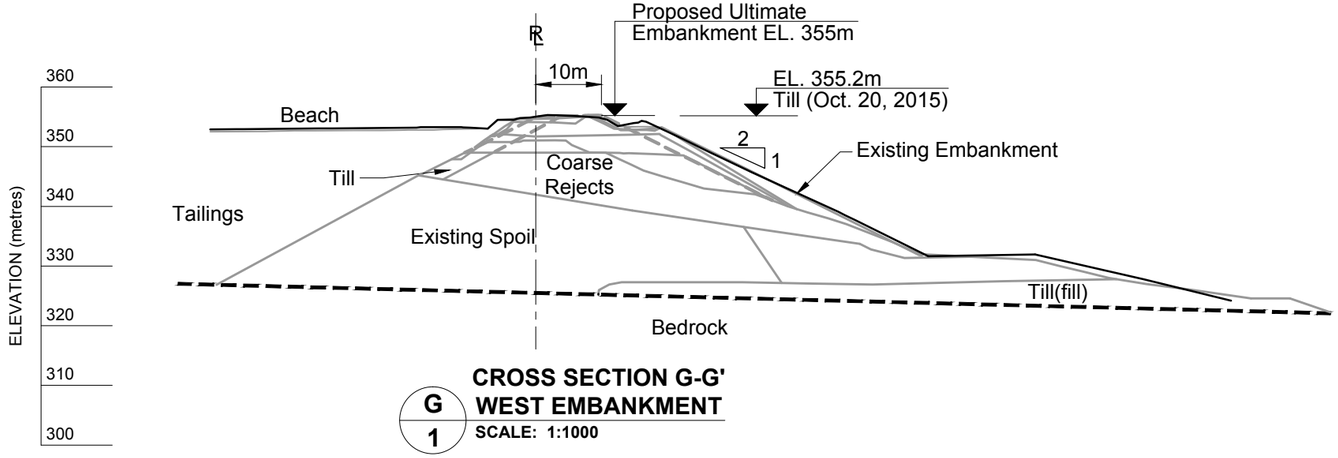
FIGURE 5



CROSS SECTION E-E'
EAST EMBANKMENT
E / 1
SCALE: 1:1000



CROSS SECTION F-F'
WEST EMBANKMENT
F / 1
SCALE: 1:1000



CROSS SECTION G-G'
WEST EMBANKMENT
G / 1
SCALE: 1:1000

LEGEND

- PREVIOUS EMBANKMENT CONSTRUCTION
- EXISTING SURFACE
- PROPOSED ULTIMATE EMBANKMENT
- INFERRED ORIGINAL GROUND SURFACE
- POND ELEVATION

NOTES

1. EXISTING ELEVATIONS REFER TO OCTOBER 20, 2015 SURVEY DATA FROM QUINSAM COAL CORPORATION. SURVEY DATA FOR ROAD AT DOWNSTREAM TOE OF WEST EMBANKMENT RECEIVED MARCH 2016.
2. LOCATION OF CAST BLAST, COARSE REJECTS AND SPOILS PLACED PRIOR TO 2006 (BELOW ELEV. 348.5m) ARE APPROXIMATE.

0 10 20 30 40 50
SCALE: 1:1000

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
2	30MAR16	ET	ISSUED FOR FINAL	JY	ET	BEW
1	10MAR16	ET	ISSUED FOR REVIEW	JY		

PROJECT
HILLSBOROUGH RESOURCES LIMITED
2-NORTH PIT TAILINGS DISPOSAL FACILITY
CAMPBELL RIVER, BC.

TITLE
EAST AND WEST EMBANKMENTS CROSS SECTIONS

Golder Associates

PROJECT No.		1528261	PHASE	1000	TASK –
DESIGN	ET	10MAR16	FILE No.	1528261-1000_06	
CADD	JY	10MAR16	SCALE	AS SHOWN	REV. 0
CHECK	ET	30MAR16			
REVIEW	BEW	30MAR16			

FIGURE 6

NOTE

1. UPSTREAM SLOPES OF EMBANKMENTS WERE MEASURED AT BETWEEN 1.8 H:1V AND 1.9 H:1V ON AUGUST 26, 2014, SHOWN AS 2H:1V.
2. BEACH LIMITS APPROXIMATE.

REFERENCES

1. COORDINATE SYSTEM BASED ON MINE GRID.

ULTIMATE EMBANKMENT TOE

PORTAL SUMP

UNDERGROUND WORKINGS

UNDERGROUND WORKINGS

UNDERGROUND WORKINGS

EAST EMBANKMENT CREST EL. 354.1m TILL

NORTH EMBANKMENT CREST EL. 354.9m TO 355.9m

99400 E

POND EL. 351.4m

2-NORTH PIT TAILINGS DISPOSAL FACILITY

SHOP

SOUTH EMBANKMENT CREST EL. 354.1m TILL

Pond EL. DRY AUG 26, 2014

Ditch

SEEPAGE COLLECTION POND

STORAGE YARD

TAILINGS BEACH
EL. 351.4m TO 353.1m
(OCT 10, 2015)

EXISTING EMBANKMENT TOE

RAW COAL STOCKPILE AREA

STACKER

TO 7 SOUTH

WEST EMBANKMENT CREST EL. 355.0m (TILL)

99200 E

STORAGE YARD

SHOP

TREE LINE

103200 N

103000 N

102800 N

102600 N

0 20 40 60 80 100

SCALE: 1:2000

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
0	30MAR16	BEW	ISSUED FOR FINAL	JD	ET	BEW
A	07JAN16	BEW	ISSUED FOR REVIEW	JD		

PROJECT

HILLSBOROUGH RESOURCES LIMITED
2-NORTH PIT TAILINGS DISPOSAL FACILITY
CAMPBELL RIVER, BC.

TITLE

SITE PLAN SHOWING UNDERGROUND WORKINGS

Golder Associates

PROJECT No.		1528261	PHASE	1000	TASK –
DESIGN	BEW	05JAN16	FILE No.	1528261-1000_07	
CADD	JD	05JAN16	SCALE	AS SHOWN	REV. 0
CHECK	ET	30MAR16			
REVIEW	BEW	30MAR16			

FIGURE 7

Y:\burnaby\CAD-GIS\Client\quinsam coal corporation\quinsam coal mine\99_projects\1528261\02_PRODUCTION\1000\DWG\ Drawing file: 1528261-1000_07.dwg Mar 30, 2016 - 9:40am

APPENDIX A

Dam Safety Inspection Photographs

APPENDIX A
Photographs

Photograph 1: North Embankment Crest, Looking West, May 26, 2015.

Photograph 2: North Embankment Upstream Slope, Looking West, May 26, 2015.

Photograph 3: North Embankment Downstream Slope, Looking Southeast, May 26, 2015.

Photograph 4: North Embankment Downstream Slope and Toe Area, Looking North, May 26, 2015.

Photograph 5: North Embankment Downstream Toe Area, Looking South, May 26, 2015.

Photograph 6a (left): North Embankment Abutment Seep, Looking Southwest, and 6b (right) Weir, Looking East, May 26, 2015.

Photograph 7: North Embankment West Abutment, Looking Southwest, May 26, 2015.

Photograph 8: North Embankment East Abutment, Looking Southeast, May 26, 2015.

Photograph 9: East Embankment Crest, Looking South, May 26, 2015.

Photograph 10: East Embankment Upstream Slope, Looking North from South Embankment, May 26, 2015.

Photograph 11: East Embankment Upstream Slope with Freeboard Gage, Looking South, May 26, 2015.

Photograph 12: East Embankment Downstream Slope, Looking North, May 26, 2015.

Photograph 13: East Embankment Downstream Slope, Looking South, May 26, 2015.

Photograph 14: East Embankment Downstream Toe Area, Looking Southeast, May 26, 2015

Photograph 15: South Embankment Crest, Looking West, May 26, 2015.

Photograph 16: South Embankment Upstream Slope, Looking West, May 26, 2015.

Photograph 17: South Embankment Downstream Slope and Toe Area, Looking East, May 26, 2015.

Photograph 18: South Embankment Downstream Slope, Looking West, May 26, 2015.

Photograph 19a (left): South Embankment Drainage Ditch Along Downstream Toe, Looking West, and 19b (right): Looking Northwest, May 26, 2015.

Photograph 20: Pond at South Embankment Downstream Toe, Looking South, May 26, 2015.

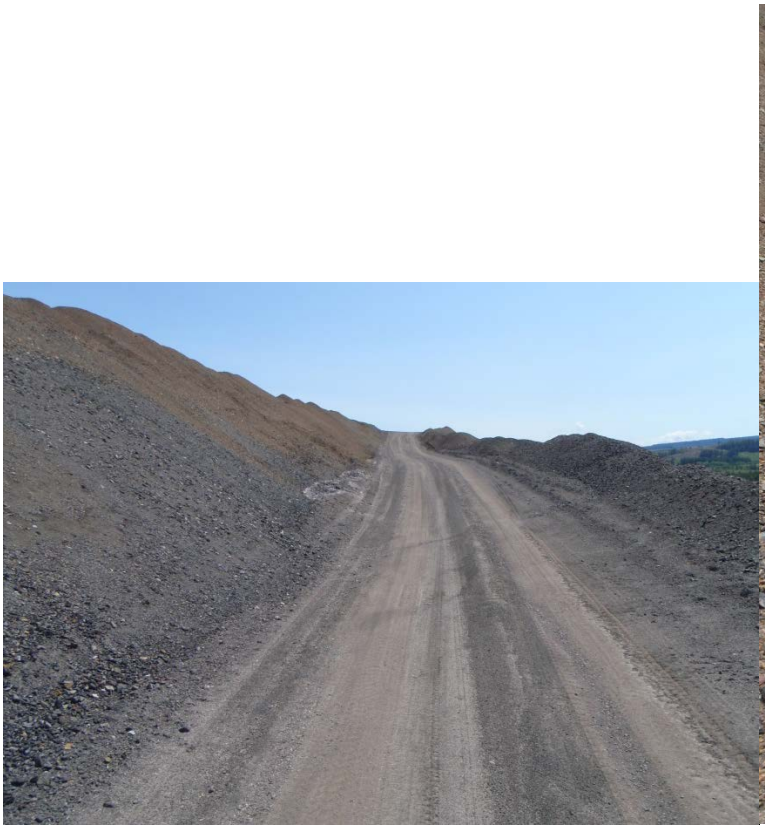
Photograph 21: South Embankment Downstream Slope and East Abutment, Looking East, May 26, 2015.

Photograph 22: West Embankment South Crest, Looking South May 26, 2015.

Photograph 23: West Embankment Downstream Slope with Wash Plant Pipeline, Looking Southeast, May 26, 2015.

Photograph 24: West Embankment Upstream Slope and Wash Plant Pipeline Discharge, Looking South, May 26, 2015.

Photograph 25: West Embankment Upstream Slope, Looking North, May 26, 2015.



Photograph 26a (left): West Embankment Access Ramp, Looking South, and 26b (left) Seep and Soft Ground, Looking South, May 26, 2015.

Photograph 27: West Embankment Downstream Slope and Toe, Looking South, May 26, 2015.

Photograph 28: Interior Berm and Tailings Area, Looking Southeast, May 26, 2015.

Photograph 29: Tailings on North Side of Interior Berm, Looking Northeast, May 26, 2015.

Photograph 30: Tailings Beach North Side of Interior Berm, Looking East, May 26, 2015.

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APPENDIX B

Records of Dam Safety Inspections

Client:	Hillsborough Resources Limited	**By:**	Ben Wickland and Erin Thomas
Project:	Quinsam Mine	**Date:**	May 26, 2015
Location:	Campbell River, BC	**Reviewed:**	Ben Wickland

GENERAL INFORMATION

Dam Name: North Embankment, 2-North Pit Tailings Disposal Facility
Dam Type: Earthfill

Weather Conditions:	Mainly sunny	**Temp:**	21°C

INSPECTION ITEM	OBSERVATIONS/ DATA	PHOTO	COMMENTS AND OTHER DATA
1. DAM CREST		*1*	*Tailings pond is against the upstream face of the dam.*
1.1 Crest elevation	*~356 m*		
1.2 Reservoir Level			
Freeboard	*~3.5 m*		*Some rutting observed.*
1.3 Distance To Tailings Pond	*At dam*		
(if applicable)			*Inactive pipeline along the upstream and downstream edge of the crest.*
1.4 Surface Cracking	*Not observed*		
1.5 Unexpected Settlement	*No*		
1.6 Lateral Movement	*Not observed*		
1.7 Other Unusual Conditions	*Yes*		
2. UPSTREAM SLOPE		*2*	
2.1 Slope angle	*~1.4H:1V*		
2.2 Signs of Erosion	*Yes*		*Minor erosion near water line.*
2.3 Signs of Movement	*Not observed*		
(Deformation)			*No exposed geotextile observed.*
2.4 Cracks	*Not observed*		*High sulphide content waste has been*
2.5 Face liner condition	*Not observed*		*dumped and dozed into the northwest*
(if applicable)			*corner of the facility as an upstream*
2.5 Other Unusual Conditions	*Yes*		*extension of the north embankment.*
			The waste is level with the north embankment crest;
			Armouring of coarse coal rejects visible near waterline..

INSPECTION ITEM	OBSERVATIONS/ DATA	PHOTO	COMMENTS AND OTHER DATA
3. DOWNSTREAM SLOPE		*3,4,5,6*	*Deer tracks visible;*
3.1 Slope angle	*~2H:1V*		*Underground tailings discharge*
3.2 Signs of Erosion	*Minor ravelling*		*pipeline removed. Pipeline notch in*
3.3 Signs of Movement (Deformation)	*Not observed*		*embankment still exists; Vibrating wire piezometer cable is*
3.4 Cracks	*Yes - minor*		*exposed on dam face;*
3.5 Seepage or Wet Areas	*Yes*		*Horsetail and broom on the lower*
3.6 Vegetation Growth	*Yes*		*slope above rock foundation; Steeper portion on the northwest*
3.7 Other Unusual Conditions	*No*		*corner; Road surfacing material on bench; Dry iron staining at northwest corner.*
4. DOWNSTREAM TOE AREA		*5,6,7,8*	
4.1 Seepage from Dam	*Yes*		*Clear seepage from northwest corner.*
4.2 Signs of Erosion	*Not observed*		*Three points of discharge from*
4.2 Signs of Turbidity in Seepage Water	*Not observed*		*bedrock with no signs of flow from granular embankment. Measured flow*
4.5 Discoloration/staining	*Yes*		*installed at northwest at weir is 0.62*
4.6 Other Unusual Conditions	*Not observed*		*L/s. Visually estimated 0.5 L/s. Algae in downstream toe area on rocks and weir. Salt/iron staining at northwest corner.*
5. ABUTMENTS		*6,7,8*	
5.1 Seepage at contact zone (abutment/embankment)	*Yes*		
5.2 Signs of Erosion	*No*		
5.3 Excessive Vegetation	*Yes*		*Trees, horsetails, broom and other*
5.4 Presence of Rodent Burrows	*Not observed*		*vegetation at west abutment.*
5.5 Other Unusual Conditions	*Not observed*		

INSPECTION ITEM	OBSERVATIONS/ DATA	PHOTO	COMMENTS AND OTHER DATA
6. RESERVOIR 6.1 Stability of Slopes 6.2 Distance to Nearest Slide (if applicable) 6.3 Estimate of Slide Volume (if applicable) 6.4 Floating debris 6.5 Other Unusual Conditions	*No signs of instability* *Not applicable* *Not applicable* *Not observed* *Not observed*	*2*	*Minor erosion and armouring near water line.*
7. EMERGENCY SPILLWAY/ OUTLET STRUCTURE 7.1 Surface Condition 7.2 Signs of Erosion 7.3 Signs of Movement (Deformation) 7.4 Cracks 7.5 Settlement 7.6 Presence of Debris or Blockage 7.7 Closure mechanism operational 7.8 Slope Protection 7.9 Instability of Side Slopes 7.10 Other Unusual Conditions	*Not applicable*		
8. INSTRUMENTATION 8.1 Piezometers 8.2 Settlement Cells 8.3 Thermistors 8.4 Settlement Monuments 8.5 Accelerograph 8.6 Inclinometer 8.7 Weirs and Flow Monitors 8.8 Data logger(s) 8.9 Other	*Yes* *None* *None* *None* *None* *None* *V-notch Weir* *None* *None*	*6*	*Vibrating wire piezometer cable 16734 exposed on downstream dam face. Flowing water audible at well casing.* *Weir at downstream toe*

INSPECTION ITEM	OBSERVATIONS/ DATA	PHOTO	COMMENTS AND OTHER DATA
9. DOCUMENTATION		*None*	
9.1 Operation, Maintenance and Surveillance (OMS) Plan	*Yes*		*Combined OMS Manual and EPP.*
9.1.1 OMS Plan exists	*Yes*		
9.1.2 OMS Plan reflects current dam conditions	*Not reviewed*		
9.1.3 Date of last revision	*April 1, 2016*		
9.2 Emergency Preparedness Plan (EPP)	*Yes*		
9.2.1 EPP exists	*Yes*		
9.2.2 EPP reflects current conditions	*Not reviewed*		
9.2.3 Date of last revision	*April 1, 2016*		

10. NOTES			
Inspector's Signature		**Date:**	

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Client:	Hillsborough Resources Limited	**By:**	Ben Wickland and Erin Thomas
Project:	Quinsam Mine	**Date:**	May 26, 2015
Location:	Campbell River, BC	**Reviewed:**	Ben Wickland

GENERAL INFORMATION

Dam Name: East Embankment, 2-North Pit Tailings Disposal Facility
Dam Type: Earthfill

Weather Conditions:	Mainly sunny	**Temp:**	21°C

INSPECTION ITEM	OBSERVATIONS/DATA	PHOTO	COMMENTS AND OTHER DATA
1. DAM CREST		*9*	
1.1 Crest elevation	*~354.1 to 355.0*		
1.2 Reservoir Level Freeboard	*~2.4 m*		
1.3 Distance To Tailings Pond (if applicable)	*At dam*		*Pond against the upstream slope.*
1.4 Surface Cracking	*Yes*		*Minor surface cracking in till.*
1.5 Unexpected Settlement	*No*		*Minor rutting observed in coarse coal rejects.*
1.6 Lateral Movement	*Not observed*		
1.7 Other Unusual Conditions	*Yes*		*At the time of inspection, organics embedded in the till along a 10 m section were being removed and the till was re-compacted with the excavator bucket.*
2. UPSTREAM SLOPE		*10,11*	
2.1 Slope angle	*1.5 to 2H:1V*		
2.2 Signs of Erosion	*Yes*		*Minor erosion near water line.*
2.3 Signs of Movement (Deformation)	*Not observed*		
2.4 Cracks	*Not observed*		
2.5 Face liner condition (if applicable)	*Not applicable*		
2.5 Other Unusual Conditions	*Yes*		*More vegetation (broom and brush) visible along upstream slope.*

INSPECTION ITEM	OBSERVATIONS/DATA	PHOTO	COMMENTS AND OTHER DATA
3. DOWNSTREAM SLOPE		*12,13*	
3.1 Slope angle	*Angle of repose*		
3.2 Signs of Erosion	*Not observed*		
3.3 Signs of Movement (Deformation)	*Not observed*		
3.4 Cracks	*Not observed*		
3.5 Seepage or Wet Areas	*Not observed*		*Deer track running parallel to and ~1.5 m above the toe of the embankment at the south end.*
3.6 Vegetation Growth	*Not observed*		
3.7 Other Unusual Conditions	*No*		
4. DOWNSTREAM TOE AREA		*14*	
4.1 Seepage from Dam	*Not observed*		
4.2 Signs of Erosion	*Not observed*		*No ponding observed along the northeastern portion of toe as described in the previous dam inspection. Appears coarse coal rejects placed in this area.*
4.2 Signs of Turbidity in Seepage Water	*Not observed*		
4.5 Discoloration/staining	*Not observed*		
4.6 Other Unusual Conditions	*Not observed*		
5. ABUTMENTS	*Not applicable*		
5.1 Seepage at contact zone (abutment/embankment)			
5.2 Signs of Erosion			
5.3 Excessive Vegetation			
5.4 Presence of Rodent Burrows			
5.5 Other Unusual Conditions			
6. RESERVOIR			
6.1 Stability of Slopes	*Not applicable*		
6.2 Distance to Nearest Slide (if applicable)	*Not applicable*		
6.3 Estimate of Slide Volume (if applicable)	*Not applicable*		
6.4 Floating debris	*Not observed*		
6.5 Other Unusual Conditions	*Not observed*		
7. EMERGENCY SPILLWAY/ OUTLET STRUCTURE	*Not applicable*		
7.1 Surface Condition			
7.2 Signs of Erosion			

INSPECTION ITEM	OBSERVATIONS/DATA	PHOTO	COMMENTS AND OTHER DATA
7.3 Signs of Movement (Deformation) 7.4 Cracks 7.5 Settlement 7.6 Presence of Debris or Blockage 7.7 Closure mechanism operational 7.8 Slope Protection 7.9 Instability of Side Slopes 7.10 Other Unusual Conditions			
8. INSTRUMENTATION 8.1 Piezometers 8.2 Settlement Cells 8.3 Thermistors 8.4 Settlement Monuments 8.5 Accelerograph 8.6 Inclinometer 8.7 Weirs and Flow Monitors 8.8 Data logger(s) 8.9 Other	*Freeboard meter*	*11*	*Freeboard meter installed in the upstream slope at the north end of embankment.*
9. DOCUMENTATION 9.1 Operation, Maintenance and Surveillance (OMS) Plan 9.1.1 OMS Plan exists 9.1.2 OMS Plan reflects current dam conditions 9.1.3 Date of last revision 9.2 Emergency Preparedness Plan (EPP) 9.2.1 EPP exists 9.2.2 EPP reflects current conditions 9.2.3 Date of last revision	 *Yes* *Yes* *Not reviewed* *April 1, 2016* *Yes* *Yes* *Not reviewed* *April 1, 2016*		*Combined OMS Manual and EPP.*

10. NOTES			
Inspector's Signature		**Date:**	

o:\final\2015\3 proj\1528261 hillsboro_2015consultsrvcs_quinsam\1528261-003-r-rev0-1000\appendices\appendix b - dsi record\b2 - east embankment record of dam inspection - 12mar_16.docx

Client:	Hillsborough Resources Limited	**By:**	Ben Wickland and Erin Thomas
Project:	Quinsam Mine	**Date:**	May 26, 2015
Location:	Campbell River, BC	**Reviewed:**	Ben Wickland

GENERAL INFORMATION

Dam Name: South Embankment, 2-North Pit Tailings Disposal Facility
Dam Type: Earthfill

Weather Conditions:	Mainly sunny	**Temp:**	21°C

INSPECTION ITEM	OBSERVATIONS/ DATA	PHOTO	COMMENTS AND OTHER DATA
1. DAM CREST		*15,16*	
1.1 Crest elevation	*~354.1 m*		
1.2 Reservoir Level Freeboard	*~3 m*		
1.3 Distance To Tailings Pond (if applicable)	*At dam*		*Tailings pond is against the upstream face of the dam.*
1.4 Surface Cracking	*Not observed*		
1.5 Unexpected Settlement	*No*		*Minor rutting observed.*
1.6 Lateral Movement	*Not observed*		
1.7 Other Unusual Conditions	*Not observed*		*Vegetation growth on till surface in two 10 m sections at the west and east end of the embankment.*
2. UPSTREAM SLOPE		*16*	
2.1 Slope angle	*2H:1V*		
2.2 Signs of Erosion	*Yes*		*Minor raveling.*
2.3 Signs of Movement (Deformation)	*Not observed*		*More vegetation (broom and brush) visible along inside face. Plan in progress to exterminate and control vegetation growth;*
2.4 Cracks	*Not observed*		
2.5 Face liner condition (if applicable)	*Not applicable*		*Waterline and CCR armouring visible ~1 m above pond.*
2.5 Other Unusual Conditions	*Yes*		

INSPECTION ITEM	OBSERVATIONS/ DATA	PHOTO	COMMENTS AND OTHER DATA
3. DOWNSTREAM SLOPE		*17,18,21*	
3.1 Slope angle	*2H:1V*		
3.2 Signs of Erosion	*Yes*		*Minor ravelling.*
3.3 Signs of Movement (Deformation)	*Not observed*		
3.4 Cracks	*Not observed*		
3.5 Seepage or Wet Areas	*Yes*		
3.6 Vegetation Growth	*Not observed*		
3.7 Other Unusual Conditions	*Yes*		*Dry, salt stains near access road ~ 2 m above the toe.*
4. DOWNSTREAM TOE AREA		*17, 19, 20*	
4.1 Seepage from Dam	*Yes*		*Damp area in drainage ditch at toe. Drainage ditch appears wider. No signs of flow..*
4.2 Signs of Erosion	*Not observed*		
4.2 Signs of Turbidity in Seepage Water	*Not observed*		
4.5 Discoloration/staining	*Yes*		*Salt staining along drainage ditch at toe.*
4.7 Other Unusual Conditions	*Yes*		*Vegetation growth at toe; Pond at east side at downstream toe. Water is stagnant and murky with no signs of flow.*
5. ABUTMENTS		*21*	
5.1 Seepage at contact zone (abutment/embankment)	*Yes*		*West highwall has two dark coloured/white stained areas indicating seepage exit points.*
5.2 Signs of Erosion	*Yes*		
5.3 Excessive Vegetation	*Not observed*		
5.4 Presence of Rodent Burrows	*Not observed*		
5.5 Other Unusual Conditions	*Not observed*		*Minor rockfall from abutment.*
6. RESERVOIR			
6.1 Stability of Slopes	*Not applicable*		
6.2 Distance to Nearest Slide (if applicable)	*Not applicable*		

INSPECTION ITEM	OBSERVATIONS/ DATA	PHOTO	COMMENTS AND OTHER DATA
6.3 Estimate of Slide Volume (if applicable)	*Not applicable*		
6.4 Floating debris	*Not observed*		
6.5 Other Unusual Conditions	*Not observed*		
7. EMERGENCY SPILLWAY/ OUTLET STRUCTURE	*Not applicable*		
7.1 Surface Condition			
7.2 Signs of Erosion			
7.3 Signs of Movement (Deformation)			
7.4 Cracks			
7.5 Settlement			
7.6 Presence of Debris or Blockage			
7.7 Closure mechanism operational			
7.8 Slope Protection			
7.9 Instability of Side Slopes			
7.10 Other Unusual Conditions			
8. INSTRUMENTATION	*None*		
8.1 Piezometers			
8.2 Settlement Cells			
8.3 Thermistors			
8.4 Settlement Monuments			
8.5 Accelerograph			
8.6 Inclinometer			
8.7 Weirs and Flow Monitors			
8.8 Data logger(s)			
8.9 Other			
9. DOCUMENTATION			*Combined OMS Manual and EPP.*
9.1 Operation, Maintenance and Surveillance (OMS) Plan	*Yes*		
9.1.1 OMS Plan exists	*Yes*		
9.1.2 OMS Plan reflects current dam conditions	*Not reviewed*		
9.1.3 Date of last revision	*April 1, 2016*		

INSPECTION ITEM	OBSERVATIONS/ DATA	PHOTO	COMMENTS AND OTHER DATA
9.2 Emergency Preparedness Plan (EPP)	*Yes*		
9.2.1 EPP exists	*Yes*		
9.2.2 EPP reflects current conditions	*Not reviewed*		
9.2.3 Date of last revision	*April 1, 2016*		

10. NOTES			
Inspector's Signature		**Date:**	

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Client:	Hillsborough Resources Limited	**By:**	Ben Wickland and Erin Thomas
Project:	Quinsam Mine	**Date:**	May 26, 2015
Location:	Campbell River, BC	**Reviewed:**	Ben Wickland

GENERAL INFORMATION

Dam Name: West Embankment, 2-North Pit Tailings Disposal Facility
Dam Type: Earthfill

Weather Conditions:	Mainly sunny	**Temp:**	21°C

INSPECTION ITEM	OBSERVATIONS/ DATA	PHOTO	COMMENTS AND OTHER DATA
1. DAM CREST		*22*	
1.1 Crest elevation	*~354.3 m*		*Downstream crest width surveyed and staked for re-sloping.*
1.2 Reservoir Level Freeboard	*~2.5 m*		*Tailings against most of embankment*
1.3 Distance To Tailings Pond (if applicable)	*Between 0 m (at dam) and ~100 m*		
1.4 Surface Cracking	*Yes*		*Minor*
1.5 Unexpected Settlement	*Yes*		*Some rutting observed.*
1.6 Lateral Movement	*Not observed*		
1.7 Other Unusual Conditions	*Yes*		*Underground tailings discharge pipeline visible on crest. Only water, no tailings observed during site inspection.*
2. UPSTREAM SLOPE		*24,25*	
2.1 Slope angle	*2H:1V or steeper*		
2.2 Signs of Erosion	*Yes*		*Minor raveling*
2.3 Signs of Movement (Deformation)	*Not observed*		
2.4 Cracks	*Not observed*		
2.5 Face liner condition (if applicable)	*Not applicable*		
2.6 Other Unusual Conditions	*Yes*		*Minor vegetation*

INSPECTION ITEM	OBSERVATIONS/ DATA	PHOTO	COMMENTS AND OTHER DATA
3. DOWNSTREAM SLOPE		*23,26,27*	
3.1 Slope angle	*2H:1V to angle of repose*		
3.2 Signs of Erosion	*Yes*		*Minor.*
3.3 Signs of Movement (Deformation)	*Not observed*		
3.4 Cracks	*Yes*		*Minor.*
3.5 Seepage or Wet Areas	*Yes*		*Soft, damp ground and salt staining at the base of the first bench along the access road.*
3.6 Vegetation Growth	*Yes*		*Shrubs and broom on slope near downstream toe.*
3.7 Other Unusual Conditions	*Yes*		*Tailings and water pipes on the northwest corner slope.* *Slope steeper 2H:1V over southwest end.*
4. DOWNSTREAM TOE AREA		*27*	
4.1 Seepage from Dam	*Not observed*		
4.2 Signs of Erosion	*Not observed*		
4.2 Signs of Turbidity in Seepage Water	*Not observed*		
4.5 Discoloration/staining	*Not observed*		
4.6 Other Unusual Conditions	*Yes*		*Vegetation growth along toe- Shrubs and broom.* *Area downstream of west embankment has been deforested.*
5. ABUTMENTS	*Not applicable*		
5.1 Seepage at contact zone (abutment/embankment)			
5.2 Signs of Erosion			
5.3 Excessive Vegetation			
5.4 Presence of Rodent Burrows			
5.5 Other Unusual Conditions			

INSPECTION ITEM	OBSERVATIONS/ DATA	PHOTO	COMMENTS AND OTHER DATA
6. RESERVOIR		*28,29,30*	
6.1 Stability of Slopes	*Not applicable*		
6.2 Distance to Nearest Slide (if applicable)	*Not applicable*		
6.3 Estimate of Slide Volume (if applicable)	*Not applicable*		
6.4 Floating debris	*None*		
6.5 Other Unusual Conditions	*Yes*		*Berm of tailings about 1.5 to 2 m high, about 5 m wide, and about 100 m length that extends from the middle of the West Embankment towards the centre of the facility.*
7. EMERGENCY SPILLWAY/ OUTLET STRUCTURE	*Not applicable*		
7.1 Surface Condition			
7.2 Signs of Erosion			
7.3 Signs of Movement (Deformation)			
7.4 Cracks			
7.5 Settlement			
7.6 Presence of Debris or Blockage			
7.7 Closure mechanism operational			
7.8 Slope Protection			
7.9 Instability of Side Slopes			
7.10 Other Unusual Conditions			
8. INSTRUMENTATION	*None*		
8.1 Piezometers			
8.2 Settlement Cells			
8.3 Thermistors			
8.4 Settlement Monuments			
8.5 Accelerograph			
8.6 Inclinometer			
8.7 Weirs and Flow Monitors			
8.8 Data logger(s)			
8.9 Other			

INSPECTION ITEM	OBSERVATIONS/ DATA	PHOTO	COMMENTS AND OTHER DATA
9. DOCUMENTATION			*Combined OMS Manual and EPP.*
9.1 Operation, Maintenance and Surveillance (OMS) Plan	*Yes*		
9.1.1 OMS Plan exists	*Yes*		
9.1.2 OMS Plan reflects current dam conditions	*Not reviewed*		
9.1.3 Date of last revision	*April 1, 2016*		
9.2 Emergency Preparedness Plan (EPP)	*Yes*		
9.2.1 EPP exists	*Yes*		
9.2.2 EPP reflects current conditions	*Not Reviewed*		
9.2.3 Date of last revision	*April 1, 2016*		

10. NOTES			
Till notch for wash plant water pump back pipeline crossing should be raised.			
Inspector's Signature		**Date:**	

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APPENDIX C

Instrumentation Data

Figure C-1
Piezometric Head Versus Time

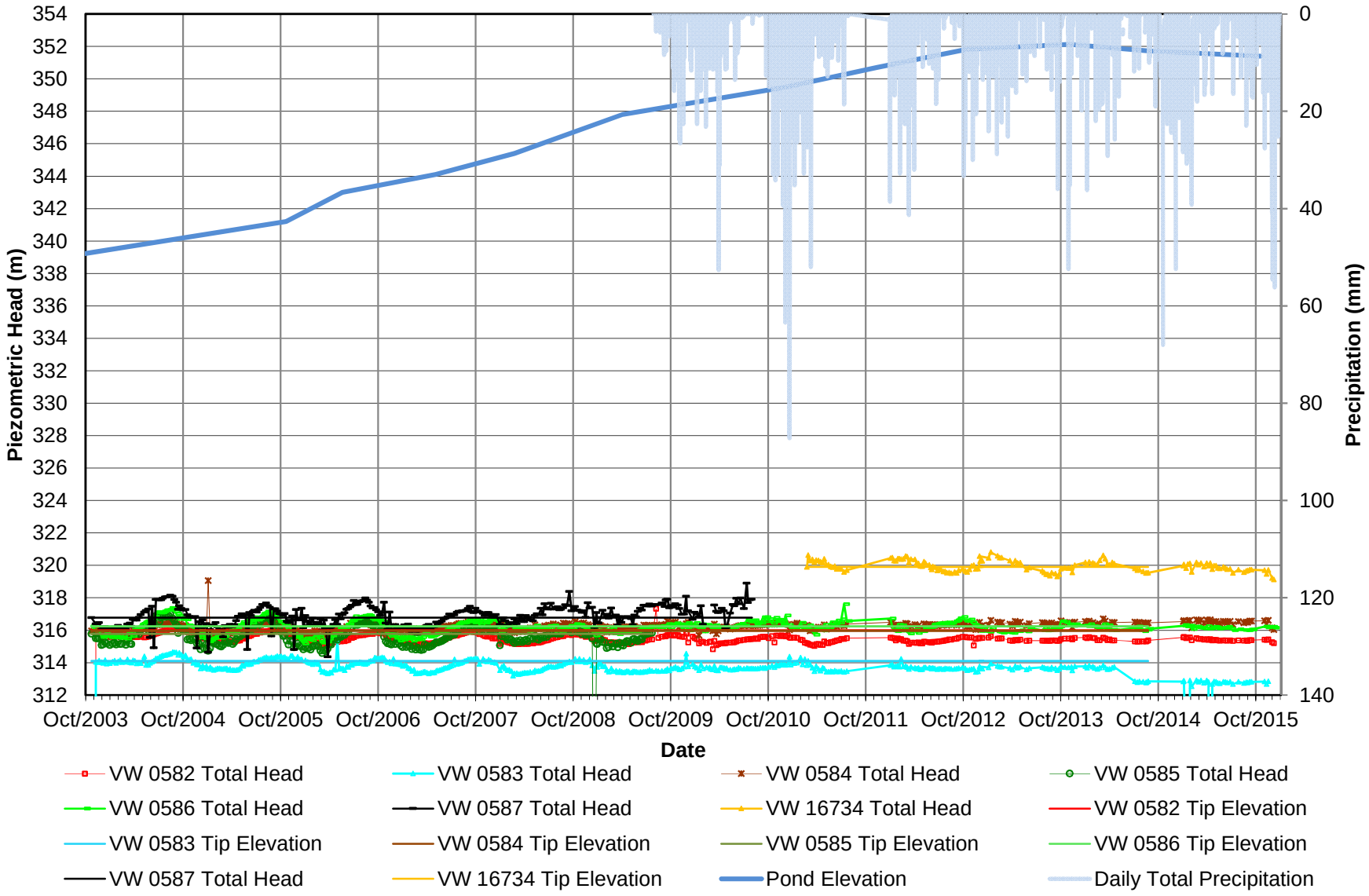


Figure C-2
Thermistor Temperatures Versus Time

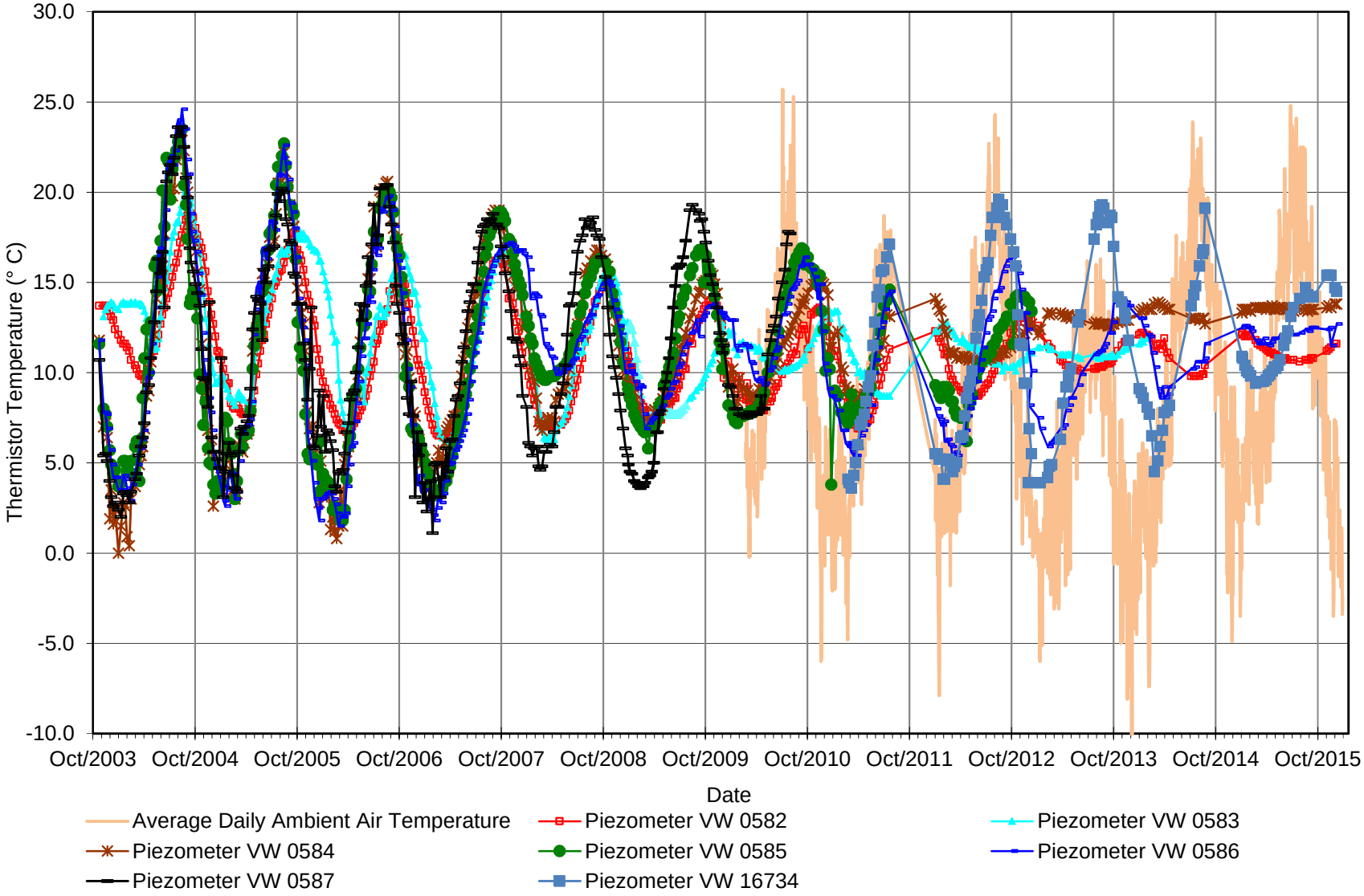
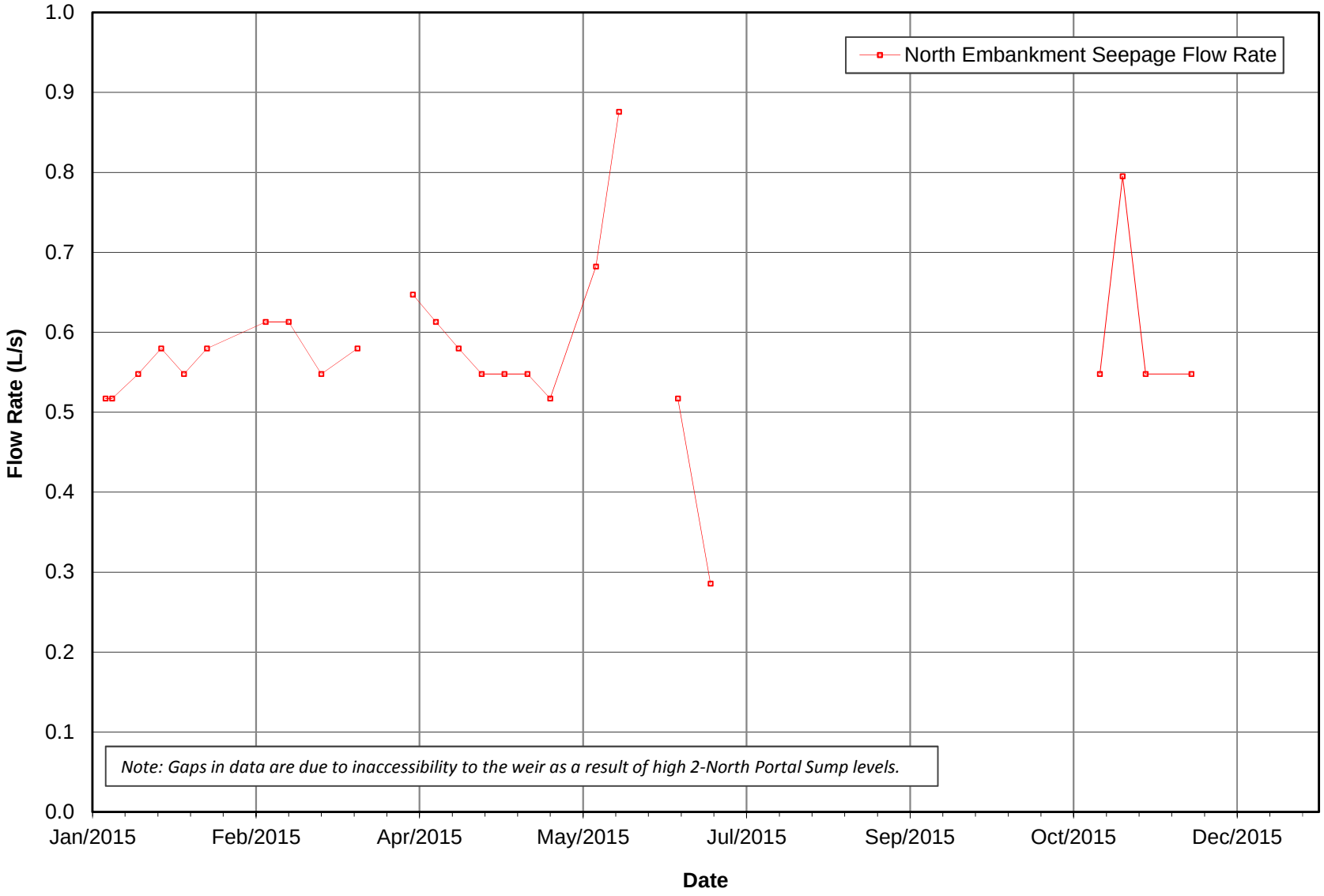


Figure C-3
North Embankment Seepage Flow Rate



APPENDIX D

Construction Quality Control Testing Records

McElhanney
1307 Shoppers Row, Campbell River, BC, V9W 2C9
ph: (250) 287-7799 fax: (250) 287-7662

Report of:

In Place Density Tests

ASTM Ref: D2922 D3017 D4718

Client:	**Quinsam Coal Corporation**	**Report No.:**	2	**Proctor No.:**	1
		Project:	Misc. Materials Testing, 2015	**Max. Dry Density:**	2027 **kg/m^3**
		Project No.:	2221-48951-08	**Optimum Moist.:**	10.7 **%**
		Test Date:	30-Jun-15	**Gauge Type:**	Instrotek
		Tech.:	CW	**Req'd Compaction:**	95%
				ASTM:	D 698

TEST NO.	LOCATION: Tailings Pond	ELEV.	PROBE DEPTH (mm)	WET DENSITY (kg/m3)	MOIST. (%)	OVER-SIZE (%)	CORR. PROCT (kg/m3)	DRY DENSITY (kg/m3)	% PROCT.	REMARKS
1	99279.6 E 102633.5 N	354.8m	200	2291	7.6%	28%	2214	2129	96.2%	
2	99200.9 E 102749.4 N	355.1m	200	2311	7.8%	28%	2214	2144	96.8%	
3	99203.2 E 102835.1 N	355.2m	200	2285	6.3%	28%	2214	2150	97.1%	
4	99196.0 E 102800.1 N	355.2m	200	2322	7.9%	28%	2214	2152	97.2%	
5	99205.2 E 102706.2 N	355.2m	200	2420	6.5%	28%	2214	2272	102.6%	
6	99229.3 E 102644.3 N	355.2m	200	2373	8.2%	28%	2214	2193	99.1%	

Reviewed By:
Alex Bates, Gradtech

McElhanney
1307 Shoppers Row, Campbell River, BC, V9W 2C9
ph: (250) 287-7799 fax: (250) 287-7662

Report of:

In Place Density Tests

ASTM Ref: D2922 D3017 D4718

Client:	**Quinsam Coal Corporation**	**Report No.:**	3	**Proctor No.:**	1
		Project:	Misc. Materials Testing, 2015	**Max. Dry Density:**	2027 **kg/m^3**
		Project No.:	2221-48951-08	**Optimum Moist.:**	10.7 **%**
		Test Date:	24-Sep-15	**Gauge Type:**	Instrotek
		Tech.:	CW	**Req'd Compaction:**	95%
				ASTM:	D 698

TEST NO.	LOCATION: Tailings Pond	ELEV.	PROBE DEPTH (mm)	WET DENSITY (kg/m3)	MOIST. (%)	OVER-SIZE (%)	CORR. PROCT (kg/m3)	DRY DENSITY (kg/m3)	% PROCT.	REMARKS
1	10U 0322320 5533519	363m	300	2389	12.9%	28%	2214	2116	95.6%	
2	10U 0322271 5533562	363m	300	2368	12.4%	28%	2214	2107	95.2%	
3	10U 0322233 5533644	362m	300	2381	11.5%	28%	2214	2135	96.5%	
4	10U 0322203 5533691	361m	300	2424	10.7%	28%	2214	2190	98.9%	
5	10U 0322166 5533742	359m	300	2394	10.5%	28%	2214	2167	97.9%	
6	10U 0322141 5533799	359m	300	2418	13.5%	28%	2214	2130	96.2%	

Reviewed By:
Alex Bates, Gradtech

APPENDIX E

West Embankment Re-Sloping

Photograph 1: Removing Vegetation From The Downstream Slope Of The West Embankment, Looking North August 17, 2015.

Photograph 2: Vegetation Removal, Looking South, August 17, 2015.

Photograph 3: Re-sloping At Downstream Crest, Looking South, August 17 2015.

Photograph 4: Placement Coarse Coal Rejects To Widen The Downstream Toe, Looking West, August 18, 2015.

Photograph 5: Placing Coarse Coal Rejects, Looking North, September 2, 2015.

Photograph 6: Widening The Downstream Slope, Looking South September 8, 2015.

Photograph 7: Downstream Face After Re-sloping, Looking Northwest, September 11, 2015.

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