

November 24, 2014

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ISSUED FOR USE  
FILE: V15103102-01  
via Email: gbg@hillsboroughresources.com

**Attention:** Mr. Gary Gould  
Vice President

**Subject:** Review of the 2014 Annual Dam Safety Inspection Report, 2-North Pit Tailings Disposal Facility, Quinsam Coal Mine

## 1.0 INTRODUCTION

Quinsam Coal Corporation (Quinsam) retained Tetra Tech EBA Inc. (Tetra Tech EBA) to undertake this review of the 2014 Annual Dam Safety Inspection Report, 2-North Pit Tailings Disposal Facility, Quinsam Coal Mine. The review was undertaken to meet the requirements of the orders issued by the Chief Inspector of Mines of British Columbia on August 18, 2014. The orders include a requirement for Third Party Review of a Dam Safety Inspection (DSI) report and the dam consequence classification. The review is to be undertaken by an “independent qualified third party professional engineer from a firm that has not been associated with the tailings dam.”

The intent of the review is to look for gaps in the DSI and assess whether the recommendations in the report are consistent with current engineering practice.

The Quinsam Mine is situated approximately 15 km west of Campbell River, BC.

## 2.0 SCOPE

The scope involved a ‘desk top’ review of a DSI report prepared by others (Golder Associates). The scope includes review of the dam consequence classification undertaken as part of the DSI.

Specifically, the DSI was assessed in comparison to the requirements of the 2013 BC Ministry of Energy and Mines (MEM) guidelines and the 2007 Dam Safety Guidelines of the Canadian Dam Association (CDA).

The scope did not include a site visit nor engineering assessments of geotechnical stability, hydrology or hydraulics.

## 3.0 INFORMATION PROVIDED

The following document was provided by Quinsam for the review:

- *2014 Annual Dam Safety Inspection Report, 2-North Pit Tailings Disposal Facility, Quinsam Coal Mine.* Report prepared for Hillsborough Resources Limited by Golder Associates Ltd. October 29, 2014. Report ID: 1411846-004-R-Rev0-3000.

## 4.0 DOCUMENT REVIEW

Table 1 provides a summary of the Quinsam Tailings Storage Facility 2014 Annual DSI report content in relation to the requirements of the 2013 BC MEM Guidelines for Annual Dam Safety Inspection Reports. The DSI report compliance with CDA guidelines is addressed in the text of this section of the letter report.

**Table 1: Summary of Report Compliance with 2013 BC Guidelines for Annual DSI Reports**

No	Item	Compliance (Yes/No/Partial)	Comment
1a	Dam Classification (CDA, 2007)	Yes	
1b	Instrumentation/Visual monitoring changes	Yes	
1c	Dam stability and/or surface water control changes	Yes	Referenced 2002 stability analysis. Used 1:475 as design event for Very High consequence dam, so revised assessment was recommended.
1d	OMS manual latest revision date	Yes	Not reviewed by Tetra Tech EBA
1e	EPP manual latest revision date	Yes	Not reviewed by Tetra Tech EBA
1f	Date for next DSR	Yes	DSI did not include recommendations from 2013 DSR
2	Recent construction	Yes	Description and topographic survey available, but no QA/AC monitoring data available.
3	Plan and cross sections	Yes	
4	Photographs	Yes	
5	Climate data review	Yes	
6	Water balance review	Yes	
7	Freeboard and storage availability	Yes	
8	Water discharge system	Yes	
9	Seepage occurrence and water quality	Partial	Seepage observed and discussed, but no discussion of water quality provided.
10	Surface water control and surface erosion	Yes	
11a	Instrumentation review - piezometers	Yes	Measurements were within design limits
11b	Instrumentation review - settlement	Yes	No Instruments, but item discussed
11c	Instrumentation review - lateral movement	Yes	No Instruments, but item discussed

### 4.1 Tailings Storage Facility Description

The following description of the tailings storage facility (TSF) was obtained from the Quinsam 2014 Annual DSI report.

The 2-North Pit Tailings Disposal Facility was originally constructed in 1994 within and around an open pit. Tailings are contained within four embankments at the facility: the North Embankment, the East Embankment, the South Embankment, and the West Embankment. The open pit was mined from 1986 and subsequently an underground extension was mined to the east that underlies the East Embankment of the facility. The embankments were raised in stages by downstream methods. The embankments were constructed by a complex combination of materials including:

- Cast blast, a mixture of blasted overburden rock and soil including oversize material.
- Coarse coal reject (CCR), a waste product of the coal washing process typically comprised of gravel size fragments of coal and waste rock.
- Glacial till, including gravel, sand, silt and clay size particles.

The East, South, and West Embankments include a low permeability, compacted till zone along the upstream batter and the North Embankment does not. The embankments are founded on a range of materials including intact bedrock, blasted and fractured rock, and transported mine waste. Toe filters and geotextile fabric have been incorporated into the North and South Embankments to mitigate piping of tailings fines through the embankment. In addition, geotextile fabric and CCR was placed in areas of observed subsidence cracks in the footprint of the East Embankment. The potential impact of the subsidence cracks on the tailings facility development and on underground mining was assessed by Golder in a separate report not provided for review. The underground workings adjacent to the eastern side of the facility are abandoned and were assessed by Golder to have caved in and that the potential for future settlement was considered to be limited. The potential for piping of tailings or embankment materials at subsidence cracks was not specifically addressed in the DSI.

A summary of the 2-North Pit Tailings Disposal Facility embankment dimensions is provided in Table 2. The embankments are approaching the ultimate design crest elevation.

**Table 2: Approximate 2-North Pit Tailings Disposal Facility Embankment Dimensions**

Embankment	Length (m)	Height (m)	Crest Width (m)
North	240	40	20 – 40
East	400	15	18 – 25
South	200	40	17 – 22
West	450	30	8 – 18

A small seepage collection pond that is approximately 10 m by 20 m is located downstream of the South Embankment. Seepage from the South Embankment was observed in 2002 and a toe filter on the embankment and the collection pond were constructed to mitigate risks associated with this seepage.

Tailings is deposited from a single discharge point at the West Embankment immediately south of a partially constructed tailings berm. The berm was proposed to divide the facility into two cells and extends approximately halfway across the middle of the facility but not completed.

Several pipelines are operated in the area of the tailings facility including: tailings slurry pipeline, a wash plant water pipeline that discharges from the West Embankment south of tailings pipeline, a seepage water return pipeline at the southeast corner of the facility, and an underground tailings deposition pipeline that splits off from the West Embankment discharge pipeline and runs down the North Embankment crest in an open trench.

There is no spillway at the TSF, and the catchment area for rainfall inflow is within the embankments that surround the full perimeter of the storage.

Approximately 11,500 tonnes of tailings were deposited in the TSF between January and August 2014, which was lower than previous years' deposition due to diversion of a portion of the tailings stream to underground backfill and also due to reduced coal production. It was estimated that there was a total of approximately 1,010,000 tonnes of tailings solids stored in the Quinsam TSF.

No information on tailings physical or chemical characteristics was provided in the inspection report. No water quality monitoring data or summary was included in the report.

## 4.2 Dam Status

The tailings storage facility is currently active. Quinsam conducts periodic surveillance and emergency response is possible based on the facility proximity to mining operations and the community of Campbell River.

The tailings beach slopes away from the deposition point midway along the West Embankment. The water pond covered most of the storage surface and was located against the North, East, and South Embankments at the time of the inspection.

## 4.3 CDA Dam Classification

The reported hazard classification of the tailings storage facility under the CDA Dam Safety Guidelines (2007) was broken down by embankment as follows:

- North Embankment: Very High consequence
- East Embankment: Low consequence
- South Embankment: High consequence
- West Embankment: High consequence

The reported population at risk of more than 10 but less than 100 persons downstream of the North Embankment supports the Very High consequence classification. The High consequence classification of the South and West Embankments is consistent with potential significant loss of important fish habitat. The classification for the perimeter embankments is to be reviewed following completion of a dam breach study.

## 4.4 Inspection Standard of Care

The described site inspection scope was adequate and included observations of the accessible crests and toes of the TSF. Weather conditions were suitable for inspection. Based on photographs, it appears that the toe of the East Embankment is not accessible by vehicle for ease of inspection and trees are growing in close proximity to the toe.

The seepage collection pond downstream of the South Embankment was dry at the time of the inspection.

Minor erosion of upstream till layer was noted and was assessed as not significant to embankment stability.

The report included a summary of potential dam failure modes and the assessed status:

- Piping — no adverse seepage observed and the filter compatibility of the tailings and embankment construction materials was assessed as adequate.
- Instability — summarised material properties and geometry used in design. Advised design embankment stability Factor of Safety was acceptable but noted that the seismic analysis needed to be updated to reflect latest CDA guideline and also that the current embankment geometry was steeper than design at some locations. Piezometer levels were noted to be within design tolerance and no visual evidence of embankment deformation was observed. Golder had previously determined that the abandoned underground workings did not adversely impact the East Embankment stability.

- Overtopping — the pond and perimeter embankment elevations were noted in relation to the maximum allowable pond levels. The minimum perimeter embankment crest elevation reported in the text is 351.9 m and on Figure 1 is 351.7 m. This difference is not significant, as both values indicate the minimum freeboard level was met as compared to the pond level measured on August 20, 2014. The embankments are surveyed annually and visually inspected weekly, but there are no instruments installed to measure settlement.

Survey data indicated the beach was approximately 1.7 m lower than the adjacent West Embankment, and there was 2 m of freeboard between the pond level and the low point of the perimeter embankments.

Geotechnical instrumentation at the facility is comprised of five vibrating wire piezometers installed in the North Embankment. Four of the five operating piezometers in the North Embankment measured zero (0) pressure, and the fifth piezometer measured 0.5 m of pressure head.

The design embankment stability assessment was not provided for review; however, it was noted that the design assessment needs to be updated to reflect the current CDA guidelines for seismic hazard assessment. For a 'very high' consequence rated facility, the stability assessment should incorporate a design earthquake motion associated with an Annual Exceedance Probability Earthquake of halfway between the 1:2,475 and the 1:10,000 year event.

Hydrotechnical considerations for a 'very high' consequence rated facility include that the facility be designed to store and/or safely pass an event with an annual exceedance probability of 2/3 between 1/1,000 year event and the Probable Maximum Flood. It was assessed that the minimum required 'operating freeboard', defined as crest elevation to pond elevation, was 1.25 m. This assessment incorporated an updated Inflow Design Flood (IDF) calculated by others (Lorax Environmental, 2010) and based on a determination that the freeboard remaining after this event would be adequate for wave run-up. These assessments and supporting information were not reviewed as part of the scope of this review; however, the IDF value of 310 mm rainfall over 24-hrs appears to be in the range of expected results for this area. It was unclear if the design freeboard included consideration of the volume occupied by the tailings beach and the internal tailings berm.

Weekly tailings storage facility inspection records prepared by Quinsam operations staff were reviewed as part of the DSI. The *Operation, Maintenance, and Surveillance (OMS) Manual for the 2-North Pit Tailings Disposal Facility and South Dam* was not provided for review, but the DSI indicates it was updated August 31, 2014. The DSI indicates that the Emergency Preparedness Plan is incorporated as a section within the OMS document.

Recent construction activities were described including embankment raising of select zones of the East Embankment and the West Embankment. It was noted that there were no earthwork monitoring records for this construction, and that the compacted till zone in the East Embankment contained unsuitable material (organics).

## 4.5 Review of Recommendations

The list of recommendations provided in the 2014 Annual Dam Safety Inspection are consistent with the gaps identified in the report and relevant guideline requirements.

Selected key recommendations in the report were:

- Flatten selected downstream slopes, remove plants on the embankments, and remove materials from the embankments not conforming to design specifications.
- Adopt quality control monitoring during construction.

- Relocate a pipeline away from the North Embankment to reduce risk associated with erosion in the event of pipeline failure.
- Undertake design assessments of the embankment stability and flood storage capacity in accordance with guideline requirements.
- Improve the monitoring program to include measurements of freeboard, seepage rate and quality, more frequent assessment of piezometer data, and staff training.

The following issues should be considered in conjunction with the recommendations included in the 2014 DSI:

- The 2014 DSI would benefit from the inclusion of the 2013 DSR recommendations.
- Review of available historical construction records should be undertaken to assess potential requirement to follow up with boreholes or other measures where as-built condition of embankments is unknown.
- The proposed flood storage capacity assessment should include consideration of the volume occupied by the tailings beach and the partially constructed internal tailings berm.
- The proposed stability assessment should include review of foundation conditions and consideration of the requirement for additional geotechnical instrumentation to assess settlement, deformation, foundation pore pressures, and embankment seepage zones. In addition, it should be confirmed that consideration of potential piping risks associated with cracked or gap graded foundation materials has been assessed.
- The planned update to the dam risk classification should be considered as a recommendation in the DSI report.
- Improved access to the East Embankment toe may be required to permit visual inspection in this area given historical observations of cracking and deformation.
- The minor erosion observed at the upstream areas of the West, South, and East Embankments should be monitored as part of the routine surveillance program and repairs undertaken if erosion increases and potentially compromises embankment integrity.
- Consideration of the need for alarms and protocols associated with potential elevated seepage, elevated piezometer levels, or observed embankment deformation should be assessed and included in the Emergency Preparedness Plan as required.
- The current minimum embankment crest elevation should be clarified for future capacity and freeboard assessments. The crest width dimension on Cross Section B-B' (Figure 3) and Cross Sections E-E' and G-G' (Figure 6) should be checked and updated as required.
- It is unclear from the description of the 'Old Tailings Facility' if it has been incorporated into the 2-North Pit Tailings Disposal Facility or if it is a separate facility.

## 4.6 Conclusions

A review of the provided documentation indicates that the 2014 Quinsam 2-North Pit Tailings Disposal Facility DSI was undertaken in general accordance with the requirements of the CDA Dam Safety Guidelines (2007) and the BC MEM Guidelines for Annual Dam Safety Inspection Reports (2013). In addition, the dam consequence classification undertaken as part of the DSI adequately reflects the potential impacts associated with a dam failure.

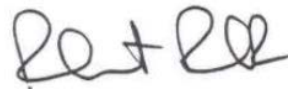
## 5.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Quinsam Coal Corporation, and their agents. Tetra Tech EBA does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Quinsam Coal Corporation, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in Tetra Tech EBA's Services Agreement. Tetra Tech EBA's General Conditions are provided in Appendix A of this report.

## 6.0 CLOSURE

We trust that this report meets your present requirements. Please contact the undersigned should you have questions or comments.

Yours truly,  
Tetra Tech EBA Inc.



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Attachments: Appendix A Tetra Tech EBA's General Conditions

# APPENDIX A

## TETRA TECH EBA'S GENERAL CONDITIONS

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# GENERAL CONDITIONS

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## GEOTECHNICAL REPORT

This report incorporates and is subject to these “General Conditions”.

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### 1.0 USE OF REPORT AND OWNERSHIP

This geotechnical report pertains to a specific site, a specific development and a specific scope of work. It is not applicable to any other sites nor should it be relied upon for types of development other than that to which it refers. Any variation from the site or development would necessitate a supplementary geotechnical assessment.

This report and the recommendations contained in it are intended for the sole use of Tetra Tech EBA's Client. Tetra Tech EBA does not accept any responsibility for the accuracy of any of the data, the analyses or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than Tetra Tech EBA's Client unless otherwise authorized in writing by Tetra Tech EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of Tetra Tech EBA. Additional copies of the report, if required, may be obtained upon request.

### 2.0 ALTERNATE REPORT FORMAT

Where Tetra Tech EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed Tetra Tech EBA's instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by Tetra Tech EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of Tetra Tech EBA's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except Tetra Tech EBA. Tetra Tech EBA's instruments of professional service will be used only and exactly as submitted by Tetra Tech EBA.

Electronic files submitted by Tetra Tech EBA have been prepared and submitted using specific software and hardware systems. Tetra Tech EBA makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

### 3.0 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, Tetra Tech EBA has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

### 4.0 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. Tetra Tech EBA does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

### 5.0 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

### 6.0 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. Tetra Tech EBA does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

## 7.0 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

## 8.0 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

## 9.0 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

## 10.0 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

## 11.0 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

## 12.0 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

## 13.0 SAMPLES

Tetra Tech EBA will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

## 14.0 INFORMATION PROVIDED TO TETRA TECH EBA BY OTHERS

During the performance of the work and the preparation of the report, Tetra Tech EBA may rely on information provided by persons other than the Client. While Tetra Tech EBA endeavours to verify the accuracy of such information when instructed to do so by the Client, Tetra Tech EBA accepts no responsibility for the accuracy or the reliability of such information which may affect the report.