REPORT

January 31, 2014

PWGSC GIANT MINE

Paste Field Trial and Flow Loop Testing

Submitted to:

Public Works and Government Services Canada (PWGSC)
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Project Number: 1314260010-105-R-Rev0-5000

Distribution:

1 Electronic Copy: PWGSC, Edmonton, AB

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

Golder Associates

Study Limitations

This report was prepared for the exclusive use of Public Works and Government Services Canada (PWGSC) on the Giant Mine Remediation 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 on-site trial and laboratory studies conducted by Golder Associates Ltd. (Golder) for PWGSC. The test results are based solely on the ambient conditions of the site and 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.***

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Table of Contents

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

PWGSC has retained Golder Associates Ltd. (Golder) to carry out a field trial at Giant Mine prior to full scale paste backfill production as part of the Giant Mine Remediation Project (GMRP). The purpose of the trial was to understand the efficacy of the various void filling materials and to collect engineering data on the behavior of the material in a controlled environment. Such knowledge can only be gained at a field scale and thus this test phase is an essential first step to the remediation works.

The field test was structured to evaluate the following:

- Overall system performance and verification of equipment suitability (calibration of equipment and producing paste with tailings).
- Process for backfilling drifts (defined as an isolated mine development tunnel which is typically rectangular shaped e.g. 3 m wide by 3 m high) using low slump cemented paste tailings delivered through boreholes i.e. amount of material and flow characteristics plus rest periods to achieve a suitable barricade (flow loop testing, piles/sea can tests).
- Suitable multiple mix designs for placement of low slump cemented paste tailings backfill barricades and high slump lightly cemented paste tailings material for bulk filling that will resist liquefaction in the event of a seismic loading (continuous pour, piles/sea cans).
- Pumping performance for various backfill mix designs (flow loop).

Bulk fill is needed to backfill underground stopes. The most readily available and suitable raw material for making bulk void filling material at Giant Mine is the existing tailings on site. Tailings, which is finely crushed rock and is the main by-product of milling gold ore, is abundant on surface in the existing tailings ponds and is also present in large quantities in the underground as it was used during the active mining to stabilize voids.

The material proposed to be used for the majority of the void backfilling material was lightly cemented paste tailings and this same material was therefore used in the paste trial. The paste tailings was made from different recipes of tailings, treated water (which was sourced from the Giant Mine Polishing Pond), binder material (comprised of normal Portland cement [NPC]), and inert rock aggregate sourced from existing stockpiles sourced from nearby locations.

During the field trial, no paste tailings were pumped into any underground workings, chambers or stopes. Used shipping containers, called sea cans, were used to simulate the underground drifts that need to be barricaded (plugged) and backfilled so that the optimal paste recipes could be determined.

A variety of testing was completed including digging test pits, conducting on-site rheological testing, on-site flow loop testing, truck calibration, and piles/sea can testing. These tests are explored in more detail below.

The first step was to determine which tailings would be suitable for the creation of paste – this was done using information generated in July and September 2013, from a test pit program. The test pits were dug and samples gathered from various locations in the south and central tailings ponds at Giant Mine to determine their suitability as feed material. Prior to being sampled, the material in the test pits was visually inspected for content of sand, silt, and clay. The visual inspection assessed whether or not the material was suitable for being used for paste backfill. Tailings containing predominately silty-sand material are the most desirable, and samples were taken from these locations. Locations containing any clay and high quantities of silt material were rejected. Moisture content observations of each test pit were also made during the program.

A field trial equipment general arrangement layout is presented in Appendix A.

2.0 TAILINGS SELECTION AND PREPARATION

2.1 Tailings Selection

The stockpile for the trials, at the northeast area of the South Tailings Pond, was built by contractors using what was thought to be material that could be used to create paste. After Golder arrived on site and inspected the stockpile it was concluded that the material was not suitable due to high amounts of clay and silt material. Therefore, a second stockpile was required to be built from the west area of the south tailings pond which was determined to be good feed material. Figure 1 shows both tailings stockpiles.

Figure 1: Comparison of prepared tailings stockpiles - left: Stockpile #2 used during paste trial; right: Stockpile #1 unusable for paste trial.

Once the proper tailings were identified and gathered, the next step was to calibrate the equipment that would be delivering the paste.

3.0 CALIBRATION OF THE MIXER TRUCK

The following sections outline the methods used to generate the calibration data for the two Reimer mixer trucks used on site to blend tailings, cement, water, and aggregate into paste for the trial and paste production. Both mixer trucks (Mixer #1 and Mixer #2) were calibrated for mass and volumetric throughput during the paste trial prior to paste production.

3.1 Mass Calibrations

During the paste trial both mixer trucks contained a divider that split their material bins in two. This feature allowed the trucks to run alternative materials such as aggregate on one side of the bin and tailings on the other. Aggregate in the mix was used to produce high strength paste for the construction of paste barricades.

Each of the mixer trucks have a hydraulically driven belt feeder under the main center bin. The discharge from the bin falls onto the belt feeder and is controlled by two independent gates. Each gate has a scale with 120 divisions on it. One gate was used for tailings while the other was used to regulate the flow of aggregate. If there was no aggregate, both sides of the bin were filled with tailings so both gates were used to regulate the flow of tailings.

The head pulley of the belt feeder has a toothed wheel attached to the drive shaft. A proximity sensor mounted beside the toothed wheel produces a pulse signal each time a tooth passes by. A totaliser display counts the pulses as they are generated. The pulse signal can be correlated to the amount of material flowing on the belt feeder. This is done by running the belt feeder at a gate setting for a fixed time period and collecting the material discharged. The weight of the material is divided by the pulses or "counts" generated during the time period to produce a kg/count value.

The mixer trucks were calibrated at various gate settings with tailings to produce a kg/count for each gate setting. The mixer trucks were also calibrated with aggregate on a single side of the divided center bin, at various gate settings in order to produce a kg/count value specific to aggregate. This is necessary due to the fact that tailings and aggregate have different bulk specific gravities.

Cement intake also required calibration. Each of the mixer trucks are equipped with a cement screw feeder powered by a hydraulic motor. Both the belt feeder and screw feeder's hydraulic motors are driven by the same hydraulic pump. A proportioning valve precisely splits the flow between the belt feeder and screw feeder motors in a constant ratio. The proportioning valve can be adjusted in order to change the ratio of cement to tailings. The cement feeder is calibrated (in the same way as the belt feeder) by dividing the weight of cement discharged by the counts generated by the belt feeder to produce the kg/count of cement discharged. This is possible because the proportioning valve always keeps the ratio of tailings to cement equal. The discharge of cement is controlled by a 2 positioned valve – lean mix and rich mix (maximum binder output). Paste production was done on the lean mix setting.

The resulting calibration graphs for Mixer #1 and #2 are shown in Figures 2 to 5. Calibrations for 100% tailings were done with both sides of the bins full of tailings, both gates at varying settings. The sum of both gates settings are shown in the figures below (Figures 2 and 4). Calibration for the aggregate was done with one side with tailings (gate at 120 units) and one side with aggregate (gate at varying settings).

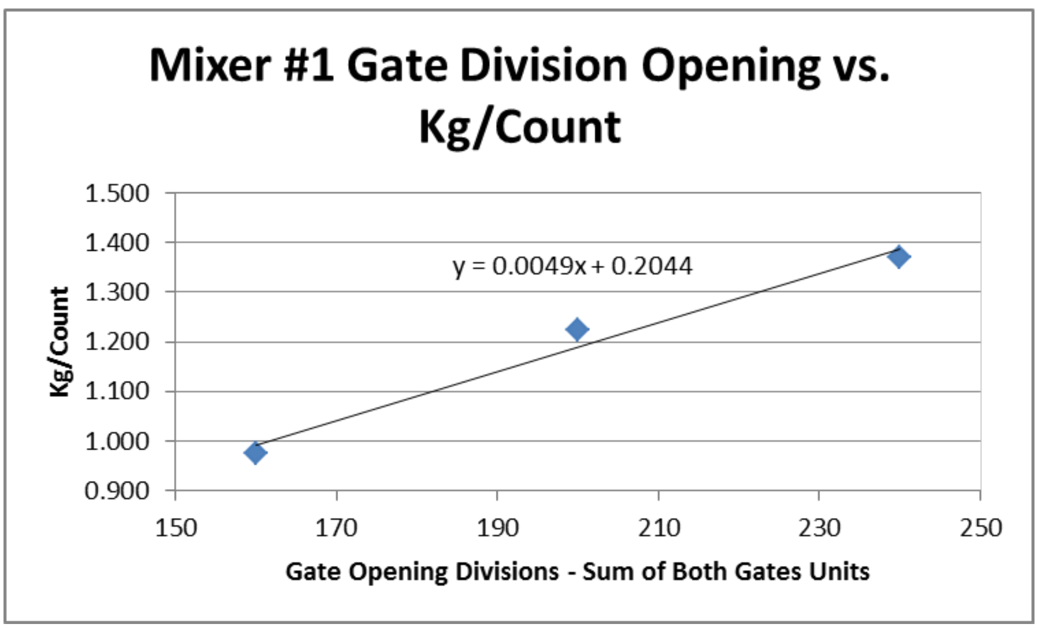

Figure 2: 100% tailings calibration for Mixer #1

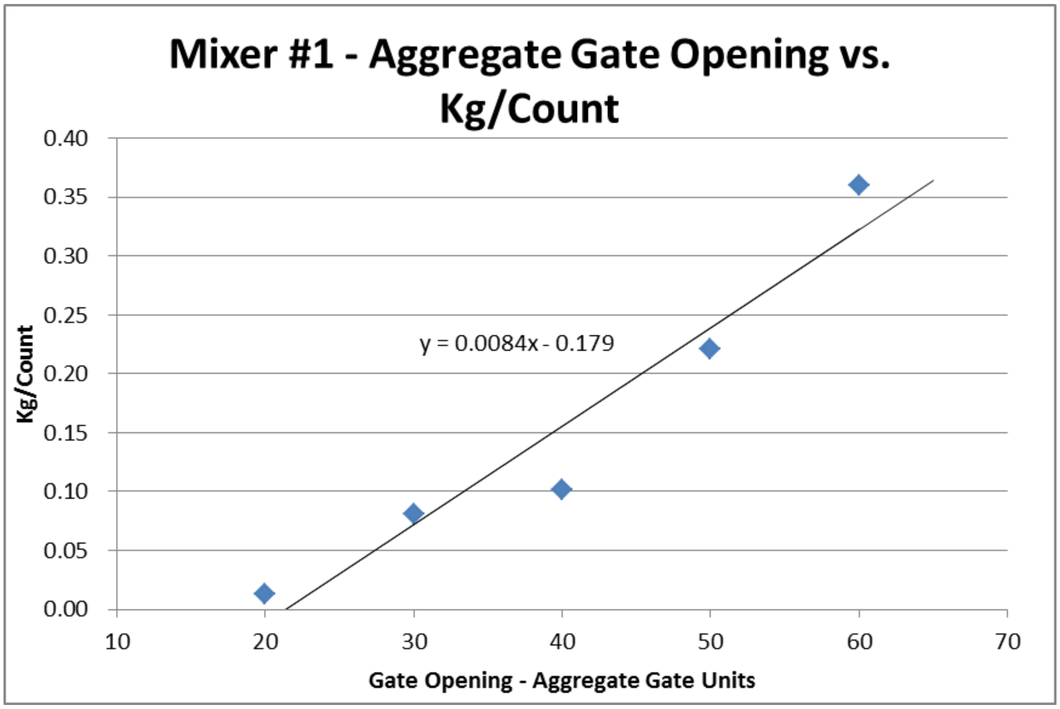

Figure 3: Aggregate calibration for Mixer #1

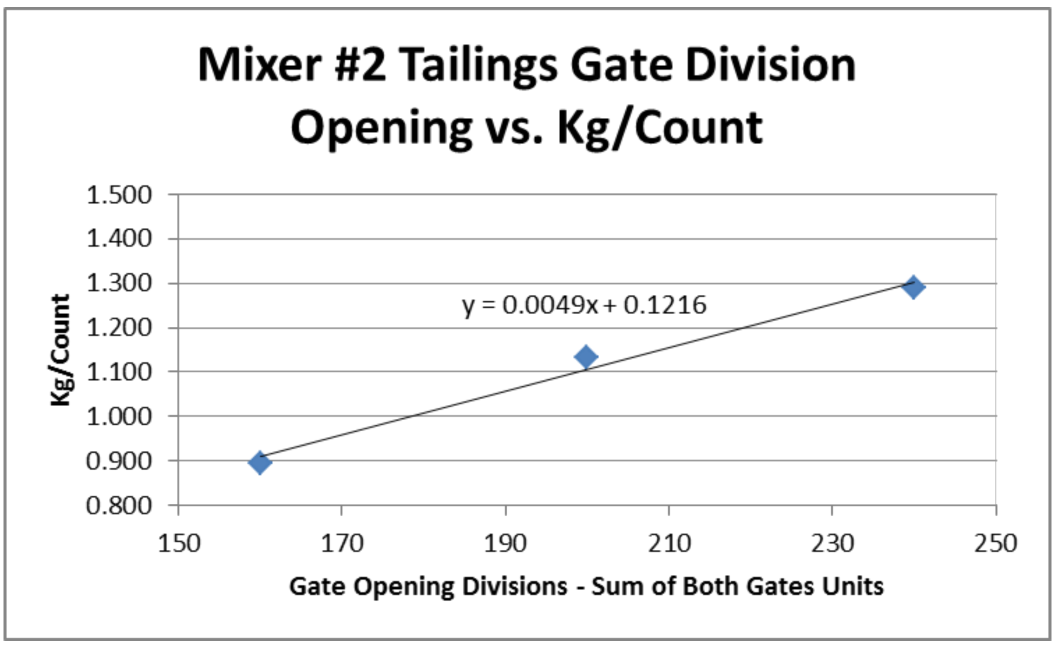

Figure 4: 100% tailings calibration for Mixer #2

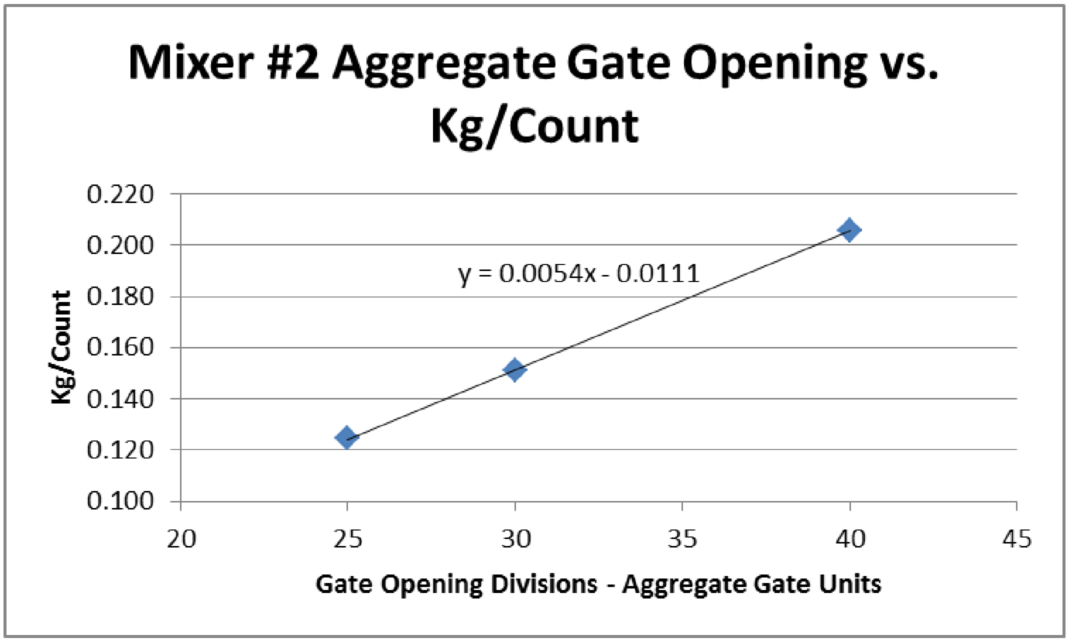

Figure 5: Aggregate calibration for Mixer #2

The calibration data was used to determine the precise amounts of tailings, cement and aggregate used for a specific paste pour by multiplying the counts for the run by the respective kg/count at a specific gate setting for that material. Separate calibrations were required to determine the volume throughputs of the mixer trucks.

3.2 Volume Calibrations

Volumetric calibrations were determined using a 1 m x 1 m x 1 m wooden yield box. Paste of a known slump was blended in the mixer truck and poured into the yield box. The quantity of counts to fill the 1 m^3 box was measured at each slump.

Using this data, the cubic meters of paste produced for a specific batch could be determined by dividing the counts generated for that batch by the counts/m^3. The results are shown in Table 1 for Mixer #1 and #2.

Table 1: Yield Box Results

Truck	Slump	Counts/m^3
Mixer #1	7"	1103
Mixer #2	5"	1040

After Mixer #1 was calibrated, it was used for the on-site flow loop test performed on the south pond in the paste trial area.

4.0 ON-SITE FLOW LOOP TESTING

Flow loop testing provides essential data for the design and operation of pump and pipeline distribution systems. An assessment of the data provides fluid characterization and corresponding rheological properties such as viscosity and yield stress values.

Truck #1 was used to create paste by mixing water, tailings, and aggregate (no cement was used in these flow loop tests). The paste was then pumped through a positive displacement pump to the field scale flow loop system consisting of 100 mm (4-inch) and 125 mm (5-inch) Schedule 40 steel piping. The flow loop pipelines are instrumented with a magnetic flow meter and various pressure transmitters. Instrumentation data was collected by a high-speed data acquisition system and laptop computer for data storage.

The paste recipes for the individual test runs were 100% tailings mix and a 90/10 tailings/aggregate mix at a range of moisture contents (targeting 5", 7", 8.5", and 10" slumps). The tests were to measure pipeline friction loss at the different moisture contents at several flow rates. A 'ramp up' and 'ramp down' technique was used to determine any possible changes in measured pipeline friction loss over time, which would indicate either shear thinning or thickening properties.

The ranges of losses for the aggregate mix were slightly larger with higher top range losses, except in the case of a 5" slump, than the losses experienced by the 100% tailings mixture. For the 100% tailings flowloop, the pressure losses in the 5" pipe varied from 4-37kPa/m while the pressure losses in the 4" pipe varied from 6-51kPa/m. The highest and lowest losses for this sample were seen at the 5" and 10.25" respectively. For the 90/10 Tailings/aggregate ratio flowloop, the pressure losses in the 5" pipe varied from 4-34kPa/m while the pressure losses in the 4" pipe varied from 9-55kPa/m. The highest and lowest losses were at the 5" slump.

The samples collected during the flow loop test were tested for pH, specific gravity and particle size distribution (PSD). The pH of the tailings and the tailings with aggregate were 8.3 and 8.2 respectively. The specific gravity of these two samples was 2.78 and 2.81 respectively. The particle size D50 for the tailings was 96 µm, for the aggregate was 9326 µm and for the tailings and aggregate for both 5" and 9.75" slump was 2172 and 114 µm respectively. The change in the tailings and aggregate PSD is due to the sizes and amount of aggregate in each sample.

For the 100% tailings samples, the weight percent solids varied between 80-77.5% from a 5-10.25" slump respectively with corresponding yield stress values of 487 Pa and 206 Pa for the 5" and 10.25" slump respectively. For the 90/10 Tailings/aggregate samples, the weight percent solids varied between 86.3-82.6% from a 5-10" slump respectively. Yield stress could not be performed on this sample due to the coarseness of the aggregate.

The assessment of data for each mixture, material characterization and a general arrangement of the flow loop are presented in Appendix B.

5.0 PILES AND SEA CAN TESTING

Piles and sea can testing was performed using varying slump paste (with and without aggregate) in order to simulate the pouring of remote paste barricades as well as to refine the recipe for the underground paste program. The paste would be mixed in the mixer truck until the desired slump was achieved, which was confirmed with slump tests, and then the pump truck would deposit a certain amount of paste, at a height approximately 3 m above the ground, in a pile adjacent to the sea cans. The 3 m height was to simulate the drop from the back of the drift to the floor in the underground scenarios. The truck counts were recorded, as well as the heights and width of the pours. These piles were used to experiment with the paste recipes and refine the mixes before depositing the paste into sea cans.

During the sea can trial, paste was pumped into the top of an empty sea can in order to simulate an underground drift. Several lifts were deposited until the paste reached the walls and ceiling of the sea can. Data was gathered and used to calculate the volumes, weights, and dimensions of these mock barricades. The resulting data can be seen in Appendix C. Location of these piles and sea cans can be seen in the Field Trial General Arrangement (Appendix A).

In between the piles and sea can tests, two continuous pours were performed to fine tune calibration and obtain field verification of throughput. The two pours lasted for 38 min 47 sec, and 25 min 0.3 sec respectively. The slumps which varied during the pour were tested and recorded and when the pours were completed, the counts on the mixer truck were used to calculate the weight of the tailings poured. Calculations involving the counter on the mixer truck, buckets of excavator and pump strokes were examined during these pours.

6.0 CLOSURE

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

GOLDER ASSOCIATES LTD.

ORIGINAL SIGNED

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Mechanical Specialist

ORIGINAL SIGNED

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Associate, Mechanical Engineer

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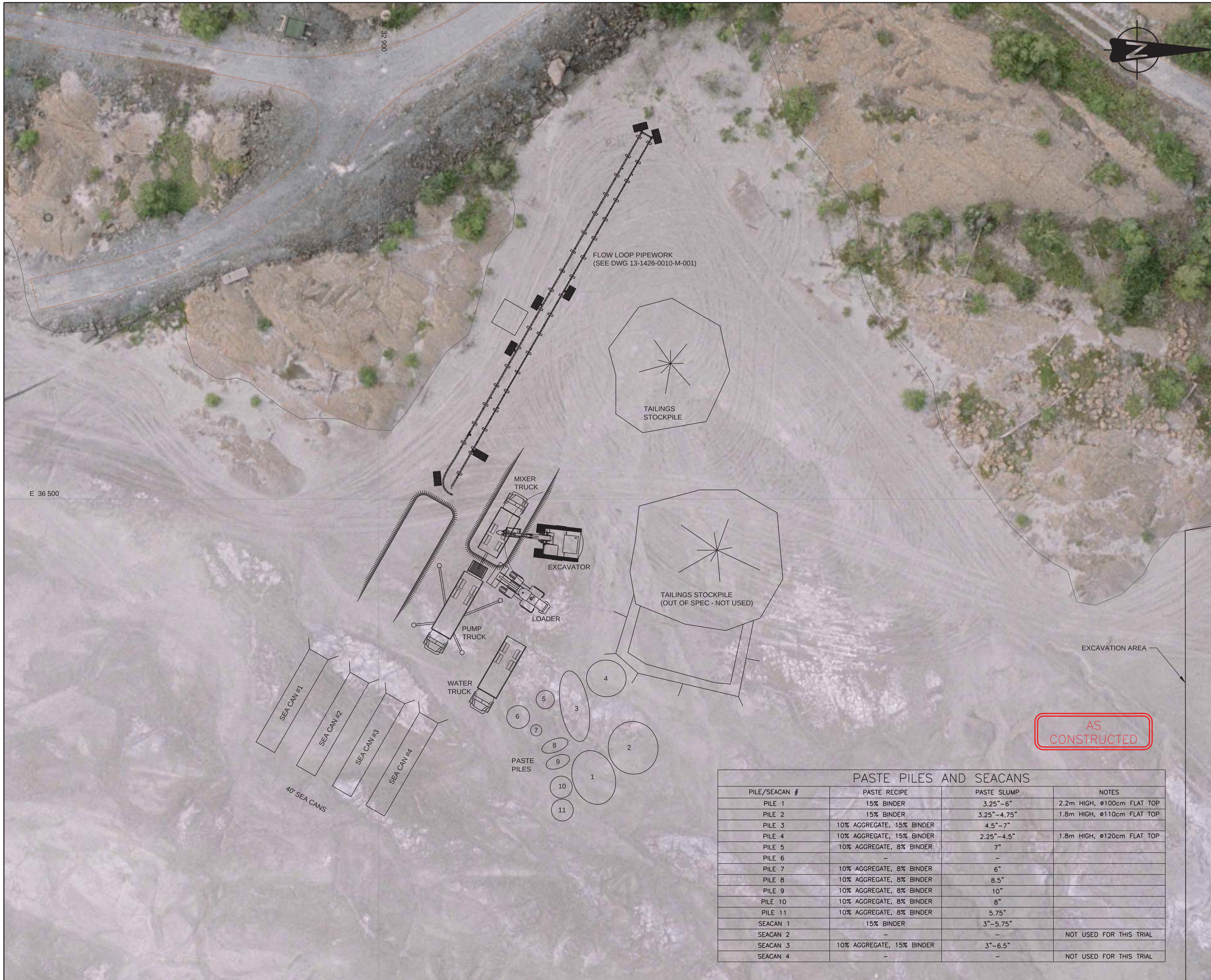
APPENDIX A

Field Trial General Arrangement

APPENDIX A



PASTE PILES AND SEACANS

PILE/SEACAN #	PASTE RECIPE	PASTE SLUMP	NOTES
PILE 1	15% BINDER	3.25"–6"	2.2m HIGH, ø100cm FLAT TOP
PILE 2	15% BINDER	3.25"–4.75"	1.8m HIGH, ø110cm FLAT TOP
PILE 3	10% AGGREGATE, 15% BINDER	4.5"–7"	
PILE 4	10% AGGREGATE, 15% BINDER	2.25"–4.5"	1.8m HIGH, ø120cm FLAT TOP
PILE 5	10% AGGREGATE, 8% BINDER	7"	
PILE 6	–	–	
PILE 7	10% AGGREGATE, 8% BINDER	6"	
PILE 8	10% AGGREGATE, 8% BINDER	8.5"	
PILE 9	10% AGGREGATE, 8% BINDER	10"	
PILE 10	10% AGGREGATE, 8% BINDER	8"	
PILE 11	10% AGGREGATE, 8% BINDER	5.75"	
SEACAN 1	15% BINDER	3"–5.75"	
SEACAN 2	–	–	NOT USED FOR THIS TRIAL
SEACAN 3	10% AGGREGATE, 15% BINDER	3"–6.5"	
SEACAN 4	–	–	NOT USED FOR THIS TRIAL

Public Works and Government Services Canada / Travaux publics et Services gouvernementaux Canada

REAL PROPERTY SERVICES
Western Region
SERVICES IMMOBILIERS
Région de l'ouest

Golder Associates

Revision/Revision	Description/Description	Date/Date
0	AS-BUILT	13-12-05

Client/client

PUBLIC WORKS GOVERNMENT SERVICES CANADA

Project title/Titre du projet

GIANT MINE REMEDIATION PROJECT
YELLOWKNIFE, N.W.T.

Approved by/Approuve par: S.L.

Designed by/Concept par: J.S.

Drawn by/Dessine par: J.S.

PWGSC Project Manager/Administrateur de Projets TPSGC: DAVE COLBOURNE

PWGSC, Architectural and Engineering Resources Manager/Ressources Architectural et de Directeur d'Ingénierie, TPSGC

Client/client: PWGSC

Drawing title/Titre du dessin

PASTE TRIAL AREA
SOUTH TAILINGS POND
GENERAL ARRANGEMENT
AS CONSTRUCTED

Project No./No. du projet	Sheet/Feuille	Revision no./La Révision no.
13-1426-0010	1 OF 1	0

PWGSC – A1 – 841X594

0 10 20 30 40 50 60 70 80 90 100mm

13-1426-0010-L-001

APPENDIX B

Flow Loop Data, Material Characterization, and Flow Loop General Arrangement

January 29, 2014

PILOT SCALE FLOW LOOP TEST

Giant Mine Backfill Testing

Submitted to:
Public Works and Government Services Canada (PWGSC)
Telus Tower North
5th Floor, 10025 Jasper Avenue
Edmonton, Alberta T5J 1S6

Attention: Brad Thompson

REPORT

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Table of Contents

TABLES

FIGURES

Table of Contents (cont.)

1.0 INTRODUCTION

Public Works and Government Services Canada (PWGSC) has retained Golder Associates Ltd. (Golder) to perform an on-site flow loop test at the Giant Mine in Yellowknife, NT. The flow loop testing results provide a basis for the design of the tailings pumping and distribution system.

Transport properties are a function of a number of parameters including tailings characteristics (mineralogy, PSD, chemical composition, slurry pH), slurry densities, volumetric flow rates, temperature, pipeline diameter, degree of shear, pipeline layout. The tests conducted at Giant Mine covered a range of consistencies typical for paste backfill, using un-cemented material.

2.0 SCOPE OF SERVICES

Golder's scope of services included the following.

- On-site flow loop testing:
  - providing instrumentation;
  - monitoring and recording of data; and
  - analysing and reporting of data.
- Bench scale lab testing:
  - material testing; and
  - analysing and reporting of data.

3.0 FLOW LOOP TESTING

3.1 Flow Loop Setup

An instrumented flow loop was constructed by LPR Concrete, RTL Construction, and Golder personnel to determine the transport characteristics of high solids content paste backfill. The loop was a closed circuit pipeline powered by a diesel engine piston pump, specifically a Concord CCP-40X-170 boom truck pump. The pump was capable of delivering up to 170 m^3/hour.

Industrial, high accuracy flush mount pressure transmitters (Endress+Hauser PMC71) designed for up to 41 bar (600 PSI) were installed in predetermined sections of straight pipe. Pressure data was recorded and the pressure differential between the units was calculated to determine unit pressure gradients. The unit pressure gradients are related to material density, flow velocities and pipeline diameters.

A magnetic flow meter (Endress Hauser Model Promag 55S) was provided by Golder for the flow loop test. During the commissioning of the flow loop, using water, the flow meter was used to determine the delivery volume per stroke of the positive displacement pump. As a supplemental check, the volume of material delivered by the pump was also estimated using the number of strokes required to fill the flow loop, a known volume.

The pipeline and instrumentation layout is presented in Appendix A and Photographs are presented in Appendix B.

3.2 Test Mixes

Testing was conducted on October 8, 2013 (Day 1) for the un-cemented tailings paste sample and October 9, 2013 for the un-cemented tailings and aggregate paste sample.

The tailings from the South Pond were transferred into a Reimer mixer truck and the moisture content adjusted to get a measureable slump of approximately 5” (125 mm). The material initially used to fill the flow loop had a measured slump of 5” (125 mm). A sample of the tailings was collected to determine the moisture content of the starting material. Samples were also collected to determine the moisture content for each of the pulp densities for which flow loop data was collected.

Several paste backfill mixes were prepared from tailings stockpiled and stored onsite next to the flow loop in the South tailings pond area. Table 1 presents the details for each mix tested.

Table 1: Flow Loop Mix Details

Day	Slump (mm)	Material	Aggregate	Solids Content (%)
1	125 (5”)	100% South Pond Tailings	N/A	80.0
	170 (6.75”)			79.0
	216 (8.5”)			78.6
	260 (10.25”)			77.5
2	125 (5”)	90% South Pond Tailings	10% Aggregate	86.3
	190 (7.5”)			84.6
	216 (8.75”)			83.2
	248 (9.75”)			82.6

Moisture determinations during the flow loop were completed by Golder’s on-site laboratory personnel and in our Sudbury Ontario Laboratory. Each mix was pumped at variable rates from approximately 20% of maximum flow up to the maximum flow rates possible with the supplied pump. Targeted minimum flow velocity through the Diameter Nominal (DN) 125 mm (National Pipe Size (NPS) (5”)) pipe was around 0.5 m/sec to minimize the potential for sliding bed to occur.

3.3 Material Properties

Samples collected during the flow loop test were tested for pH, specific gravity and particle size distribution. Results are presented in Tables 2 to 4 and on Figures 1 to 3.

3.3.1 pH of Samples

Table 2: pH of Samples Received

Sample	pH
13-1426-0010 South Pond Tailings	8.3
13-1426-0010 South Pond Tailings + Aggregate	8.2

3.3.2 Specific Gravity

The specific gravity (SG) of the sample was determined using vacuum de-aired water. Each slurry sample was also vacuum de-aired prior to SG measurement.

Table 3: Specific Gravity Results

Sample	Average
13-1426-0010 South Pond Tailings	2.78
13-1426-0010 South Pond Tailings + Aggregate	2.81

3.3.3 Particle Size Distribution

The particle size distribution (PSD), Specific D-values (% passing a sieve opening). The PSD of the samples were similar to the sample(s) as tested in our Sudbury laboratory in previous phases.

Table 4: Particle Size Distribution

Sample	D10	D30	D50	D60	D80
	(µm)				
13-1426-0010 South Pond Stockpile	6	30	84	115	139
13-1426-0010 Aggregate	4516	7003	9326	10401	12521
13-1426-0010 South Pond Tailings – 5” (127 mm) slump	5	34	95	118	141
13-1426-0010 South Pond Tailings – 10.5” (267 mm) slump	5	35	98	118	140
13-1426-0010 South Pond Tailings + Aggregate – 5” (127 mm) slump	14	119	2172	6727	11887
13-1426-0010 South Pond Tailings + Aggregate – 9.75” (248 mm) slump	5	26	114	3044	10848

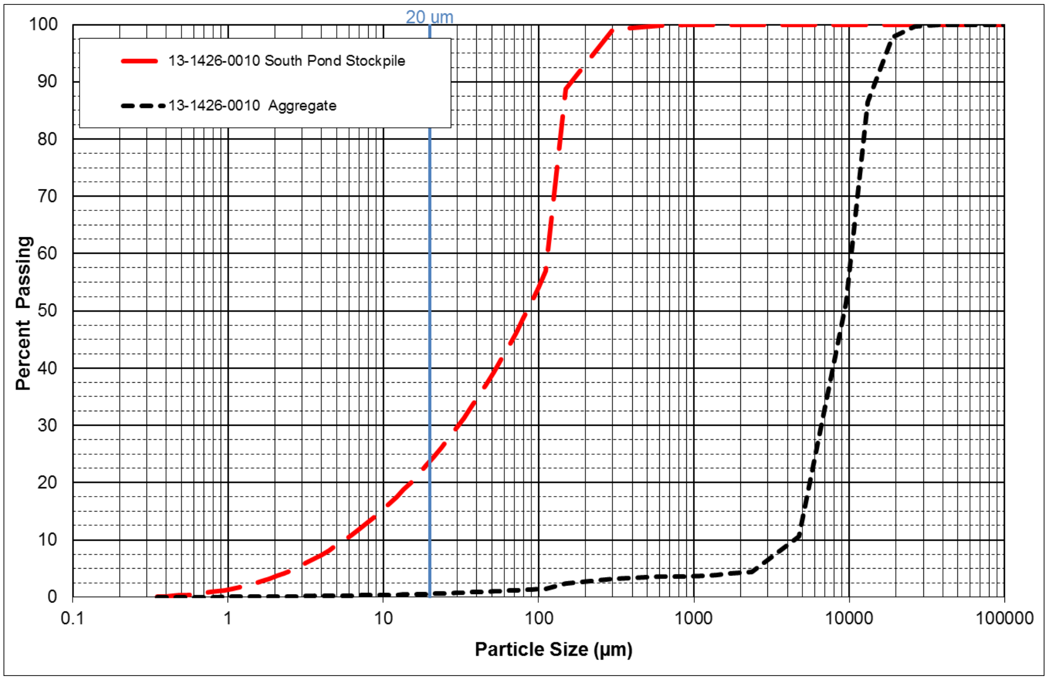


Figure 1: Particle Size Distribution

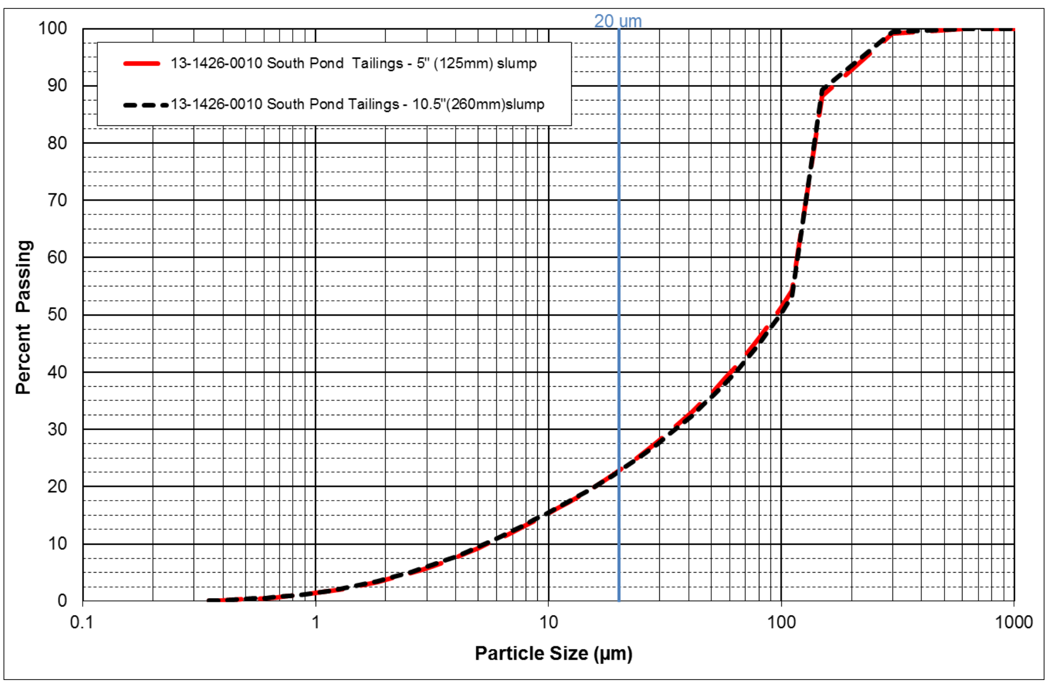


Figure 2: Particle Size Distribution – South Pond Tailings Flow Loop

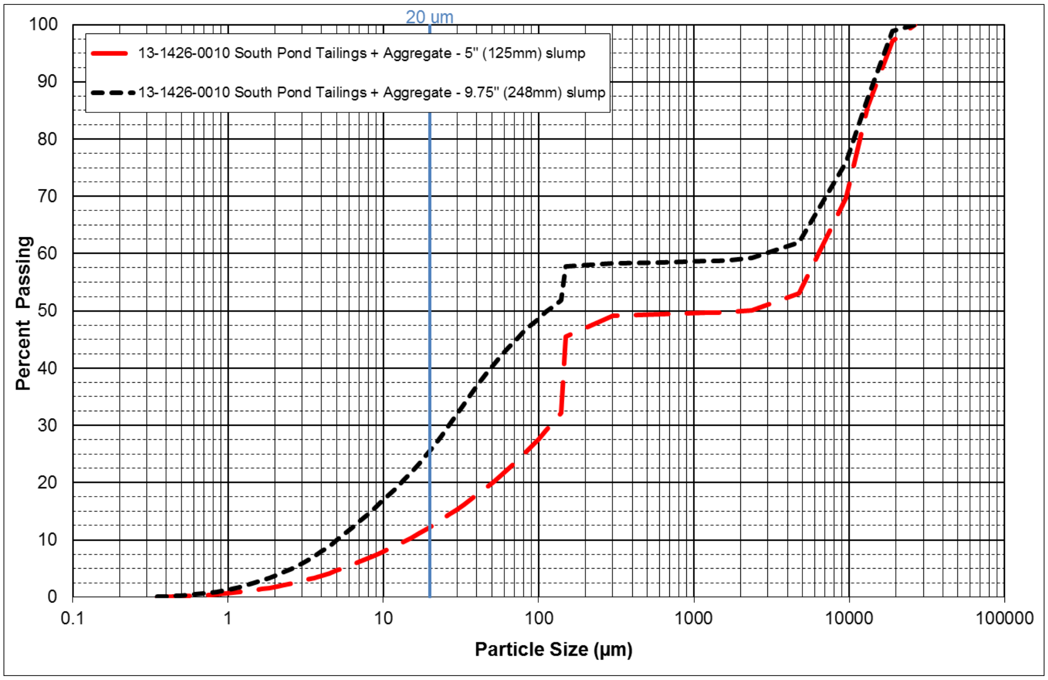


Figure 3: Particle Size Distribution – South Pond Tailings + Aggregate Flow Loop

4.0 RHEOLOGICAL CHARACTERIZATION

Rheological testing was carried out to evaluate flow and handling properties. These tests provide an indication regarding the material's behaviour in the course of mixing, slump adjustment, pumping, flowing and also while sitting idle. Rheological characterization provides data for the selection of process equipment such as mixers, pumps and pipelines.

4.1 Slump vs. Solids Content

To gauge sensitivity to water additions, small increments of water were added to the bulk sample. After each addition, slump and solids content was determined. This generates a relationship between slump and solids content which is typically used to determine the degree of process control required to maintain slump control of the final product. The results are presented on Figures 4 and 5.

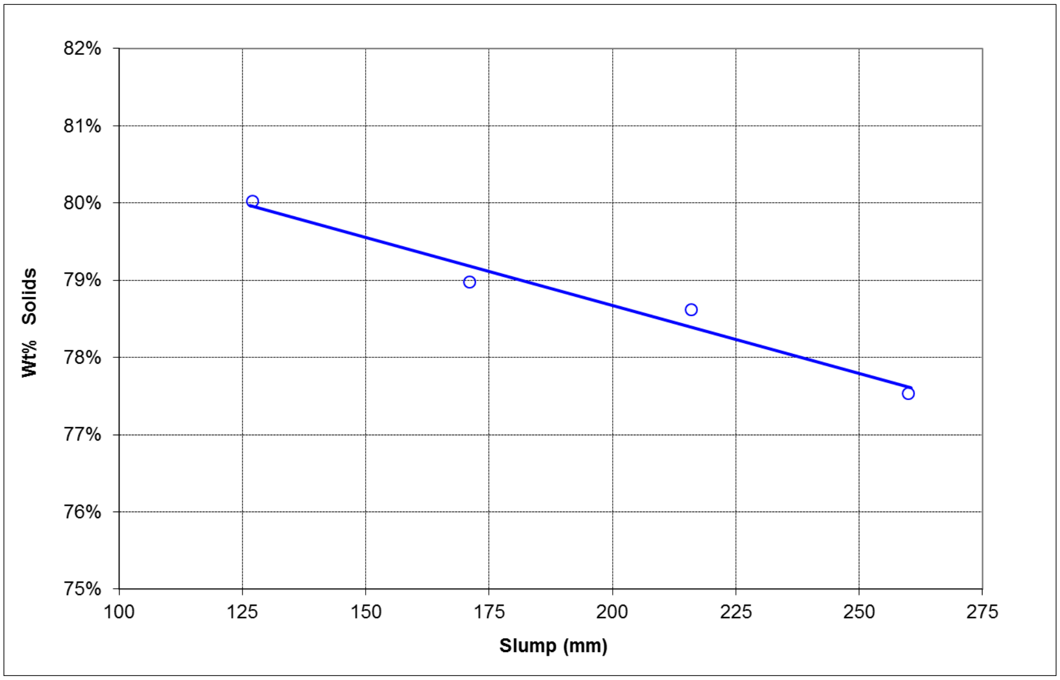


Figure 4: Solids Content vs. Slump - 13-1426-0010 South Pond Tailings

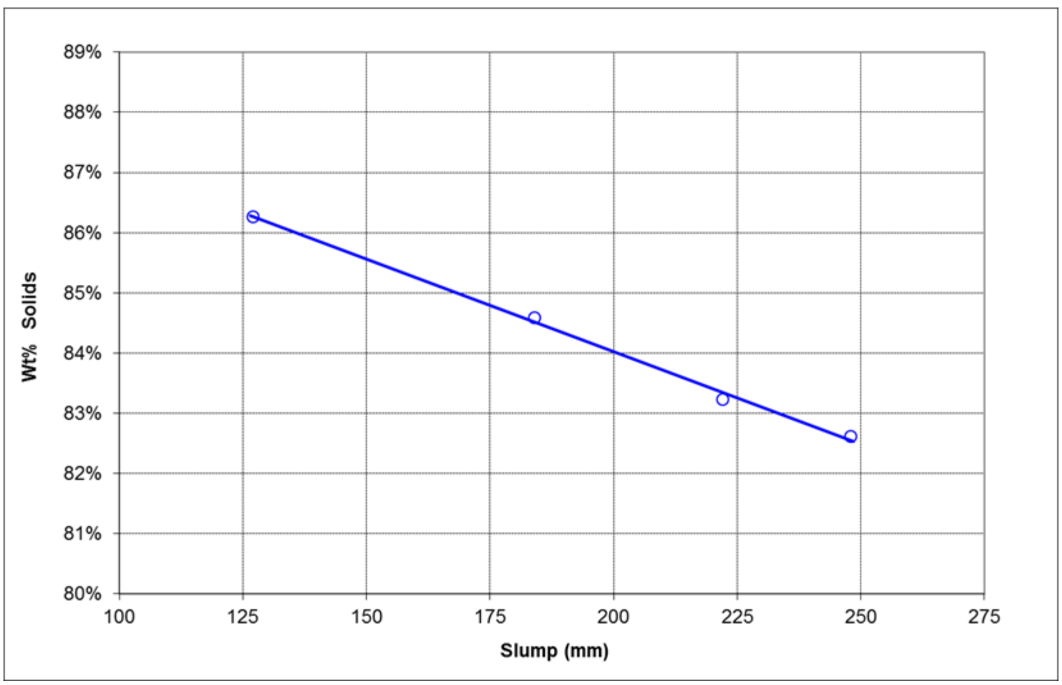


Figure 5: Solids Content vs. Slump - 13-1426-0010 South Pond Tailings + Aggregate

4.2 Static Yield Stress Testing

Yield stress is defined as the minimum force required to initiate flow. Static yield stress was determined by using a very slow moving (0.2 RPM) vane spindle attached to a torque spring. The spindle was immersed in the sample and measurements were taken at various solids contents. There are different test methods to determine yield stress, one termed ‘static’ and the other ‘dynamic’. Figure 6 presents the static yield stress testing results.

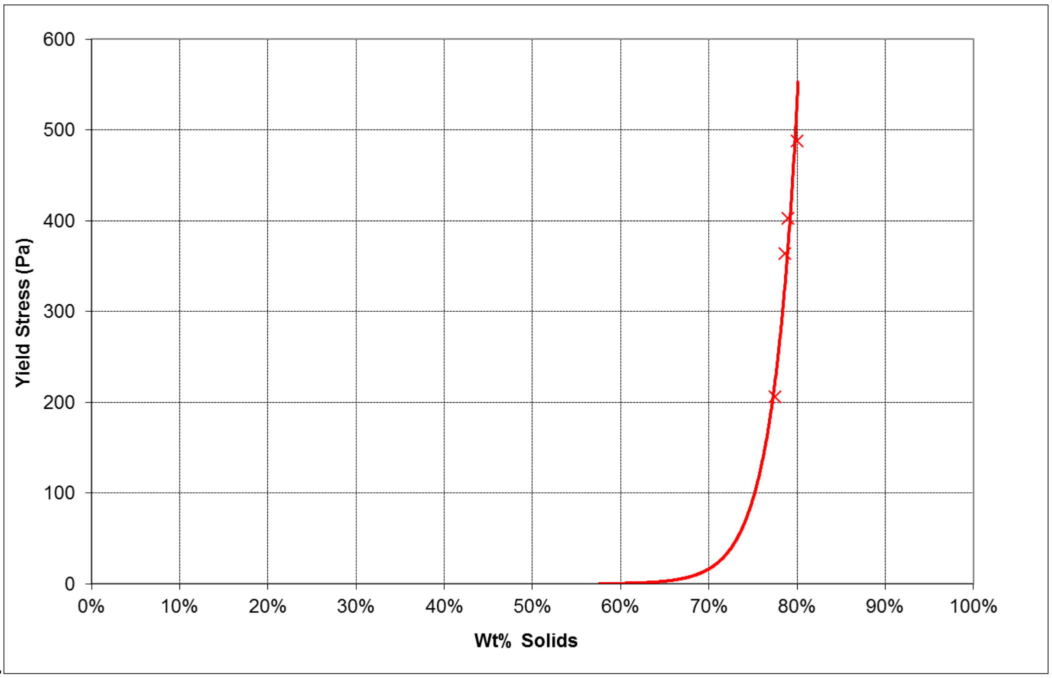


Figure 6: Static Yield Stress vs. wt% Solids - 13-1426-0010 South Pond Tailings

4.3 Flow Loop Test Results

4.3.1 Un-cemented Paste – 100% Tailings

Flow loop testing of the un-cemented paste samples occurred on Day 1 of the flow loop test. The Reimer mixer truck was loaded using an excavator. Once the material was prepared to the target slump, it was discharged via a chute to the concrete pump.

The system was first charged with the thickest material, 125 mm (5”), slump and progressively diluted until 267 mm (10.5”) slump was achieved. At the above slumps and each additional interval outlined in Table 1, full data sets were recorded consisting of pressure loss recordings at varying flow rates. To understand possible changes in flow properties (shear sensitivity) from the beginning to end of each run, pressure losses for the ramp up and ramp down were measured.

The results are presented in Table 5 and on Figures 7 to 10.

Table 5: Un-cemented 100% Tailings Paste Pressure Losses

Slump	DN 125 mm (NPS 5") Pipe		DN 100 mm (NPS 4") Pipe	
	Range of Flow Velocities and Rates	Range of Pressure Losses (kPa/m)	Range of Flow Velocities and Rates	Range of Pressure Losses (kPa/m)
125 mm (5")	0.4 – 2.0 m/s	10 - 37	0.6 – 2.9 m/s	17 – 51
	17 – 87 m^3/hr		17 – 87 m^3/hr	
170 mm (6.75")	0.5 – 2.0 m/s	8 -16	0.7 – 2.6 m/s	14 – 25
	20 – 86 m^3/hr		20 - 86 m^3/hr	
216 mm (8.5")	0.4 – 2.1 m/s	7 - 13	0.5 – 3.0 m/s	10 – 20
	15 -90 m^3/hr		15 – 90 m^3/hr	
260 mm (10.25")	0.4 – 2.1 m/s	4 - 7	0.5 – 3.0 m/s	6 - 10
	15 - 91 m^3/hr		15 – 91 m^3/hr	

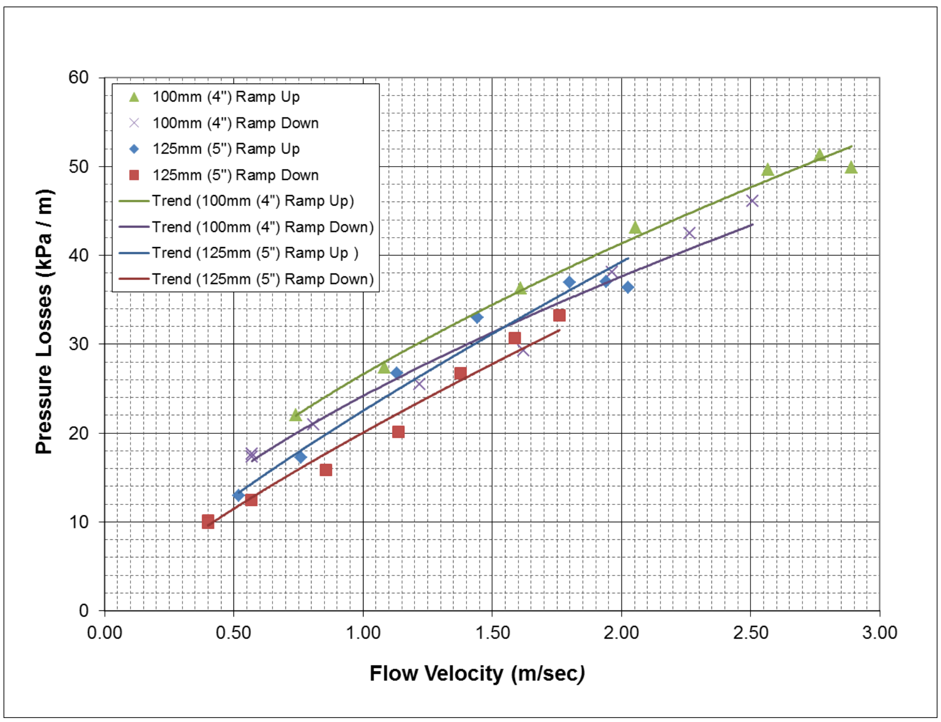


Figure 7: 125 mm (5") Slump - 80.0wt% Solids, Pressure Losses vs. Flow Velocities

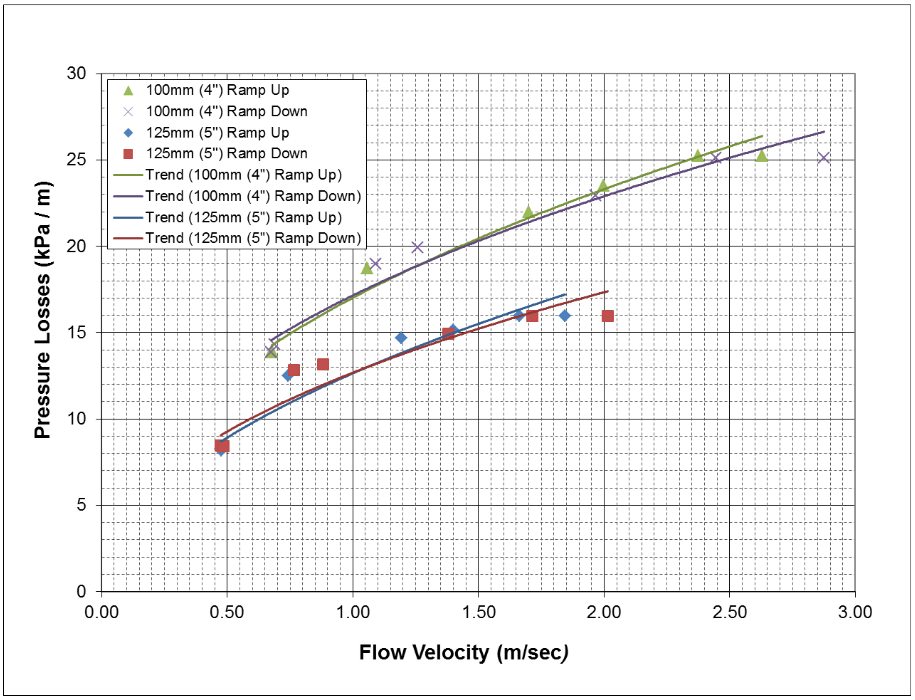


Figure 8: 170 mm (6.75") Slump - 79.0 wt% Solids, Pressure Losses vs. Flow Velocities

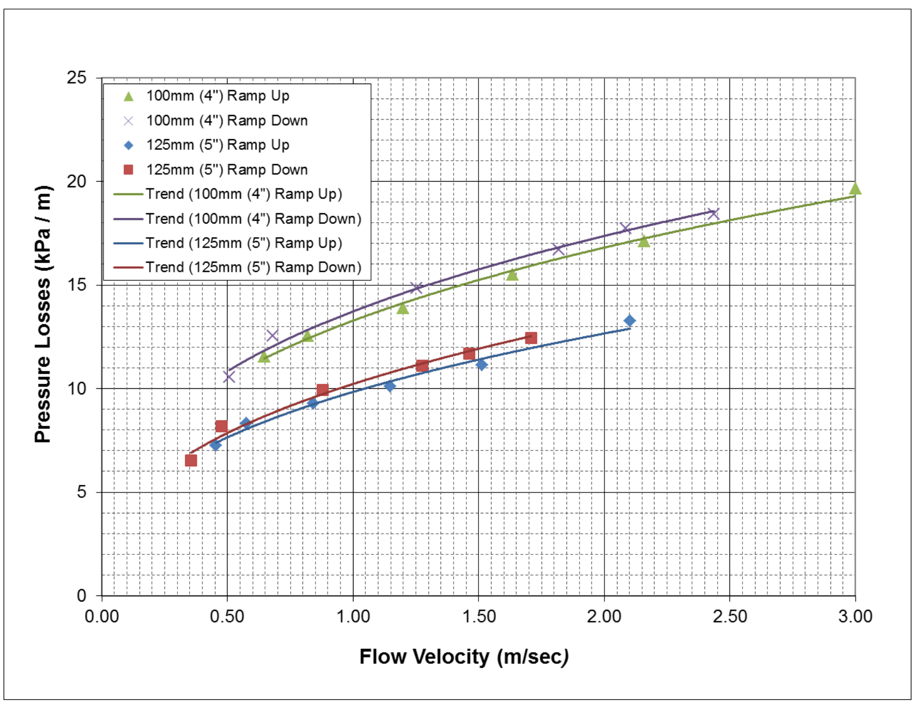


Figure 9: 216 mm (8.5") Slump - 78.6 wt% Solids, Pressure Losses vs. Flow Velocities

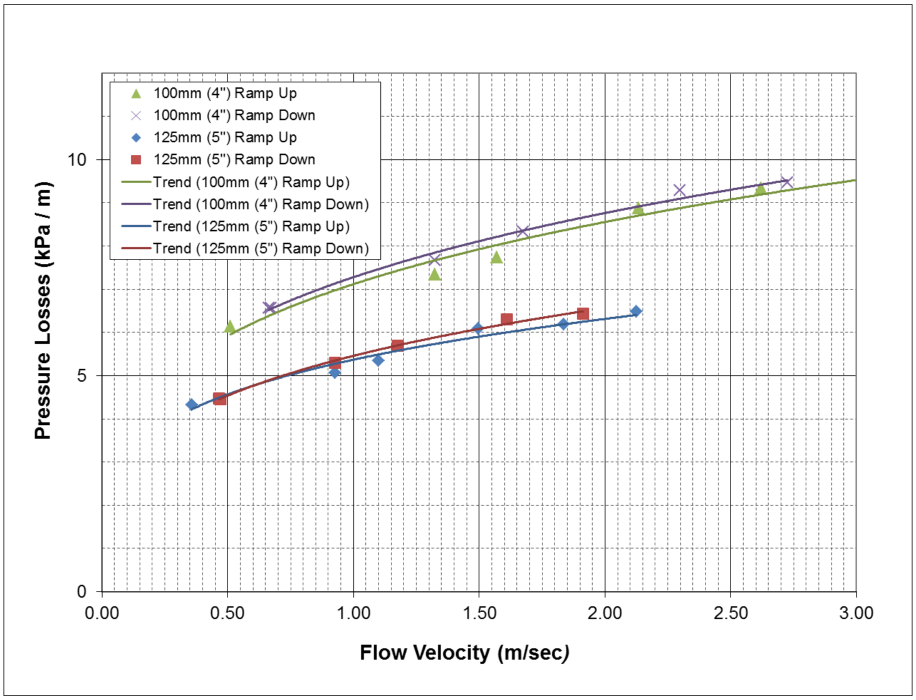


Figure 10: 260 mm (10.25") Slump - 77.5 wt% Solids, Pressure Losses vs. Flow Velocities

4.3.2 Un-cemented Paste + Aggregate

Flow loop testing of the un-cemented 90/10 Tailings/aggregate paste samples occurred on Day 2 of the flow loop test. A blend of 90 wt% South Pond Tailings and 10 wt% aggregate was prepared using the Reimer mixer truck and added slowly to the pump hopper as the paste circulated through the system.

As with the previous un-cemented tailings testing, pressure losses for flow rate ramp up and ramp down were measured. The results are presented in Table 6 and on Figures 11 to 14.

Table 6: Un-cemented 90/10 Tailings/Aggregate Paste Pressure Losses

Slump	ND 125 mm (NPS 5") Pipe		ND 100 mm (NPS 4") Pipe	
	Range of Flow Velocities and Rates	Range of Pressure Losses (kPa/m)	Range of Flow Velocities and Rates	Range of Pressure Losses (kPa/m)
125 mm (5")	0.2 – 1.5 m/s 9 - 62 m^3/hr	4 - 34	0.3 – 2.1 m/s 9 - 62 m^3/hr	9 – 55
190 mm (7.5")	0.3 – 2.2 m/s 14 – 92 m^3/hr	10 - 28	0.5 – 3.1 m/s 14 - 92 m^3/hr	18 – 46
216 mm (8.75")	0.3 – 2.0 m/s 13 - 87 m^3/hr	10 – 28	0.4 – 2.9 m/s 13 - 87 m^3/hr	16 – 46
248 mm (9.75")	0.3 – 1.9 m/s 11 – 80 m^3/hr	9 – 16	0.4 – 2.7 m/s 11 – 80 m^3/hr	12 - 24

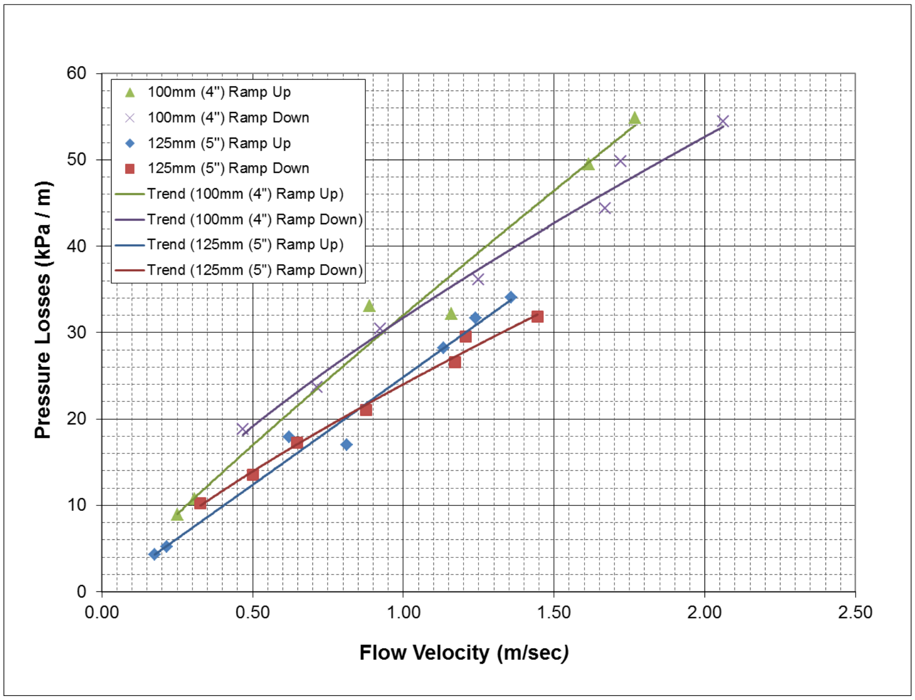


Figure 11: 125 mm (5") Slump with Aggregate - 86.3 wt% Solids, Pressure Losses vs. Flow Velocities

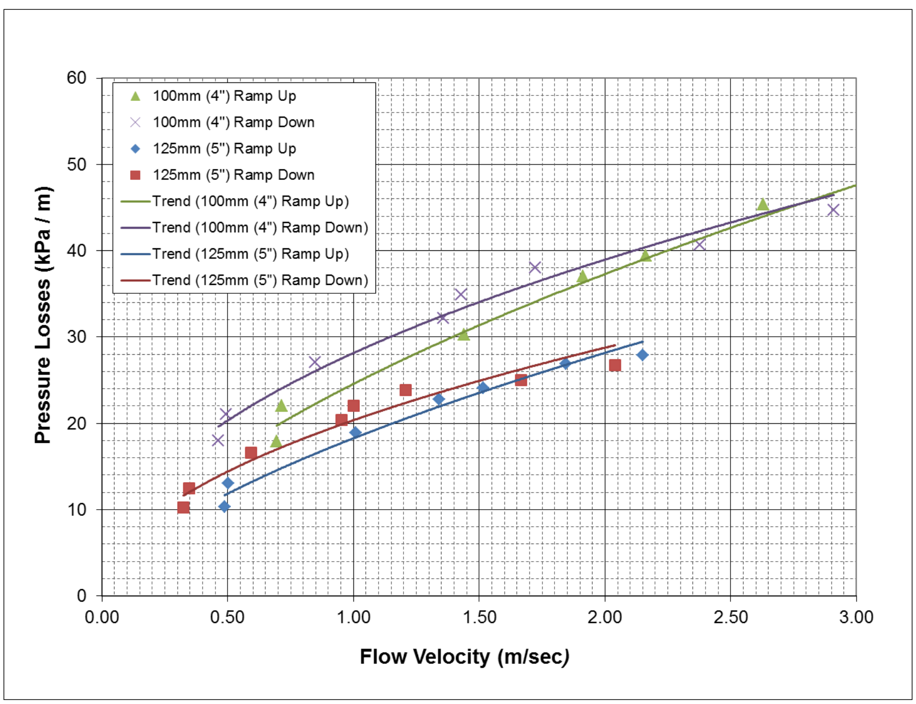


Figure 12: 190 mm (7.5") Slump with Aggregate - 84.6 wt% Solids, Pressure Losses vs. Flow Velocities

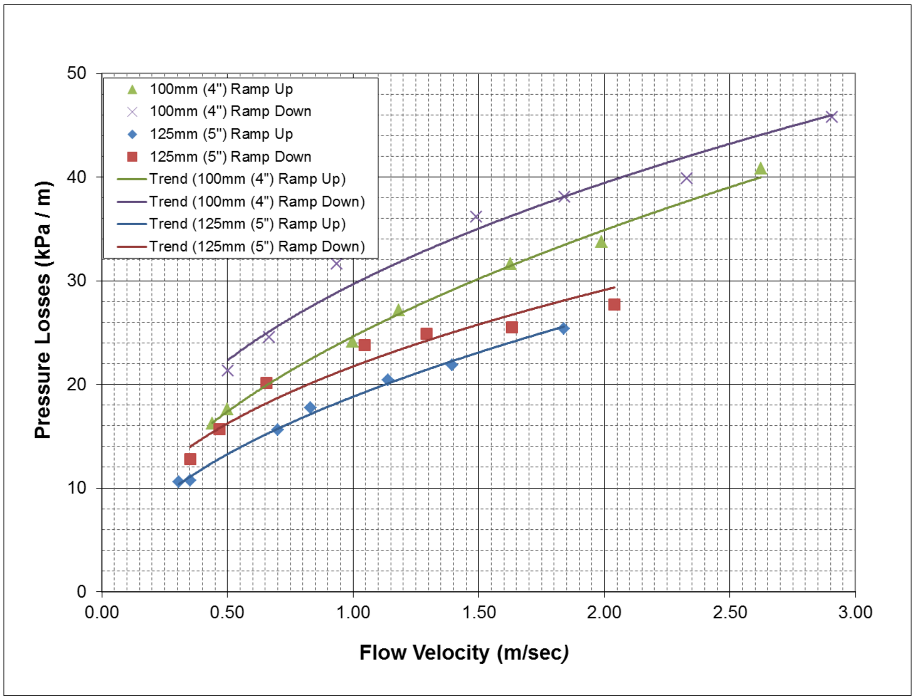


Figure 13: 216 mm (8.5") Slump with Aggregate - 83.2 wt% Solids, Pressure Losses vs. Flow Velocities

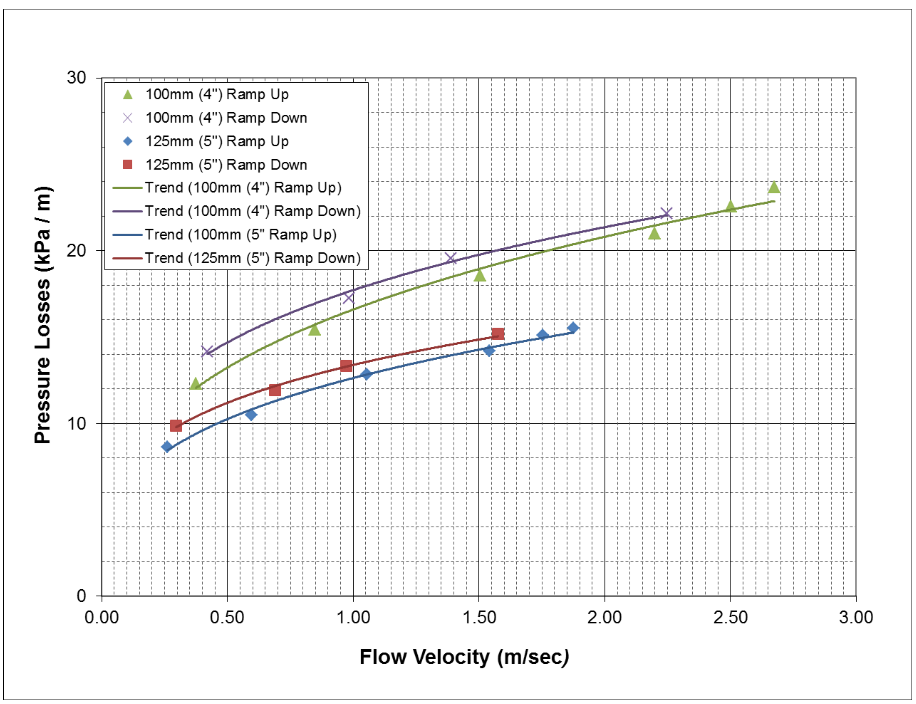


Figure 14: 248 mm (9.75") Slump with Aggregate - 82.6wt% Solids, Pressure Losses vs. Flow Velocities

5.0 CLOSURE

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

GOLDER ASSOCIATES LTD.

ORIGINAL SIGNED	ORIGINAL SIGNED
Mark Labelle Process Laboratory Manager	Sue Longo, P.Eng. Associate / Mechanical Engineer

ML/SL/ds

APPENDIX A

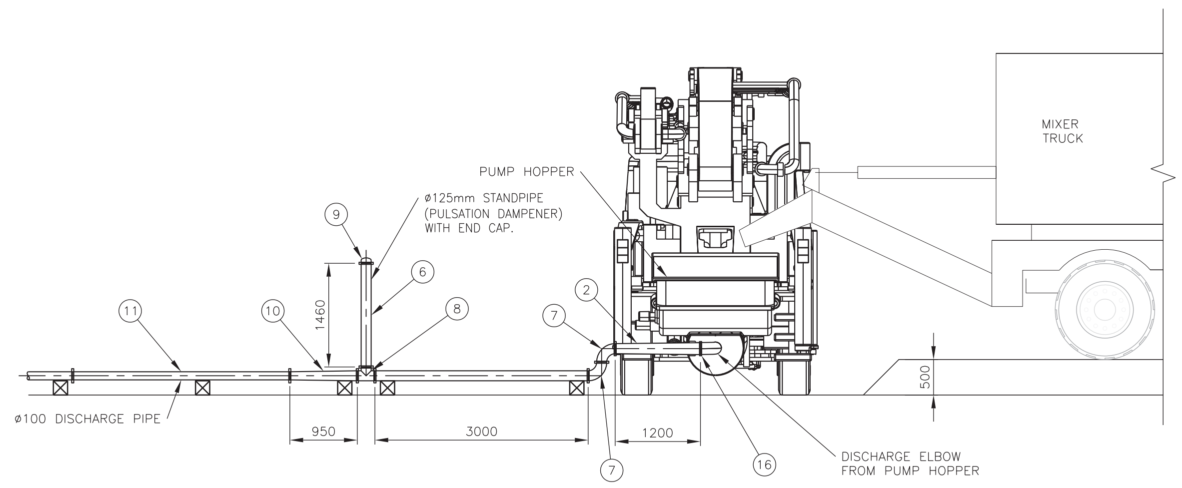
Pipeline and Instrumentation Layout

APPENDIX B
APPENDIX A

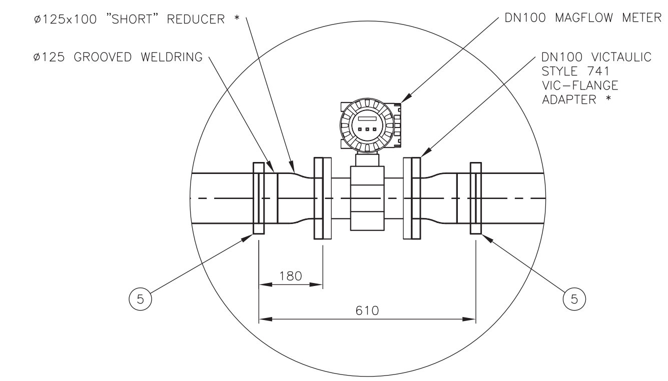
BILL OF MATERIALS

ITEM	QTY.	DESCRIPTION
1	1	POSITIVE DISPLACEMENT PUMP
2	1	ø150mm x ø125mm 'LONG' REDUCER
3	12	ø125mm SCH40 PIPE, 3m LONG
4	2	ø125mm SCH40 TRANSDUCER SPOOL, 3m LONG
5	24	ø125mm FIGURE 780 GROOVED SNAP COUPLING C/W GASKET
6	2	ø125mm 1.46m LONG SPOOL PIECE
7	3	ø125mm SCH40 90° ELBOW
8	1	ø125mm SCH40 EQUAL TEE
9	1	ø125mm SCH40 END CAP
10	2	ø125mm x ø100mm 'LONG' REDUCER
11	11	ø100mm SCH40 PIPE 3m LONG
12	2	ø100mm SCH40 TRANSDUCER SPOOL, 3m LONG
13	15	ø100mm FIGURE 780 GROOVED SNAP COUPLING C/W GASKET
14	1	ø100mm SCH40 90° ELBOW
15	1	ø125mm X 20' LONG FLEXIBLE HOSE WITH GROOVED END FITTINGS
16	1	ø150mm FIGURE 780 GROOVED SNAP COUPLING C/W GASKET
17	Ass't	SOURCE OF WATER FOR FLUSHING / DILUTION

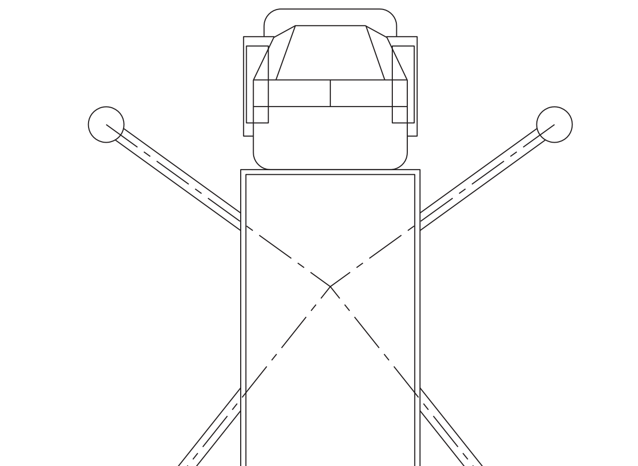
ITEMS MARKED WITH * ARE GOLDER SUPPLY (PRESSURE TRANSDUCERS, FLOWMETER, DATA LOGGING EQUIPMENT AND WIRING TO PRESSURE TRANSDUCERS.)

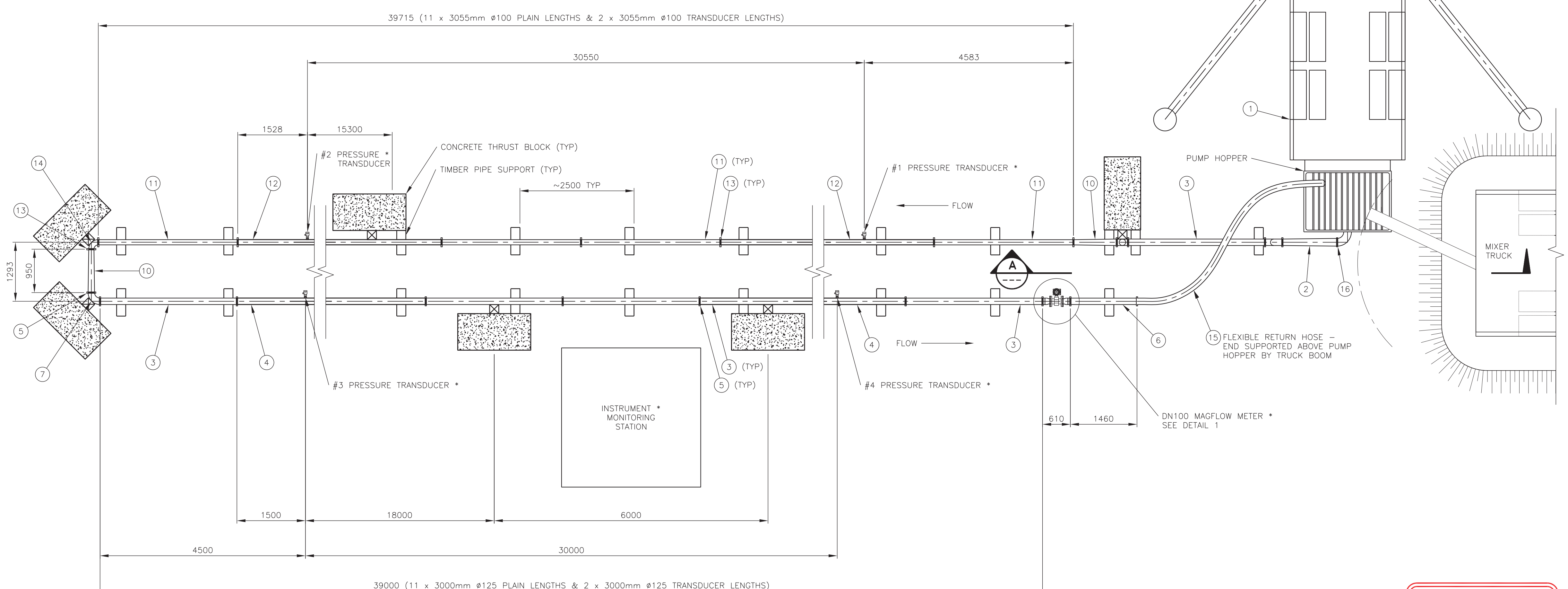


A DISCHARGE LINE
SCALE = 1:50



1 DETAIL – FLOWMETER SPOOL
SCALE = 1:10





AS CONSTRUCTED

Public Works and Government Services Canada / Travaux publics et Services gouvernementaux Canada
REAL PROPERTY SERVICES
Western Region
SERVICES IMMOBILIERS
Région de l'ouest

Golder Associates

Revision/Révision	Description/Description	Date/Date
0	AS-BUILT	13-12-03

Client/client
PUBLIC WORKS GOVERNMENT SERVICES CANADA

Project title/Titre du projet
GIANT MINE REMEDIATION PROJECT YELLOWKNIFE, N.W.T.

Approved by/Approuvé par: S.L.
Designed by/Conçu par: J.S.
Drawn by/Dessiné par: J.S.
PWGSC Project Manager/Administrateur de Projets TPSGC: DAVE COLBOURNE
PWGSC, Architectural and Engineering Resources Manager/Ressources Architectural et de Directeur d'ingénierie, TPSGC
Client/client: PWGSC

Drawing title/Titre du dessin
PASTE TRIAL AREA
FLOWLOOP
GENERAL ARRANGEMENT
AS CONSTRUCTED

Project No./No. du projet: 13-1426-0010
Sheet/Feuille: 1 OF 1
Revision no./La Révision no.: 0

PWGSC – A1 – 841X594

13-1426-0010-M-001

APPENDIX B

Photos

APPENDIX B

Client : PWGSC Giant Mine	Project Number : 13-1426-0010
Site Name : South Pond Tailings Pond	

Photograph 1

South Pond Tailings Stockpile for Flow loop testing

Photograph 2

Large clay pieces located within the stockpile

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APPENDIX B

Client : PWGSC Giant Mine	Project Number : 13-1426-0010
Site Name : South Pond Tailings Pond	

Photograph 3

South Pond Tailings trial using the Reimer truck

Photograph 4

Paste Trial with the Reimer truck

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APPENDIX B

Client : PWGSC Giant Mine	**Project Number : 13-1426-0010**
Site Name : South Pond Tailings Pond	

Photograph 5 Flow loop pipe setup	
Photograph 6 Pressure transmitter installed in the pipeline	

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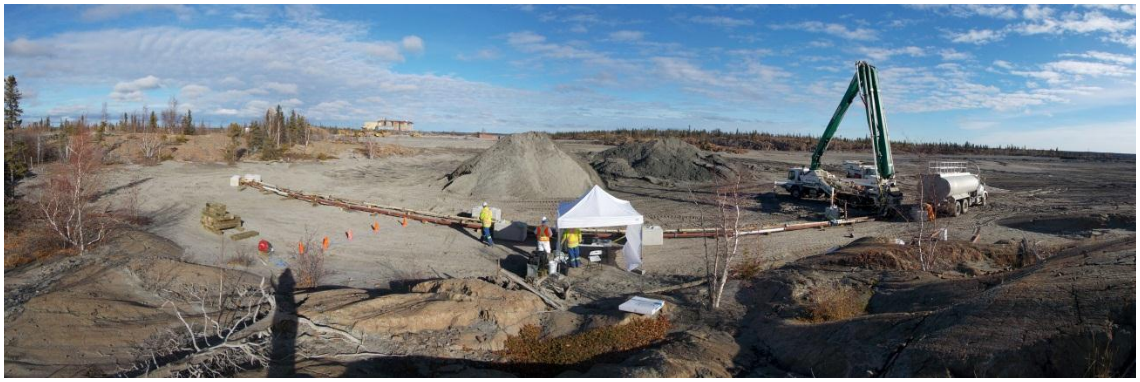
APPENDIX B

Client : PWGSC Giant Mine	**Project Number : 13-1426-0010**
Site Name : South Pond Tailings Pond	

Photograph 7

Complete Flow loop set up including pump and water truck for pressure test



Photograph 8

Data collection area

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APPENDIX B

Client : PWGSC Giant Mine	Project Number : 13-1426-0010
Site Name : South Pond Tailings Pond	

Photograph 9 Start of South Pond tailings flow loop – Reimer truck feeding pump hopper with paste	
Photograph 10 Slump test – 170mm	

APPENDIX B

Client : PWGSC Giant Mine	**Project Number : 13-1426-0010**
Site Name : South Pond Tailings Pond	
Photograph 11 Collection of samples for laboroatory testing	
Photograph 12 Slump test – 260mm	

APPENDIX B

Client : PWGSC Giant Mine	**Project Number : 13-1426-0010**
Site Name : South Pond Tailings Pond	
Photograph 13 Flow loop return line into the pump hopper	
Photograph 14 Flushing of the pipeline with water into an escavator bucket	

APPENDIX B

Client : PWGSC Giant Mine	**Project Number : 13-1426-0010**
Site Name : South Pond Tailings Pond	
Photograph 15 90% South Pond Tailings – 10% Aggregate flow loop set up - small trailer was used as a data collection area due to high winds	
Photograph 16 90% South Pond Tailings – 10% Aggregate slump test – 125mm	

APPENDIX B

Client : PWGSC Giant Mine	**Project Number : 13-1426-0010**
Site Name : South Pond Tailings Pond	

Photograph 17

90% South Pond Tailings – 10% Aggregate slump test – 190mm

END OF DOCUMENT

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APPENDIX C

Pile and Sea Can Testing

Lift Number	Pour Date	Mixture Ratio (%) [Tailings/Aggregate /Cement]	Slump (in)	Moisture Content (wt%)	Paste Specific Gravity	Weight of Tailings (kg)	Height of Paste Stack (m)	Volume of Paste Pumped (m^3)	Notes
Pile #1 (Tailings)									
Lift 1	10-Oct	100/0/15	5"	79.95%	2.14	N/A	1	N/A	
Lift 2	10-Oct	100/0/15	3.5"/6"	80.63%	2.16	15474	1	7.16	
Lift 3	11-Oct	100/0/15	4.5"- 6"	80.18%	2.15	N/A	0.7	N/A	boom is 3m above ground, paste is sticky on shovel
Lift 4	11-Oct	100/0/15	4"	80.40%	2.16	N/A	N/A	N/A	average slump is 4"
Lift 5	12-Oct	100/0/15	3.75"	80.51%	2.16	9170	0.9	4.25	medium sticky
Lift 6	12-Oct	100/0/15	4.5"	80.18%	2.15	5098	N/A	2.37	boom at a height of 3m
Lift 7	12-Oct	100/0/15	N/A	N/A	N/A	N/A	1.4	N/A	
Lift 8	14-Oct	100/0/15	4.75"	80.06%	N/A	N/A	N/A	N/A	
Lift 9	14-Oct	100/0/15	4"	80.40%	2.16	949	N/A	0.44	
Lift 10	15-Oct	100/0/15	2.75"	80.96%	2.17	3086	1.9	1.42	not sticky
Lift 11a	15-Oct	100/0/15	3.25"	80.74%	2.17	2690	1.92	1.24	
Lift 11b	15-Oct	100/0/15	3.25"	80.74%	2.17	2188	1.92	1.01	
Lift 12a	16-Oct	100/0/15	2.75"	80.96%	2.17	2797	N/A	1.29	pretty juicy
Lift 12b	16-Oct	100/0/15	N/A	N/A	N/A	1502	N/A	N/A	pretty juicy
Pile #2 (Tailings)									
Lift 1	10-Oct	100/0/15	N/A	N/A	N/A	N/A	N/A	N/A	
Lift 2a	11-Oct	100/0/15	3.75"	80.51%	2.16	6450	N/A	2.99	
Lift 2b	11-Oct	100/0/15	4.75"	80.06%	2.14	9369	0.53	4.37	
Lift 3	11-Oct	100/0/15	N/A	N/A	N/A	N/A	0.8	N/A	
Lift 4	12-Oct	100/0/15	N/A	N/A	N/A	3905	N/A	N/A	boom at a height of 3m
Lift 5	12-Oct	100/0/15	N/A	N/A	N/A	N/A	1.05	N/A	
Lift 6	14-Oct	100/0/15	4.75"	80.06%	2.14	4274	1.45	1.99	very sticky
Lift 7	15-Oct	100/0/15	3"	80.85%	2.17	2169	1.45	1.00	
Lift 8	15-Oct	100/0/15	3.25"	80.74%	2.17	2394	1.64	1.11	
Lift 9	16-Oct	100/0/15	5"	79.95%	2.14	1783	N/A	0.83	
Pile #3 (Tailings)									
Lift 1	10-Oct	100/0/15	3.5"/6"	80.63%	2.16	15474	N/A	7.16	boom at a height of 3m
Lift 2	11-Oct	100/0/15	N/A	N/A	N/A	N/A	N/A	N/A	
Lift 3	11-Oct	100/0/15	4.75"	80.06%	2.14	N/A	0.5	N/A	average slump for 3 lifts is 4.75"
Lift 4	12-Oct	100/0/15	4.75"	80.06%	2.14	N/A	0.62	N/A	average slump for 3 lifts: 4.75"
Pile #4 (Aggregate)									
Lift 1	11-Oct	90/10/15	4.5"	80.18%	2.15	N/A	0.3	N/A	boom at a height of 4.5m
Lift 2		90/10/15	N/A	N/A	N/A	N/A	N/A	N/A	
Lift 3	12-Oct	90/10/15	N/A	N/A	N/A	N/A	0.7	N/A	
Lift 4	14-Oct	90/10/15	2.25"	81.19%	2.18	2056	1.1	0.94	paste is squishy, very thick, but not sticky
Lift 5	14-Oct	90/10/15	2.25" - 4"	81.19%	2.18	N/A	N/A	N/A	
Lift 6	15-Oct	90/10/15	3.5"	80.63%	2.16	1658	1.5	0.77	
Lift 7		90/10/15	2.75"	80.96%	2.17	N/A	N/A	N/A	
Seacan #1 (Tailings)									
Lift 1	11-Oct	100/0/15	3.75"	80.51%	2.16	5015	N/A	2.32	approx 1/3 binder bin 'solid' cake - slides well
Lift 2	11-Oct	100/0/15	5.75"	79.61%	2.13	5801	0.3	2.72	good consistent cake
Lift 3	12-Oct	100/0/15	5.25"/4"	79.84%	2.14	4850	0.62	2.27	mildly sticky
Lift 4	12-Oct	100/0/15	4"	80.40%	2.16	5829	N/A	2.70	mildly sticky
Lift 5	14-Oct	100/0/15	3.75"/4.5"	80.51%	2.16	5629	1.06	2.61	3.75" paste is not sticky; 4.5" paste is mildly sticky
Lift 6	14-Oct	100/0/15	4.25"	80.29%	2.15	2654	N/A	1.23	mildly sticky
Lift 7	15-Oct	100/0/15	3"/3.25"	80.85%	2.17	3764	1.53	1.74	3" paste is not sticky; 3.25" paste is mildly sticky
Lift 8a	15-Oct	100/0/15	3.25"/3"	80.74%	2.17	3161	N/A	1.46	
Lift 8b	15-Oct	100/0/15	4.5"	80.18%	2.15	2636	N/A	1.23	
Lift 9	15-Oct	100/0/15	4.75"	80.06%	2.14	3329	N/A	1.55	
Lift 10a	16-Oct	100/0/15	4"	80.40%	2.16	1589	2.08	0.74	
Lift 10b	16-Oct	100/0/15	4.5"	80.18%	2.15	619	N/A	0.29	very sticky
Lift 10c	16-Oct	100/0/15	4"	80.40%	2.16	2099	N/A	0.97	mildly sticky
Seacan #2(Aggregate)									
Lift 1	11-Oct	90/10/15	4"/6.5"/4.75"	80.40%	2.16	N/A	N/A	N/A	
Lift 2	12-Oct	90/10/15	6.5"/4"	79.50%	2.13	6811	0.48	3.20	6.5" paste is very sticky; 4" paste is mildy sticky; sample taken
Lift 3	12-Oct	90/10/15	3.3"/5"	80.74%	2.17	4285	N/A	1.98	3" paste is not sticky; 5" paste is mildly sticky
Lift 4	14-Oct	90/10/15	3.75"/3"	80.51%	2.16	5367	1.13	2.49	3.75" paste is mildly sticky; 3" paste is not sticky
Lift 5	14-Oct	90/10/15	3.25"/3.5"	80.74%	2.17	2776	N/A	1.28	3.25" paste is not sticky; 3.5" paste is not sticky
Lift 6	14-Oct	90/10/15	3"	80.85%	2.17	2699	N/A	1.24	paste is not sticky
Lift 7	15-Oct	90/10/15	3"	80.85%	2.17	2653	1.89	1.22	paste is mildly sticky
Lift 8	15-Oct	90/10/15	5.5"/5.25"	79.73%	2.13	2708	N/A	1.27	paste forms a narrow shoulder in the sea can (almost at the top)
Lift 9	16-Oct	90/10/15	3.5"/3.75"	80.63%	2.16	2651	2.2	1.23	

Figure 1: Summary of pile and sea can testing

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