

**Independent Expert Engineering Investigation and Review Panel**

**Report on Mount Polley  
Tailings Storage Facility Breach**

**Appendix C: ATTACHMENTS**

**Attachment C1:** Laboratory Test Results

**Attachment C2:** Block Sampling

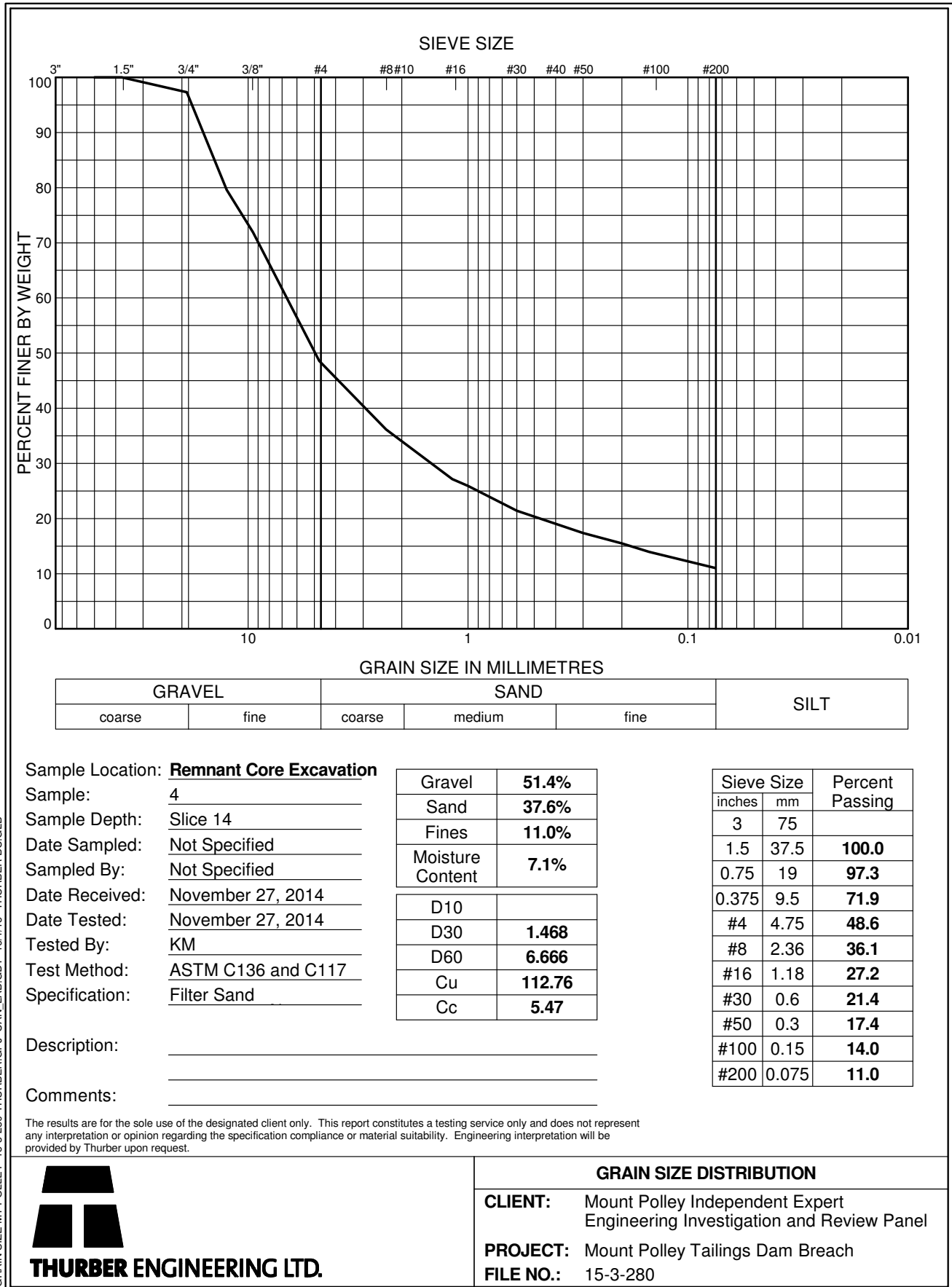
## ATTACHMENT C1: LABORATORY TEST RESULTS

Laboratory testing on the grab samples collected during the field mapping and remnant till core excavation consisted of classification and moisture content testing. Selected samples also underwent grain size analyses (GSA), and/or Atterberg Limit testing. Where silt and clay fractions are separately reported, the GSA also included hydrometer testing. **Table 1** provides the results of laboratory testing.

**TABLE 1. SURFACE INVESTIGATION LABORATORY TEST RESULTS**

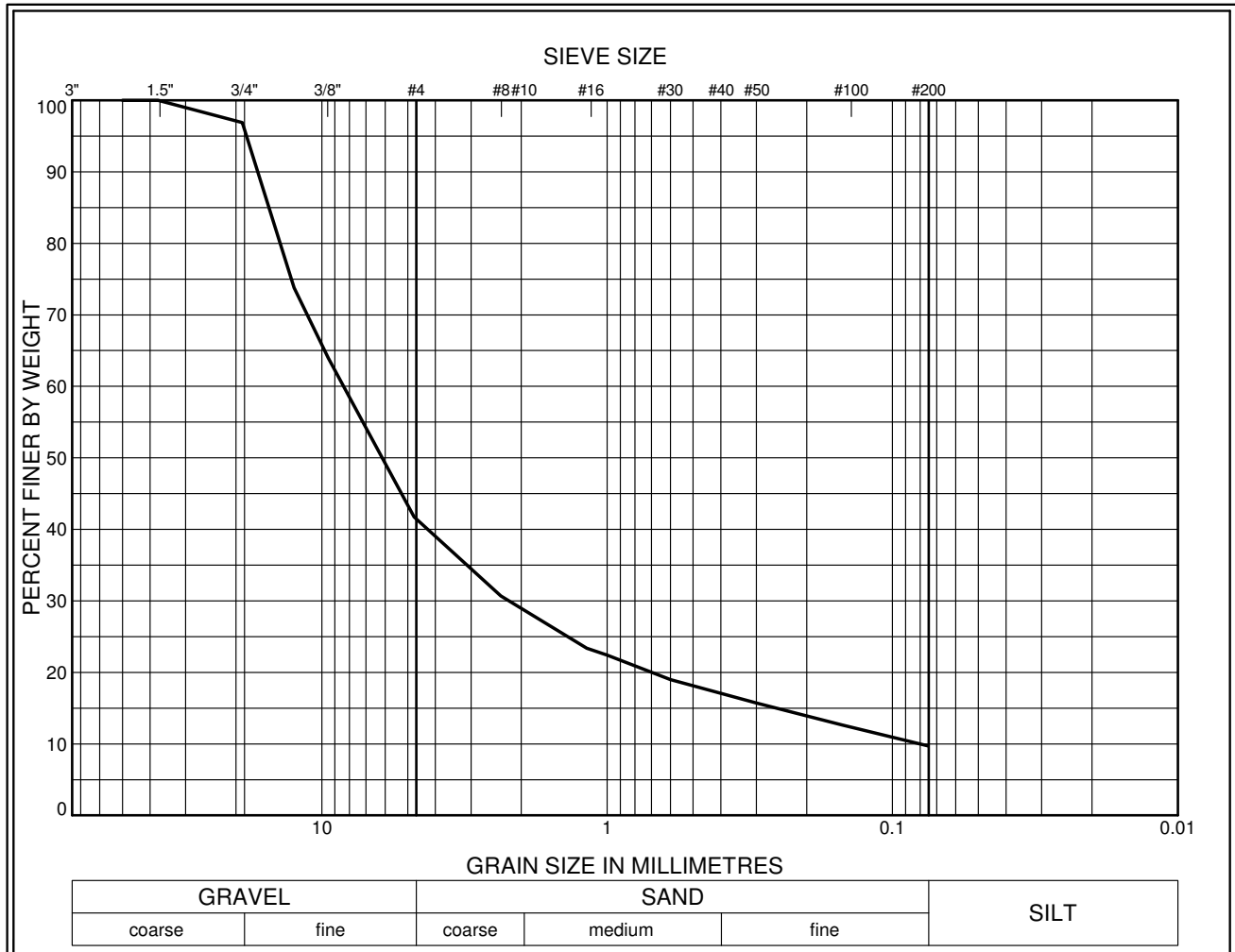
SAMPLE #	DESCRIPTION	UCS	MC %	GRAIN SIZE				LIMITS		
				% GRAVEL	% SAND	% SILT	% CLAY	LL	PL	PI
Sa #1	Till Core	SM/ML	7.0	9.5	38.2	39.7	12.6	-	-	-
Sa #2	Till	SM/SC	8.8	10.2	37.2	34.6	18.0	-	-	-
Sa #3	Clayey Silt	ML	38.8	0.0	0.5	72.6	26.9	42	29	13
Sa #4	Till	CL/ML	9.2	8.0	30.4	43.7	17.9	-	-	-
Sa #5	Silt & Sand	ML/SM	10.7	0.0	57.9	42.1	-	-	-	-
Sa #6	Sand	SM	1.8	0.0	78.6	21.4	-	-	-	-
Sa #7	Till Core	SC/SM	5.5	6.0	37.1	41.4	15.6	-	-	-
Sa #8	Gravel	GP-GM	9.3	60.9	27.5	11.6	-	-	-	-
Sa #9	Clayey Silt	ML	35.5	0.0	1.5	75.0	23.5	39	29	10
Sa #10	Silt & Sand	ML/SM	15.9	0.0	58.4	41.6	-	-	-	-
Sa #11	Till	SM/SC	6.7	13.6	36.0	34.5	15.9	-	-	-
Sa #12	Till	CL/SC	6.9	22.1	32.1	31.6	14.2	-	-	-
Sa #13	Till	CL/ML	4.7	11.4	34.8	39.1	14.6	-	-	-
Slice 4	Till Core (S)	SC/CL	10.1	-	-	-	-	-	-	-
Slice 6	Till Core (S)	SM	12.9	-	-	-	-	-	-	-
Slice 9	Till Core (S)	SC/CL	11.8	-	-	-	-	-	-	-
Slice 14	Filter (F)	GW-GM	7.1	51.4	37.6	11	-	-	-	-
Slice 14	Till Core (S)	SC/CL	10.8	-	-	-	-	-	-	-
Slice 18	Filter (F)	GW-GM	6.8	58.3	32	9.7	-	-	-	-
Slice 18	Sand	SM	15.7	1	77.6	21.4	-	-	-	-
Slice 20	Till Core (S)	CL	9	12.5	32.6	38.5	16.4	-	-	-
Slice 20	Filter (F)	SM/GM	8.1	50.6	37.5	12	-	-	-	-
Slice 24	Gravel (Shear)	GM	11.1	-	-	-	-	-	-	-
Slice 27	Till Core (S)	CL	11.4	-	-	-	-	-	-	-
Slice 27	Till Core (S)	SC/CL	10.3	-	-	-	-	-	-	-
Slice 31	Till Core (S) (U/S)	CL	10.6	7.6	38.4	37.8	16.2	-	-	-
Slice 31	Till Core (S) (D/S)	SC	10.9	18.4	34.3	34	13.3	-	-	-

Gradation curves are shown on the following grain size plots.<sup>1</sup>



GRAIN SIZE MT POLLEY 15-3-280 THURBER.GPJ CAN LAB.GDT 16/1/15 THURBER BC.GLB

<sup>1</sup> MP00008



GRAVEL		SAND			SILT
coarse	fine	coarse	medium	fine	

Sample Location: **Remnant Core Excavation**

Sample: 7  
 Sample Depth: Slice 18  
 Date Sampled: Not Specified  
 Sampled By: Not Specified  
 Date Received: November 27, 2014  
 Date Tested: November 27, 2014  
 Tested By: KM  
 Test Method: ASTM C136 and C117  
 Specification: Filter Sand

Gravel	<b>58.3%</b>
Sand	<b>32.0%</b>
Fines	<b>9.7%</b>
Moisture Content	<b>6.8%</b>

D10	<b>0.08</b>
D30	<b>2.208</b>
D60	<b>8.39</b>
Cu	<b>104.59</b>
Cc	<b>7.24</b>

Sieve Size	Percent Passing
inches	mm
3	75
1.5	37.5
0.75	19
0.375	9.5
#4	4.75
#8	2.36
#16	1.18
#30	0.6
#50	0.3
#100	0.15
#200	0.075

Description: \_\_\_\_\_  
 \_\_\_\_\_  
 Comments: \_\_\_\_\_  
 \_\_\_\_\_

The results are for the sole use of the designated client only. This report constitutes a testing service only and does not represent any interpretation or opinion regarding the specification compliance or material suitability. Engineering interpretation will be provided by Thurber upon request.

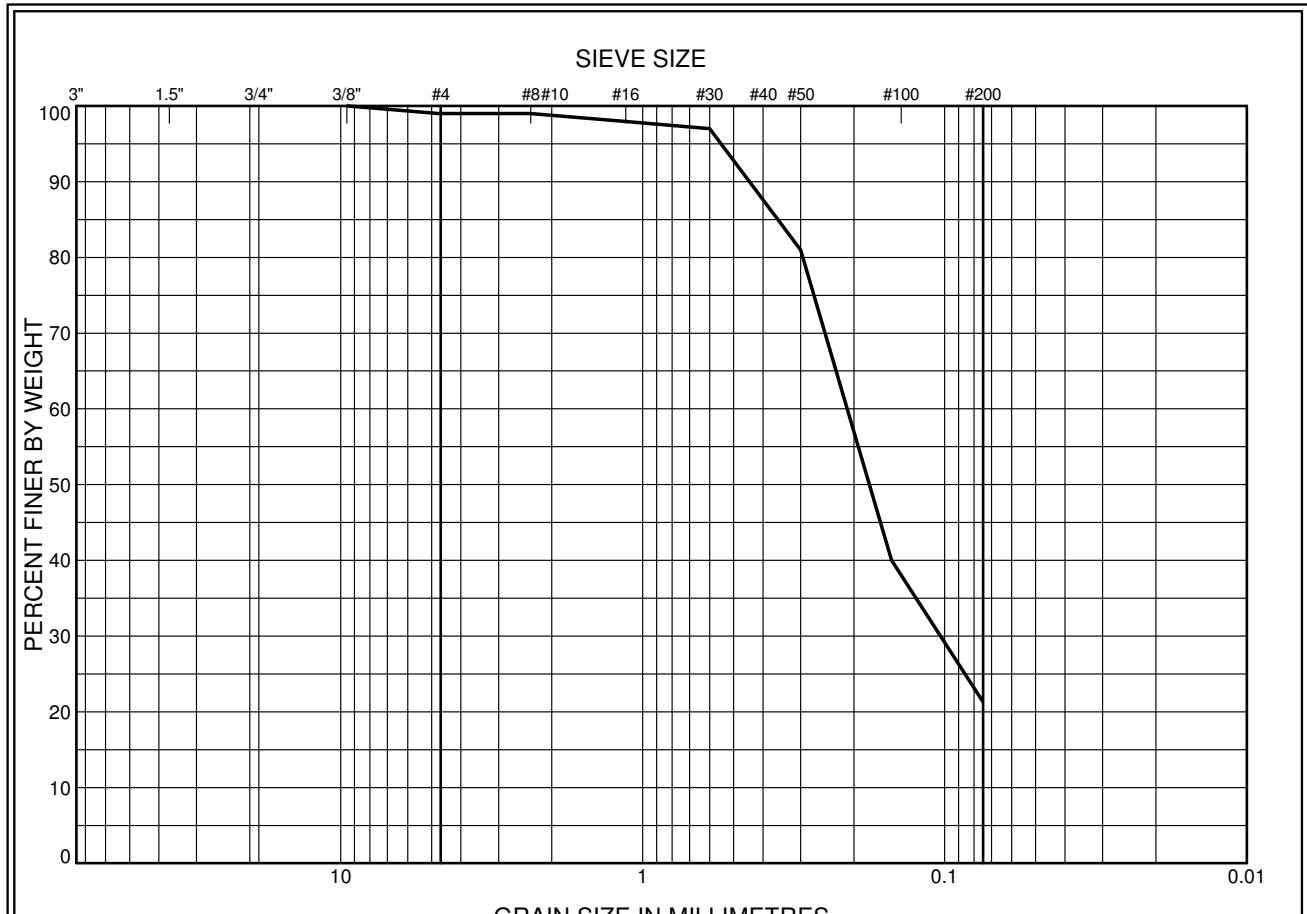


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**GRAIN SIZE DISTRIBUTION**

**CLIENT:** Mount Polley Independent Expert Engineering Investigation and Review Panel  
**PROJECT:** Mount Polley Tailings Dam Breach  
**FILE NO.:** 15-3-280

GRAIN SIZE MT POLLEY 15-3-280 THURBER.GPJ CAN LAB.GDT 16/1/15- THURBER BC.GLB



GRAVEL		SAND			SILT
coarse	fine	coarse	medium	fine	

Sample Location: **Remnant Core Excavation**

Sample: 8

Sample Depth: Slice 18

Date Sampled: Not Specified

Sampled By: Not Specified

Date Received: November 27, 2014

Date Tested: November 27, 2014

Tested By: KM

Test Method: ASTM C136 and C117

Specification: \_\_\_\_\_

Description: \_\_\_\_\_

Comments: \_\_\_\_\_

Gravel	<b>1.0%</b>
Sand	<b>77.6%</b>
Fines	<b>21.4%</b>
Moisture Content	<b>15.7%</b>

D10	
D30	<b>0.103</b>
D60	<b>0.21</b>
Cu	
Cc	

Sieve Size		Percent Passing
inches	mm	
3	75	
1.5	37.5	
0.75	19	
0.375	9.5	<b>100.0</b>
#4	4.75	<b>99.0</b>
#8	2.36	<b>99.0</b>
#16	1.18	<b>98.0</b>
#30	0.6	<b>97.0</b>
#50	0.3	<b>81.0</b>
#100	0.15	<b>40.0</b>
#200	0.075	<b>21.4</b>

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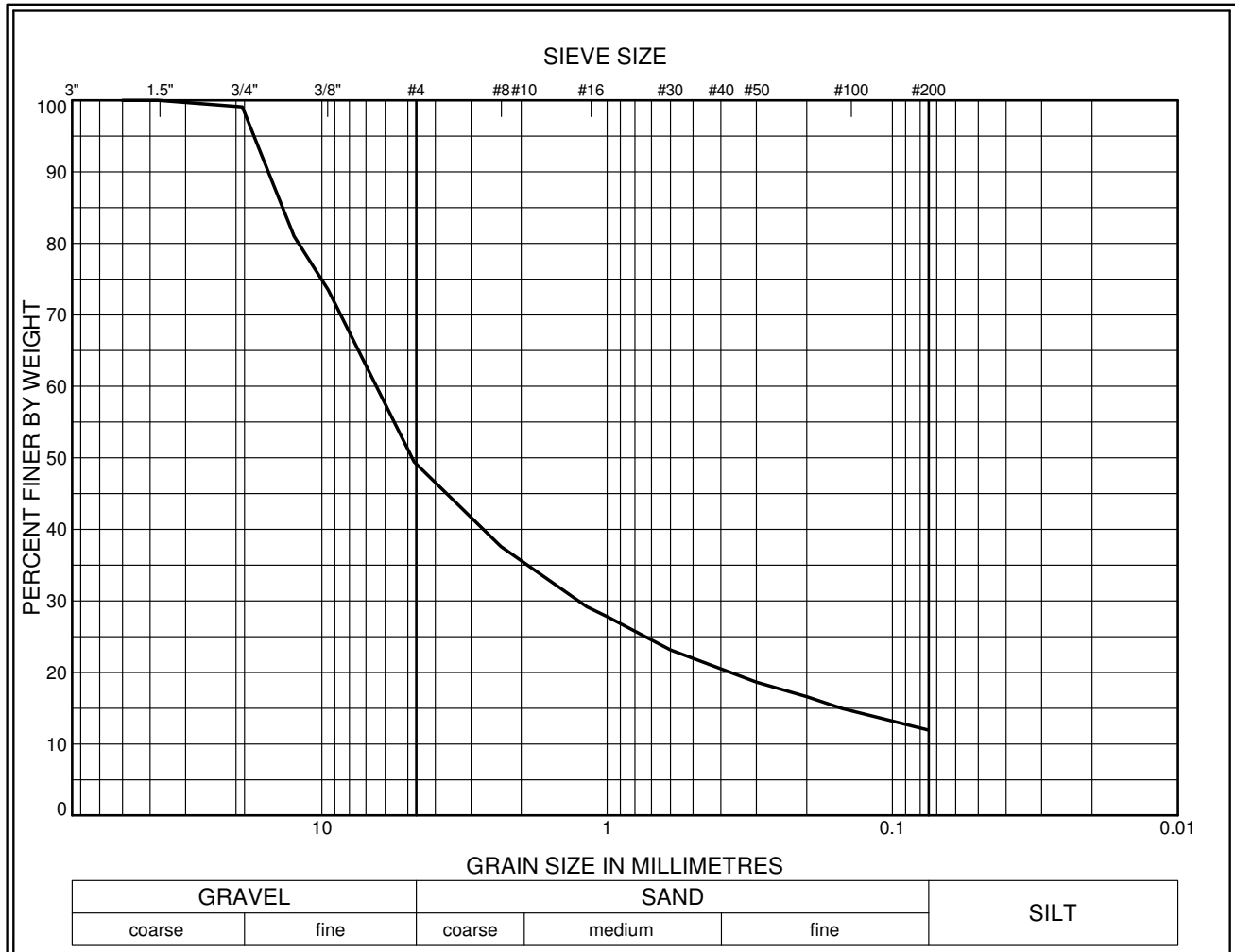
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**FILE NO.:** 15-3-280

GRAIN SIZE MT POLLEY 15-3-280 THURBER.GPJ CAN LAB.GDT 16/1/15 THURBER BC.GLB



Sample Location: **Remnant Core Excavation**

Sample: 9  
 Sample Depth: Slice 20  
 Date Sampled: Not Specified  
 Sampled By: Not Specified  
 Date Received: November 27, 2014  
 Date Tested: November 27, 2014  
 Tested By: KM  
 Test Method: ASTM C136 and C117  
 Specification: Filter Sand

Gravel	<b>50.6%</b>
Sand	<b>37.5%</b>
Fines	<b>12.0%</b>
Moisture Content	<b>8.1%</b>

D10	
D30	<b>1.262</b>
D60	<b>6.439</b>
Cu	<b>134.50</b>
Cc	<b>5.17</b>

Sieve Size		Percent Passing
inches	mm	
3	75	
1.5	37.5	<b>100.0</b>
0.75	19	<b>99.1</b>
0.375	9.5	<b>73.5</b>
#4	4.75	<b>49.4</b>
#8	2.36	<b>37.6</b>
#16	1.18	<b>29.2</b>
#30	0.6	<b>23.1</b>
#50	0.3	<b>18.7</b>
#100	0.15	<b>15.0</b>
#200	0.075	<b>12.0</b>

Description: \_\_\_\_\_  
 \_\_\_\_\_  
 Comments: \_\_\_\_\_  
 \_\_\_\_\_

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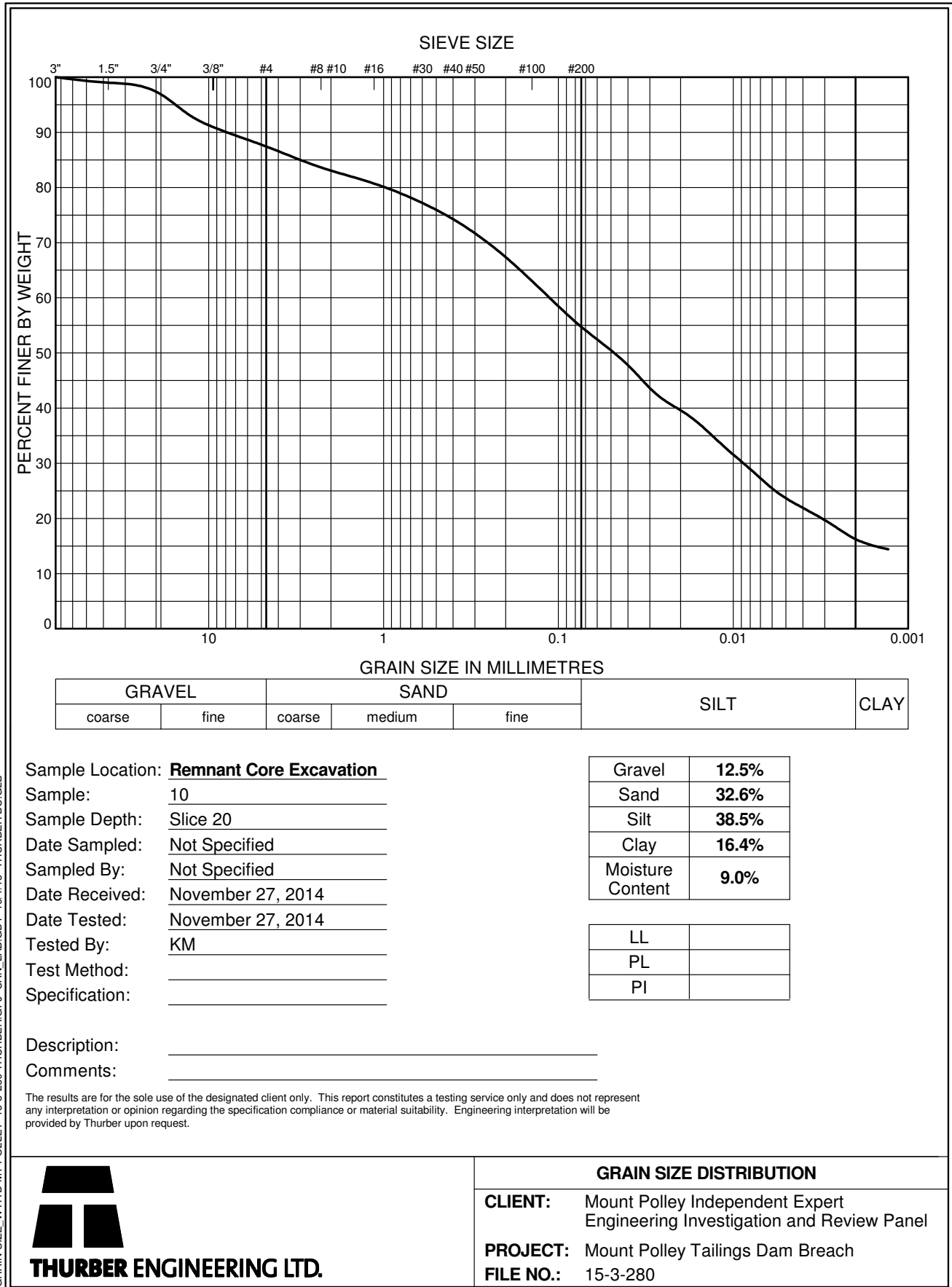


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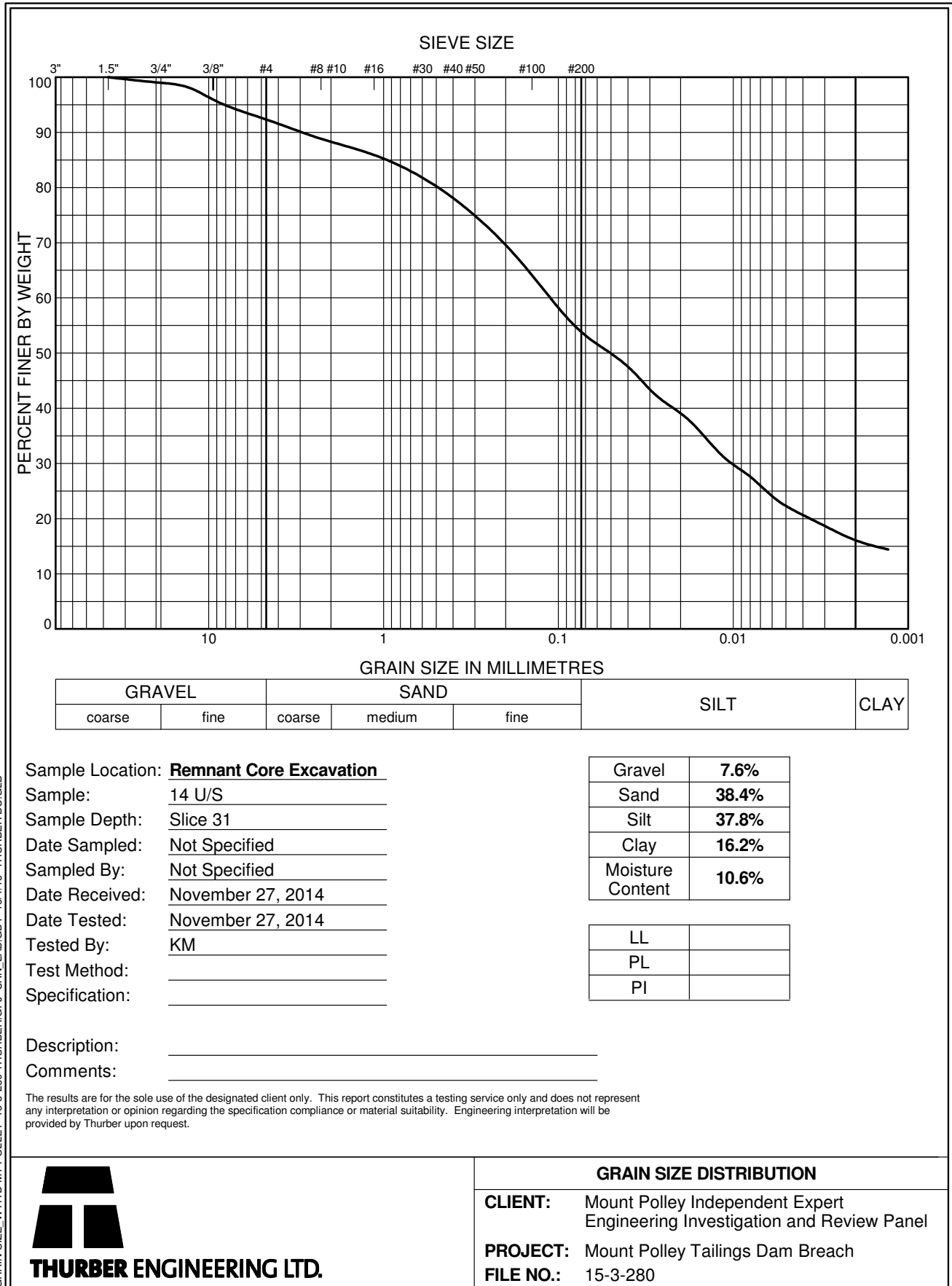
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**FILE NO.:** 15-3-280

GRAIN SIZE MT POLLEY 15-3-280 THURBER.GPJ CAN LAB.GDT 16/1/15- THURBER BC.GLB

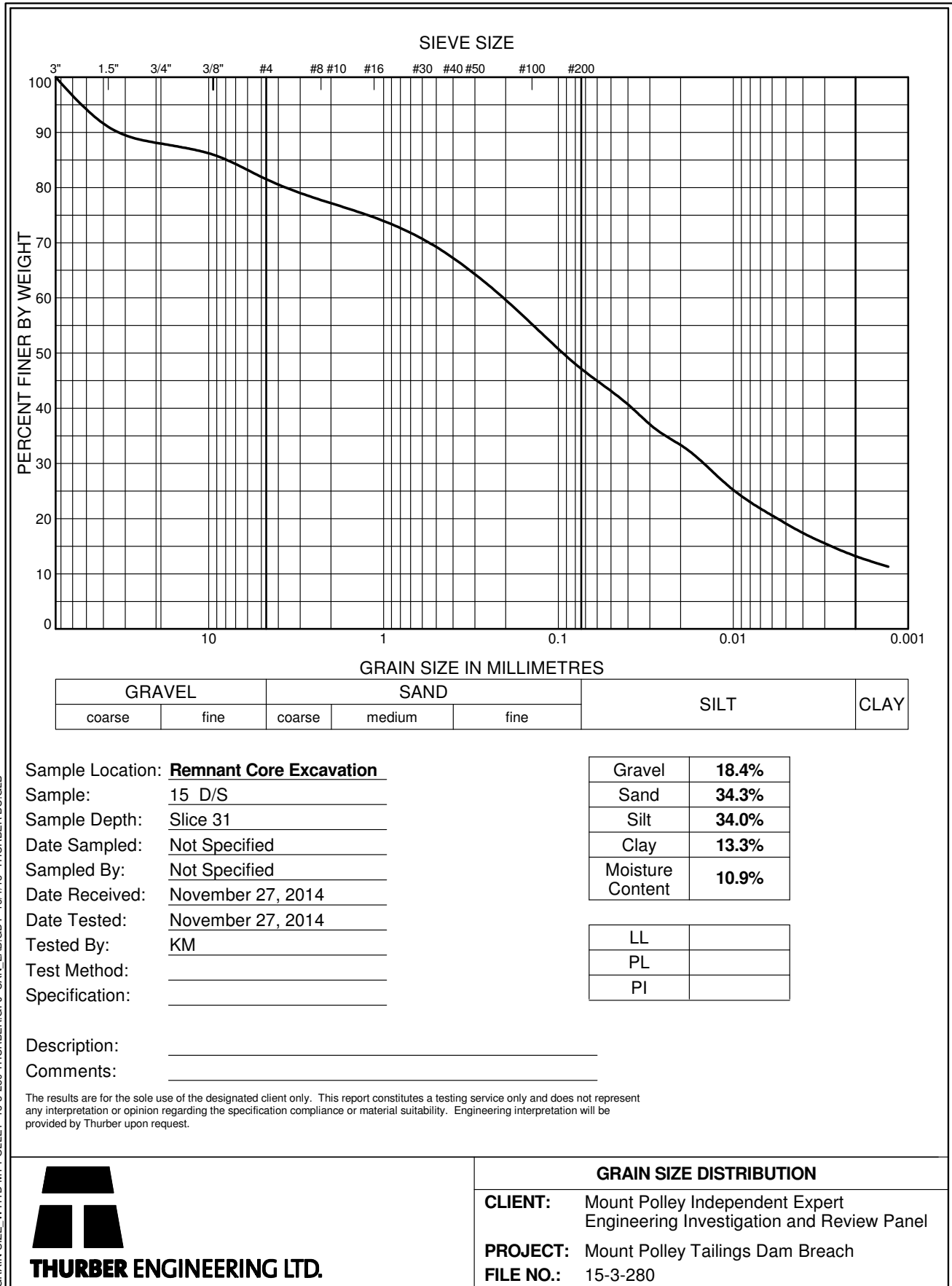


GRAIN-SIZE\_W HYD MT POLLEY\_15-3-280\_THURBER.GPJ\_CAN\_LAB.GDT\_16/1/15\_THURBER.BC.GLB



GRAIN-SIZE\_W HYD MT POLLEY\_15-3-280 THURBER.GPJ\_CAN\_LAB.GDT\_16/1/15- THURBER.BC.GLB





GRAIN-SIZE\_W HYD MT POLLEY\_15-3-280\_THURBER.GPJ\_CAN\_LAB.GDT\_16/1/15\_THURBER.BC.GLB

The following describes an assessment of the origin of the reddish sand observed in the remnant core in cracks, pockets and the shear during the remnant till core excavation. Grain size analyses (GSA) were conducted on the Slice 18 sand sample, three of the till samples, and on the sand grab samples collected during the initial field mapping investigation for comparison.

The GSA of the Slice 18 sand sample was compared to the coarse and fine limits of cycloned sand underflow measured during construction in 1999.<sup>2</sup> The particle shape, colour and visual mineralogy of the sand-size particles from the Slice 18 sand were also compared to the till core samples. The Slice 18 sample has a similar distribution of particle sizes to the cycloned sand, but is at or beyond the coarse limit of the 1999 samples.

Observations made from comparison of sand particles retained on the 0.3 mm sieves are as follows:

- The Slice 18 sand particles can be described as angular, immature sediments that have not been transported a significant distance. The composition of the sand is primarily a mix of lithic fragments of unknown mineralogy and less than about 5% quartz. This is consistent with the mineralogical composition of the tailings, which consist predominantly of feldspar with only trace amounts of quartz.<sup>3</sup>
- The till core samples are sub-angular to sub-rounded in shape. The particles are considered to have moderate to low maturity and appear to have been transported some distance. However, they have not been significantly eroded and rounded off. In contrast to the low quartz content of the tailings, the mineralogy of this part of the till sample consists of primarily quartz (50% or more). The remaining proportion of the sample is a mix of several unidentified minerals.

<sup>2</sup> MP00014

<sup>3</sup> MP00023

## ATTACHMENT C2: BLOCK SAMPLING

This attachment describes details of block sampling conducted during the remnant till core excavation. Two block samples of the till were collected beyond Slice 29. Block Sample 1 was collected from within the till core downstream of the shear plane and Block Sample 2 was collected at the shear.

The block sample collection work procedure was carried out as follows:

- The excavator was used to cut a pedestal of soil approximately 0.9 m to 1.2 m wide, long and high.
- The pedestal was then visually examined to determine the preferred sample location.
- Hand tools were used to trim the pedestal to a sample 0.3 m W x 0.3 m D x 0.3 m H. The tools used consisted of pick axe, chisels, hammer, and putty knives.
- The samples were then wrapped with shrink wrap plastic and labelled with top, upstream, downstream and north arrow marks.
- To remove the sample at the base, an SDS hammer drill with a 300 mm long 15 mm bit was used to line drill across the base. The line drilling was then used as a guide for chisels to be inserted around the perimeter for the block.
- The blocks were then packaged in heavy duty ¾" plywood boxes using Polystyrene foam and expanding polyurethane foam for transport.
- Sample 2 at the shear was considered fragile and it was feared that the removal process would result in deformation at the shear. It was decided to allow the sample to freeze overnight (in place with approximate overnight temperature of -20°C) prior to final trimming and removal.
- Sample 2 was removed the following day and the freezing appeared to assist holding the sample together. The sample was then transported in its frozen state until delivery to Thurber's laboratory in Vancouver.

**Figure 1** below shows the pedestal prepared for Block Sample 1.

**FIGURE 1: EXCAVATED PEDESTAL FOR BLOCK SAMPLE 1**



**Figure 2** below shows Block Sample 1 being trimmed to final size using a pick axe and a sledge hammer with a chisel. The material classified as very stiff till with trace to some gravel and cobbles, and the cobble content made trimming to the exact size difficult. Consequently, it was decided to use a large box (450 mm inside dimensions) to allow placement of packing materials around the oversize sample to avoid the precise trimming and the significant gravel and cobble removal this would entail.

**FIGURE 2: TRIMMING BLOCK SAMPLE 1**



**Figure 3** below shows the final trimming step using 50 mm wide, 5 mm thick steel chisels with a single-beveled tip to cut the sample from the base of the pedestal. Once the chisels had been inserted from all sides, the sample was pried off the foundation using a flat shovel underneath the fully inserted chisels.

**FIGURE 3: CHISELING THE BASE OF BLOCK SAMPLE 1**



**Figure 4** below shows the pedestal prepared for Block Sample 2. The shear (A) passing through the pedestal is denoted by a distinct contact between brown till fill on the upstream side and grey on the downstream side. It is not known if the shear is also associated with a construction material interface.

**FIGURE 4: PEDESTAL FOR BLOCK SAMPLE 2**



**Figure 5** below shows the Block Sample 2 prior to final trimming. Several large cobbles near the shear plane make trimming difficult. Sand deposits are also present along the shear plane (A) and very little cohesion was observed in the plane during trimming. The sample is considered very fragile was allowed to freeze overnight to reduce the likelihood of breakage during removal.

**FIGURE 5: PHOTO SHOWING THE PARTIALLY TRIMMED BLOCK SAMPLE 2**





**Figure 6** below shows Block Sample 2 being prepared for transport. The open plywood box was lowered over the sample and packed with polystyrene foam on the sides. The top was then packed with polystyrene foam and the lid screwed in place. The sample was tilted on its side for final trimming of the base and installation of the box bottom.

**FIGURE 6: BASE OF BLOCK SAMPLE 2 READY FOR FINAL TRIMMING**



Block sample 2 across the shear zone was subjected to scanning at FP Innovations at the University of British Columbia, a facility capable of completing X-rays and CT scanning on large items. CT scanning on the block samples was performed following several rounds of CT scans on thin-walled tube samples, which included a prototyping scanning exercise to determine the scanning technique and orientation providing the best information.

The block sample remained in the field packaging and was oriented vertically when placed on the scanning platform. CT scans were completed at horizontal slices at a 50 mm vertical spacing up the entire height of the sample. The CT scanning method utilized does produce some noise in the images due to wave interference, typically manifesting as small scale lineal features. A select CT scan is shown in **Figure 7** where the shear zone can be clearly identified.

FIGURE 7: ORIENTATION AND CONFIGURATION OF SHEAR ZONE IN BLOCK SAMPLE SCAN

