January 31, 2014

LABORATORY REPORT FOR

Giant Mine
On-Site Backfill Testing

Submitted to:

Public Works and Government Services Canada
(PWGSC)
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REPORT

Reference Number: 1314260010-106-R-Rev0-5000

Distribution:

1 Electronic Copy: PWGSC

1 Hard Copy: Golder Associates Ltd., Sudbury, Ontario

Golder Associates

Study Limitations

This report was prepared for the exclusive use of Public Works and Government Services Canada (PWGSC) on the Giant Mine Project. The report, which specifically includes all tables, figures and appendices, is based on measurements and observations made and data and information collected during the laboratory studies conducted by Golder Associates Ltd. (Golder) for PWGSC. The test results are based solely on the ambient conditions of the laboratory at the time the measurements and tests were conducted.

The services performed, as described in this report, were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions, subject to the time limits and financial and physical constraints applicable to the services.

The sample(s) provided for the tests are assumed to be representative of material found at the site. The test data given herein pertains to the sample(s) provided, and may not be applicable to material from other production periods or zones. Assessment of the sample environmental conditions and possible hazards associated with the material composition is based on the results of chemical analysis of samples which are possibly from a limited number of locations. However, it is never possible, even with exhaustive sampling and testing, to dismiss the possibility that part of a site or a production line may remain undetected. The results found from the tests may not be reproducible under the field conditions.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by PWGSC, communications between Golder and PWGSC, and to any other reports prepared by Golder for PWGSC relative to the specific site described in the report, tables, drawings, figures and appendices. ***In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder cannot be responsible for use of portions of the report without reference to the entire report.***

No other party may use or rely on this report or any portion thereof without Golder's express written consent. Any use, which a third party makes of this report, or any reliance on, or decisions to be made based on it, are the responsibilities of such third parties. Golder accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

The findings and conclusions of this report are valid only as of the date of this report. If new information is discovered in future work, Golder should be requested to re-evaluate the conclusions of this report, and to provide amendments as required.

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1.0 INTRODUCTION

Public Works and Government Services Canada (PWGSC) has retained Golder Associates Ltd. (Golder) to carry out on-site quality assurance laboratory testing on Giant Mine tailings to assess the moisture content and strength properties of the backfill being placed underground in Giant Mine's B1-18 Stope. This test work coincides with work done previously to determine the suitability of the Giant Mine tailings as backfill material preceding the paste production phase of the project.

2.0 SAMPLE RECEIPT

2.1 Sample Receipt

Daily moisture samples were taken from the tailings feed pile positioned beside the Mixer truck (#1 or #2). The samples were stored in sealed 1L standard plastic sample containers. In addition, 3"x6" cylinders for unconfined compressive strength (UCS) testing were cast during daily production at the B1 Pit area and stored temporarily in coolers before shipping them initially to Golder's off-site laboratory in the Golder Yellowknife office and after Nov 12, 2013, to the on-site Golder laboratory at the Giant Mine Mobile Equipment Garage (M.E.G.). Cylinders were cast in the morning and afternoon and whenever the recipe or borehole changed. As a result there may be several cylinders taken on the same day.

Table 1: UCS Sample Receipt Summary

Date	Amount/Container	Golder Sample Pour ID
Oct 21, 2013	12 cylinders	BH 118-05 - Trk #1 - afternoon
Oct 22, 2013	12 cylinders	BH 118-05 - Trk #1 - morning
Oct 22, 2013	12 cylinders	BH 118-05 - Trk #1 - afternoon
Oct 25, 2013	12 cylinders	BH 118-05 - Trk #1 - morning
Oct 25, 2013	12 cylinders	BH 118-05 - Trk #1 - afternoon
Oct 25, 2013	12 cylinders	BH 118-05 - Trk #2 - morning
Oct 25, 2013	12 cylinders	BH 118-05 - Trk #2 - afternoon
Oct 26, 2013	12 cylinders	BH 118-05 - Trk #1 - morning
Oct 26, 2013	12 cylinders	BH 118-05 - Trk #1 - afternoon
Oct 26, 2013	12 cylinders	BH 118-05 - Trk #2 - morning
Oct 26, 2013	12 cylinders	BH 118-05 - Trk #2 - afternoon
Oct 27, 2013	12 cylinders	BH 118-03 - Trk #1 - morning
Oct 27, 2013	12 cylinders	BH 118-03 - Trk #2 - morning
Oct 27, 2013	12 cylinders	BH 118-03 - Trk #2 - afternoon
Oct 28, 2013	12 cylinders	BH 118-03 - Trk #1 - morning
Oct 28, 2013	12 cylinders	BH 118-03 - Trk #2 - morning
Oct 28, 2013	12 cylinders	BH 118-03 - Trk #2 - afternoon
Oct 29, 2013	12 cylinders	BH 118-05 - Trk #1 - afternoon
Oct 29, 2013	12 cylinders	BH 118-04 - Trk #2 - afternoon
Oct 30, 2013	12 cylinders	BH 118-04 - Trk #2 - morning
Oct 30, 2013	12 cylinders	BH 118-05 - Trk #1 - afternoon
Oct 30, 2013	12 cylinders	BH 118-03 - Trk #1 - afternoon

Date	Amount/Container	Golder Sample Pour ID
Oct 31, 2013	12 cylinders	BH 118-05 - Trk #1 - morning
Oct 31, 2013	12 cylinders	BH 118-05 - Trk #2 - morning
Oct 31, 2013	12 cylinders	BH 118-03 - Trk #1 - afternoon
Oct 31, 2013	12 cylinders	BH 118-04 - Trk #2 - afternoon
Nov 1, 2013	12 cylinders	BH 118-03 - Trk #1 - afternoon
Nov 1, 2013	12 cylinders	OB 118-02 - Trk #1 - afternoon
Nov 1, 2013	12 cylinders	BH 118-04 - Trk #2 - morning
Nov 1, 2013	12 cylinders	OB 118-02 - Trk #2 - afternoon
Nov 1, 2013	12 cylinders	BH 118-03 - Trk #2 - afternoon
Nov 2, 2013	12 cylinders	BH 118-04 - Trk #2 - morning
Nov 2, 2013	12 cylinders	BH 118-03 - Trk #1 - afternoon
Nov 2, 2013	12 cylinders	BH 118-03 - Trk #2 - afternoon
Nov 3, 2013	12 cylinders	BH 118-03 - Trk #1 - morning
Nov 3, 2013	12 cylinders	BH 118-03 - Trk #2 - morning
Nov 3, 2013	12 cylinders	BH 118-03 - Trk #1 - afternoon
Nov 3, 2013	12 cylinders	BH 118-04 - Trk #2 - morning
Nov 4, 2013	12 cylinders	BH 118-03 - Trk #1 - morning
Nov 4, 2013	12 cylinders	BH 118-03 - Trk #1 - afternoon
Nov 4, 2013	12 cylinders	BH 118-03 - Trk #2 - afternoon
Nov 4, 2013	12 cylinders	BH 118-04 - Trk #2 - morning
Nov 5, 2013	12 cylinders	BH 118-04 - Trk #2 - morning
Nov 5, 2013	12 cylinders	BH 118-12 - Trk #1 - morning
Nov 5, 2013	12 cylinders	BH 118-12 - Trk #2 - morning
Nov 5, 2013	12 cylinders	BH 118-12 - Trk #1 - afternoon
Nov 6, 2013	12 cylinders	BH 118-01 - Trk #1 - afternoon
Nov 6, 2013	12 cylinders	BH 118-04 - Trk #2 - morning
Nov 6, 2013	12 cylinders	BH 118-12 - Trk #1 - morning
Nov 6, 2013	12 cylinders	BH 118-12 - Trk #2 - morning
Nov 6, 2013	12 cylinders	BH 118-12 - Trk #1 - afternoon
Nov 7, 2013	12 cylinders	BH 118-01 - Trk #1 - morning
Nov 7, 2013	12 cylinders	BH 118-01 - Trk #2 - morning
Nov 7, 2013	12 cylinders	BH 118-01 - Trk #1 - afternoon
Nov 7, 2013	12 cylinders	BH 118-01 - Trk #2 - afternoon
Nov 7, 2013	12 cylinders	BH 118-12 - Trk #1 - morning
Nov 7, 2013	12 cylinders	BH 118-12 - Trk #2 - morning
Nov 8, 2013	12 cylinders	BH 118-12 - Trk #1 - morning
Nov 8, 2013	12 cylinders	BH 118-12 - Trk #1 - afternoon
Nov 9, 2013	12 cylinders	BH 118-03 - Trk #1 - afternoon
Nov 10, 2013	12 cylinders	BH 118-01 - Trk #1 - morning
Nov 10, 2013	12 cylinders	BH 118-12 - Trk #1 - morning

Date	Amount/Container	Golder Sample Pour ID
Nov 11, 2013	12 cylinders	BH 118-12 - Trk #1 - afternoon
Nov 11, 2013	12 cylinders	BH 118-12 - Trk #1 - afternoon 2:30
Nov 11, 2013	12 cylinders	BH 118-06- Trk #2 - morning
Nov 11, 2013	12 cylinders	BH 118-06- Trk #2 - afternoon
Nov 12, 2013	12 cylinders	BH 118-01- Trk #1 - morning
Nov 12, 2013	12 cylinders	BH 118-01- Trk #2 - morning
Nov 12, 2013	12 cylinders	BH 118-12- Trk #1 - afternoon
Nov 12, 2013	12 cylinders	BH 118-06- Trk #2 - afternoon
Nov 13, 2013	12 cylinders	BH 118-01- Trk #1 - morning
Nov 13, 2013	12 cylinders	BH 118-01- Trk #2 - morning
Nov 13, 2013	12 cylinders	BH 118-12- Trk #1 - afternoon
Nov 14, 2013	12 cylinders	BH 118-01- Trk #1 - morning
Nov 14, 2013	12 cylinders	BH 118-01- Trk #2 - afternoon
Nov 14, 2013	12 cylinders	BH 118-12- Trk #1 - morning
Nov 15, 2013	9 cylinders	BH 118-01- Trk #1 - morning
Nov 15, 2013	12 cylinders	BH 118-01- Trk #2 - morning
Nov 16, 2013	12 cylinders	BH 118-01- Trk #2 - morning
Nov 17, 2013	12 cylinders	BH 118-01- Trk #2 - morning
Nov 17, 2013	12 cylinders	BH 118-01- Trk #2 - afternoon
Nov 18, 2013	12 cylinders	BH 118-01- Trk #2 - morning
Nov 19, 2013	12 cylinders	BH 118-03- Trk #1 - morning
Nov 20, 2013	12 cylinders	BH 118-03- Trk #1 - morning
Nov 20, 2013	12 cylinders	BKGT 12-15- Trk #1 - afternoon
Nov 21, 2013	12 cylinders	BKGT 12-15- Trk #1 - morning
Nov 21, 2013	12 cylinders	BKGT 12-15- Trk #1 - afternoon
Nov 22, 2013	12 cylinders	BH 118-11- Trk #2 - morning
Nov 22, 2013	12 cylinders	BKGT 12-15- Trk #1 - afternoon
Nov 23, 2013	12 cylinders	BH 118-03- Trk #1 - morning
Nov 23, 2013	12 cylinders	BH 118-03- Trk #1 - afternoon
Nov 24, 2013	12 cylinders	BH 118-03- Trk #1 - morning
Nov 24, 2013	12 cylinders	BH 118-15- Trk #1 - afternoon
Nov 25, 2013	12 cylinders	BH 118-15- Trk #1 - morning
Nov 25, 2013	12 cylinders	BH 118-15- Trk #1 - afternoon
Nov 26, 2013	12 cylinders	BH 118-03- Trk #1 - morning
Nov 26, 2013	12 cylinders	BH 118-03- Trk #1 - afternoon
Nov 27, 2013	12 cylinders	BKGT 12-15 - Trk #2 - afternoon
Nov 28, 2013	12 cylinders	BKGT 12-15 - Trk #1 - morning
Nov 28, 2013	12 cylinders	BH 118-12 - Trk #1 - afternoon
Nov 29, 2013	12 cylinders	BH 118-11 - Trk #2 - afternoon
Dec 2, 2013	12 cylinders	BH 118-11 - Trk #2 - morning

Date	Amount/Container	Golder Sample Pour ID
Dec 3, 2013	12 cylinders	BH 118-11 - Trk #2 - afternoon
Dec 5, 2013	12 cylinders	BH 118-01 - Trk #1 - morning
Dec 5, 2013	12 cylinders	BH 118-01 - Trk #1 - afternoon
Dec 6, 2013	12 cylinders	BH 118-15 - Trk #1 - afternoon
Dec 7, 2013	12 cylinders	BH 118-15 - Trk #1 - morning
Dec 7, 2013	12 cylinders	BH 118-03 - Trk #1 - afternoon
Dec 8, 2013	12 cylinders	BH 118-08 - Trk #1 - morning
Dec 9, 2013	12 cylinders	OBS-02 - Trk #1 - morning
Dec 9, 2013	12 cylinders	BH 118-08 - Trk#1 - morning
Dec 10, 2013	12 cylinders	BH 118-08 - Trk#1 - morning

Table 2: Moisture Sample Receipt Summary

Date	Amount/Container	Golder Sample ID
Oct 21, 2013	1 - 1L container	Oct 21-13 - tailings moisture
Oct 22, 2013	1 - 1L container	Oct 22-13 - tailings moisture
Oct 25, 2013	1 - 1L container	Oct 25-13 - tailings moisture
Oct 26, 2013	1 - 1L container	Oct 26-13 - tailings moisture
Oct 27, 2013	1 - 1L container	Oct 27-13 - tailings moisture
Oct 28, 2013	1 - 1L container	Oct 28-13 - tailings moisture
Oct 30, 2013	1 - 1L container	Oct 30-13 - tailings moisture
Oct 31, 2013	1 - 1L container	Oct 31-13 - tailings moisture
Nov 1, 2013	1 - 1L container	Nov 01-13 - tailings moisture
Nov 2, 2013	1 - 1L container	Nov 02-13 - tailings moisture
Nov 3, 2013	1 - 1L container	Nov 03-13 - tailings moisture
Nov 5, 2013	1 - 1L container	Nov 05-13 - tailings moisture
Nov 6, 2013	1 - 1L container	Nov 06-13 - tailings moisture
Nov 7, 2013	1 - 1L container	Nov 07-13 - tailings moisture
Nov 8, 2013	1 - 1L container	Nov 08-13 - tailings moisture
Nov 12, 2013	1 - 1L container	Nov 12-13 - tailings moisture
Nov 13, 2013	1 - 1L container	Nov 13-13 - tailings moisture
Nov 14, 2013	1 - 1L container	Nov 14-13 - tailings moisture
Nov 15, 2013	1 - 1L container	Nov 15-13 - tailings moisture
Nov 16, 2013	1 - 1L container	Nov 16-13 - tailings moisture
Nov 17, 2013	1 - 1L container	Nov 17-13 - tailings moisture
Nov 18, 2013	1 - 1L container	Nov 18-13 - tailings moisture
Nov 20, 2013	1 - 1L container	Nov 20-13 - tailings moisture
Nov 21, 2013	1 - 1L container	Nov 21-13 - tailings moisture
Nov 22, 2013	1 - 1L container	Nov 22-13 - tailings moisture
Nov 23, 2013	1 - 1L container	Nov 23-13 - tailings moisture - AM
Nov 23, 2013	1 - 1L container	Nov 23-13 - tailings moisture - PM

Date	Amount/Container	Golder Sample ID
Nov 24, 2013	1 - 1L container	Nov 24-13 - tailings moisture
Nov 24, 2013	1 - 1L container	Nov 24-13 – bulk tailings moisture for cylinder's
Nov 25, 2013	1 - 1L container	Nov 25-13 - tailings moisture
Nov 26, 2013	1 - 1L container	Nov 26-13 - tailings moisture
Nov 27, 2013	1 - 1L container	Nov 27-13 - tailings moisture
Nov 28, 2013	1 - 1L container	Nov 28-13 - tailings moisture
Nov 29, 2013	1 - 1L container	Nov 29-13 - tailings moisture
Dec 2, 2013	1 - 1L container	Dec 02-13 - tailings moisture
Dec 3, 2013	1 - 1L container	Dec 03-13 - tailings moisture
Dec 5, 2013	1 - 1L container	Dec 05-13 - tailings moisture
Dec 7, 2013	1 - 1L container	Dec 07-13 - tailings moisture
Dec 9, 2013	1 - 1L container	Dec 09-13 - tailings moisture

3.0 MOISTURE CONTENT TESTING

The tailings moisture samples were weighted and dried in an oven located in the laboratory. The oven temperature was adjusted to 60°C. The results are presented in Table 3 as well as on Figure 1.

Table 3: Tailings Moisture Content

Sample ID	Pan Tare (g)	Pan/Tails Wet (g)	Pan/Tails Dry (g)	Wt% Solids	Wt% Moisture
Oct 21 -13 - tailings moisture	2.10	136.10	110.20	80.67%	19.33%
Oct 22 -13 - tailings moisture	2.10	126.20	114.70	90.73%	9.27%
Oct 25 -13 - tailings moisture	2.20	104.00	93.70	89.88%	10.12%
Oct 26 -13 - tailings moisture	2.60	77.80	70.30	90.03%	9.97%
Oct 27 -13 - tailings moisture	2.20	79.80	74.20	92.78%	7.22%
Oct 28 -13 - tailings moisture	2.20	92.30	85.00	91.90%	8.10%
Oct 30 -13 - tailings moisture	2.20	91.10	84.30	92.35%	7.65%
Oct 31 -13 - tailings moisture	2.20	95.70	88.70	92.51%	7.49%
Nov 01 -13 - tailings moisture	2.20	90.70	83.90	92.32%	7.68%
Nov 02 -13 - tailings moisture	2.20	95.80	88.20	91.88%	8.12%
Nov 03 -13 - tailings moisture	2.30	83.50	77.00	92.00%	8.00%
Nov 05 -13 - tailings moisture	2.30	76.20	70.80	92.69%	7.31%
Nov 06 -13 - tailings moisture	2.20	85.50	79.30	92.56%	7.44%
Nov 07 -13 - tailings moisture	2.30	91.30	84.70	92.58%	7.42%
Nov 08 -13 - tailings moisture	2.30	99.50	91.90	92.18%	7.82%
Nov 12 -13 - tailings moisture	2.30	84.30	75.60	89.39%	10.61%
Nov 13 -13 - tailings moisture	2.20	75.50	66.80	88.13%	11.87%
Nov 14 -13 - tailings moisture	2.20	76.40	66.90	87.20%	12.80%
Nov 15 -13 - tailings moisture	2.30	79.20	69.00	86.74%	13.26%

Sample ID	Pan Tare (g)	Pan/Tails Wet (g)	Pan/Tails Dry (g)	Wt% Solids	Wt% Moisture
Nov 16 -13 - tailings moisture	2.20	83.40	72.70	86.82%	13.18%
Nov 17 -13 - tailings moisture	2.30	93.90	81.60	86.57%	13.43%
Nov 18 -13 - tailings moisture	2.20	91.90	77.10	83.50%	16.50%
Nov 20 -13 - tailings moisture	2.20	100.00	85.50	85.17%	14.83%
Nov 21 -13 - tailings moisture	2.20	93.00	78.90	84.47%	15.53%
Nov 22 -13 - tailings moisture	2.30	94.30	81.60	86.20%	13.80%
Nov 23 -13 - tailings moisture - AM	2.20	84.50	73.90	87.12%	12.88%
Nov 23 -13 - tailings moisture - PM	2.30	91.80	80.50	87.37%	12.63%
Nov 24 -13 - tailings moisture	2.30	92.30	82.00	88.56%	11.44%
Nov 25 -13 - tailings moisture	2.20	78.40	70.70	89.90%	10.10%
Nov 26 -13 - tailings moisture	2.10	86.10	74.90	86.67%	13.33%
Nov 27 -13 - tailings moisture	2.10	84.10	75.60	89.63%	10.37%
Nov 28 -13 - tailings moisture	2.20	94.10	84.50	89.55%	10.45%
Nov 29 -13 - tailings moisture	2.40	89.50	80.10	89.21%	10.79%
Dec 02 -13 - tailings moisture	2.10	86.10	78.10	90.48%	9.52%
Dec 03 -13 - tailings moisture	2.10	89.40	80.80	90.15%	9.85%
Dec 05 -13 - tailings moisture	2.30	100.40	90.60	90.01%	9.99%
Dec 07 -13 - tailings moisture	2.20	100.20	91.00	90.61%	9.39%
Dec 09 -13 - tailings moisture	2.20	91.60	82.80	90.16%	9.84%

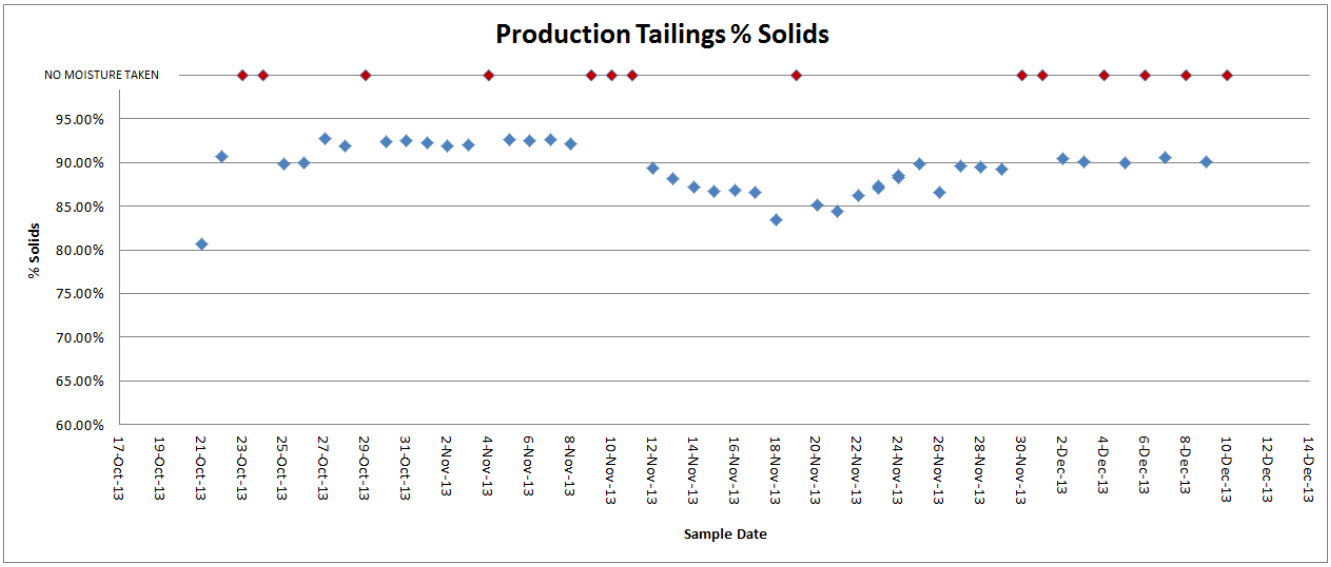

Figure 1: Tailings Feed Material % Solids Content

4.0 UNCONFINED COMPRESSIVE STRENGTH (UCS) TESTING

UCS testing was carried out using a Sigma-1 GeoTac load frame. The load was measured using a 10,000 lb (45 kN) s-type load cell for all test work.

The cured cylinders were placed one at a time between two platens and during testing, the bottom platen advanced at a rate of 2 mm (0.08 inch) per minute. The load was continuously monitored and the load data including the peak load were automatically recorded by the instrument.

4.1 Lab Test Equipment and Setup

A temporary lab was setup to perform the required testwork during the production period. Initially the lab was located in the Golder Yellowknife office however this was changed to an onsite facility mid-way through production to better accommodate the storage, transportation and disposal of UCS cylinders. The setup at both facilities made use of the same equipment.

Figure 2: UCS Lab Equipment as set up at Giant Mine M.E.G. Facility.

Major equipment used during the UCS programme included a GeoTac load frame complete with DAQ software used to break cylinders, a 10,000lb load cell, and a digital scale to weigh the samples. Cylinders were stored in on-site 'curing chambers' consisting of a galvanized tub with shelving installed. The tub was wrapped in wet

burlap and covered in a plastic drop cloth in an attempt to maintain 100% humidity at room temperature (24-30°C). The burlap was regularly sprayed with water to maintain this target humidity.

All tests were performed in the same manner. Cylinders were removed from their mold, their tops were trimmed level, and they were weighed and positioned appropriately in the load frame. The data file was set up accordingly and the break took place while automatically recording the necessary information. The broken cylinder was observed and discarded. Test pictures were captured of all cylinders tested after November 14th.

4.2 Cylinder Preparation

At the paste production area, cylinders were cast immediately after a sample was pulled and a slump test was performed. The samples were subsequently stored and transported in coolers (see figure 3 below).

Figure 3: Cylinders Being Prepared in the Field

4.3 UCS Program and Results

The UCS program was carried out to assess the backfill strength using 76 x 152 mm (3'' x 6'') cylinders. Cylinders were transferred to the curing tubs in the laboratory immediately following the end of daily production. Three cylinders per curing period were casted and broken and the results were averaged. The results are separated by mix design and presented in Figures 4 to 15 as well as in Appendix A in tabular form. The laboratory data represented in Figure 15 was the test performed in Sudbury lab in August, 2013. The remaining laboratory data results for the on-site recipes will be added as the results become available.

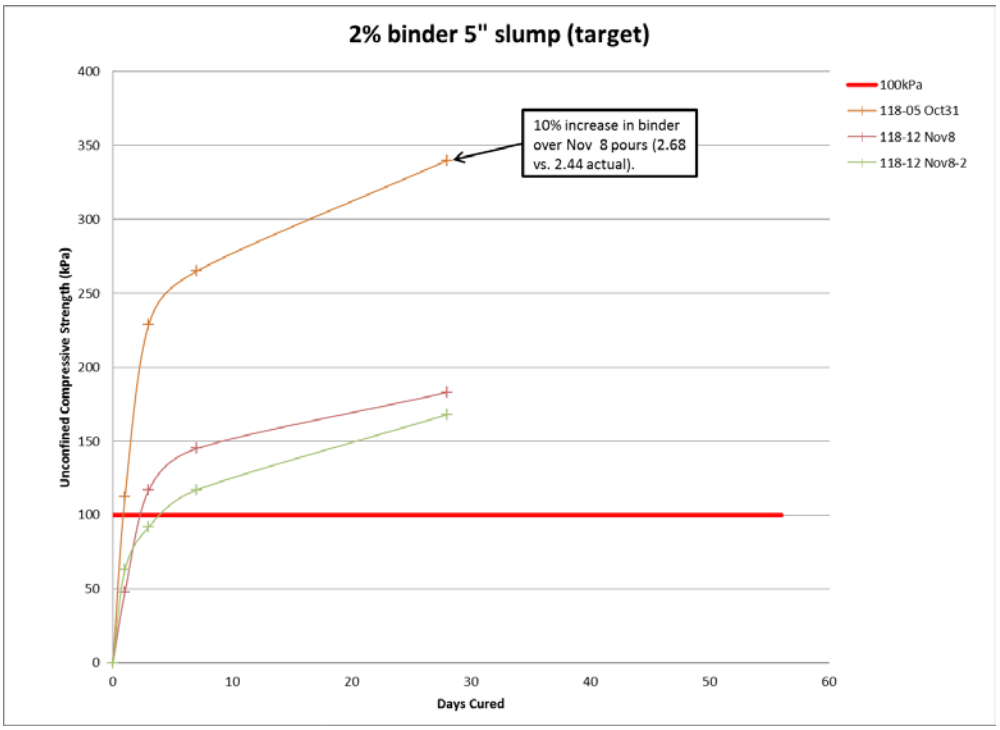

Figure 4: UCS Results- 2 % Binder 5" Slump

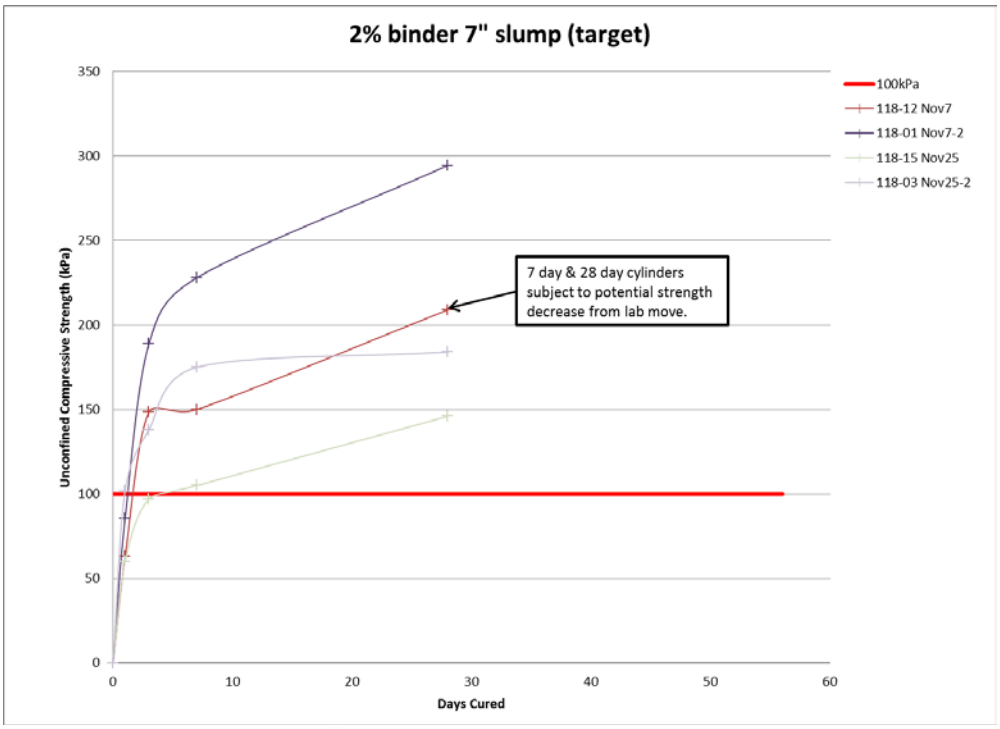

Figure 5: UCS Results- 2% Binder 7" Slump

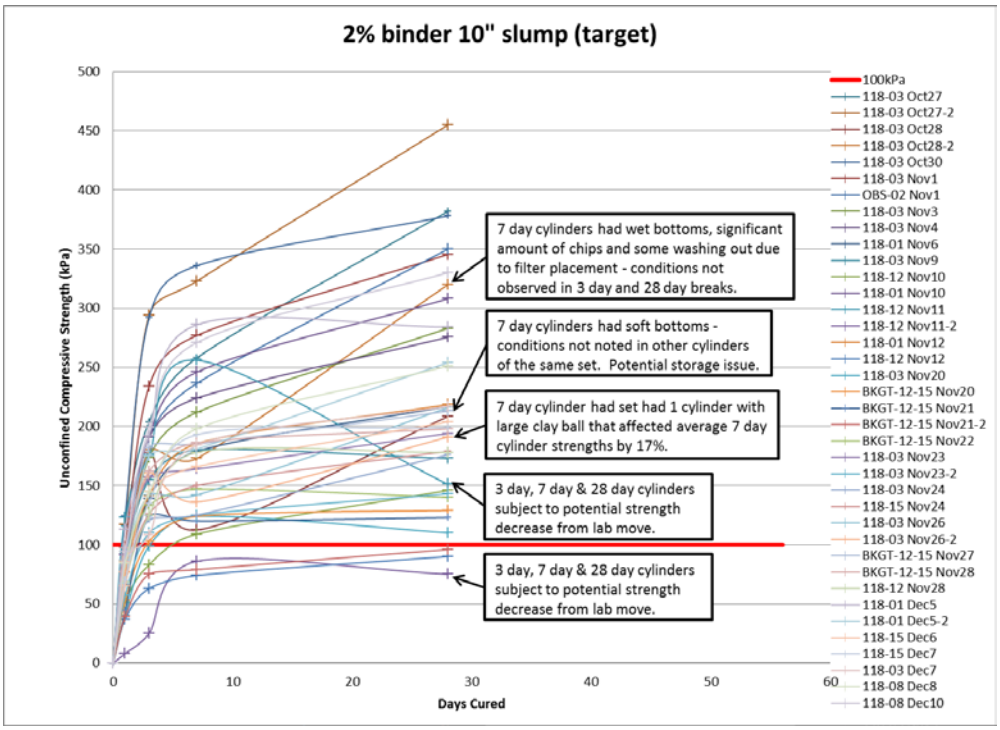

Figure 6: UCS Results- 2% Binder 10" Slump

Figure 7: UCS Results- 3% Binder 5" Slump

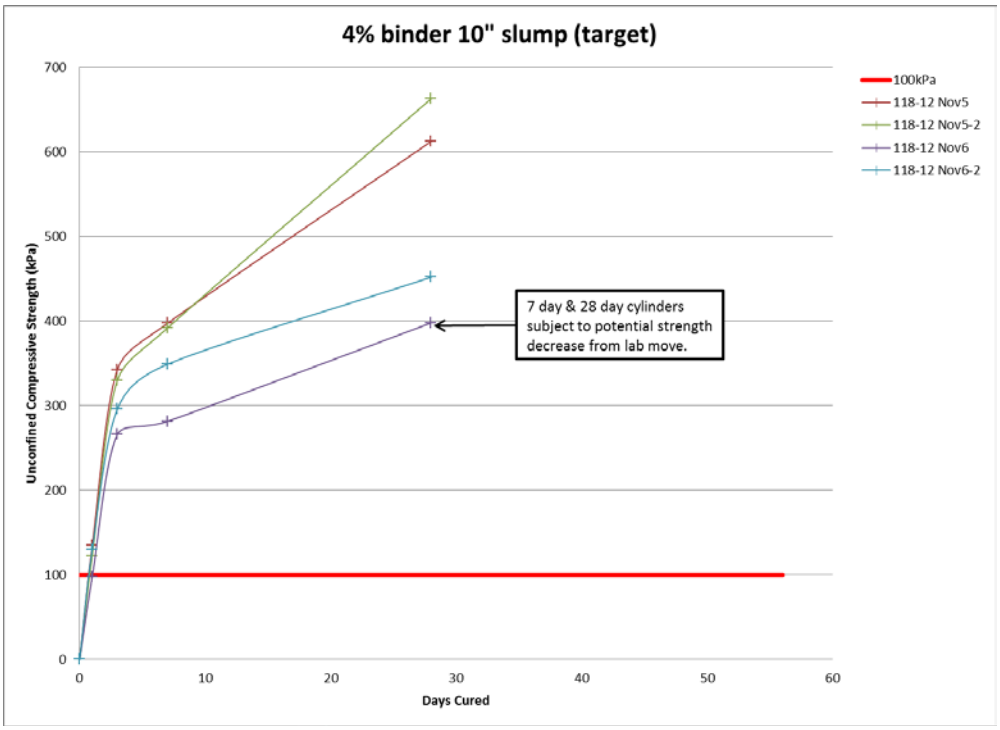

Figure 8: UCS Results- 4% Binder 10" Slump

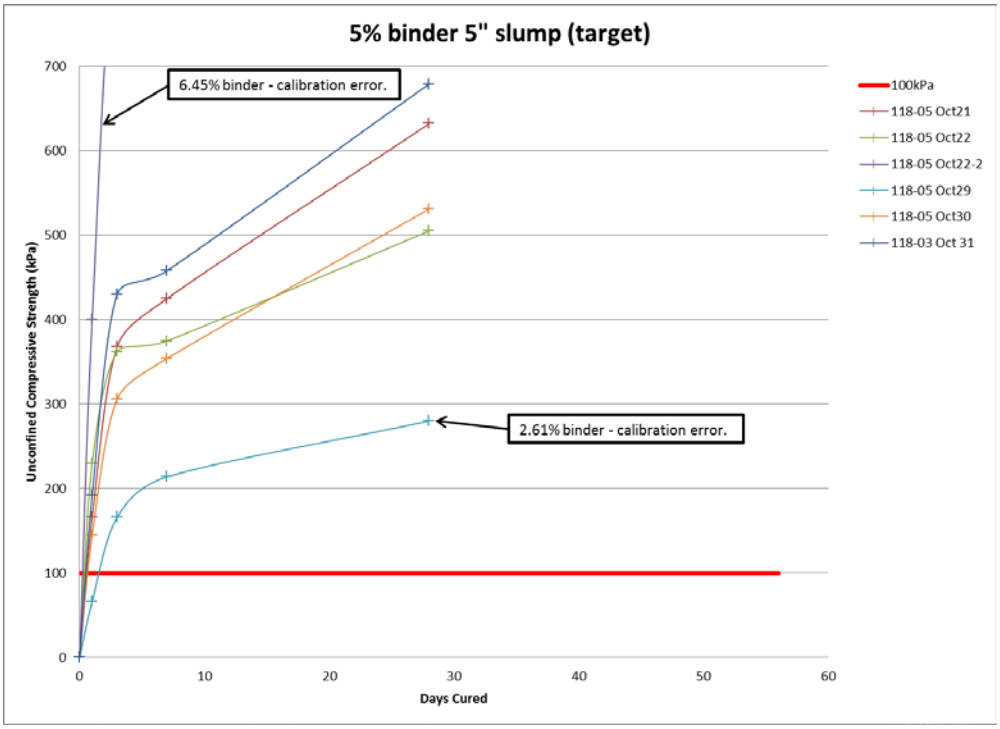

Figure 9: UCS Results- 5% Binder 5" Slump

Figure 10: UCS Results- 5% Binder 8" Slump

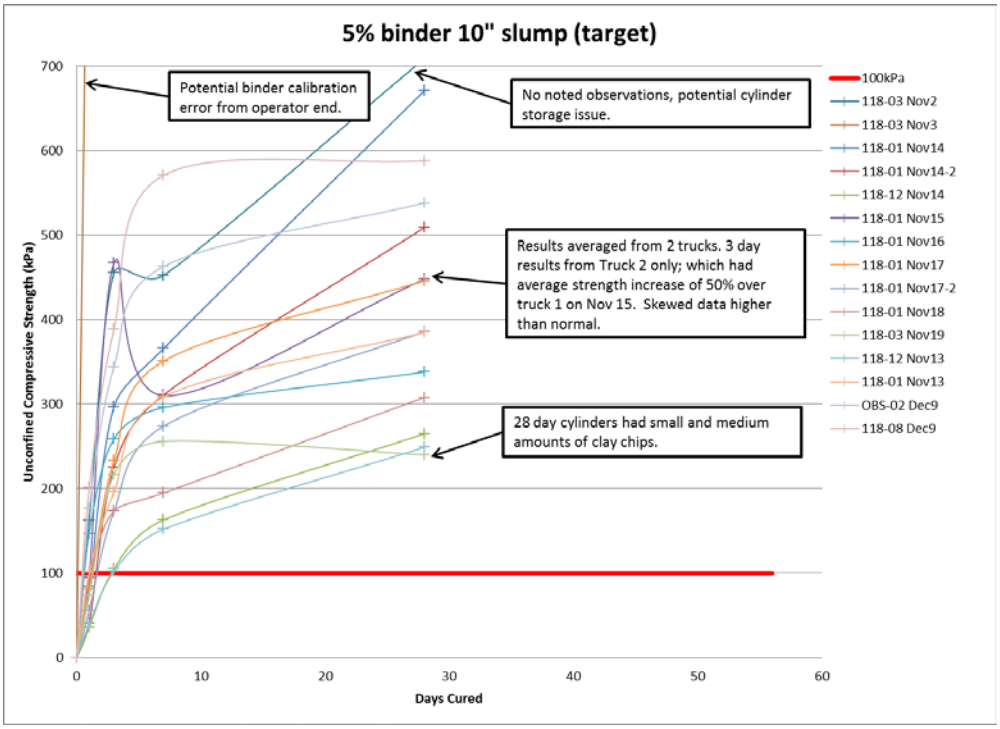

Figure 11: UCS Results- 5% Binder 10" Slump

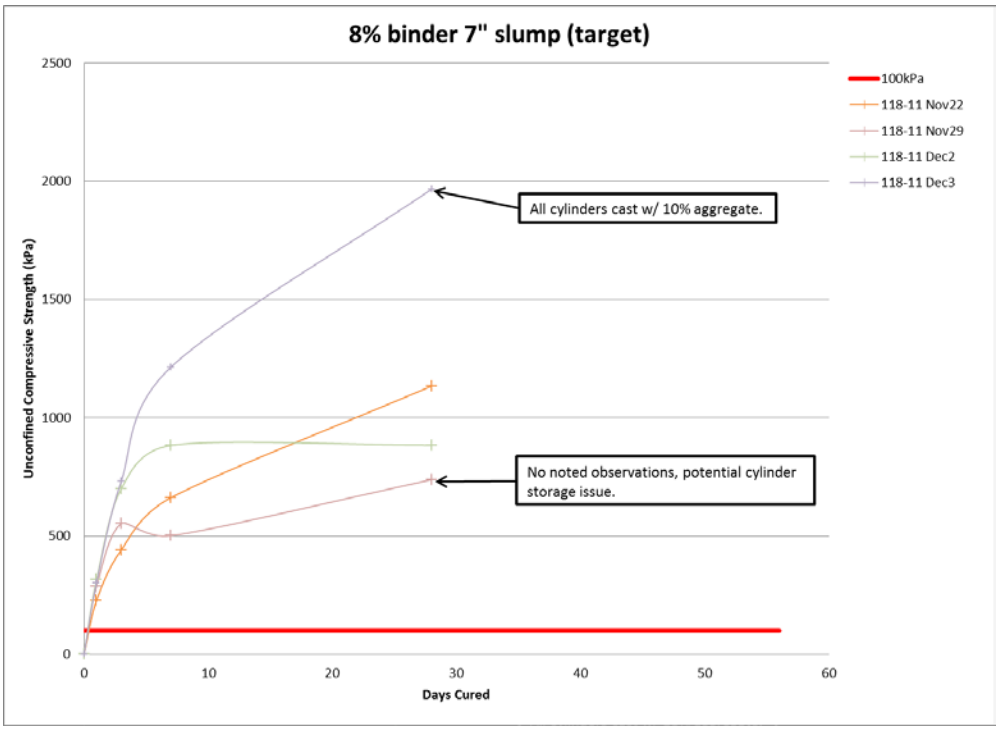

Figure 12: UCS Results- 8% Binder 7" Slump

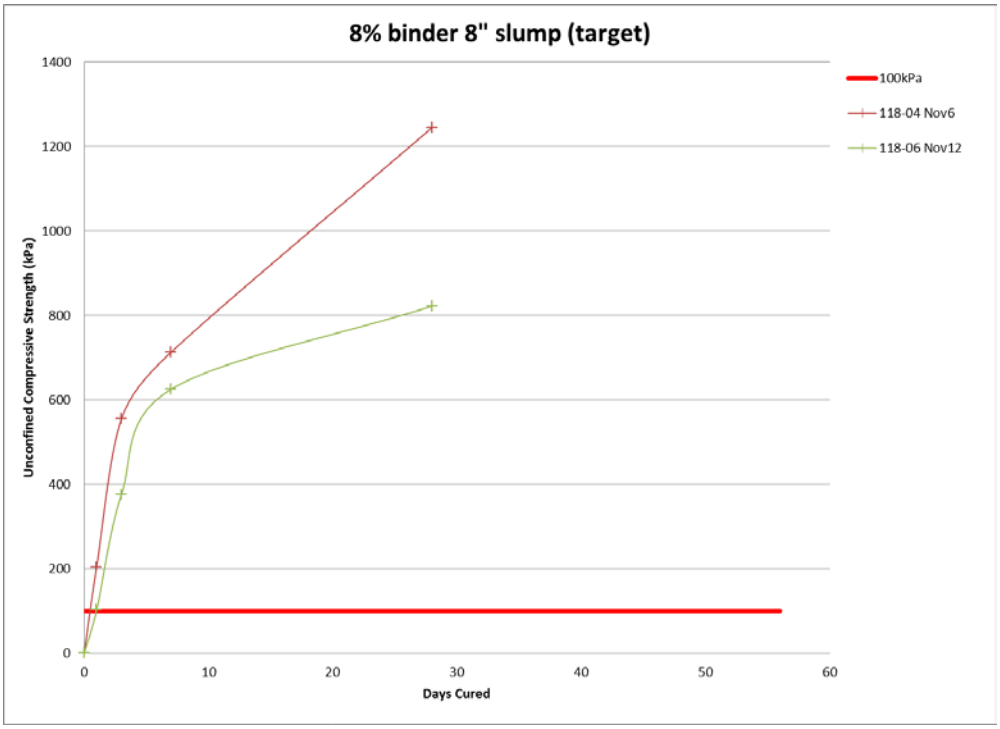

Figure 13: UCS Results- 8% Binder 8" Slump

Figure 14: UCS Results- 8% Binder 10" Slump

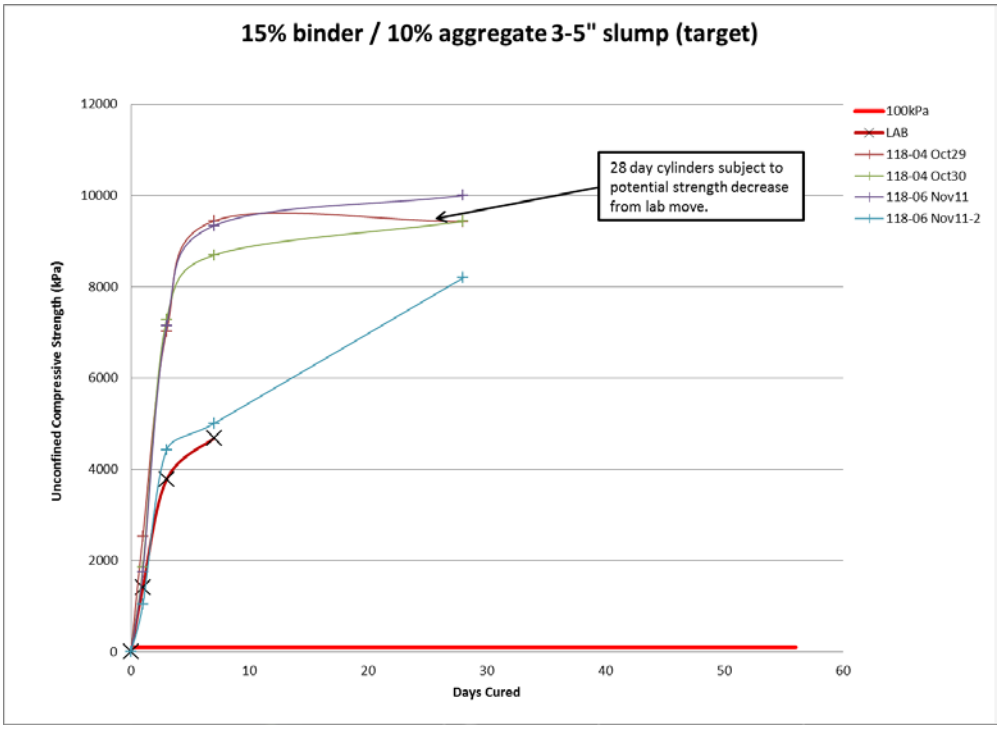

Figure 15: UCS Results- 15% Binder, 10% Aggregate 3-5" Slump

4.4 Observations

In addition to the factual evidence presented within the report, several anecdotal observations are noted in response to the results obtained. Appendix C displays anecdotal observations obtained during the cylinder breaks performed in the lab in a table format. Appendix D includes photographs of the observations discussed below along with commentary that further addresses these and other qualitative observations in a general manner. Observations of interest include; relocating lab, cylinder storage within the lab, drainage filter placement in cylinder mold, tailings content and temperature.

The largest disruption, and potentially biggest contributing factor to the results obtained, during the testing program is the relocation of the lab mid-way through production. This move had the potential to affect the strength in the 276 cylinders that were moved during their curing period (about 20% of the total amount of cylinders for the program). Cylinders subject to the move are noted in Appendix C. The potential for adverse effects on cylinder strength is increased the more they are handled. During the move, cylinders that were partially cured were re-loaded into coolers and transported to the new facility by road where they are subject to some degree of vibration. It is unknown to what extent the displacement had on the cylinder strengths however some cylinders that were part of the move were observed to have a reduction in strength from others within their set.

A large deal of effort had gone into maintaining appropriate conditions for cylinder curing in accordance with ASTM D2166. Both human and environmental conditions played a large role in what conditions the cylinders were subject to during their cure time. The cylinders were regularly moistened (one to two times daily) to keep humidity levels high relative to the dry ambient air. In addition to a physical spraying of water onto the cylinders; burlap and plastic wrap were used to both absorb moisture (slowing the dry time after a spray) and contain moisture condensate and keep it near the sample. Quality control of the process was insufficient during the first days of production resulting in a dryer, less humid curing chamber. Temperature also played a potential role concerning strengths developed over time. The lab in Golder's Yellowknife office did maintain an average temperature of 21 degrees centigrade with little deviation. In contrast, the lab and cylinder storage area at Giant's M.E.G. facility had observed temperatures varying from 15 to 30 degrees.

A control test was performed in the Golder Sudbury Laboratory to determine the effects of humidity and temperature. Cylinders were casted with 100% tailings plus 3% binder at 10" slump. The results are presented in table 4 below.

Table 4: Temperature Control Test

Sample I.D.	Curing Conditions	Strength (kPa)				
		Curing 1 day	Curing 3 day	Curing 7 days	Curing 28 days	Curing 56 days
100% 13-1426-0010 SP-TP 4+5+6	100% humid. 21°C - 25°C (Curing Chamber)	59	118	135	183	192
100% 13-1426-0010 SP-TP 4+5+6	4°C (Laboratory fridge)	Too soft	48	72	125	175
100% 13-1426-0010 SP-TP 4+5+6	30% humid. 20°C	41	97	164	228	369

Based on the control test results, the cylinders cured inside the fridge, in colder and dryer conditions than the other two sets, showed lower strengths results in the short and long term. Humidity seems to affect the strengths of the samples, as the samples placed in the curing chamber showed lower strength results in the long term. The higher strengths were obtained from the cylinders cured at laboratory ambient conditions, 30% humid and 20ºC

Outside ambient temperature could have also played a role in strength development of cylinders samples collected for the UCS testwork. Cylinders prepared in the field were often cast and stored outside in coolers. Sample material could range from 10°C to 2°C during casting and be subject to -25°C temperature for a period of 6 hours before being transported to the lab to cure in the curing chamber. This effect would be most prominent in the 1 day cylinder breaks as the cylinders had little time to thaw and cure before being subject to removal from their mold and loaded till failure; however all cylinders from a set affected by cold would have residual strength loss. This effect is strictly applicable to cylinders stored on surface and not applicable to production fill placed underground because of the temperature differences (sub-surface temperatures averaging 5°C).

Strength results may also have been affected by filter inclusion/placement within the cylinder mold. This was evident during UCS breaks as voids appeared in many of the cylinders tested with filters that were either improperly placed or missing altogether (prevalent during the first few days of production). The creation of the void is due to the displacement of tailings fines that washed out of the cylinder during initial water drainage. Filter placement did play a significant role in the few cylinders that were missing them. Strengths noted from cylinders labelled ‘BH118-05 trk1 morn’ showed a decrease in strength ranging from 25% to as much as 68% for cylinders without filters as compared to others in the same set with the filters. About 80 cylinders were affected by misplaced or missing filters.

Also affecting strength results were the contents of the cylinders. Many cylinders contained clay chunks that, depending on their size and quantity, had impacted the UCS result in an adverse manner. Some cylinders had clay chunks present so massive in diameter that the cylinder broke during removal from the mold. Another detrimental content was water in the form of ice which had the potential to delay/reduce the binder curing process resulting in weaker fill. The quality of the tailings being fed into the mix truck was constantly being monitored and daily moisture samples were taken as a precaution, in addition to long term storage being in an enclosed dome. This observation is difficult to quantify in terms of strength vs. cylinder contents however there is a strong indication that strength was adversely affected by a poorer mix, or greater content of chunks that existed with in a cylinder – some cylinders of a set not possessing any strength whatsoever while the others in the same set showed average results.

5.0 CLOSURE

If there are any questions regarding this report, please do not hesitate to contact the undersigned.

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APPENDIX A

UCS Strength Tables

Table 1: UCS Results – 100% Tailings + 2% Binder, 5" Slump

Time of Casting		Borehole	Wt.% Binder	Average UCS (kPa)				Average Bulk Density (kg/m^3)
				Curing 1 day	Curing 3 days	Curing 7 days	Curing 28 days	
Oct 31-13	AM	Plug_Deliv_118_05	2	112	229	265	340	2146.5
Nov 8-13	AM	P_Deliv_118_12	2	48	117	145	183	2088
Nov 8-13	PM	P_Deliv_118_12	2	63	92	117	168	2084

Table 2: UCS Testing Results – 100% Tailings + 2% Binder, 7" Slump

Time of Casting		Borehole	Wt.% Binder	Average UCS (kPa)				Average Bulk Density (kg/m^3)
				Curing 1 day	Curing 3 days	Curing 7 days	Curing 28 days	
Nov 7-13	AM	P_Deliv_118_12	2	63	148.5	150	209	2118
Nov 7-13	PM	P_Deliv_118_01	2	85.5	189	228	294.5	2052
Nov 25-13	AM	P_Deliv_118_15	2	60	97	105	146	2104
Nov 25-13	PM	P_Deliv_118_15	2	102	138	175	184	2124

Table 3: UCS Testing Results – 100% Tailings + 2% Binder, 10" Slump

Time of Casting		Borehole	Wt.% Binder	Average UCS (kPa)				Average Bulk Density (kg/m^3)
				Curing 1 day	Curing 3 days	Curing 7 days	Curing 28 days	
Oct 27-13	AM	P_Deliv_118_03	2	116	204	258	382	2168
Oct 27-13	PM	P_Deliv_118_03	2	117	294	323	455	2180
Oct 28-13	AM	P_Deliv_118_03	2	67	178	112.5	208.5	2130.5
Oct 28-13	PM	P_Deliv_118_03	2	67	180	173	320	2152
Oct 30-13	PM	P_Deliv_118_03	2	124	292	336	378	2136
Nov 1-13	PM	P_Deliv_118_03	2	97.5	234	277	345.5	2165
Nov 1-13	PM	OBS_118_02	2	94	191	236.5	350	2150
Nov 3-13	AM	P_Deliv_118_03	2	76.5	173.5	212	283	2145.5
Nov 4-13	PM	P_Deliv_118_03	2	92	190.5	224	275.5	2158
Nov 6-13	PM	P_Deliv_118_03	2	66	139	179	217	2159
Nov 7-13	AM	P_Deliv_118_03	2	72.5	187.5	239	286	2144
Nov 9-13	PM	P_Deliv_118_03	2	86	155	180	173	2127
Nov 10-13	AM	P_Deliv_118_03	2	51	83	109	146	2072
Nov 10-13	AM	P_Deliv_118_03	2	94	192	246	308	2126
Nov 11-13	PM	P_Deliv_118_03	2	123	176	256	151	2131
Nov 11-13	PM	P_Deliv_118_03	2	8	25	86	75	2012
Nov 12-13	AM	P_Deliv_118_03	2	76.5	141	185.5	218.5	2121

Time of Casting		Borehole	Wt.% Binder	Average UCS (kPa)				Average Bulk Density (kg/m^3)
				Curing 1 day	Curing 3 days	Curing 7 days	Curing 28 days	
Nov 12-13	PM	P_Deliv_118_03	2	37	63	74	90	2061
Nov 20-13	AM	P_Deliv_118_03	2	40	99	124	110	2046
Nov 20-13	AM	BKGT-12-15	2	53	103	124	129	2066
Nov 21-13	AM	BKGT-12-15	2	44	124	120	123	2068
Nov 21-13	PM	BKGT-12-15	2	39	75	79	96	2030
Nov 22-13	PM	BKGT-12-15	2	86	133	147	140	2137
Nov 23-13	AM	P_Deliv_118_03	2	91	157	164	194	2113
Nov 23-13	PM	P_Deliv_118_03	2	57	110	125	143	2097
Nov 24-13	AM	P_Deliv_118_03	2	69	121	125	176	2097
Nov 24-13	PM	P_Deliv_118_15	2	67	126	150	179	2098
Nov 26-13	AM	P_Deliv_118_03	2	82	142	142	216	2107
Nov 26-13	PM	P_Deliv_118_03	2	77	160	136	191	2124
Nov 27-13	PM	BKGT-12-15	2	87	182	185	213	2177
Nov 28-13	AM	BKGT-12-15	2	97	162	186	198	2157
Nov 28-13	PM	P_Deliv_118_12	2	68	125	178	178	2145
Dec 5-13	AM	P_Deliv_118_01	2	113	192	286	284	2188
Dec 5-13	PM	P_Deliv_118_01	2	67	175	181	254	2158
Dec 6-13	PM	P_Deliv_118_15	2	65	145	166	204	2171
Dec 7-13	AM	P_Deliv_118_15	2	70	135	193	199	2167
Dec 7-13	PM	P_Deliv_118_03	2	85	108	184	217	2182
Dec 8-13	AM	P_Deliv_118_08	2	84	144	198	251	2174
Dec 10-13	AM	P_Deliv_118_08	2	94	199	271	330	2199

Table 4: UCS Testing Results – 100% Tailings + 3% Binder, 5” Slump

Time of Casting		Borehole	Wt.% Binder	Average UCS (kPa)				Average Bulk Density (kg/m^3)
				Curing 1 day	Curing 3 days	Curing 7 days	Curing 28 days	
Oct 25-13	AM	Plug_Deliv_118_05	3	127.5	254.5	317	430.5	2145.5
Oct 25-13	PM	Plug_Deliv_118_05	3	109.5	252.5	339	429.5	2148.5
Oct 26-13	AM	Plug_Deliv_118_05	3	150	298.5	314	522.5	2159
Oct 26-13	PM	Plug_Deliv_118_05	3	99	188	248	356	2143.5

Table 5: UCS Testing Results – 100% Tailings + 4% Binder, 10" Slump

Time of Casting		Borehole	Wt.% Binder	Average UCS (kPa)				Average Bulk Density (kg/m^3)
				Curing 1 day	Curing 3 days	Curing 7 days	Curing 28 days	
Nov 5-13	AM	P_Deliv_118_12	4	135	342.5	397.5	612.5	2158.5
Nov 5-13	PM	P_Deliv_118_12	4	123	330	392	663	2150
Nov 6-13	AM	P_Deliv_118_12	4	98	266	281.5	398	2140.5
Nov 6-13	PM	P_Deliv_118_12	4	130	296	349	452	2140

Table 6: UCS Testing Results – 100% Tailings + 5% Binder, 5" Slump

Time of Casting		Borehole	Wt.% Binder	Average UCS (kPa)				Average Bulk Density (kg/m^3)
				Curing 1 day	Curing 3 days	Curing 7 days	Curing 28 days	
Oct 21-13	PM	Plug_Deliv_118_05	5	166	368	425	632	2192
Oct 22-13	AM	Plug_Deliv_118_05	5	230	362	375	505	2140
Oct 22-13	PM	Plug_Deliv_118_05	5	400	873	994	1385	2188
Oct 29-13	PM	Plug_Deliv_118_05	5	66.5	166	214	280	2094
Oct 30-13	PM	Plug_Deliv_118_05	5	145	306	354	531	2145
Oct 31-13	PM	P_Deliv_118_03	5	192	430	458	679	2144

Table 7: UCS Testing Results – 100% Tailings with 5% Binder, 8" Slump

Time of Casting		Borehole	Wt.% Binder	Average UCS (kPa)				Average Bulk Density (kg/m^3)
				Curing 1 day	Curing 3 days	Curing 7 days	Curing 28 days	
Nov 4-13	AM	P_Deliv_118_03	5	142	323	442	572	2142

Table 8: UCS Testing Results – 100% Tailings + 5% Binder, 10" Slump

Time of Casting		Borehole	Wt.% Binder	Average UCS (kPa)				Average Bulk Density (kg/m^3)
				Curing 1 day	Curing 3 days	Curing 7 days	Curing 28 days	
Nov 2-13	PM	P_Deliv_118_03	5	162.5	455.5	452.5	709	2175
Nov 3-13	PM	P_Deliv_118_03	5	1130	3872	3893	9552	2218
Nov 13-13	AM	P_Deliv_118_01	5	101	196	308.5	385	2086
Nov 13-13	PM	P_Deliv_118_12	5	40	102	152	249	2036
Nov 14-13	AM	P_Deliv_118_01	5	84	297	366	671	2085
Nov 14-13	PM	P_Deliv_118_01	5	41	225	311	509	2095
Nov 14-13	AM	P_Deliv_118_12	5	36	105	163	265	2053
Nov 15-13	AM	P_Deliv_118_01	5	95.5	467	310	448	2112

Time of Casting		Borehole	Wt.% Binder	Average UCS (kPa)				Average Bulk Density (kg/m^3)
				Curing 1 day	Curing 3 days	Curing 7 days	Curing 28 days	
Nov 16-13	AM	P_Deliv_118_01	5	147	259	296	338	2109
Nov 17-13	AM	P_Deliv_118_01	5	81	233	351	446	2092
Nov 17-13	PM	P_Deliv_118_01	5	56	173	274	386	2073
Nov 18-13	AM	P_Deliv_118_01	5	94	174	195	308	2102
Nov 19-13	AM	P_Deliv_118_03	5	73	217	256	240	2081
Dec 9-13	AM	OBS_118_02	5	176	344	463	538	2188
Dec 9-13	PM	P_Deliv_118_08	5	201	389	571	588	2189

Table 9: UCS Testing Results – 100% Tailings + 8% Binder, 7" Slump

Time of Casting		Borehole	Wt.% Binder	Average UCS (kPa)				Average Bulk Density (kg/m^3)
				Curing 1 day	Curing 3 days	Curing 7 days	Curing 28 days	
Nov 22-13	AM	P_Deliv_118_11	8	227	441	662	1134	2095
Nov 29-13	PM	P_Deliv_118_11	8	287	552	501	738	2139
Dec 2-13	AM	P_Deliv_118_11	8	315	700	883	884	2184

Table 10: UCS Testing Results – 100% Tailings + 8% Binder, 8"Slump

Time of Casting		Borehole	Wt.% Binder	Average UCS (kPa)				Average Bulk Density (kg/m^3)
				Curing 1 day	Curing 3 days	Curing 7 days	Curing 28 days	
Nov 6-13	AM	Plug_Deliv_118_04	8	204	555	713	1245	2135
Nov 12-13	AM	P_Deliv_118_06	8	102	376	625	822	2111

Table 11: UCS Testing Results – 100% Tailings + 8% Binder, 10" Slump

Time of Casting		Borehole	Wt.% Binder	Average UCS (kPa)				Average Bulk Density (kg/m^3)
				Curing 1 day	Curing 3 days	Curing 7 days	Curing 28 days	
Oct 31-13	PM	Plug_Deliv_118_04	8	206	685	906	1205	2202
Nov 1-13	AM	Plug_Deliv_118_04	8	185	519	690	1230	2143
Nov 2-13	AM	Plug_Deliv_118_04	8	236	550	673	1061	2138
Nov 3-13	AM	Plug_Deliv_118_04	8	232	561	712	909	2146
Nov 4-13	AM	Plug_Deliv_118_04	8	226	488	673	1102	2138
Nov 5-13	AM	Plug_Deliv_118_04	8	186	485	724	1132	2148

Table 12: UCS Testing Results – 90% Tailings, 10% Aggregate + 8% Binder, 7" Slump

Time of Casting		Borehole	Wt.% Binder	Average UCS (kPa)				Average Bulk Density (kg/m^3)
				Curing 1 day	Curing 3 days	Curing 7 days	Curing 28 days	
Dec 3-13	PM	P_Deliv_118_11	8	302	733	1214	1967	2354

Table 13: UCS Testing Results – 90% Tailings, 10% Aggregate + 15% Binder, 3-5" Slump

Time of Casting		Borehole	Wt.% Binder	Average UCS (kPa)				Average Bulk Density (kg/m^3)
				Curing 1 day	Curing 3 days	Curing 7 days	Curing 28 days	
Oct 29-13	PM	Plug_Deliv_118_04	15	2517	7017	9440	9426	2351
Oct 30-13	AM	Plug_Deliv_118_04	15	1848	7284	8693	9431	2309
Nov 11-13	AM	P_Deliv_118_06	15	1752	7139	9337	10000	2267
Nov 11-13	PM	P_Deliv_118_06	15	1034	4422	5005	8195	2242

APPENDIX B

UCS Strength Tables Target vs. Actual

Table 1: UCS Results – 100% Tailings + 2% Binder, 5" Slump

Time of Casting		Borehole	Target Wt.% Binder	Actual Wt.% Binder	Target Slump	Actual Slump @ test
Oct 31-13	AM	Plug_Deliv_118_05	2	2.68	5	7.5,6
Nov 8-13	AM	P_Deliv_118_12	2	2.44	5	4.5
Nov 8-13	PM	P_Deliv_118_12	2	2.44	5	6

Table 2: UCS Testing Results – 100% Tailings + 2% Binder, 7" Slump

Time of Casting		Borehole	Target Wt.% Binder	Actual Wt.% Binder	Target Slump	Actual Slump @ test
Nov 7-13	AM	P_Deliv_118-12	2	2.41,2.59	7	7.5,8.25
Nov 7-13	PM	P_Deliv_118-01	2	2.41,2.59	7	10.25,7.5
Nov 25-13	AM	P_Deliv_118-15	2	2.35	7	6
Nov 25-13	PM	P_Deliv_118-15	2	2.35	7	7.75

Table 3: UCS Testing Results – 100% Tailings + 2% Binder, 10" Slump

Time of Casting		Borehole	Target Wt.% Binder	Actual Wt.% Binder	Target Slump	Actual Slump @ test
Oct 27-13	AM	P_Deliv_118-03	2	3.14,2.78	10	10,9.5
Oct 27-13	PM	P_Deliv_118-03	2	2.78	10	9.5
Oct 28-13	AM	P_Deliv_118-03	2	2.61,3.34	10	10,9.75
Oct 28-13	PM	P_Deliv_118-03	2	2.61,3.34	10	9.5
Oct 30-13	PM	P_Deliv_118-03	2	2.68	10	9.5
Nov 1-13	PM	P_Deliv_118-03	2	2.68	10	10,10
Nov 1-13	PM	OBS_118_02	2	2.79,2.08	10	10,10
Nov 3-13	AM	P_Deliv_118-03	2	2.26,2.50	10	10,9
Nov 4-13	PM	P_Deliv_118-03	2	2.26,2.13	10	9.5,9.5
Nov 6-13	PM	P_Deliv_118-01	2	1.94,2.11	10	10.5
Nov 7-13	AM	P_Deliv_118-01	2	2.41,2.59	10	10,10
Nov 9-13	PM	P_Deliv_118-03	2	2.43	10	10
Nov 10-13	AM	P_Deliv_118-12	2	2.43	10	9.75
Nov 10-13	AM	P_Deliv_118-01	2	2.43	10	9.5
Nov 11-13	PM	P_Deliv_118-12	2	2.43,2.56	10	9.75
Nov 11-13	PM	P_Deliv_118-12	2	2.43,2.56	10	10.25
Nov 12-13	AM	P_Deliv_118-01	2	2.43,2.26	10	10.5,9.75
Nov 12-13	PM	P_Deliv_118-12	2	2.26	10	9
Nov 20-13	AM	P_Deliv_118-03	2	2.35	10	9.5
Nov 20-13	AM	BKGT-12-15	2	2.35	10	10

Time of Casting		Borehole	Target Wt.% Binder	Actual Wt.% Binder	Target Slump	Actual Slump @ test
Nov 21-13	AM	BKGT-12-15	2	2.35	10	10
Nov 21-13	PM	BKGT-12-15	2	2.35	10	8.75
Nov 22-13	PM	BKGT-12-15	2	2.35	10	10.75
Nov 23-13	AM	P_Deliv_118-03	2	2.35	10	10.25
Nov 23-13	PM	P_Deliv_118-03	2	2.35	10	9.25
Nov 24-13	AM	P_Deliv_118-03	2	2.35	10	10
Nov 24-13	PM	P_Deliv_118-15	2	2.35	10	10
Nov 26-13	AM	P_Deliv_118-03	2	2.35	10	NA
Nov 26-13	PM	P_Deliv_118-03	2	2.35	10	NA
Nov 27-13	PM	BKGT12-15	2	2.06	10	9
Nov 28-13	AM	BKGT12-15	2	2.60	10	10.5
Nov 28-13	PM	P_Deliv_118-12	2	2.60	10	11
Dec 5-13	AM	P_Deliv_118-01	2	2.24	10	10.25
Dec 5-13	PM	P_Deliv_118-01	2	2.24	10	10.75
Dec 6-13	PM	P_Deliv_118-15	2	2.24	10	NA
Dec 7-13	AM	P_Deliv_118-15	2	2.24	10	9.5
Dec 7-13	PM	P_Deliv_118-03	2	2.24	10	8.5
Dec 8-13	AM	P_Deliv_118-08	2	2.00	10	10.25
Dec 10-13	AM	P_Deliv_118-08	2	2.34	10	9.5

Table 4: UCS Testing Results – 100% Tailings + 3% Binder, 5” Slump

Time of Casting		Borehole	Target Wt.% Binder	Actual Wt.% Binder	Target Slump	Actual Slump @ test
Oct 25-13	AM	Plug_Deliv_118-05	3	3.05	5	NA
Oct 25-13	PM	Plug_Deliv_118-05	3	3.05	5	NA
Oct 26-13	AM	Plug_Deliv_118-05	3	3.05	5	5,5.75
Oct 26-13	PM	Plug_Deliv_118-05	3	3.05	5	5,5.75

Table 5: UCS Testing Results – 100% Tailings + 4% Binder, 10” Slump

Time of Casting		Borehole	Target Wt.% Binder	Actual Wt.% Binder	Target Slump	Actual Slump @ test
Nov 5-13	AM	P_Deliv_118-12	4	3.95,3.90	10	10,10
Nov 5-13	PM	P_Deliv_118-12	4	3.95,3.90	10	10.25
Nov 6-13	AM	P_Deliv_118-12	4	4.51,4.18	10	10.5,10.25
Nov 6-13	PM	P_Deliv_118-12	4	4.51,4.18	10	10.25

Table 6: UCS Testing Results – 100% Tailings + 5% Binder, 5” Slump

Time of Casting		Borehole	Target Wt.% Binder	Actual Wt.% Binder	Target Slump	Actual Slump @ test
Oct 21-13	PM	Plug_Deliv_118-05	5	6.23	5	6.5
Oct 22-13	AM	Plug_Deliv_118-05	5	6.45	5	5.75
Oct 22-13	PM	Plug_Deliv_118-05	5	6.45	5	7.5
Oct 29-13	PM	Plug_Deliv_118-05	5	2.61	5	5
Oct 30-13	PM	Plug_Deliv_118-05	5	5.01	5	8
Oct 31-13	PM	P_Deliv_118-03	5	5.30	5	6.25

Table 7: UCS Testing Results – 100% Tailings + 5% Binder, 8” Slump

Time of Casting		Borehole	Target Wt.% Binder	Actual Wt.% Binder	Target Slump	Actual Slump @ test
Nov 4-13	AM	P_Deliv_118-03	5	5.42	8	8.75

Table 8: UCS Testing Results – 100% Tailings + 5% Binder, 10” Slump

Time of Casting		Borehole	Target Wt.% Binder	Actual Wt.% Binder	Target Slump	Actual Slump @ test
Nov 2-13	PM	P_Deliv_118-03	5	5.44	10	9.5,9.5
Nov 3-13	PM	P_Deliv_118-03	5	5.42	10	7.25
Nov 13-13	AM	P_Deliv_118-01	5	5.51,5.82	10	10.5,10
Nov 13-13	PM	P_Deliv_118-12	5	5.51,5.82	10	10.75
Nov 14-13	AM	P_Deliv_118-01	5	5.51,5.82	10	10
Nov 14-13	PM	P_Deliv_118-01	5	5.51,5.82	10	10
Nov 14-13	AM	P_Deliv_118-12	5	5.51,5.82	10	8.75
Nov 15-13	AM	P_Deliv_118-01	5	5.51,5.82	10	10.25,9.75
Nov 16-13	AM	P_Deliv_118-01	5	5.51,5.82	10	10
Nov 17-13	AM	P_Deliv_118-01	5	5.82	10	9.75
Nov 17-13	PM	P_Deliv_118-01	5	5.82	10	10
Nov 18-13	AM	P_Deliv_118-01	5	5.82	10	11
Nov 19-13	AM	P_Deliv_118-03	5	5.82	10	9
Dec 9-13	AM	OBS_118_02	5	5.29	10	10.75
Dec 9-13	PM	P_Deliv_118-08	5	5.29	10	9.75

Table 9: UCS Testing Results – 100% Tailings + 8% Binder, 7” Slump

Time of Casting		Borehole	Target Wt.% Binder	Actual Wt.% Binder	Target Slump	Actual Slump @ test
Nov 22-13	AM	P_Deliv_118-11	8	8.05	7	7
Nov 29-13	PM	P_Deliv_118-11	8	8.21	7	7.5
Dec 2-13	AM	P_Deliv_118-11	8	7.69	7	8
Dec 3-13	PM	P_Deliv_118-11	8	7.44	7	7.5

Table 10: UCS Testing Results – 100% Tailings + 8% Binder, 8”Slump

Time of Casting		Borehole	Target Wt.% Binder	Actual Wt.% Binder	Target Slump	Actual Slump @ test
Nov 6-13	AM	Plug_Deliv_118-04	8	8.35	8	7.75
Nov 12-13	AM	P_Deliv_118-06	8	8.67	8	9.5

Table 11: UCS Testing Results – 100% Tailings + 8% Binder, 10” Slump

Time of Casting		Borehole	Target Wt.% Binder	Actual Wt.% Binder	Target Slump	Actual Slump @ test
Oct 31-13	PM	Plug_Deliv_118-04	8	8.09	10	8
Nov 1-13	AM	Plug_Deliv_118-04	8	8.09	10	10
Nov 2-13	AM	Plug_Deliv_118-04	8	8.22	10	10.5
Nov 3-13	AM	Plug_Deliv_118-04	8	7.68	10	10.5
Nov 4-13	AM	Plug_Deliv_118-04	8	7.82	10	10
Nov 5-13	AM	Plug_Deliv_118-04	8	7.67	10	10

Table 12: UCS Testing Results – 90% Tailings, 10% Aggregate + 15% Binder, 3-5” Slump

Time of Casting		Borehole	Target Wt.% Binder	Actual Wt.% Binder	Target Slump	Actual Slump @ test
Oct 29-13	PM	Plug_Deliv_118-04	15	16.13	3-5	4
Oct 30-13	AM	Plug_Deliv_118-04	15	16.13	3-5	2.5
Nov 11-13	AM	P_Deliv_118-06	15	16.13	3-5	3.75
Nov 11-13	PM	P_Deliv_118-06	15	16.13	3-5	3

APPENDIX C

Observations

Table 1: UCS Results – Observations

Time of Casting		Borehole	Day	Moved during cure	Observations
Oct 21-13	PM	P_ Deliv_118_05 trk#1	1	N	All Cylinders without filter.
			3	N	All Cylinders without filter.
			7	N	All Cylinders without filter.
			28	Y	All Cylinders without filter.
Oct 22-13	AM	P_ Deliv_118_05 trk#1	1	N	Cylinder #2 without filter.
			3	N	Cylinder #3 without filter, clay balls in all cylinders.
			7	N	Cylinder #1 without filter, clay balls in cylinder #1, break propagated from fines void.
			28	Y	Cylinder #3 without filter, break propagated from fines void.
Oct 22-13	PM	P_ Deliv_118_05 trk#1	1	N	Cylinder #1 without filter.
			3	N	Cylinder #1 without filter.
			7	N	Cylinder #2 without filter.
			28	Y	Cylinder #3 without filter.
Oct 25-13	AM	P_ Deliv_118_05 trk#1	28	N	One 28 day result is weaker than 7 day's - significant amount of medium size clay in that cylinder.
Oct 25-13	PM	P_ Deliv_118_05 trk#1	28	N	Most cracks appeared on top 1/4 of the cylinder. Large void in cylinder 3.
Oct 25-13	AM	P_ Deliv_118_05 trk#2	28	N	Aggregate observed in the cylinders.
Oct 25-13	PM	P_ Deliv_118_05 trk#2	28	Y	Aggregate observed in the cylinders.
Oct 26-13	PM	P_ Deliv_118_05 trk#1	1	N	Holes drilled late in bottom of cylinder.
			3	N	No drain holes drilled.
			7	N	Cylinder #1 no drain holes drilled.
Oct 26-13	PM	P_ Deliv_118_05 trk#2	1	N	Holes drilled late in bottom of cylinder.
Oct 27-13	AM	P_ Deliv_118_03 trk#1	3	N	Cylinder #3 test ran improperly, excluded from data.
Oct 27-13	AM	P_ Deliv_118_03 trk#2	28	Y	Cylinder #1 appears dryer than other cylinders.

Time of Casting		Borehole	Day	Moved during cure	Observations
Oct 28-13	AM	P_ Deliv_118_03 trk#1	1	N	All cylinders without filter. Cylinder#1 Crumbling bottom, Cylinder #2&3 wet bottom removed before test.
			3	N	All cylinders without filter. No observed abnormalities.
			7	N	All cylinders without filter. Cylinder #1&2 wet bottom removed before test, Cylinder #3 had silt washout leaving hole.
			28	Y	All cylinders without filter. No observed abnormalities.
Oct 28-13	AM	P_ Deliv_118_03 trk#2	1	N	All cylinders without filter. Cylinder #3 had washout pockets, no test.
			3	N	All cylinders without filter.
			7	N	All cylinders without filter. Cylinder #1 significant silt chips. Cylinder #2 holes in cylinder from washout
			28	Y	All cylinders without filter. No observed abnormalities.
Oct 28-13	PM	P_ Deliv_118_03 trk#2	1	N	All cylinders without filter. No observed abnormalities.
			3	N	All cylinders without filter. No observed abnormalities.
			7	N	All cylinders without filter. Soft bottom.
			28	Y	All cylinders without filter. No observed abnormalities.
Oct 29-13	PM	P_ Deliv_118_04 trk#2	28	Y	No observed abnormalities. Cylinders stronger than load frame
Oct 30-13	AM	P_ Deliv_118_04 trk#1	28	Y	No observed abnormalities. Cylinders stronger than load frame.
Nov 1-13	PM	OBS_118_02 trk#1	28	Y	Cylinder #2 small piece of wood in cylinder, no effect on strength.
Nov 1-13	PM	OBS_118_02 trk#2	7	N	Cylinder #3 silt chips with water.
Nov 1-13	PM	P_ Deliv_118_03 trk#1	28	Y	Cylinder #3 lots of small silt and clay chunks.
Nov 2-13	PM	P_ Deliv_118_03 trk#1	1	N	Cylinder #2 cut short for testwork
			3	N	Cylinder #3 without filter.
			28	Y	All cylinders medium sized clay balls along break. Cylinder #2&3 without filter.

Time of Casting		Borehole	Day	Moved during cure	Observations
Nov 2-13	PM	P_ Deliv_118_03 trk#2	1	N	Cylinder #2&3 without filter.
			28	Y	Cylinder #1 half filter. Cylinder #2&3 medium sized clay balls along break.
Nov 2-13	AM	P_ Deliv_118_04 trk#2	28	Y	Cylinder #2 half filter, mass less than smaller cylinders indicating loss of fines through filter misplacement.
Nov 3-13	AM	P_ Deliv_118_03 trk#1	1	N	Cylinder #1 cut short for testwork.
Nov 3-13	PM	P_ Deliv_118_03 trk#1	7	N	Cylinder #3 large sized clay balls.
			28	Y	No observed abnormalities. Cylinder #1&3 stronger than load frame.
Nov 3-13	AM	P_ Deliv_118_04 trk#2	1	N	Cylinder #2 without filter
Nov 4-13	AM	P_ Deliv_118_03 trk#1	28	Y	Cylinder #3 medium sized clay balls.
Nov 4-13	PM	P_ Deliv_118_03 trk#1	28	Y	Cylinder #2 large sized clay in bottom of cylinder at break propagation.
Nov 5-13	AM	P_ Deliv_118_04 trk#2	28	Y	Cylinder #2 medium sized clay balls. Cylinder #3 large sized clay ball.
Nov 5-13	AM	P_ Deliv_118_12 trk#2	7	N	Cylinder #3 without filter.
			28	Y	All cylinders small clay balls throughout.
Nov 5-13	PM	P_ Deliv_118_12 trk#1	28	Y	All cylinders small clay balls throughout.
Nov 6-13	PM	P_ Deliv_118_01 trk#1	1	N	Cylinder #1&3 soft bottom.
			28	Y	Cylinder #3 during removal from mold.
Nov 6-13	AM	P_ Deliv_118_04 trk#2	28	Y	All cylinders small clay balls throughout.
Nov 6-13	AM	P_ Deliv_118_12 trk#1	1	N	Cylinder #2 half filter, cut short for testwork.
Nov 6-13	AM	P_ Deliv_118_12	28	Y	Cylinder #1 medium sized clay ball.

Time of Casting		Borehole	Day	Moved during cure	Observations
		trk#2			
Nov 7-13	AM	P_ Deliv_118_01 trk#1	28	Y	All cylinders medium sized clay balls.
Nov 7-13	AM	P_ Deliv_118_01 trk#2	28	Y	All cylinders small sized clay balls.
Nov 7-13	PM	P_ Deliv_118_01 trk#1	28	Y	Cylinder #1 small sized clay balls. Cylinder #2&3 medium sized clay balls.
Nov 7-13	AM	P_ Deliv_118_12 trk#2	28	Y	All cylinders small sized clay balls.
Nov 8-13	AM	P_ Deliv_118_12 trk#1	28	Y	Cylinder #2 missing bottom edge. Cylinder #2&3 without filter.
Nov 9-13	PM	P_ Deliv_118_03 trk#1	3	N	Cylinder #1&2 without filter.
			28	Y	Cylinder #2 1 medium sized clay ball.
Nov 10-13	AM	P_ Deliv_118_01 trk#1	7	Y	Cylinder #3 without filter.
Nov 10-13	AM	P_ Deliv_118_12 trk#1	1	N	All cylinders liquefy with vibration.
Nov 11-13	PM	P_ Deliv_118_12 trk#1	1	N	Cylinder #3 missing bottom edge.
			3	Y	Cylinder #3 without filter.
			7	Y	Cylinder #3 without filter.
			28	Y	All cylinders lots of small sized clay balls. Cylinder #1 without filter.
Nov 11-13	PM	P_ Deliv_118_12 trk#1 2:30	1	N	No observed abnormalities. Penetrometer used.
			3	Y	Cylinder #1 missing bottom edge. Cylinder #3 broke in half during removal from mold, water pockets in cylinder.
			28	Y	All cylinders lots of medium and small sized clay balls.
Nov 11-13	AM	P_ Deliv_118_06 trk#2	28	Y	No observed abnormalities. Cylinders stronger than load frame.
Nov 11-	PM	P_	1	N	Cylinder #3 without filter.

Time of Casting		Borehole	Day	Moved during cure	Observations
13		Deliv_118_06 trk#2	28	Y	Cylinder #2 medium sized clay ball. Cylinder #2 stronger than load frame.
Nov 12-13	AM	P_ Deliv_118_01 trk#2	28	N	All cylinders small sized clay balls.
Nov 12-13	PM	P_ Deliv_118_12 Trk#1	28	N	Cylinder #2 large clay ball
Nov 12-13	PM	P_ Deliv_118_06 trk#2	28	N	All cylinders small sized clay chips
Nov 13-13	AM	P_ Deliv_118_01 Trk#1	1	N	Cylinder #2 clay balls.
			3	N	Cylinder #3 clay balls.
			28	N	Cylinder #1 moist. Cylinder #2 large sized clay ball.
Nov 13-13	AM	P_ Deliv_118_01 Trk#2	1	N	Cylinder #1 filter not placed properly, poorly formed cylinder.
			3	N	Cylinder #2 poorly formed cylinder.
			28	N	Cylinder #1&2 large clay ball.
Nov 13-13	PM	P_ Deliv_118_12 trk#1	1	N	All cylinders lots of clay balls.
			3	N	All cylinders lots of clay balls.
			28	N	All cylinders lots of clay balls.
Nov 14-13	AM	P_ Deliv_118_01 trk#1	1	N	Cylinder #1 large sized clay ball.
			28	N	All cylinders lots of clay balls.
Nov 14-13	AM	P_ Deliv_118_12 trk#1	28	N	All cylinders lots of clay balls.
Nov 14-13	PM	P_ Deliv_118_01 trk#2	28	N	Cylinder #1&2 medium sized clay balls.
Nov 15-13	AM	P_ Deliv_118_01 trk#1	1	N	Cylinder #3 huge sized clay ball, no test performed.
			3	N	No 3 day cylinders cast.
			7	N	Cylinder #2 small hole on middle surface of cylinder.
			28	N	Cylinder #1 huge sized clay ball. Cylinder #2&3 medium sized clay balls.
Nov 15-13	AM	P_ Deliv_118_01	28	N	Cylinder #1 2 large sized clay balls. Cylinder #2&3 several clay chips.

Time of Casting		Borehole	Day	Moved during cure	Observations
		trk#2			
Nov 16-13	AM	P_ Deliv_118_01 trk#1	28	N	All cylinders lots of small sized clay balls.
Nov 17-13	AM	P_ Deliv_118_01 trk#2	28	N	Cylinder #1&3 large sized clay ball. Cylinder #2 lots of small sized clay balls.
Nov 17-13	PM	P_ Deliv_118_01 trk#2	28	N	All cylinders lots of small sized clay balls.
Nov 18-13	AM	P_ Deliv_118_01 trk#1	28	N	Cylinder #1 huge sized clay ball. Cylinder #2&3 lots of clay chips.
Nov 19-13	AM	P_ Deliv_118_03 trk#1	28	N	All cylinders lots of clay chips.
Nov 20-13	AM	P_ Deliv_118_03 trk#1	28	N	All cylinders lots of small sized clay balls. Cylinder #2 some medium sized clay balls.
Nov 20-13	PM	BKGT_12_15 trk#1	28	N	All cylinders lots of small sized clay balls.
Nov 21-13	AM	BKGT_12_15 trk#1	28	N	All cylinders lots of small sized clay chips, very soft.
Nov 21-13	PM	BKGT_12_15 trk#1	28	N	Cylinder #1&3 lots of large sized clay throughout. Cylinder #2 small sized clay chips.
Nov 22-13	AM	P_ Deliv_118_11 trk#2	7	N	Cylinder #1 large sized clay ball at break.
			28	N	All cylinders medium sized clay balls, bi-color.
Nov 22-13	PM	BKGT_12_15 trk#1	7	N	Cylinder #2 large sized clay ball at break.
			28	N	All cylinders small sized clay balls.
Nov 23-13	AM	P_ Deliv_118_03 trk#1	7	N	Cylinder #1&2 medium sized clay balls.
			28	N	All cylinders small sized clay balls. Cylinder #3 small piece of wood.
Nov 23-13	PM	P_ Deliv_118_03 trk#1	28	N	All cylinders small sized clay balls.
Nov 24-13	AM	P_ Deliv_118_03 trk#1	7	N	Cylinder #3 very poorly marked label.
			28	N	Cylinder # 1&3 small sized clay balls. Cylinder #2 medium sized clay balls.
Nov 24-	PM	P_	7	N	Cylinder #3 large sized clay balls.

Time of Casting		Borehole	Day	Moved during cure	Observations
13		Deliv_118_15 trk#1	28	N	All cylinders small and medium sized clay balls.
Nov 25-13	AM	P_ Deliv_118_15 trk#1	7	N	All cylinders medium sized clay chunks throughout.
Nov 25-13	PM	P_ Deliv_118_15 trk#1	28	N	All cylinders small sized clay balls.
Nov 26-13	AM	P_ Deliv_118_03 trk#1	7	N	Cylinder #3 huge clay ball at break.
			28	N	All cylinders small sized clay balls.
Nov 26-13	PM	P_ Deliv_118_03 trk#1	3	N	All cylinders very small silt and clay balls.
			7	N	Cylinder #1 huge sized clay ball.
Nov 27-13	PM	BKGT_12_15 trk#2	28	N	Cylinder #1&3 medium sized clay balls. Cylinder #2 small sized clay balls.
Nov 28-13	AM	BKGT_12_15 trk#1	3	N	All cylinders few small sized clay chunks
			7	N	Cylinder #3 power interruption mid-way through test, restarted – likely effect on axial strain.
			28	N	All cylinders few small sized clay chunks.
Nov 28-13	PM	P_ Deliv_118_12 trk#1	1	N	Cylinder #2 poor filter placement, some washout occurring.
			3	N	Cylinder #1&2 medium sized clay balls.
			28	N	All cylinders medium sized clay balls.
Nov 29-13	PM	P_ Deliv_118_11 trk#2	28	N	All cylinders medium sized clay chunks.
Dec 2-13	AM	P_ Deliv_118_11 trk#2	3	N	Cylinder #1 2 medium sized clay balls at break.
			7	N	Cylinder #2 with 2 filters. Cylinder #3 without filter.
			28	N	All cylinders small and medium sized clay balls.
Dec 5-13	AM	P_ Deliv_118_01 trk#1	1	N	All cylinders few small sized clay balls.
			3	N	All cylinders few small sized clay balls.
			28	N	All cylinders medium sized clay balls.
Dec 5-13	PM	P_ Deliv_118_01 trk#1	1	N	Cylinder #1 half filter.
			28	N	All cylinders medium sized clay balls.
Dec 6-13	PM	P_ Deliv_118_15 trk#1	1	N	Cylinder #3 missing bottom 1/3
			7	N	Cylinder #1&3 small sized clay balls.
			28	N	All cylinders small sized clay balls.

Time of Casting		Borehole	Day	Moved during cure	Observations
Dec 7-13	AM	P_ Deliv_118_15 trk#1	7	N	Cylinder #2 medium sized clay ball. Cylinder #3 layer of clay.
			28	N	Cylinder #3 1 medium sized clay ball.
Dec 7-13	PM	P_ Deliv_118_03 trk#1	3	N	Cylinder #1&2 medium sized clay ball.
			7	N	Cylinder #2 1 medium sized clay ball.
			28	N	All cylinders some clay.
Dec 8-13	AM	P_ Deliv_118_08 trk#1	7	N	All cylinders few clay chips inside of cylinders.
			28	N	All cylinders small sized clay balls.
Dec 9-13	PM	P_ Deliv_118_08 trk#1	1	N	Cylinder #2 some clay. Cylinder #3 large sized clay ball.
			3	N	Cylinder #1&2 some clay.
			7	N	Cylinder #1&3 some clay chips. Cylinder #2 2 medium sized clay balls.
			28	N	All cylinders medium sized clay balls.
Dec 9-13	AM	OBS_118_02 trk#1	1	N	Cylinder #1 few small sized clay balls.
			3	N	Cylinder #1 small sized clay ball. Cylinder #3 medium sized clay ball.
			7	N	All cylinders small sized clay chips.
			28	N	All cylinders small sized clay chips.
Dec 10-13	AM	P_ Deliv_118_08 trk#1	1	N	Cylinder #1 half filter, missing bottom edge.
			3	N	Cylinder #3 2 clay balls.
			7	N	All cylinders few small sized clay balls.
			28	N	Cylinder #1 medium sized clay chunks. Cylinder #2&3 small sized clay chunks.

APPENDIX D

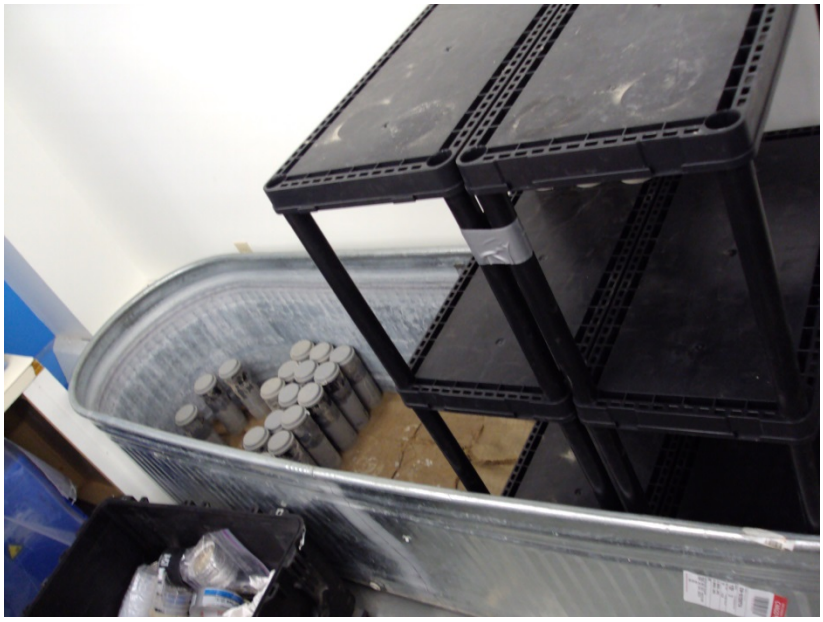
Photos

Client : PWGSC Giant Mine	**Project Number : 13-1426-0010**
Site Name : Giant Mine On-Site Lab	

Photograph 1 Lab setup Golder Yellowknife office.	
Photograph 2 Lab setup Golder Yellowknife office. UCS load frame and drying oven.	

Golder Associates

Client : PWGSC Giant Mine	**Project Number : 13-1426-0010**
Site Name : Giant Mine On-Site Lab	

Photograph 3 Lab setup Golder Yellowknife office. Curing tub with first few production cylinders in place. Picture taken prior to adding the burlap and plastic covering.	
Photograph 4 Lab setup Giant Mine M.E.G. building. UCS load frame and drying oven.	

Golder Associates

Client : PWGSC Giant Mine	**Project Number : 13-1426-0010**
Site Name : Giant Mine On-Site Lab	

Photograph 5 Lab setup Giant Mine M.E.G. building. Cylinder mold wash station and prep table.	
Photograph 6 Lab setup Giant Mine M.E.G. building. Additional curing tubs fabricated to house samples. Picture taken post production.	

Golder Associates

Client : PWGSC Giant Mine	**Project Number : 13-1426-0010**
Site Name : Giant Mine On-Site Lab	

Photograph 7 Paste production area. Slump tests and cylinders being cast on site. Cylinders would be stored at the production area until end of day; revised near the end of the production programme as cylinders were freezing.	
Photograph 8 Paste production area. Cylinders being cast on site.	

Golder Associates

Client : PWGSC Giant Mine	**Project Number : 13-1426-0010**
Site Name : Giant Mine On-Site Lab	

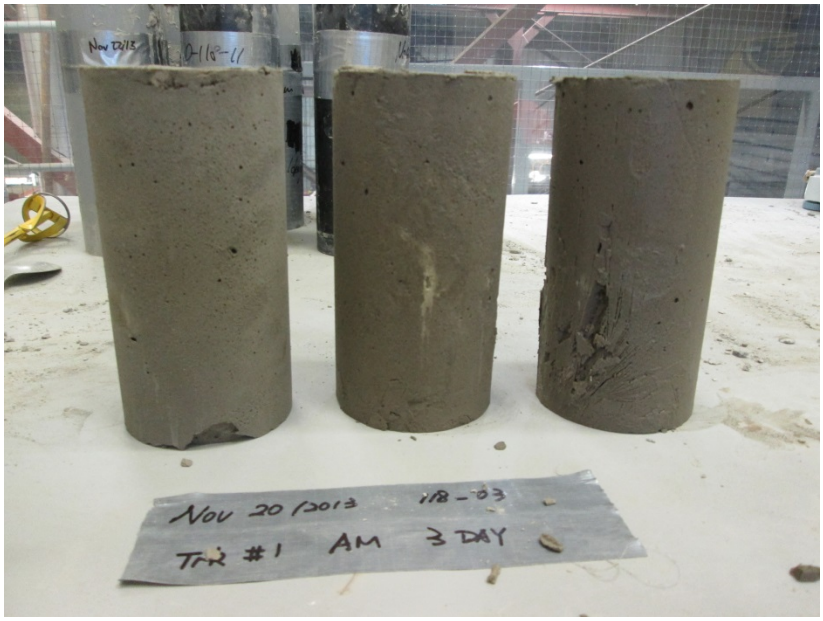
Photograph 9 Typical cylinder mold complete with removable collars.	
Photograph 10 Sample cylinders after a 1 day curing period.	

Golder Associates

Client : PWGSC Giant Mine	**Project Number : 13-1426-0010**
Site Name : Giant Mine On-Site Lab	

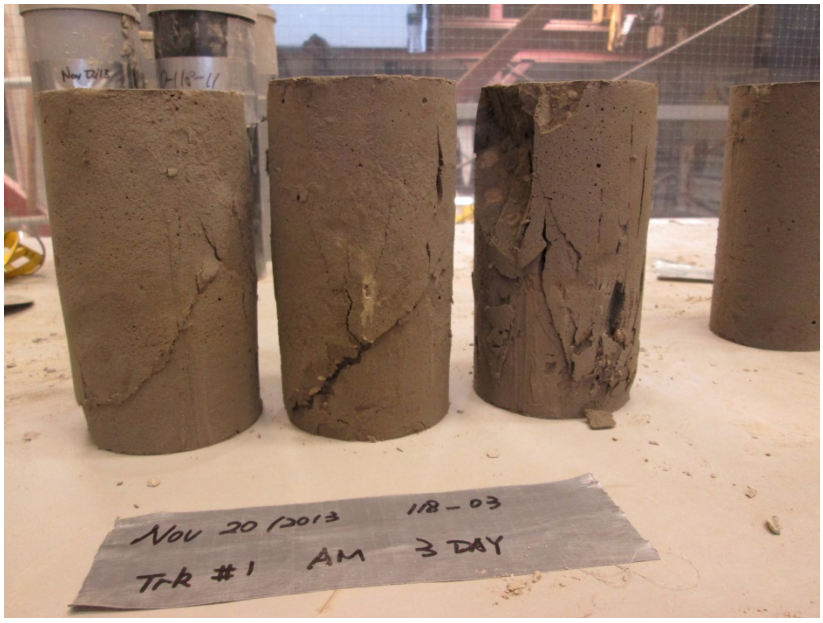
Photograph 11a)

Cylinder set as removed from mold. Note striations in the third cylinder from the left from ice formations that melt out after curing has occurred.



Photograph 11b)

Cylinder set as removed from UCS load frame after test trial.



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Client : PWGSC Giant Mine	**Project Number : 13-1426-0010**
Site Name : Giant Mine On-Site Lab	

Photograph 11c) Cylinder set further pulled apart to examine break patterns and contents. Small clay balls apparent through breaks in all cylinders.	
Photograph 12 Bottom of cylinder shown as removed from mold. Material washout as a result of poor filter placement. Result adversely affects break strength.	

Golder Associates

Client : PWGSC Giant Mine	**Project Number : 13-1426-0010**
Site Name : Giant Mine On-Site Lab	

Photograph 13 Material washout occurring as a result of poor filter placement. Result is reduced strength and higher stresses from smaller cross sectional area surrounding void.	
Photograph 14 Typical 1 day UCS test samples after test performed. Samples undergo lots of axial strain as they are still moist. Sample shown was cast at 2% binder 10” slump.	

Golder Associates

Client : PWGSC Giant Mine	**Project Number : 13-1426-0010**
Site Name : Giant Mine On-Site Lab	

Photograph 15 Huge clay ball present in the third cylinder from the left observed during removal from mold. No strength.	
Photograph 16 Large clay ball and surrounding moisture observed in cylinder break. Reduced strength.	

Golder Associates

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

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