Mount Polley Mine
Tailing Storage Facility
2011 Stage 7 Expansion Stability Analyses

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1.0 INTRODUCTION

Mount Polley Mine is owned by Mount Polley Mining Corporation (MPMC), and is located 56 kilometres northeast of Williams Lake. The initial production began in 1997, with a temporary shutdown from October 2001 to March 2005. Currently it is estimated that the mill throughput is approximately 20,000 tpd of tailings which is deposited as slurry into the Tailings Storage Facility (TSF). TSF is comprised of one embankment that is approximately 4.2km in length. The embankment is subdivided into 3 sections referred to as the Main Embankment, Perimeter Embankment and South Embankment. Embankment heights vary and are approximately 45m, 27, ad 17m respectively. The design and construction monitoring of the TSF embankments to date has been performed by Knight Peisold Consulting (KP). The embankments incorporate a staged expansion design utilizing a modified centre line construction methodology. The latest expansion was completed in August 2010, which entailed 4 m embankment raise to a crest elevation of 958 m.

Comment [d1]: Imperial Metals?

AMEC Earth & Environmental (AMEC), a division of AMEC Americas Limited, was retained by MPMC to provide design and construction monitoring for future expansions. To facilitate the additional volume of tailing the next expansion (Stage 7) is scheduled for 2011 and entails a 2.5m embankment raise to a crest elevation of 960.5 m.

The objective of the analyses presented herein was to assess the short term stability of the TSF under static loading conditions. The factor of safety required for long term conditions is 1.5 while for the short term conditions the factor of safety required is 1.3.

The analyses presented herein considers only the short term stability of the 2011 expansion and as currently not enough information is available to analyze the long term stability. In order to perform the stability analysis, 3 as-built sections of the embankments were modeled. The locations of these sections are shown in Appendix A, Figure 1.1.

2.0 ANALYSIS PARAMETERS AND METHODOLOGY

2.1 General

Two-dimensional limit equilibrium stability analyses were carried out using the computer code SLOPE/W 2007 (Version 7.14, Build 4921) developed by Geo-Slope International Ltd. of Calgary, Alberta. The analyses incorporated the Morgenstern-Price method of slices solution. There are seven main materials incorporated into the analyzed sections, Zone S (compacted till fill), Zone C (Rockfill), tailings, foundation tills (ablation, basal), glaciolacustrine/glaciofluvial sediments, and bedrock. The material properties used for the analyses are based on previously established parameters assumed by KP[1], with minor modification that AMEC deemed appropriate. The parameters used in the stability analyses presented herein are summarized in Table 2.1.

[1] Knight Piesold Consulting, Design of the Tailings Storage Facility to Ultimate Elevation, March 14, 2005.

The stability of the 3 dam sections is dependant on the strength of the downstream rockfill shell and foundation materials. The compacted till core is supported by the downstream rockfill shell and does not directly contribute to the stability of the embankment.

2.2 Material Parameters

Compacted Till Fill

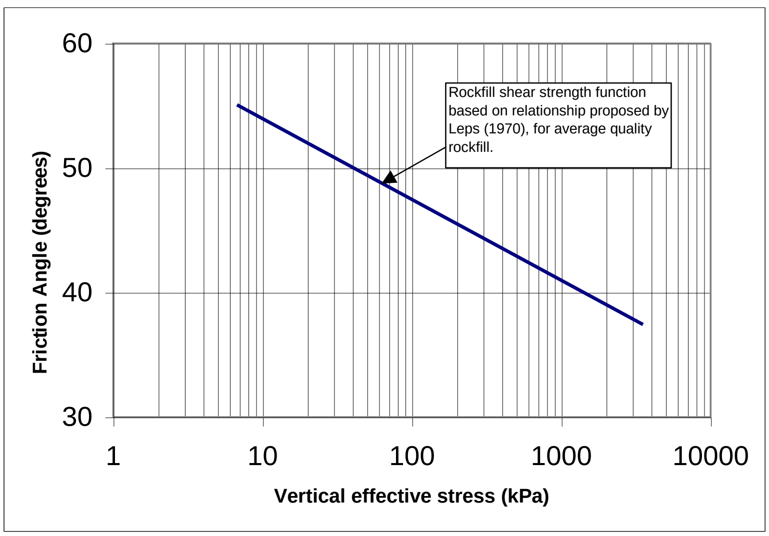
Not enough information is currently available to confirm or modify the material parameters, thus the material properties assumed by KP are utilized.

Comment [d2]: After a closer look at the compaction reports provided by KP for Zone S during the 2010 construction the average measured maximum density was 2114 kg/m^3 with a soil classification CL thus $\gamma = 20.7$ kN/m^3 should be used. I did a quick check to see the change and the FoS increases by 0.008 (1.711 to 1.719) in the 2011 main case. Do you want me to incorporate it into this report and change the comment accordingly?

Rockfill

The rockfill shear strength is taken as stress-level dependent as per Leps (1970)[2], as illustrated in Figure 2.1.

Figure 2.1 Shear Strength Relationship Used for Rockfill



It is anticipated that the rockfill used for construction of the 2011 expansion will be comparable to that used for the past dam rises. As such, the trend for average rockfill was used because the rockfill is anticipated to be:

- strong and durable with high compressive strength;
- well-graded, and comprised of highly angular rock; and
- will receive moderate compactive effort.

It is the latter point that disqualifies the high quality rockfill trend from Leps (1970) being used.

In the past, KP utilized a different material model for the rockfill to assess the stability of the dams. However, through past experiences with tailings dams AMEC believes that utilizing the Leps (1970)[2] material model closer estimates the actual material properties that exist within the rockfill.

In-Situ Foundation

According to a previous KP report[1] the in-situ foundation conditions are quoted as:

"The tailings basin is generally blanketed by naturally occurring well graded low permeability glacial till which functions as an in-situ soil liner and precludes seepage loss from the facility. However, a basin liner was constructed just upstream of the Main Embankment to ensure that the basin liner had a minimum thickness of 2 meters throughout the tailings basin. The constructed basin liner was tied into the Main Embankment core zone and the existing basin liner where the in-situ thickness exceeded 2 m.

The foundation conditions at the Main Embankment consist of low permeability glacial till material at surface underlain by fluvial and lacustrine silts up to 20 m thick. The foundation conditions at the Perimeter Embankment consist of low permeability glacial till throughout that is generally in excess of 5 m. The foundation conditions at the South Embankment consist of a relatively thin, low permeability glacial till material overlying bedrock. The glacial till is a few meters thick but its thickness is not consistent throughout the South Embankment foundation. It is important not to expose the fractured bedrock and to ensure that the glacial till cover is at least 2 m thick throughout the foundation and that it is tied into the core zone.

Laboratory testwork on the foundation soils indicates that the materials have adequate shear strength to ensure foundation stability of the embankments. Artesian pressures exist at the base of the Main Embankment. Pressure relief wells trenches have been installed at this location to depressurize the underlying glaciofluvial deposits."

Due to the lack of laboratory results and detailed borehole logs available for review, AMEC is unable confirm or modify the in-situ foundation material properties, thus the material properties assumed by KP are utilized.

In addition, statigraphy conditions that are found in the TSF area is unclear, thus additional investigations will be required to better understand the in-situ conditions. For the 2011 expansion statigraphy was mainly interpolated from 2005 design report[1]

Summary of Material Strength Parameters

The material strength parameters used in the stability analyses are as summarized in Table 2.1.

Table 2.1 Material Strength Parameters

Material	γ_b	ϕ'	c' (Cohesion)

	(Bulk Unit Weight) (kN/m^3)	(Friction Angle) (degrees)	(kPa)
Rockfill (Zone C)	22	Defined by Lep's (1970)[2] shear normal function for average quality rockfill (note 1)	0
Compacted Till Fill (Zone S)	22	35	0
Ablation Till	21	26	0
Glaciolacustrine/Glaciofluvial	20	33	0
Basal Till	21	33	0
Tailings	18	30	0

Note 1. The shear normal function used for the rockfill accounts for the stress-level dependency of the normalized shear strength as expressed by the effective friction angle (ϕ') – see Figure 2.2.

2.3 Pore Pressure Assumptions

Where possible the current phreatic surfaces were derived from vibrating wire piezometer reading that are currently installed in the embankments, as reported in 2010 Construction report[3]. Where no piezometric pressure data was available the phreatic surface was estimated using typical phreatic surfaces observed from similar projects.

The phreatic surface for the 2011 expansion was estimated by increasing current phreatic surface on the upstream side of the core by 2.5 m, equivalent to the Stage 7 raise, while maintaining the phreatic surface downstream of the core.

The rockfill was assigned zero pore pressure except where located below the phreatic surface, below which pore pressures at any given point were taken as hydrostatic.

Artesian conditions are modelled in the main embankment to reflect the pore pressures observed in the glaciolacustrine/glaciofluvial sediment unit in that area.

2.4 Minimum Factor of Safety Criteria

The minimum factor of safety (FoS) criteria for design is 1.3 for short-term (during construction) and 1.5 for long-term (closure) steady state conditions.

3.0 STABILITY ANALYSES RESULTS

The stability analyses of the TSF 2011 expansion were carried out for 3 sections of the embankment. These sections are typical as-built sections as reported in the 2010 Construction report[3]. In addition to the stability analysis of the expansion the current embankment stability was assessed to establish a FoS baseline for comparison. The sections modeled are shown in

[2] Leps, T.M. (1970). "Review of shearing strength of rockfill", ASCE Journal of the Soil Mech. and Found. Eng. Div., SM4, July, pp. 1159-1170.
[3] Knight Piesold Consulting, Tailing Storage Facility Report of Stage 6B Construction, January 25, 2011.

Figures 3.1 through 3.3 in Appendix A, with a summary Table 3.1 Factor of Safety Summary provided below.

Table 3.1 Factor of Safety Summary

Section Embankment	Current Conditions	2011 Stage 7 Expansion	FoS Reduction
Main (Ch. 20+45)	1.76	1.71	2.9%
Perimeter (Ch. 39+90)	2.10	2.00	4.8%
South (Ch. 7+15)	2.62	2.36	9.9%

The stability analyses identified that the main embankment was the critical section that would govern the 2011 expansion. However, due to the unreliability of the material parameters used in the model, only the short-term stability was analysed at this stage. In addition, to further analyze the 2011 expansion impact on the overall stability of the embankment, a comparison between the current conditions and 2011 expansion was performed. A FoS reduction of 2.9% was observed in the main embankment and deemed insignificant to the overall stability of the embankment. Thus, since the short-term design stability requirement is satisfied the results presented herein are retained as the design values for the 2011 expansion.

The long-term embankment stability will be analyzed after additional information is gathered during the 2011 expansion and instrument installation programs.