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OQM | Organizational Quality Management Program

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Project #: 341-9

Wolverine Coal Partnership
Wolverine Mine
PO Box 2140
Tumbler Ridge, BC
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**Attn: Nathan Scarbrough**
**Senior Mine Engineer, Walter Energy**

Dear Nathan:

**Subject: Wolverine Tailings Facility – Letter of Assurance Following Report on Mount Polley Breach**

Following the Mount Polley tailings dam breach, a report was compiled by an independent expert panel detailing the root cause of the failure. This report was presented to the Ministry of Energy and Mines (MEM), who have since requested a letter of assurance from tailings dam owners across British Columbia. The letter of assurance was required to address the following main risks, as noted in the February 3, 2015 letter to Walter Energy:

1. Undrained shear failure of silt and clay foundations.
2. Water balance adequacy.
3. Filter adequacy.

This letter provides commentary on the design work that was undertaken in order to address the above risks. Information used to compile the responses below was largely drawn from the following key permit design reports:

- *Permit Level Geotechnical Designs for the Tailings Facility and Coarse Coal Reject Pile, January*, 2005. This report contains the design basis to construct the dam up to the 847m elevation.
- *Mine Permit Amendment: Tailings and CCR Management Plan, April, 2007.* This report provides additional foundation information and a revised design in support of raising the dam an additional 5m to the 852m elevation.

## MEM ITEM #1: UNDRAINED SHEAR FAILURE OF SILT AND CLAY FOUNDATIONS

*a) Including a determination with respect to whether or not similar foundation conditions exist below the dams on your site.*

Drilling prior to and during initial construction of the tailings facility has revealed a significant deposit (up to a depth of approx. 130m) of glacially derived soft clay beneath a number of other distinct stratigraphic units. Behaviour of this material (referred to as Lower Clay) is similar to the glacial lacustrine soils discovered during the Mount Polley investigation. Further discussion of this material is presented in the MEM questions that follow below.

A thin near surface upper clay layer (0.5 to 2m) was also identified during drilling investigations. This material is a more recent Holocene deposit, and is not considered to behave similarly to the glacial lacustrine soils discovered during the Mount Polley investigation.

*b) Whether or not sufficient site investigation (drill holes, etc.) has been completed to have confidence in this determination.*

Norwest completed several site investigation programs across the Wolverine site between 2003 and 2006 which are referenced in the permit amendment report (Norwest, 2007) and these were deemed sufficient to support the design of the tailings structure. These included site reconnaissance, aerial photograph interpretation, drill holes, in-situ testing, test pits, and laboratory testing. Historical information was also available from drilling investigations completed by others in 1981. These investigations showed a consistent stratigraphy between drill holes completed within the tailings facility footprint.

The Lower Clay unit was identified in earlier investigations, with later site investigation programs targeted to further refine the strength properties of this unit. In-situ testing was completed to determine the shear strength of the Lower Clay and included vane, pressuremeter and cone penetration testing. Index, oedometer, direct shear laboratory tests were also undertaken on the Lower Clay. Review of all of this information was used to develop design undrained and drained shear strength properties of the Lower Clay.

*c) If present, whether or not the dam design properly accounts for these materials.*

The Lower Clay unit is the dominant foundation soil influencing dam stability. As noted above, extensive in-situ and laboratory testing was undertaken to develop the design undrained shear strength for the Lower Clay unit. An undrained shear strength relationship of ($s_u/p' = 0.20$) was obtained using the in-situ testing and laboratory data. Further details explaining the rationale used to determine the undrained shear strength is presented in the permit amendment report (Norwest, 2007).

Design slopes for the dam were obtained based on stability analysis using the undrained strength parameters for the Lower Clay (and Upper Clay) units. This was done to account for the ongoing loading of the clay units, which was created by the staged raising of the tailings embankment. Details of the analysis can be found in the permit amendment report (Norwest, 2007). This method of analysis is believed to account for the strength behaviour of the Lower Clay. Monitoring data from piezometer, slope inclinometer and magnetic extensometer installations supports the view that the Lower Clay unit is performing according to design expectations.

d) *If any gaps have been identified, a plan and schedule for additional subsurface investigation.*

Site investigations completed over several phases between 2003 and 2006 sought to resolve any significant gaps in the subsurface characterization of the tailings facility foundation strata. The tailings embankment has since been completed to ultimate height in 2012 and is currently performing as expected. No gaps have been identified at present, and additional site investigation is not currently planned.

**MEM ITEM #2: WATER BALANCE ADEQUACY**

a) *Including the total volume of surplus mine site water (if any) stored in the tailings storage facility.*

There is currently no free standing water pond within the tailings facility. This is due to the mine being idled for economic reasons since May 2014. Any water stored within the tailings facility is locked within the pore space of the tailings fines. An estimate of this volume is not presently available.

b) *The volume of surplus mine water that has been added to the facility over each of the past five years.*

Insufficient data has been made available in order to calculate this volume. This information has been identified as a data gap and is discussed further in Response 2f below.

c) *Any plans that are in place or that are under development to release surplus mine water to the environment.*

During operations, most water reporting to the tailings facility remains in the impoundment or is recycled back to the plant. Any losses outside of this are due to evaporation or from seepage into the underlying impoundment basin. There is no emergency spillway, as the impoundment has been designed to store the inflow design flood (as per CDA guidelines). Vibrating wire piezometer information indicates that there are very little (if any) seepage losses through the dam. Site personnel also report that water in the tailings dam toe drain collection ditch (between the dam and the Wolverine FSR) does not indicate tailings water chemistry.

At mine closure, it is planned to drain the tailings pond, construct a closure cover over the tailings area and install a spillway channel. Runoff from the covered tailings area will be discharged through a

spillway to the north. This closure plan for the tailings facility is presented in the permit amendment report (Norwest, 2007).

Based on the above, Norwest understand that there are no planned releases of mine water directly to the environment.

d) *Recommended beach width(s), and the ability of the mine to maintain these widths.*

The minimum beach width was recommended to be 100m, as reported in the permit amendment (Norwest, 2007). At present, there is no free standing water pond within the tailings impoundment. Historically, Norwest have conducted annual inspections of the tailings facility since 2006 (start of tailings deposition). Between 2006 and 2010, the mine encountered difficulties in maintaining a minimum beach width of 100m. Since then, the mine has generally been more successful in meeting the 100m beach width requirement.

e) *The ability of the TSF embankments to undergo deformation without the release of water (i.e. the adequacy of the recommended beach width).*

At present, there is at least 7m of freeboard within the impoundment since there is no water pond and the embankments have been constructed to almost ultimate height. During operations, the tailings impoundment is required to maintain a minimum freeboard of 2m. This is monitored by examining annual as-built surveys of the dam crest, water pond levels and installed instrumentation. Over the operational life of the tailings facility, the freeboard has been reported to be greater than 2.0m. Annual inspections completed since 2006 support this conclusion and are available upon request.

Deformation due to long-term consolidation of the foundation and /or settlement of fills is within expected rates and is relatively minor (less than 10cm per year). Release of water due to these ongoing minor deformations is very unlikely as the design considered these deformations.

A seismic event equivalent to the maximum design earthquake (1 in 2,475 year event) would likely produce the largest immediate deformations of the dam crest. Based on simplified analysis conducted in 2014, vertical deformations during the 1 in 2,475 year earthquake event were estimated to be in the order of a 0.5 to 1.0m, leaving at least 1.0m of remaining freeboard. This magnitude of deformation is unlikely to initiate release of water from the impoundment.

f) *Provisions and contingencies that are in place to account for wet years.*

The tailings impoundment has a number of provisions / contingencies to account for wet years. These include:

- Monitoring of pond water and tailings levels in relation to annual dam crest surveys.

- A decant structure to pump out surplus water from the impoundment and maintain adequate freeboard (minimum 2.0m).
- Additional freeboard of 0.7m above the inflow design flood level (updated by Tetra Tech EBA, 2015).

g) *If any gaps have been identified, a plan and schedule for addressing these issues.*

Currently, there is limited recorded information to assist water balance estimates. During operations, return water flow (metered only, not totaled) and tailings slurry solids content is measured. This information can be used, along with estimates of other related information (in-situ tailings density, pond volume, and climate information), to provide an approximation of the water balance. The mine should make this information available once the plant restarts (schedule currently unknown at present).

During the current care and maintenance period, inflows to the tailings facility are limited to immediate runoff within the pond footprint and there is no free standing water pond at present. Outflows are limited to evaporation and to consolidation seepage losses through the impoundment basin. Due to the small catchment, moderate annual precipitation, and current freeboard (at least 8m), the risk of an excessive surplus water balance increasing water levels within the impoundment to unacceptable levels is extremely low. In extreme circumstances (i.e. a prolonged wet climate period), the decant structure can be used to draw down water levels in the impoundment.

**MEM ITEM #3: FILTER ADEQUACY**

a) *Including the beach width and filter specifications necessary to prevent potential piping.*

The minimum beach requirement for the tailings facility is 100m from the upstream slope of the dam. This separation between the water pond and the dam fill is recommended to minimize steady state seepage flow through the dam fill. To date, visual assessments and monitoring of vibrating wire piezometer data in the near surface foundation indicate that there is little to no seepage through the dam fill. This is the intent of the dam design. Accordingly, it should be noted that hydraulic gradients required to create conditions for piping through the dam do not currently exist.

The tailings dam design consists of a starter dam constructed from local borrow material (till), raised using coarse coal reject (CCR) material to the ultimate height. Internal drainage is controlled using an upstream seepage blanket, a downstream toe drain, and a downstream toe drain ditch. A specific filter zone (to protect a dam core, for example) is not required to fulfill the dam design, and hence is not produced on site. However, key areas of the dam design have been identified that are required to meet filter criteria to reduce the risk of fines migration between zones. The locations are described below:

- Upstream slope: tailings and CCR dam fill.

- Downstream slope: CCR dam fill and underlying toe drain material.

For the upstream slope, grain size analysis was completed on representative samples of tailings and CCR dam fill material. The data was used to evaluate filter capability based on the following criteria:

$$(D_{15})_{CCR}/(D_{85})_{Fine\ Tailings} < 5$$

It was determined that the materials satisfied filter requirements and that no additional intermediate zone was required to transition between these two materials.

For the downstream slope, a non-woven geotextile is in place to prevent fines migration between the CCR material and the toe drain material.

*b) Whether or not the filter has been constructed in accordance with the design.*

As described above, filter material is not produced on site and hence a specification is not required to be met.

The tailings and CCR materials placed in the embankment during the construction period also have remained consistent with the materials previously tested and reported in the permit amendment (Norwest, 2007).

No reports of persistent cloudy or sediment laden water at seepage exit points have been noted at the tailings dam which would indicate fills to have inadequate filtering capacity.

*c) If any gaps have been identified, a plan and schedule for addressing these issues.*

Tetra Tech EBA completed a dam safety review in 2015 (Tetra Tech EBA, 2015) and highlighted a number of areas that should be evaluated in a formal piping assessment. These locations include:

- Through dam CCR material.
- South abutment through alluvial material.
- North or South abutments.

A schedule for completion of this assessment was not included in the recommendations provided by Tetra Tech EBA. Considering the absence of a water pond in the tailings impoundment and the lack of seepage through the dam, Norwest recommend that this evaluation be undertaken prior to mine startup.

## CLOSURE

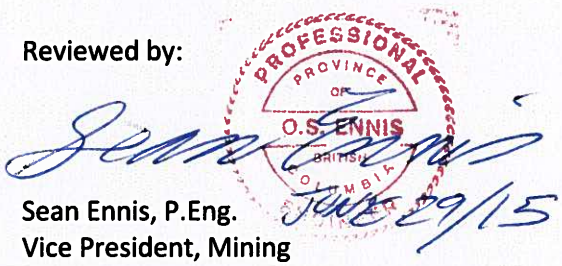
The purpose of this letter is to provide the Wolverine Coal Partnership (WCP) with Norwest's response to an information request from the Ministry of Energy and Mines (dated February 3, 2015). As mutual protection to WCP, the public, and ourselves, this letter is submitted for exclusive use by WCP. We specifically disclaim any responsibility for losses or damages incurred through the use of our work for a purpose other than as described in the letter. Our letter should not be reproduced in whole or in part without our express written permission, other than as required in relation to this regulatory submission.

We trust this information meets your needs at this time, however please do not hesitate to contact us if you require any further information regarding the information provided in this letter.

Yours sincerely,

**NORWEST CORPORATION**

Reviewed by:




Sean Ennis, P.Eng.
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**REFERENCES**

Norwest (2005). Permit Level Geotechnical Designs for the Tailings Facility and Coarse Coal Reject Pile, January, 2005.

Norwest (2007). Mine Permit Amendment: Tailings and CCR Management Plan, April, 2007.

Tetra Tech EBA (2015). Wolverine Coal Mine Tailings Facility Dam Safety Review (Draft copy), March 20, 2015.