Appendix A

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Appendix A-1: Technical Specifications

TITLE: **TECHNICAL SPECIFICATIONS FOR THE WHALE TAIL DIKE FOUNDATION BLANKET GROUTING**

CLIENT: AGNICO-EAGLE MEADOWBANK DIVISION

PROJECT: **REMEDIAL WORK FOR WTD SEEPAGE**

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1.0 INTRODUCTION

A rock grouting program was implemented during the Whale Tail Dike (WTD) construction between December 2018 and February 2019 to control the seepage flow through the WTD bedrock foundation. The rock grouting work was carried from stations 0+180 to 0+520 to depths ranging from approximate 10 to 15 m. Upon completion of the WTD construction and the development of the hydraulic gradient on this structure, seepage flow higher than the theoretical estimated amount was encountered during the dewatering process.

The purpose of the remedial drilling and grouting work is to further reduce the seepage flow through the WTD bedrock foundation to meet the project water management plan requirements which correspond to a reduction of about 40% of observed seepage. This Technical Specification is based on the discussions and recommendations of the grouting committee comprised of Owner's engineers, Contractors, Design Engineers and Consultants. This Technical Specification covers the scope of work, products, equipment and execution procedures for Whale Tail Dike foundation rock grouting work Phase I - Blanket Grouting.

Evaluation will be carried out upon completion of the Phase I drilling and grouting of upstream and downstream blankets. Based on the results and performance of Blanket grouting, decision shall be made if Phase II - Upstream curtain grouting is required.

2.0 GENERAL

2.1 Scope of Work

1. The Work described in this Section includes the supply of all labor, equipment and materials required for the execution of drilling and grouting of the Whale Tail Dike bedrock foundation.
2. Remedial works consist of all works required to reduce the seepage and hydraulic conductivity of the rock foundation by sealing fractures in the bedrock foundation by drilling and grouting holes from the crest of the dike at locations shown on the drawings and as specified herein or as required by the Engineer.
3. The work described in this specification is related to Phase I of the work, which corresponds to drilling and grouting of upstream and downstream blankets to grout fractured rock at shallow depth.
4. The Work includes but is not limited to the following:
    a. Survey and marking of the location and centerline of the secant piles cut-off wall on the crest of the dam;
    b. Survey and marking of the location of the proposed holes of downstream and upstream blankets on the crest of the WTD prior to start drilling;
    c. Drilling holes with casing from WTD crest through thermal cover (rockfill) and fine filter down to and into the bedrock foundation;
    d. Installation of a grout plug to prevent grout leakage by sealing the annulus space and contact face between steel casing and surrounding rock with grout prior to start drilling and grouting of the blanket;
    e. Drilling grout holes in the bedrock foundation through casing installed in the WTD fill materials;
    f. Supply and use of inclinometers to measure hole inclination;
    g. Hole washing prior to commencing grouting;
    h. Supply of materials including cement, water and admixtures for grout mix;
    i. Development of different grout mix designs based on the characteristics specified herein, which will be confirmed or modified according to the actual field conditions;
    j. Supply of different types of grout mixes, as required;

k. Execution of grouting in bedrock foundation in compliance with technical requirements and as required by the Engineer;

l. Backfilling and finishing of drilled holes in the rock and in the fill.

2.2 Definitions

1. Stable Grout: grout with less than 5 % bleeding after 2 hours.
2. Blanket Grouting: a procedure in which relatively closely spaced, and usually shallow holes, are drilled and grouted for the purpose of reducing the permeability of the upper portion of the bedrock beneath the dam. It is generally done in rows parallel to the grout curtain.
3. Split Spacing Grouting: a grouting sequence in which initial (primary) grout holes are relatively widely spaced and subsequent holes are placed midway between grout holes which have previously been drilled and grouted. This process is continued until one or more specific criteria are achieved.
4. Stage: A section or segment of hole grouted at one time.
5. Stage Grouting: sequential grouting of a hole in separate steps or stages in lieu of grouting the entire length at once. Holes may be drilled to the final planned depth and grouted in ascending or upward stages using packers or may be incrementally drilled in downward stages and be grouted from the collar of the hole or with packers set in a previously grouted stage.
6. Packer Installation: defines all the operations necessary to install a packer assembly which can resist the specified grouting or water testing pressure without leaks and without loss of pressure during grouting or the execution of a water pressure test.
7. Grouting Pressure: means the grout pressure measured at the collar of the hole while grouting the hole.
8. Engineer: designates SNC-Lavalin representative at site also called QA Inspector.
9. Effective Pressure: means the grout pressure effective at the middle of the stage elevation while grouting a stage in a hole.
10. Thermistor: instrument used to monitor the temperature of the rock foundation before grouting.
11. Frozen rock: rock which has a temperature of 0ºC or less, as measured with thermistors.

12. Pressure Filtration Coefficient: is defined as the volume of water lost in the pressure filtration test divided by the initial volume of grout in the cylinder of the apparatus, divided by the square root of the filtration time in minutes per the following formula:

Formula: $$Kpf = \frac{Volume\ of\ Water\ ejected}{Initial\ volume\ of\ grout \times (filtration\ time\ (\ \ )) \wedge 1/2}$$

2.3 Scope of Responsibilities

The organizational chart of the Work is presented in the figure below. The responsibilities of each stakeholder are defined in the following sub-sections.

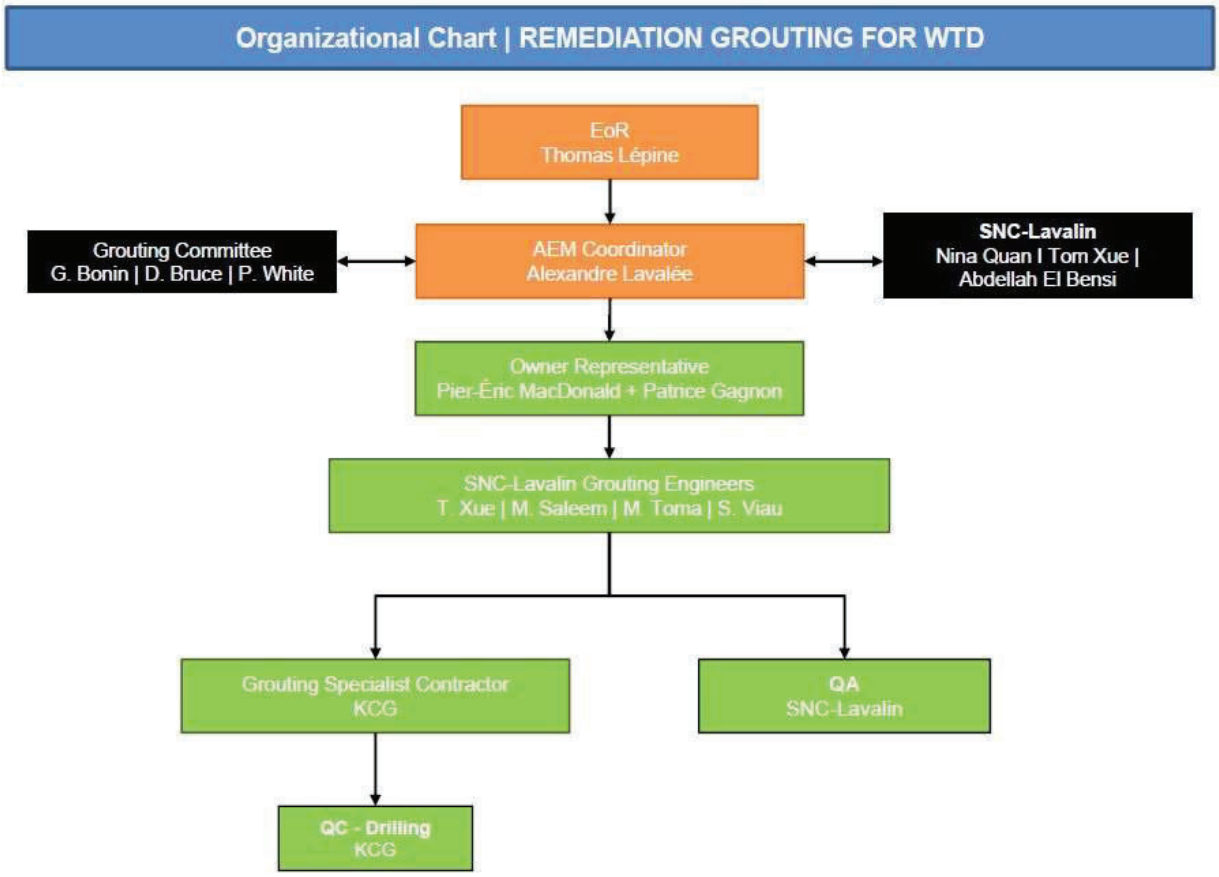


Figure 2-1: Communication Chart

2.3.1 Owner's Representative (AEM)

- Review work and monitoring of construction.

- Share data with QA Inspectors and QC Representatives including but not limited to layout, scope limit control and data collection for as-built drawings and report.
- Report changes to the Designer.
- Report any deviation to the Designer.
- Review quantities.
- Coordination, daily interaction with the Contractor and the Engineer.
- Follow-up and update the construction schedule.
- Confirm the waste disposal area.
- Responsible of the health and safety and Environmental issues on site.
- The Owner shall supply, install, maintain and operate efficient and practical communication systems between stakeholders.

2.3.2 Engineer / QA Inspectors (SNC-Lavalin)

- Review and approve contractor's work plan including methodologies, work schedule, equipment and materials and mixed for drilling and grouting.
- Review data and information of the work progress.
- Share data to the Owner's Representative and the design team.
- Participate in technical evaluation of the performance for the acceptance of grouting work
- Inspection, documentation and review of QC work to ensure that the control meets the specifications and the Design.
- Report any deviations to the Owner Representative and the Designer.
- Issue of Site Instructions (SI) to Contractor for execution and clarification of the work.
- Request additional testing when required and review of QC testing and procedures.
- Collect signed forms (approval and non-conformity forms) and provide copies to the Owner's representative and to the Designer.
- Prepare as-built report, including testing results, drawings and reports.

2.3.3 Contractor (KCG)

- Provide the submittals to the Owner's Representative and the Designer as requested in section 2.5.
- Construction of the grout curtain in compliance with the requirements of the drawings and the specifications.

- Conduct trial mixes using materials on site and submit test results prior to commencing production.
- Carry out all survey and stake out of grout holes and provide all material volumes to the Owner's Representative, QA Inspectors and QC Representatives.
- Share all collected data with Owner's Representatives, QA Inspectors and/or QC Representatives.
- Identify any deviations from the design or drawings, collect information and share it with the Owner's Representative and the Engineer.

2.3.4 Quality Control Representative (KCG)

- Inspection and documentation of work procedures to ensure the works meet the drawings and the specifications.
- QC testing as required by the specifications (Appendix 2).
- Prepare QC daily report and share it with the Owner Representative and the QA Inspector.
- Prepare approval forms.
- Realize additional testing when required or requested by the QA Inspector or the Engineer.
- Review survey data.

2.3.5 Designer (SNC-Lavalin)

- Provide rock grouting design and construction drawings.
- Provide drilling and grouting specifications subject to review of grouting committee and owner's approval.
- Attending meeting with grouting committee.
- Review documentation requested from the Contractor prior to the beginning of the Work.
- Be informed of the construction schedule and the advancement of the Work.
- Make design change(s) when required.
- Collect all deviations and update the deviation database.
- Send a sealed technical memorandum to the Owner's representative within appropriate time frame to confirm the design change(s).
- As-built documentation

2.4 Reference Standards and Procedures

The Contractor shall comply with the provisions of the last revision of the Standards and Procedures listed below:

ASTM C150/C150M	Standard Specification for Portland Cement
CSA-A23.1	Concrete Materials and Methods of Concrete Construction
CAN/CSA-A3000	Cementitious Materials Compendium
CSA-A23.2-1B	Testing for Properties of Flowable Grout
ASTM C191 / C191M	Standard Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle
ASTM C494 / C494M	Standard Specification for Chemical Admixtures for Concrete
ASTM D6910/D6910M	Standard Test Method for Marsh Funnel Viscosity of Clay Construction Slurries
API RP 13B-1	Recommended Practices for Field Testing of Water-based Drilling Fluids

2.5 Submittals

1. At least two weeks prior to the start of the drilling and grouting works, the Contractor shall submit the following for the Engineer's approval:
    a. Manufacturer's specifications and material safety data sheets of the proposed products;
    b. Drilling and grouting method statement including details of drilling, water testing and grouting procedures, the proportions of the proposed grout mixes, mixing procedure, the type of admixtures proposed and specifications and photographs of all equipment to be used in water pressure testing, batching, transporting, pumping and monitoring of the grout, inclusive of proposed standby equipment;
    c. Test results of the proposed grout mixes;
    d. Effective and gauge pressures chart based on pressure head loss in the grout lines, grout column and water level in the hole using different type of grout mixes;

e. Layout showing location and elevations of equipment in relation to discharge point, as well as proposed pumping distances including characteristics and dimensions of the shelter proposed to perform grouting works, including heating and water supply systems;

f. All equipment calibration certificates based on the manufacturer's recommendations for calibration;

g. Proposed work schedule detailing the number of shifts and size of crews;

h. CVs of the proposed drilling and grouting specialists and field supervisors.

2. The Contractor shall submit daily reports and progress records documentation to the Engineer.

3. The Contractor shall submit as-built grouting drawings after the completion of the Work to the Engineer.

2.6 Qualifications

1. The grouting work specified herein shall be undertaken by qualified staff each with a minimum of three years of recent experience in performing cementitious grouting work.

2. Grouting specialists, drilling and grouting field supervisors are required; they shall each have five years of recent experience in grouting.

3. The Contractor shall maintain on site a grouting specialist to monitor the drilling, water pressure testing, grouting and all verification works. The responsibilities of the grouting specialist are:

   a. To approve the detailed working procedures;

   b. To approve the equipment and materials brought on to site;

   c. To monitor the grouting operations conducted and to ensure that the operations are carried out in a manner to obtain expected results;

   d. To complete all quality control documentation and progress records required and submit this documentation on daily basis.

4. The Contractor shall maintain on site a grouting field supervisor to monitor, supervise and direct all phases of grouting. The responsibilities of the supervisor are:

   a. To supervise and direct the personnel carrying out the drilling and grouting Work.

b. To ensure that all personnel adhere to all safety and environmental requirements, and to ensure that all equipment and documentation for these requirements are in place before the start of the Work.

c. To obtain and maintain in good working order all equipment used for drilling, grout mixing, water pressure testing and grouting, and to ensure the equipment is suitable and is of sufficient capacity for the work to be performed.

d. To ensure that drilling, water pressure testing, grout mixing, and injecting the grout are carried out properly in accordance with the specification and the approved procedures.

e. To obtain and maintain the supply and storage of grouting material such as to ensure continuous grouting operations.

3.0 MATERIALS

3.1 Grout Mixes

1. Grout mixes for the grouting work specified herein shall be stable grout mixes and consist of cement, water and admixtures as required.
2. The grout mixes shall be prepared by the Contractor based on the characteristics specified herein, which will be confirmed or modified according to the field tests results. The grout mixes used shall be subject to the Engineer's approval.
3. The Contractor shall use chemical admixtures in the grout to produce grout mixes with different viscosity, cohesion and set time as required by the Engineer.
4. Several stable grout mixes shall be developed from standard grout mix to the shutdown grout mix by reducing the w/c ratio and adding different type of admixtures to accommodate different site conditions.

3.2 Water

1. Mixing water shall be fresh, clean and free from injurious amount of oil, acid, alkali, salts, organic matter and other deleterious substances, all in conformity with the requirements of CSA-A23.1 and CSA-A23.2.
2. Water for grout shall be at a temperature of not less than 10 °C and not more than 25 °C.
3. Water used for washing and water pressure testing shall be at a temperature of not less than 7ºC and not more than 25ºC.

3.3 Cement

1. The cement shall be Portland Cement Type HE or other approved by the Engineer. The cement materials shall comply with CSA-A3000. Cement shall be obtained from one manufacturing source. Partially hydrated cement due to poor storage conditions or other reasons are not suitable and shall not be used in grout.

3.4 Admixtures

1. Superplasticizers such as MasterGlenium 3030 or equivalent shall be used to produce high mobility grout for sealing fine joints and fractures.
2. Thixotropic admixtures such as Celbex 653 and Rheomac UW 450 or equivalent shall be used to create thixotropic and anti-washout grout mixes.

3. Accelerating agents including Calcium Chloride in powder and Liquid Sodium Silicate Type N may be used to quick set or flash set when grouting into high flow velocity conditions.
4. All the admixtures shall comply with ASTM C494.
5. Admixtures shall be handled, stored and used according to the manufacturer's recommendations.
6. All the admixtures shall be stored in heated areas to avoid freezing which may affect the performance of the admixtures.

3.5 Handling, Storage and Disposal of Grouting Materials

1. Grout materials shall be stored and handled as recommended by the manufacturer and in accordance with all regulations, codes and ordinances.
2. Suppliers and Manufacturers should be Consulted regarding the changes of properties and suitability to use if materials are stored in environment different from the Manufacturer’s recommendations.
3. Spilled, spoiled or opened, as well as unused materials shall be disposed of in accordance with all regulations in an area designated by the Owner.

4.0 EQUIPMENT

1. All drilling and grouting equipment supplied and used in the work shall be of a type, efficiency and mechanical conditions suitable for executing adequately the drilling and grouting operations and shall be subject to the Engineer's approval.

4.1 Drilling Equipment

1. The contractor shall provide sufficient drilling and grouting equipment and all necessary auxiliary equipment and accessories to complete the various types of drilling and grouting required. Such equipment shall be of the types and capacities approved by the Engineer and shall be maintained adequately.
2. To drill holes in bedrock, steel casings shall be installed through the WTD fill and socketed into the bedrock foundation. Steel casing shall be with adequate strength and large enough to permit drilling of the hole in the rock and to maintain the verticality of the hole during drilling and grouting operations.
3. The section of holes through the fill materials shall be executed by means of down the hole hammer. The section of holes in the bedrock foundation shall be executed by drilling equipment using only water flushing during drilling.
4. All drilling equipment shall produce holes free of irregularities to avoid leakage of water or grout around the packers.
5. Inclinometers shall be used to measure the inclination of holes designated by the Engineer.
6. Grout holes in bedrock foundations shall have a minimum diameter of 50 mm.
7. Steel casing in grout holes shall be left in place and casing backfilled with stable grout mix upon completion of the grouting of the hole.

4.2 Grouting Equipment

1. The grouting equipment shall be capable of adequately supplying, mixing, pumping and injecting grout mixes as specified herein and as required by the Engineer.
2. The equipment shall be of adequate size and capable of supplying an uninterrupted flow of grout at the rate of 20 liters per minute at the maximum pressure of 30 bars measured at the collar of the grout hole.
3. The pumps shall be of the variable speed progressing cavity (Mono or Moyno) type that are suitable for pumping high volumes of low W:C ratio cement grout mix. The pumps shall be able to regulate pressure and flow rate with precision from zero to the maximum allowed.

4. A separate pump (such as an Open Throat Progressive Pump) suitable for injection of cement grout with Celbex and liquid Sodium Silicate shall be available on site for use under high velocity seepage.
5. If liquid Sodium Silicate is to be injected simultaneously with cementitious grouts, concentric piping injection systems or two pipes system will be required.
6. The grout-mixing unit shall be capable of producing the required grout mixes as determined from the test results. The mixer shall be high speed, high-shear with rotation speed of between 1200 and 1500 RPM, allowing colloidal suspension of the cement particles. The grout-mixing unit shall include graduated cylinders and a digital scale of ±0.1 g accuracy.
7. Retention tanks shall have a minimum capacity of 500 liters, shall be mechanically operated with paddles rotating at up to 100 RPM and shall be designed to keep the mixed grout agitated and in suspension. The lowest paddle shall be set within about 50 mm of the base of the tank. Holding tanks shall be provided with 2.5 mm sieve to screen solids in the grout return line.
8. Hoses and supply lines used grouting shall be rated to 30 bars safe working pressure and shall have a minimum inside diameter of 25 mm. Fittings and connections shall be rated to 30 bars safe working pressure and shall include Whip check Safety Locks.
9. Packers shall be capable of sealing the lower end of the casing, and capable of withstanding the maximum pressure prescribed without leakage. The inside diameter of the tubes carrying the grout mix shall not be less than 19 mm. The Contractor shall maintain on site, at all time, a sufficient quantity and variety of packers to carry out grouting and water pressure testing.
10. Water meters on the water supply lines shall be graduated in liters, without bypass, to measure the water volume in the mixer accurately.
11. The flow meter shall be capable of measuring flows as low as 0.3 liter per minute with a precision of ±0.1 liter per minute. The flow meter capacity shall be 100 liters per minute.
12. Pressure gauges shall be in different pressure ranges including 0 to 5 bars, 0 to 10 bars, 0 to 20 bars and 0 to 30 bars. Pressure gauges shall be protected from grout using gauge savers. An adequate number of spare pressure gauges shall be available on site. A pressure gauge shall not be used for more than two shifts after which it shall be cleaned and calibrated using a reference gauge supplied by the Contractor. All pressure gauges shall be numbered for identification. All pressure

gauges shall have a minimum window diameter of 75 mm. Pressure gauges shall be installed at each pump discharge and at each hole collar.

13. Water heaters shall be used to heat mix water.
14. Thermometers shall be permanently installed in the tanks and mixers. Other thermometers shall be provided to measure temperature of the return wash water.

4.3 Data Recording System

1. The Contractor shall provide an automated data recording system capable of continuous recording real timely of pressure, flow rate, apparent lugeon and total volume injected for each stage. The recorded data shall be shown on the monitor screen and printed as an Apparent Lugeon values (Y axis) versus time (X axis). The equipment shall be able to include the pressure of the grout column above the stage grouted in order to display the effective pressure applied at the stage elevation.
2. The pressure transducer should be protected by EPDM gasketed gauge savers.
3. Manual data collections and records such as injection rate, volume and injection pressures shall be taken during the process of Sodium Silicate injection.

4.4 Arrangement and Operation of Grouting Equipment

1. The grouting equipment shall be arranged to provide continuous grout circulation throughout the circuit and permit accurate pressure control by operation of valves.
2. Plugging of the equipment and lines shall be prevented by maintaining a continuous flow of grout and by periodic flushing with water.

4.5 Field Acceptance Trial

1. Prior to commencing grouting operations, a Field Acceptance Trial involving the actual equipment, materials and procedures shall be conducted to verify their adequacy. The grouting specialist and grouting supervisor shall be on site for the Field Acceptance Trial. The Field Acceptance Trial shall cover the following:
    a. Calibration, verification of gauges, scales, water meters and grouting monitoring/ data recording equipment.
    b. Calibrating procedure for the automated monitoring/data recording system pressure transducer and flow meter.
    c. Batching, mixing and pumping of a trial mix through the circulating line system.

d. Quality control tests and grouting records: parameters such as density, viscosity, cohesion, bleeding and initial setting time shall be measured and recorded for each trial mix.

e. Contractor's methods and equipment for grouting under high flow velocity shall be tested for quality and workability on site before starting the work.

4.6 Contractor's Site Laboratory

1. The Contractor shall have on site a laboratory to undertake necessary testing. Equipment essential to undertake routine testing and to design grout mixes includes but is not limited to:

    a. Mud balance,

    b. Marsh cones,

    c. Bleeding cylinders/columns,

    d. Cube moulds, for field acceptance trial only.

    e. Glass hardware (test tubes, thermometers, beakers)

    f. Vicat Needle apparatus for cementitious grout set time

    g. Pressure filtration devices.

5.0 EXECUTION

5.1 Casing Installations

1. The grout holes shall be drilled from the crest of the WTD with an offset from the center line of the secant piles cut-off wall as shown on the drawings.
2. The set out of hole locations shall be established by survey tied to the project control points and approved by the Engineer prior to drilling.
3. The maximum permitted inaccuracy of grout hole casing positioning is 50 mm in any direction.
4. Deviation of drill hole casing and drill hole in bedrock shall be verified at all time. Maximum deviation of a drill hole casing vertical alignment shall not exceed 0.5% of its drilled length
5. Downstream blanket holes shall be drilled and grouted prior to start drilling the upstream blanket holes. Downstream blanket holes shall be staggered with the upstream blanket holes as shown on the drawings.
6. Steel casings through the fill materials section shall be executed with a rig equipped with a down the hole hammer.
7. Casings shall be advanced 300 to 500 mm maximum below the bedrock surface and sealed with cement grout plug at the bottom of the casing to prevent grout leakage around the casing. Advancement of the casing more than 500 mm below bedrock as-built level shall first be approved by the Engineer.
8. Either tremie grouting or packer grouting methods shall be used to grout the casing plug.
9. If packer grouting method is used, casing movement should be closely monitored to guarantee no uplift of casing will occur. A maximum of two (2) times of the theoretical casing volume shall be injected if no pressure buildup or grout leakage occurs. In this case, casing plug grouting in the same hole shall be repeated until refusal is obtained.
10. Holes shall be flushed with water prior to grouting the plug. The grout shall reach its final set time prior to start drilling bedrock.

5.2 Drilling for Blanket Holes in Bedrock

1. Blanket grout holes shall be drilled through installed casings and grouted in sequence starting from Primary, following by Secondary, Tertiary and Quaternary holes using split spacing method.

2. Blanket Holes shall be drilled to a nominal depth of five (5) m below the bottom of casing in one or two short stages based on the bedrock conditions and as per Engineer's instruction.

3. The section of the hole in the bedrock foundation shall be executed by drilling equipment using only water for drilling and flushing the hole. Use of air to remove cuttings from a hole is not permitted.
4. Deviation from vertical in the bedrock section of the hole shall not exceed 2 % of drilled length.
5. Drilling of all holes shall be carried-out using clean water as the drilling fluid.
6. Minimum distance between two drilled holes in bedrock is 12 m. This distance may be increased by the Engineer if communication between adjacent holes occurs.
7. Drilling of the rock section within 6 m of a grouted hole shall not be completed until the grout in the closest grouted hole reached its initial set time.
8. On completion of drilling and immediately before grouting, each grout hole shall be flushed with clean water injected at the bottom of the hole for a minimum period of 5 minutes.
9. Each hole shall be protected from clogging or obstruction by means of a temporary cap or other suitable device at the collar. Any hole obstructed shall be cleaned out and grouted otherwise another hole shall be drilled.

5.3 Grout Mixes

5.3.1 Stable Grout Mixes

- The grout mixes used for rock grouting shall be stable mixes composed of Water, Portland Cement HE and admixtures.
- Superplasticizer: MasterGlenuim 3030 or equivalent - percentage by weight of cement as recommended by the manufacturer and determined by trial mixes.
- Viscosity modifying agent, anti-washout agent, accelerating agent and/or other additives, if required: percentage by weight of cement as required.

The following grout mixes are proposed based on the mix trial on site.

Grout Mix Design for Rock Grouting (Mix A/A+)	
W/C Ratio	0.7
Water	84 L
Portland Cement Type III (HE)	120 kg
MasterGlenium 3030	0.0 / 480 ml
Calcium Chloride (2% weight of HE Cement)	2.4 kg
Specific gravity	1.5-1.6
Marsh Time	30 - 35s
Bleeding (after two hours)	2% to 5%
Pressure Filtration Coefficient	Not available

Grout Mix Design for Rock Grouting (Mix B)	
W/C Ratio	0.6
Water	72 L
Portland Cement Type III (HE)	120 kg
MasterGlenium 3030	-
Calcium Chloride (2% weight of HE Cement)	2.4 kg
Specific gravity	1.65-1.75
Marsh Time	35 – 50s
Bleeding (after two hours)	2% to 4%
Pressure Filtration Coefficient	Not available

Grout Mix Design for Rock Grouting (Mix C/C+)	
W/C Ratio	0.5
Water	60 L
Portland Cement Type III (HE)	120 kg
Calcium Chloride (2% weight of HE Cement)	2.4 kg
Celbex 653 (0.0 /0.2% of weight of HE Cement)	0.0 / 0.24 kg
Specific gravity	1.7 – 1.85
Marsh Time	80 to 180s
Bleeding (after two hours)	<2%
Pressure Filtration Coefficient	<0.02 min $^{-1/2}$

Grout Mix Design for Rock Grouting (Mix D)	
W/C Ratio	0.5
Water	60 L
Portland Cement Type III (HE)	120 kg
Calcium Chloride (1% weight of HE Cement)	1.2 kg
Rheomac UW 450	500 ml
Specific gravity	1.70 -1.80
Marsh Time	>150s
Bleeding (after two hours)	<1%
Pressure Filtration Coefficient	Not available

5.3.2 Grout Mixes for High Flow

1. Contractor shall prepare, under the supervision of the Engineer, grout mixes to prevent washout of the grout during and after injection. Contractor shall use admixtures such as Celbex 653, Rheomac UW 450, Calcium Chloride and Sodium Silicate to modify the properties of the grouts as needed based on the ground response during grouting. Grout mixes shall be approved by the Engineer prior to use.
2. The pump shall be capable of displacing thicker grout at the required pressure while considering the head losses due to grout lines.
3. Grouting under high velocity flow conditions may be performed with thicker grout mixes by adding appropriate dosage of Celbex directly into the Open Throat Pump.
4. Two components grouting with Cement grout and Sodium Silicate liquid from two pumping systems shall be carried out if deemed necessary by Engineer.

5.3.3 Casing Plug Grout Mix

1. Proposed grout mix for the bottom plug of each casing to seal the annular space between the casing and the rock and to embed the casing into the rock is grout Mix C+ (with 0.2% of Celbex) or as per the instruction of the Engineer.
2. Grout mix may be modified by the Engineer based on field conditions in order to better consolidate the rock around the bottom of the casing and also to control the grout wastage.

5.4 Grout Quality Control (QC) Testing

1. The Contractor's QC personnel shall take grout samples to perform quality control testing required as per the frequency and methods in the following Table.

QC Test	Test Methods	Minimum Frequency
Specific-gravity by mud balance	API RP 13B-1	Once per 5 batches of same grout mix, minimum twice per shift and Each time when grout mix changes
Marsh flow cone to verify the viscosity	ASTM D6910	
Grout temperature readings at the holding tank		
Grout bleeding graduated cylinder	CSA-A23.2-1B	
Pressure filtration testing	API RP 13B-1	
Grout compressive strength 2 Sets of cube molds	CSA-A23.2-1B	Only at time of field acceptance trial.

2. Accurate quality control records shall be kept.

5.5 Grout Quality Assurance Testing

1. Quality Assurance testing shall be carried out on a daily basis under supervision of the Engineer.

5.6 Grouting operation

1. Blanket grouting shall be carried-out using a stable grout mix according to site conditions and as per Engineer instructions.
2. Holes shall normally be grouted one at a time in a sequence to obtain the desired consolidation and control of seepage. If during the grouting, grout is found to flow to another hole or holes adjacent from the one being grouted, the Engineer shall be immediately informed. Such hole or holes shall be grouted simultaneously with the original grout hole, unless otherwise instructed by the Engineer.
3. Blanket hole may be grouted in one or two short stages based on the bedrock conditions and as per Engineer's instruction. In the upper stage, the packer shall be inflated at the lower extremity of the casing to ensure grouting of the topmost section of bedrock near the secant pile-bedrock contact.
4. Grouting of a hole shall continue uninterrupted until refusal occurs or the specified volume limit for that stage is reached, unless otherwise instructed by the Engineer.
5. Without noticeable increase in the grouting pressure, the maximum volume of grout for each hole is limited to 400 liters per meter, unless otherwise instructed by the Engineer.

6. If high grout take is observed without noticeable pressure increase, the Contractor may, with the Engineer's consent:
    - Use a thicker grout by adding Celbex or Anti-washout Rheomac in the grout mix;
    - Add appropriate dosage of Celbex directly into Open Throat Pump.
    - Reduce the grout flow rate;
    - Discontinue the grouting momentarily and re-grout the hole as required.
    - If none of the above procedures permits reaching the specified pressure, grouting of the hole will be discontinued and grouting shall be carried out using concentric piping two component system for Cementious grout and liquid Sodium Silicate.
7. Any loss of pressure or sudden increase in grout take shall be immediately reported to the Engineer. The QC Representative shall also report it in his shift report.
8. No grouting shall take place if the rock is frozen.
9. The temperature of the grout at any point shall be between 5°C and 20°C.
10. A grout batch which has been in circulation for over 2 hours shall be disposed of.

5.7 Grouting Pressures

1. Grouting pressure shall be applied gradually and maintained until either the maximum volume has been injected or a maximum allowable effective pressure has been reached.
2. Initial specified effective grouting pressures for a stage shall be 0.2 bar per meter measured vertically from the working platform to the top of bedrock, plus 0.5 bar per meter measured from the bedrock surface to the mid-point of a stage.
3. The applied effective grouting pressure shall be calculated using various high density grout mixes at various flow rates to establish corresponding pressure loss parameters and calculated taking into account the hydraulic head relating to depth below surface and corresponding water elevation. Effective Pressure Formula is shown on the Figure 5-1.

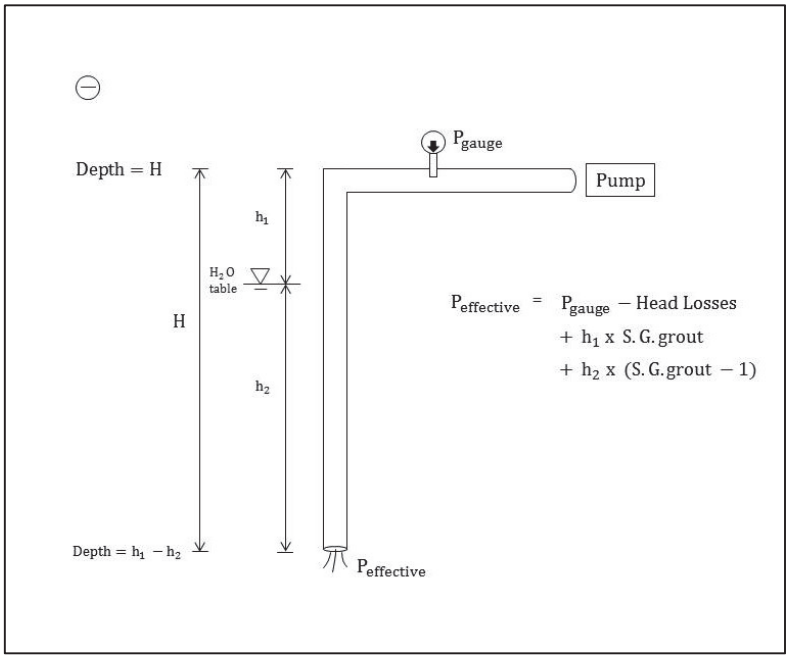


Figure 5-1: Effective pressure formula

4. In general, the effective grouting pressure shall be as high as possible but compatible with estimated critical pressures against uplift and hydro jacking.

5.8 Refusal Criteria

1. When the maximum pressure has been reached, the maximum pressure shall be maintained constantly for 5 minutes. Grouting of the stage is then considered complete if the flow to maintain this pressure is less than 3 liters per minute, measured over a 5 minutes period.
2. For injection of Celbex-assisted cementious grout using Open Throat Pump, injection shall be stopped after a maximum volume of about 200 liters/meter. Hole shall be re-grouted if the hole is found empty after a period equal to a grout final set time.
3. After the grouting of a hole is complete, the pressure shall be maintained by suitable valves until the grout pressure has decreased to zero or the grout has set sufficiently so that it will be retained in the hole.

4. If an accelerating agent is added to the grout and the initial set time of the grout has been reduced considerably, the Contractor shall evaluate the allowable time to remove safely the packer after the completion of grouting.

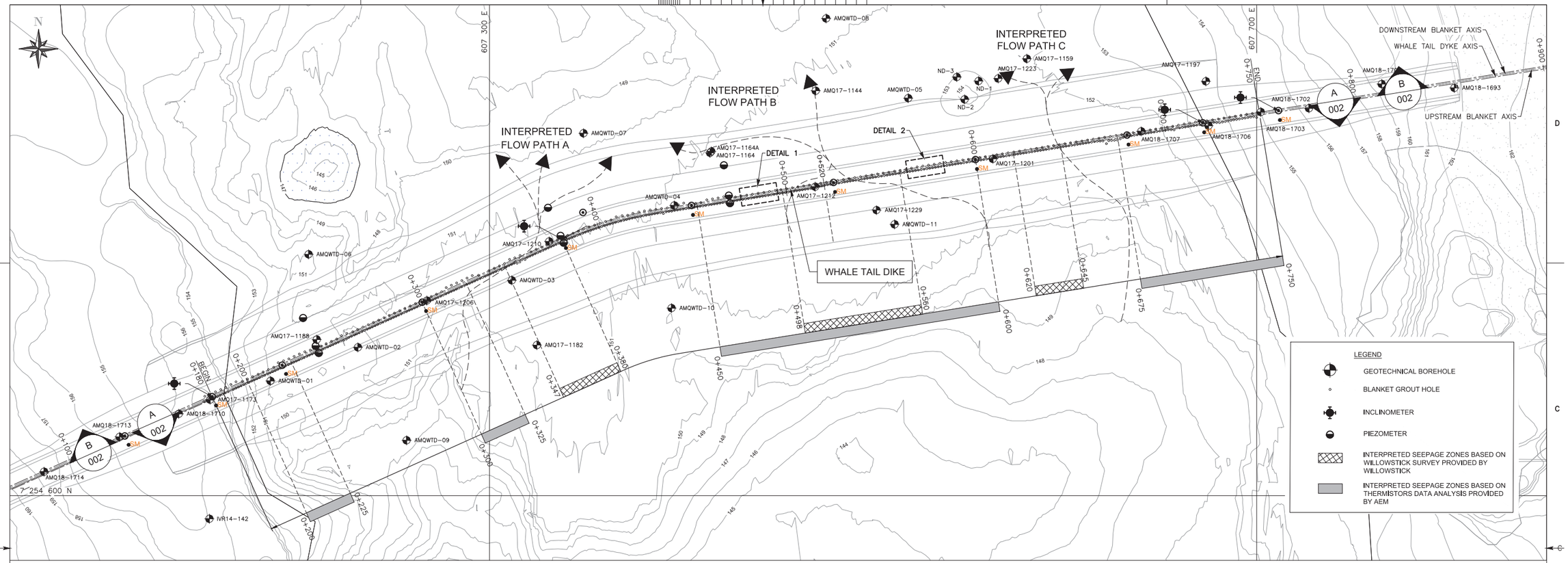
5.9 Hole Backfilling

1. After refusal is met for a downstream blanket hole, the hole shall be backfilled from the bottom up with the last grout mix, using a pipe lowered to the bottom of the hole.
2. The upstream blanket holes shall be capped or partially backfilled (to one third of the total length of the hole) to allow Phase II curtain grouting work, if required, to be performed unless otherwise instructed by the Engineer.

5.10 Records

1. During the progress of the Work, the Contractor shall maintain on site at all time a complete set of documents indicating clearly and accurately, as the Work progresses, all changes, revisions and additions to the Work.
2. The daily reports for each shift shall include at least the following information:
   a. Location of the hole and its number;
   b. Casing installation details (Collar elevation, rock contact elevation, length of casing embedded in rock, hole deviation. Etc.)
   c. Rock drilling report;
   d. In situ and Laboratory test reports
   e. Grouting details, including:
      - Hole depth
      - Stage length
      - Water elevation in the hole
      - Grout mix
      - Gout injected volume
      - Grouting Pressure.
      - Date, time and all grouting details (interruptions, communication, leaks, uplift, etc.) and
      - Printed data from Data Recording System
   f. Drilling and grouting profile showing the work progress

APPENDIX 1
Drawings



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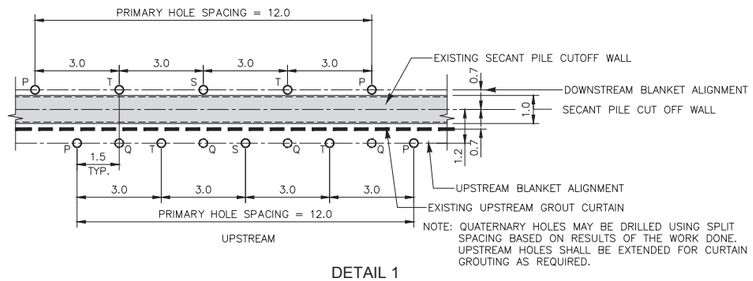
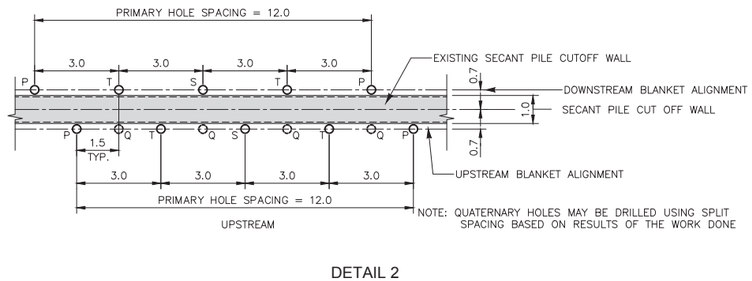


DETAIL 1
UPSTREAM AND DOWNSTREAM BLANKETS BETWEEN STATIONS 0+170 AND 0+520
FOR INSTRUMENTATION ZONE SEE TABLE 1 (DWG-003)
SCALE: 1:100



DETAIL 2
UPSTREAM AND DOWNSTREAM BLANKETS BETWEEN STATIONS 0+520 AND 0+750
FOR INSTRUMENTATION ZONE SEE TABLE 1 (DWG-003)
SCALE: 1:100

NOTES

ALL GROUTING AND ASSOCIATED WORK SHOULD BE CARRIED OUT PER THE TECHNICAL SPECIFICATIONS. SUPPLEMENTARY CLAUSES FOLLOW:

1. THE BLANKET GROUT HOLES SHALL BE DRILLED FROM THE CREST OF THE DIKE WITH AN OFFSET AS SHOWN ON DETAILS 1 AND 2. IN THE INSTRUMENTATION ZONES SHOWN ON DRAWING 003, TABLE 1, THE OFFSET IS VARIABLE; REFER TO PROVIDED EXCEL FILE: CASING LOCATION.
2. THE SET OUT OF HOLE LOCATIONS SHALL BE ESTABLISHED BY SURVEY TIED TO THE PROJECT CONTROL POINTS AND APPROVED BY THE ENGINEER REPRESENTATIVE PRIOR TO DRILLING.
3. THE CASING SHALL BE SOCKETED 300 TO 500 mm MAXIMUM PROVIDED AS BUILT BEDROCK LEVEL AND SEALED WITH CEMENT GROUT PLUG AT THE BOTTOM OF THE CASING TO PREVENT GROUT LEAKAGE AROUND THE CASING. EITHER TREMIE GROUTING OR PACKER GROUTING METHODS CAN BE USED TO GROUT THE CASING PLUG.
4. THE FINAL ELEVATION OF THE CASING SHOE AFTER BEING SOCKETED INTO BEDROCK SHOULD BE VERIFIED BY THE SURVEYOR AND REPORTED TO THE ENGINEER REPRESENTATIVE.
5. ANY ABNORMALITIES IN GROUND CONDITIONS, GROUND WATER, INGRESS OF FINE FILTER MATERIALS INTO CASING, FROZEN GROUND, AND CASING ADVANCE NEED TO BE DOCUMENTED AND REPORTED TO ENGINEER.
6. IF THE CASING STRIKES THE SECANT PILE, ITS ELEVATION SHALL BE RECORDED WITH ACCURACY. ANY PRESENCE OF MUD OR UNSET SLURRY ENCOUNTERED DURING CASING DRILLING SHOULD BE RECORDED AND BROUGHT TO THE ENGINEER REPRESENTATIVE ATTENTION.
7. THE MAXIMUM PERMITTED INACCURACY OF GROUT HOLE CASING POSITIONING IS 50 MM IN ANY DIRECTION. THE ALIGNMENT OF DRILL HOLE CASINGS SHALL BE VERIFIED AT ALL TIMES. MAXIMUM VERTICAL DEVIATION OF A DRILL HOLE CASING SHALL NOT EXCEED 0.5% OF ITS DRILLED LENGTH.
8. EACH CASING SHALL BE PROTECTED FROM ANY CLOGGING OR OBSTRUCTION BY MEANS OF A TEMPORARY CAP OR OTHER SUITABLE DEVICE AT THE COLLAR. ANY HOLE OBSTRUCTED SHALL BE CLEANED OUT OR RE-DRILLED BY THE CONTRACTOR.
9. THE CASING DRILLING RECORDS AND SURVEY DATA TO BE SUBMITTED TO THE ENGINEER REPRESENTATIVE AT THE END OF THE SHIFT.
10. BLANKET GROUTING LIMITS SHALL BE CONFIRMED BASED ON THE FIELD OBSERVATIONS.

ISSUE REGISTER

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ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE

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3	WHALE TAIL DIKE DRAFT REPORT.DOCX FROM WILLOWSTICK TECHNOLOGIES, LLC			
2	KIVALLIQ – PROFILE SECANT PILES AS-BUILT 02-12-2018			
1	AMARUQ TOPOGRAPHY RECEIVED ON 2015-09-15			

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REFERENCE DRAWINGS

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Xue, Tom
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SCALE	AS SHOWN		

CLIENT: AGNICO EAGLE

PROJECT: AGNICO EAGLE – MEADOWBANK DIVISION AMARUQ PROJECT

TITLE: REMEDIAL WORK DOWNSTREAM AND UPSTREAM BLANKETS PLAN VIEW AND DETAILS

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
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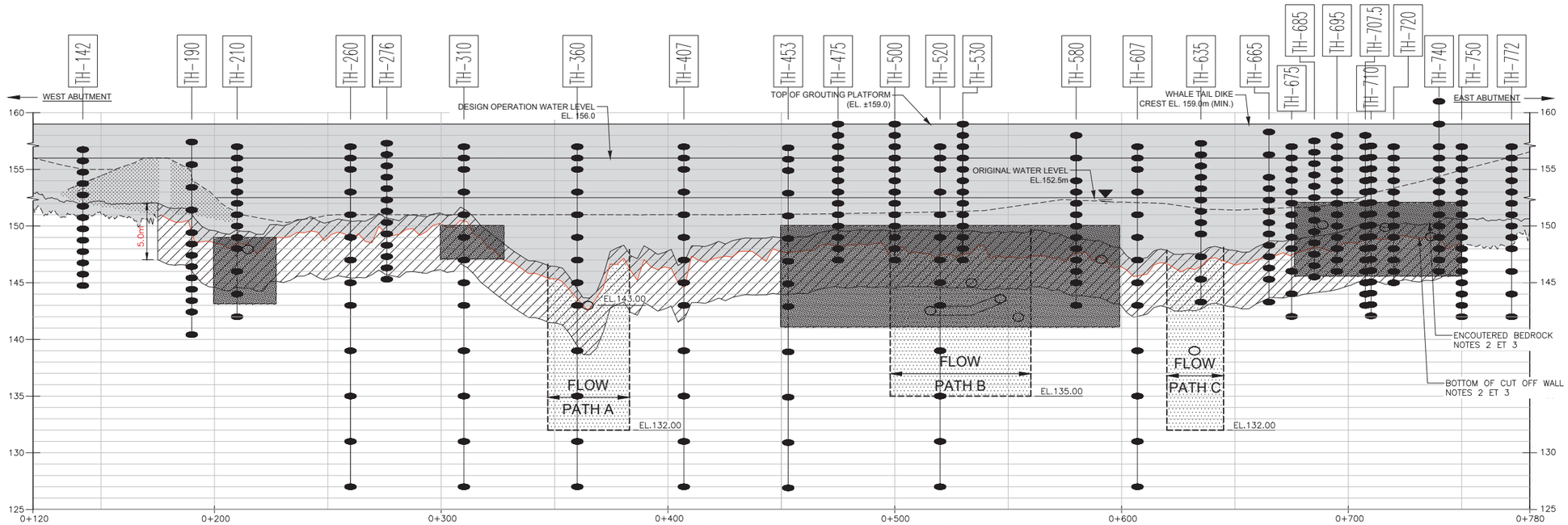

LONGITUDINAL SECTION A-A - DOWNSTREAM BLANKET (STATION 0+180 TO 0+750)

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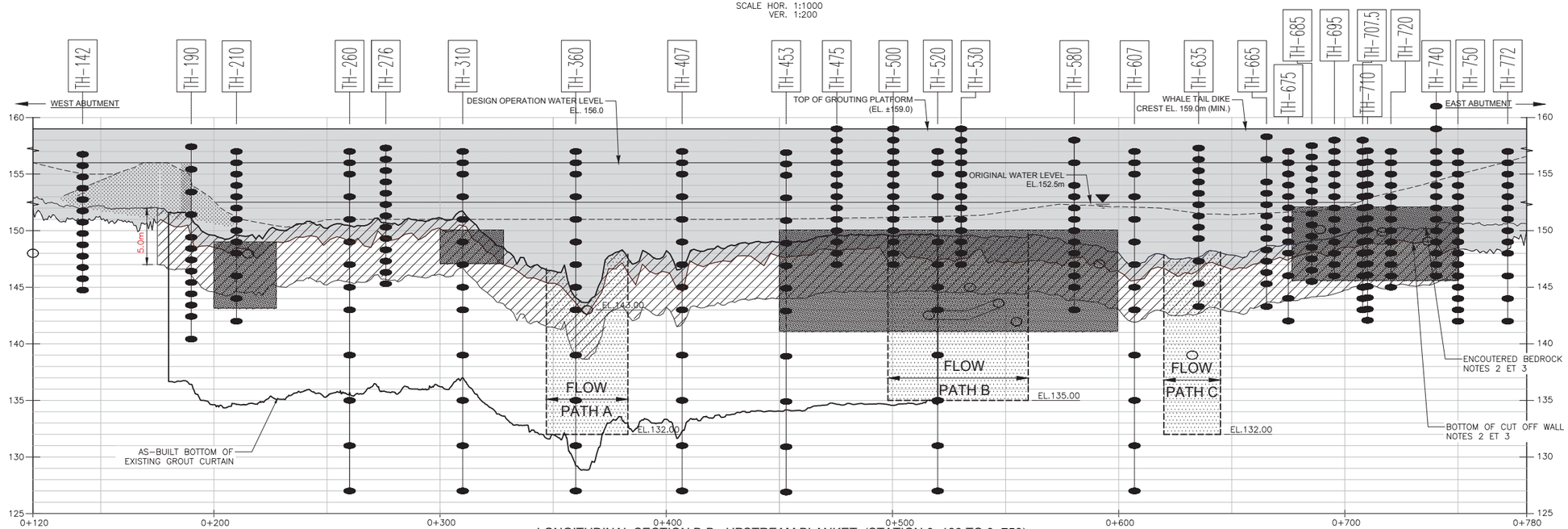

LONGITUDINAL SECTION B-B - UPSTREAM BLANKET (STATION 0+180 TO 0+750)

SCALE HOR. 1:1000
VER. 1:200

NOTES

1. ALL GROUTING AND ASSOCIATED WORK SHOULD BE CARRIED OUT PER THE TECHNICAL SPECIFICATIONS.
2. BEDROCK AND BOTTOM OF CUT-OFF WALL PROFILES WERE PRODUCED BASED ON AS-BUILT DATA PROVIDED BY AEM.
3. ROCK AND BOTTOM OF CUT-OFF WALL PROFILES AT THE LOCATION OF THE SECTION ARE THE PROJECTION OF THE PROFILES ON THE WTD AXIS.

LEGEND

- SECANT PILE ROCK SOCKET
- BLANKET GROUTING
- INTERPRETED SEEPAGE ZONE BASED ON WILLOSTICK SURVEY PROVIDED BY WILLOSTICK
- INTERPRETED SEEPAGE ZONE BASED ON THERMISTORS DATA ANALYSIS PROVIDED BY AEM
- ASSUMED LOCATION OF POTENTIAL HIGH SEEPAGE

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SCALE AS SHOWN	

CLIENT: AGNICO EAGLE

PROJECT
AGNICO EAGLE – MEADOWBANK DIVISION
AMARUQ PROJECT

TITLE
WHALE TAIL DIKE
DOWNSTREAM AND UPSTREAM - REMEDIAL WORK
LONGITUDINAL SECTIONS

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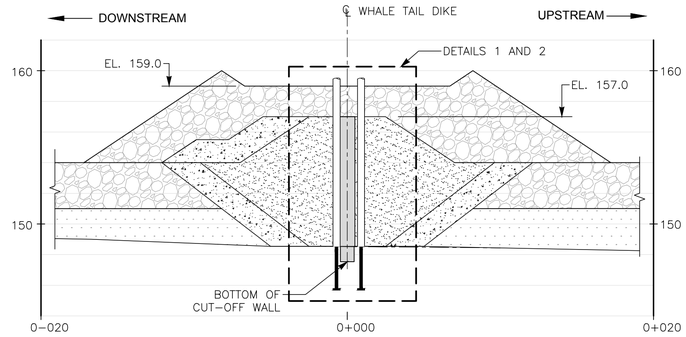

WHALE TAIL DIKE TYPICAL SECTION

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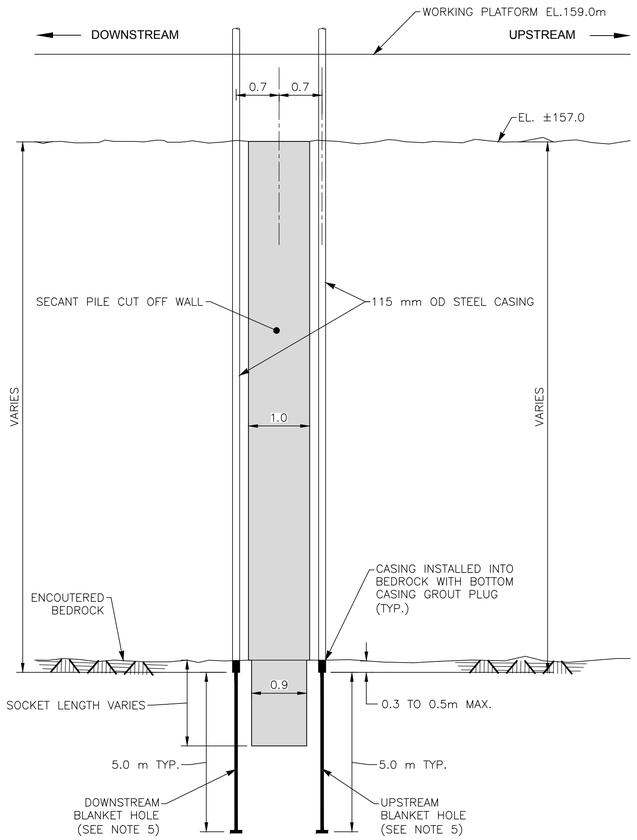
NOTES

1. DOWNSTREAM BLANKET HOLES SHALL BE DRILLED AND GROUTED FIRST PRIOR TO START THE UPSTREAM BLANKET HOLES.
2. GROUT HOLE CASINGS SHALL BE SOCKETED TO A TYPICAL DEPTH OF 300 mm MIN. TO 500 mm MAX. BELOW PROVIDED AS–BUILT BEDROCK LEVEL AND SHALL BE SEALED BY CEMENTIOUS GROUT.
3. PRIMARY, SECONDARY AND TERTIARY HOLES ARE MANDATORY AT SPACING OF 12.0; 6.0 AND 3.0 M RESPECTIVELY. QUATERNARY GROUT HOLES SHALL BE DRILLED AND GROUTED ALONG THE UPSTREAM BLANKET ROW USING SPLIT SPACING BASED ON THE RESULTS OF WORK DONE.
4. DOWNSTREAM BLANKET ROW SHALL BE LOCATED 0.7 M DOWNSTREAM OF THE SECANT PILE CENTRELINE.THE UPSTREAM BLANKET ROW SHALL BE LOCATED 0.7 M UPSTREAM SECANT PILE CENTRELINE EAST OF 0+520 AND 1.2 M WEST OF 0+520.
IN THE INSTRUMENTATION ZONES, INDICATED IN TABLE 1, THE OFFSET OF UPSTREAM AND DOWNSTREAM BLANKET ROWS IS VARIABLE, REFER TO PROVIDED CASING LOCATION EXCEL FILE.
5. DOWNSTREAM AND UPSTREAM BLANKET HOLES ARE TYPICALLY 5.0 M LENGTH AND SHALL BE GROUTED IN ONE STAGE OR IN TWO SHORT STAGES OF 1.5 M AND 3.5 M RESPECTIVELY ACCORDING TO SITE CONDITION USING DOWNSTAGE GROUTING METHOD.

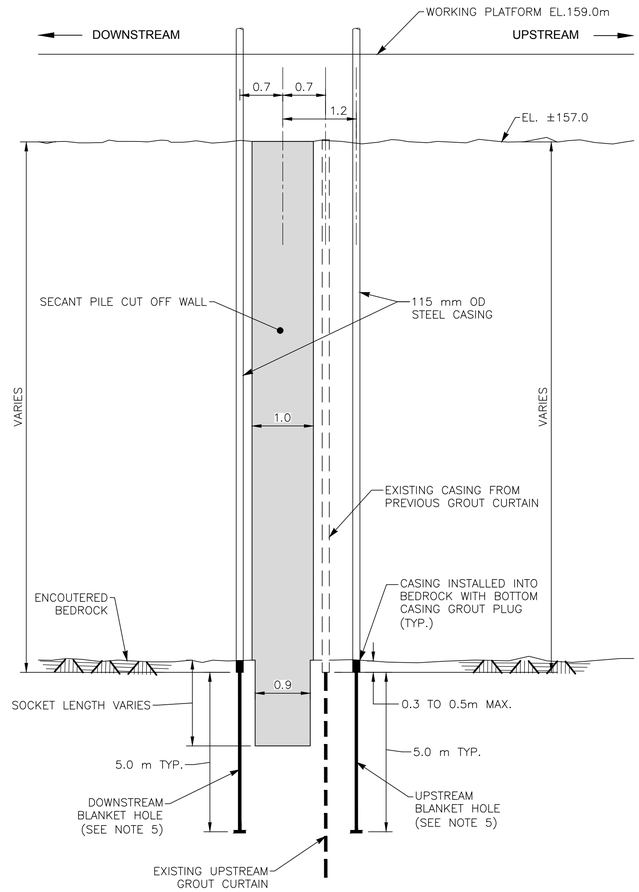


DETAIL 1

UPSTREAM AND DOWNSTREAM BLANKETS BETWEEN STATION 0+520 AND 0+750

FOR INSTRUMENTATION ZONE SEE TABLE 1

SCALE: 1:50



DETAIL 2

UPSTREAM AND DOWNSTREAM BLANKETS BETWEEN STATION 0+170 AND 0+520

FOR INSTRUMENTATION ZONE SEE TABLE 1

SCALE: 1:50

TABLE 1
INSTRUMENTATION ZONES (NOTE 4)

UPSTREAM BLANKET	DOWNSTREAM BLANKET
0+254 TO 0+261	0+176 TO 0+195
0+353 to 0+360	0+206.5
0+434 TO 0+439.5	0+218 TO 0+237
0+560.5	0+254 TO 0+261
0+663.5 TO 0+678	0+314 TO 0+330
0+702 TO 0+707	0+350 TO 0+366
0+725 TO 0+749	0+410 TO 0+471
	0+560 TO 0+594
	0+671 TO 0+675
	0+707 TO 0+720

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DATE 2019–12–11	
SCALE AS SHOWN	

CLIENT: AGNICO EAGLE

PROJECT: AGNICO EAGLE – MEADOWBANK DIVISION AMARUQ PROJECT

TITLE: WHALE TAIL DIKE REMEDIAL WORK UPSTREAM AND DOWNSTREAM BLANKETS SECTIONS AND DETAILS

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
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APPENDIX 2
QA/QC Plan

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APPENDIX 2

SUMMARY OF MAIN QUALITY CONTROL (QC) AND QUALITY ASSURANCE (QA) PROCEDURES DURING WORK

ITEMS	ELEMENT	RESPONSABILITIES OF THE QA REPRESENTATIVES			RESPONSABILITIES OF THE QC REPRESENTATIVES		
		TASK	FREQUENCY	FORM TO FILL	TASK	FREQUENCY	FORM TO FILL
Survey	General : Section 2.0	• Survey and marking of the location and centerline of the secant piles cut-off wall on the crest of the WTD location. • Survey and marking of location of downstream and upstream blanket holes • Verification of spacing and offset • Downstream hole to be staggered with upstream holes.	As required	Daily report	• Ensure that the surveyors use the updated information and have a good understanding of the Project and meet the requirements. Use provided hole coordinates (Hole location excel file) • Use as-built data. • Survey all the works. • Implementation and verification of works.	Continuously	Raw file (txt) and processed file (dwg) Daily report
Materials (Section 3.0)	Cement	• Cement Type HE • Check cement powder certification (CSA-A3000)	As required	Daily report	• Check cement constituents per spec	1 per shipment or as required by QA	Daily report and approval form
	Admixtures	• Check admixture constituents per manufacturer's product sheet and specifications	As required	Daily report	• Check admixture constituents per manufacturer's product sheet and specifications	1 per shipment or as required by QA	Daily report and approval form
	Water	• Ensure quality control requirements are maintained by QC.	Periodically	Daily report	• Water quality, cleanliness, oil, acid, alkali, organics, etc. • Temperature of water • pH	One test per shift or as required by QA	Daily report and approval form Lab compilation file and test reports
Handling and Storage	Cement Admixtures	• Visual inspection	Weekly	Daily report	• Visual inspection • Storage in conformity with the manufacturer's specifications • Count the quantity of cement used • Count complete stock inventory	As required Weekly Daily Weekly	Daily report
Equipment Section 4.0	Drilling Equipment Grouting Equipment Data recording system Site Laboratory	• Equipment working conditions • Calibration • identification	Before use or as required by the Engineer	Daily Report	• Maintenance of equipment as manufacturer's recommendations • Calibration as required • Identification of all equipment	As required	Calibration report Daily report
Field Acceptance Trial Section 4.5	Equipment	• Verify Calibration	During test	Field Acceptance Trial report	• Calibration of all equipment	During Field acceptance test	Field Acceptance Trial
	Automated monitoring data recording system	• Calibration procedures and stage setup (update parameters) • Output data format	During Field acceptance test	Field Acceptance Trial report	• Demonstrate calibration procedures and stage setup (update parameters) • Setup output data format, as required	During Field acceptance test	Field Acceptance Trial
	Grouting Procedure	• Verification of batching, mixing, pumping and injection to the hole	During Field acceptance test	Field Acceptance Trial report	• Batching, mixing, pumping and injection to the hole	During Field acceptance test	Field Acceptance Trial
	Grout	• Grout in-situ quality tests • Grout thickening sequence	During Field acceptance test	Field Acceptance Trial report	• Carry out grout in-situ quality tests • Carry out grout thickening sequence	During Field acceptance test	Field Acceptance Trial
	Records	• Verification of QC forms and follow up	During Field acceptance	Field Acceptance Trial report	• Fill QC forms	During Field acceptance test	Field Acceptance Trial

ITEMS	ELEMENT	RESPONSABILITIES OF THE QA REPRESENTATIVES			RESPONSABILITIES OF THE QC REPRESENTATIVES		
		TASK	FREQUENCY	FORM TO FILL	TASK	FREQUENCY	FORM TO FILL
			test				
Casing Installation Section 5.1	Grout Hole Location	• Check on site location, offset and spacing prior to start drilling. Holes to be tagged with hole number	Every grout hole	Shift report	• Check on site location and spacing prior to start drilling. Holes to be tagged with hole number	Every grout hole	Daily report Survey report
	Casing Installation	• Check hole deviation • Notice rock contact elevation • Casing imbedded in rock 300 mm to 500 mm below provided as-built level • Casing washing and installation of cement grout plug (use Grout mix C for plug by tremie or packer methods)	Every grout hole	Shift report	• Check hole deviation • Notice rock contact elevation • Casing imbedded in rock 300 mm to 500 mm • Casing washing and installation of the plug (use Grout mix C for plug)	Every grout hole	Casing drilling daily report
Drilling blanket holes Section 5.2	Blanket Hole	• Drill and grout downstream blanket holes first, then Upstream blanket holes • Drill 5.0 m below the bottom of casing in one or two short stages based on the bedrock conditions • Drilling of all holes shall be carried-out using clean water as the drilling fluid • Drilling of the rock section within 6 m of a grouted hole shall not be completed until the grout in the closest grouted hole reached its initial set time • Each hole shall be protected from clogging or obstruction by means of a temporary cap or other suitable device at the collar	For each hole	Shift report	• Drill and grout downstream blanket holes first, then Upstream blanket holes • Drill 5.0 m below the bottom of casing in one or two short stages based on the bedrock conditions • Drilling of all holes shall be carried-out using clean water as the drilling fluid • Drilling of the rock section within 6 m of a grouted hole shall not be completed until the grout in the closest grouted hole reached its initial set time • Each hole shall be protected from clogging or obstruction by means of a temporary cap or other suitable device at the collar	For each hole	Daily Record/rock drilling and grouting reports
Grout Quality Control Section 5.4	Cement Type	• ASTMC150 and/or CSA-A3001 Type 30 (HE)	1 per shipment	Approval Form	• ASTMC150 and/or CSA-A3001 Type 30 (HE)	1 per shipment	Approval Form
	Chemical Admixtures for Grout	• ASTM C494/C494 M	Per shipment	Check if product specification Admixtures meet ASTM requirements	• ASTM C494/C494 M	Per shipment	Check if product meets ASTM requirements
	Grout Mix Specific Gravity	• Check specific gravity with mud balance	Once per 5 batches and when grout mix changes	Daily record/report	• Check specific gravity with mud balance	Once per 5 batches and when grout mix changes	Quality Control report
	Grout Mix Marsh Cone Time	• Check grout viscosity with marsh cone	Once per 5 batches and when grout mix changes	Daily record/report	• Check grout viscosity with marsh cone	Once per 5 batches and when grout mix changes	Quality Control report
	Grout Mix Bleeding	• Check bleeding of the grout with graduated cylinder	Once per 5 batches and when grout mix changes	Daily record/report	• Check bleeding of the grout with graduated cylinder	Once per 5 batches and when grout mix changes	Quality Control report
	Grout Mix Set Time	• Check the setting time of different grout	Once per grout mix and when grout mix changes	Weekly record/report	• Check the setting time of different grout	Once per grout mix and when grout mix changes	Quality Control report
	Pressure filtration Coefficient Test	• Check resistance against pressure filtration of the grout	Once per grout mix	Once during field acceptance trial mix	• Check resistance against pressure filtration of the grout	Once per grout mix	Quality Control report
	Grout Cubic Strength	• Check the strength of the grout	Once per grout mix	Once during Field Acceptance Trial	• Take grout samples and carry out tests	Once per grout mix	Quality Control report
	Grout Pressure Gauge Calibration	• Check the pressure gauge works properly	After two shifts	Daily report	• Check the pressure gauge works properly	After two shifts	Calibration Record
	Flow meter calibration	• Check the flow meter works properly	Visual verification	Daily report	• Check the flow gauge works properly	As required by Engineer	Calibration Record

ITEMS	ELEMENT	RESPONSABILITIES OF THE QA REPRESENTATIVES			RESPONSABILITIES OF THE QC REPRESENTATIVES		
		TASK	FREQUENCY	FORM TO FILL	TASK	FREQUENCY	FORM TO FILL
Grouting Section 5.6	Effective pressure Section 5.6	• Verify effective pressure chart of the hole	Visual verification	Daily report	• Provide effective pressure chart for each hole	Each hole	Pressure chart data file
	Grout Quality Section 5.2.4	• Verify Grout Quality	Witness tests	Daily report	• Carry out grout quality tests as per specifications	QC grout test frequency	Grout test report
	Packer Installation	• Verify packer installation and inflation at the top of the stage	Check depth	Daily report	• Install and inflate packer at the top of the stage	Visual verification	Daily report
	Data recording system	• Verify data recording system	Verify stage parameters in the system	Daily report	• Update the data recording system with the stage grouting parameters	Input data	Grouting report
	Grouting	• In one or two short stages based on the bedrock conditions and as per Engineer's instruction	For each hole	Daily report	• In one or two short stages based on the bedrock conditions and as per Engineer's instruction	For each hole	Grouting Report
	High Take (Section 5.5.8)	• Use ticker grout as required (as per established thickening sequence)	If required / Verbal instruction	Daily report	• Use ticker grout as required (as per established thickening sequence)	If required	Grouting Report
	High Flow velocity	• Use appropriate grout Mix (as per established thickening sequence) • Use of open throat pump with appropriate Celbex dosage	If required / Verbal instruction	Daily report	• Use appropriate grout mix (as per established thickening sequence) • Use of open throat pump with appropriate Celbex dosage	If required / Verbal instruction	Grouting report
	Refusal (Section 5.8)	• Refusal criteria	Each hole	Daily Report	• Refusal criteria	Each hole	Grouting Report
	Hole backfilling (Section 5.9)	• Use stage stable grout mix • Grout from the bottom up	Each hole	Daily Report	• Use stage stable grout • Grout from the bottom up	Each hole	Grouting Report
	Records (Section 5.10)	• Verification of QC documents	Each hole	Daily reports	• Produce all drilling and grouting reports	Each hole	QC Daily Reports

Appendix A-2: Site Instructions and Field Work Instructions

SNC-LAVALIN INC.

195, The West Mall Street
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Tel: (416) 252-5315
Fax: (514) 231-5356

Memorandum

TO :	Frédérick L. Bolduc, Alexandre Lavallée, Thomas Lepine	**DATE :**	2019-11-19
C.C. :	Pier-Éric McDonald, Patrice Gagnon Nina Quan, Hafeez Baba		
FROM :	Tom Xue/ El Bensi Abdellah	**REF. :**	669034-0000-40CA-0001
SUBJECT :	Site Instructions for Drilling and Blanket Grouting		

1.0 Introduction

This memo is to provide brief instructions for starting the drilling and grouting of the blanket at the WTD foundation. This document is not meant to replace the project specifications and should be viewed as guidelines to allow the work to be started timely.

This document will subject to changes and updates based on the field findings of the progress of the construction activities and finalized project Specifications

2.0 Sequence of the Work

The following sequence of work should be followed as general guideline:

2.1 Drilling and Grouting of Downstream Holes

Step 1 Casing Installations:

Advancing all steel casings from the WTD crest as a spacing of 3.0 m c/c along the downstream line of grout holes to 300 mm to 500 mm below the bedrock surface. The set out of hole locations shall be established by survey tied to the project control points and approved by the Engineer prior to drilling.

Step 2 Casing Plugging

To seal the annual space between steel casing and bedrock interfaces by injection at low pressure of 160 L (about 2 times of the theoretical volume of the casing). Injection pressure and rate should be as low as possible, and closely monitored to avoid casing upward movement.

The casing grout used will be grout Mix C and is comprised of W/C=0.5 grout with 2% of calcium chloride and 0.2% of Cellbex 653 both by weight of cement.

Step 3 Bedrock Drilling

Drilling of primary grout holes at 12.0 m c/c with flushing water until the grout hole has been advanced to a nominal depth of 5 m below the rock surface. Drilling and Grouting will be in completed in one single stage.

Step 4 Grouting Primary Holes

Grout the Primary grout holes will start with grout Mix C with a W/C =0.5, 2% Calcium Chloride and 0.2% of Cellbex 653, both by weight of cement.

If no pressure built-up is observed after a maximum of 400 L/m (2000 L per hole with nominal depth of 5 m) of grout being injected or if cement grout escape or leakage to downstream side, grouting of the hole will be stopped and will grout again later at the instructions of the Engineer.

Additional steps in Section 2.3 will apply.

Step 5 Grouting of Secondary Holes

Repeat Steps 3 and 4, for split-spaced Secondary Holes.

Step 6 Grouting Tertiary Holes

Repeat Steps 3 and 4 for spilt-spaced Tertiary Holes.

2.2 Drilling and Grouting of Upstream Holes

Step 1 Casing Installations:

Advancing all steel casings from the WTD crest as a spacing of 1.5 m c/c along the upstream line of grout holes to 300 mm to 500 mm below the bedrock surface. Where the Primary holes will be off-set by 6.0 m from the Primary holes in downstream row with Secondary and Tertiary holes split-spaced.

Steps 2 to 5

As per Steps 2 to 5 of **Section 2.1.**

Step 6 Tertiary Holes

If a Primary or Secondary hole indicates a grout take less than 50 kg of dry cement per meter of grout hole with grout Mix C with on both sides of a Tertiary hole, a thinner grout mix such as Mix A or Mix B will be the starting mix as per the instruction of the Engineer.

Step 7 Quarters Holes

If a Primary/Secondary/Tertiary hole indicates a grout take of less than 50 kg of dry cement per meter with grout on both sides of a Quartery hole, thinner grout mix will be the starting mix as per the instruction of the Engineer.

2.3 Additional Steps

When grout take greater than 400 L per meter of grout hole length without pressure response, the following Additional Steps will be taken at the request of the Engineer:

1. High density grout with Antiwash such as Celbex or MasterMatrix® UW 450 and/or
2. Two components grouting with Cementious grout and Sodium Silicate gel from seperate pumps.

2.4 Assessment of Results

After the completion of the above sequence of the works, the success of the work carried out against the objective should be assessed.

Based on the results of the assessment, additional holes in upstream and/or deepen the current upstream row of grout holes for Curtain Grouting may become necessary.

SNC-LAVALIN INC.

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Memorandum

TO :	Frédérick L. Bolduc, Alexandre Lavallée, Thomas Lepine	**DATE :**	2020-01-08
C.C. :	Pier-Éric McDonald, Patrice Gagnon Nina Quan, Hafeez Baba		
FROM :	Tom Xue/ El Bensi Abdellah	**REF. :**	669034-0000-40CA-0001 Rev. 01
SUBJECT :	Site Instructions for Drilling and Grouting of WTD Blanket Holes		

1.0 Introduction

This memo is to provide brief site instructions for drilling and grouting of the blanket holes at the WTD foundation (Project Phase I). This document is not meant to replace the project specifications and should be read in conjunction with the project specifications and drawings. The document provides guidelines to allow the work to be carried out timely.

This document will subject to changes and updates based on the field findings of the progress of the construction activities, review of field data , and inputs from project Grouting Committee to allow work to be carried out effectively and efficiently.

2.0 Sequence of the Work

The following sequence of work should be followed as general guidelines for drilling and grouting of the blanket holes.

2.1 Drilling and Grouting of Downstream Holes

Step 1 Casing Installations:

Advancing all steel casings from the WTD crest at a spacing of 3.0 m c/c along the downstream line of grout holes to 300 mm to 500 mm below the provided as-built bedrock surface. The set out of hole locations shall be established by survey tied to the project control points and approved by the Engineer prior to drilling.

Step 2 Casing Plugging

To seal the annular space between steel casing and bedrock interfaces by injection of grout at low pressure of about 2 times of the theoretical volume of the casing. Injection pressure and rate should be as low as possible, and closely monitored to avoid casing upward movement.

The casing grout used shall be grout Mix C+ and is comprised of W/C=0.5 grout with 2% of calcium chloride and 0.2% of Celbex 653 both by weight of cement.

Step 3 Bedrock Drilling

Drilling of primary grout holes at 12.0 m c/c with flushing water to a nominal depth of 5 m below the bottom end of casing.

In general, Drilling and Grouting shall be completed in one single stage of 5 m except for the two following cases where drilling and grouting shall be carried out in two short stages of 1.5 m (first stage) and 3.5 m using the downstage grouting method:

a. If the water flushing loss occurs during the drilling of the first 1.5 m of the hole in rock.
b. If the hole collapses (caving-in) during drilling due to poor bedrock conditions.

A minimum of 12 hours shall be allowed prior to drilling and grouting the second stage of the same hole.

Step 4 Blanket Hole Grouting

Grout for the blanket holes will start with grout Mix C with a W/C =0.5 and 2% of Calcium Chloride by weight of cement.

If grout take of Mix C reached 200 L/m of the stage without refusal or grouting pressure building-up, grouting with Mix D (W/C = 0.5, 2% of Calcium Chloride and 500 ml (per batch) of Rheomac UW 450) or Mix C+ (W/C =0.5 with 2% of Calcium Chloride and 0.2% for Celbex) shall start.

Dosage of calcium Chloride may be reduced based on the results of the compatibility tests between Celbex and Calcium Chloride.

If no pressure building-up or no grout refusal is observed after a maximum grout take of 400 L/m been injected or if cement grout escapes or leaks to the downstream side observed at any time, grouting of the hole shall be stopped and will be re-grouted later at the instruction of the Engineer.

Additional steps in Section 2.3 will apply.

Step 5 Grouting of Secondary Holes

Repeat Steps 3 and 4, for split-spaced Secondary Holes.

Step 6 Grouting Tertiary Holes

Repeat Steps 3 and 4 for spilt-spaced Tertiary Holes.

2.2 Drilling and Grouting of Upstream Holes

Step 1 Casing Installations:

Advancing all steel casings from the WTD crest as a spacing of 1.5 m c/c along the upstream line of grout holes to 300 mm to 500 mm below the provided as-built bedrock surface. The Primary holes shall be off-set by 6.0 m from the Primary holes in downstream row with Secondary and Tertiary holes split-spaced.

Steps 2 to 5

As per Steps 2 to 5 of **Section 2.1.**

Step 6 Tertiary Holes

If a Primary or Secondary hole indicates a grout take less than 50 kg of dry cement per meter of grout hole with grout Mix C with on both sides of a Tertiary hole, a thinner stable grout mix such as Mix A or Mix B shall be the starting mix as per the instruction of the Engineer.

Step 7 Quarters Holes

If a Primary/Secondary/Tertiary hole indicates a grout take of less than 50 kg of dry cement per meter with grout on both sides of a Quaternary hole, thinner grout mix will be the starting mix as per the instruction of the Engineer.

2.3 Additional Steps

At any time, when grout take is greater than 400L per meter of grout stage length without noticeable increase of the grouting pressure, the following additional steps shall be taken at the request of the Engineer:

1. Celbex-assisted grout with appropriate Celbex dosage shall be used by adding Celbex directly into the Open Throat Pump starting with 0.3% and increasing progressively by 0.2% increment as necessary.
2. Open Throat pump will be used only to re-grout holes showing high grout take. To verify the compatibility between Celbex and Calcium chloride, Calcium chloride shall be reduced to 1% or less when adding Celbex in the Open Throat Pump.
3. Maximum Pressure Threshold when using open throat pump is 10 bars.
4. The injection shall be carried out with a target of a total of 400 L per meter of grout injected using Open Throat Pump. If the Maximum volume is reached without reaching the maximum pressure, the grouting will be discontinued, and the hole will be re-grouted later, Otherwise, the hole will be backfilled.
5. Under the case that high flow can not be cut-off with the application of highest Celbex dosage that is allowed by the Open Throat Pump system, two component grouting with Cementitious grout and liquid Sodium Silicate from separate pumps injecting through concentric pipe to perform flash set grouting shall be ready for implementation at the request of the Engineer.

2.4 Assessment of Results

After the completion of the above sequence of the works, the success of the work carried out against the objective should be assessed.

Based on the results of the assessment, additional holes in the upstream and/or deepening of the current upstream row of grout holes for Curtain Grouting may become necessary.

SNC-LAVALIN INC.

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Memorandum

TO :	Alexandre Lavallée, Frédérick L. Bolduc, Thomas Lepine, and Jesse Clark	**DATE :**	2020-03-24
C.C. :	Pier-Éric McDonald, Patrice Gagnon, Marion Habersetzer Nina Quan, Hafeez Baba		
FROM :	Tom Xue/ El Bensi Abdellah	**REF. :**	669034-0000-40CA-0001 Rev. 01 Addendum-01
SUBJECT :	Site Instructions for Drilling and Grouting WTD Blanket Holes Addendum		

1.0 Introduction

This memo is an Addendum to the Site Instruction (Ref. 669034-0000-40CA-0001 Rev. 01) for the WTD foundation seepage reduction (Project Phase I – Blanket Grouting). This Addendum provides additional instructions based on the discussions and recommendations from the recent Grouting Committee Meeting #8 (Online meeting) on March 19th, 2020.

This document shall be read with the project technical specifications, construction drawings and site instructions provided previously.

This document shall be subject to changes and updates based on the progress of the construction, seepage reduction assessment based on field data, and inputs from the Grouting Committee.

2.0 Sequence of the Work

As recommended and agreed on the Grouting Committee Meeting #8, the following instructions and path forward are presented with focus on priority area between Stations: 0+750 and 0+520.

2.1 Drilling and Grouting of Downstream Holes

- Complete the downstream blanket grouting of Primary, Secondary, Tertiary and Quaternary holes prior to starting the Upstream Blanket grouting between 0+750 and 0+520.
- Additional Quaternary Holes outside (between 0+520 and 0+180) can be done later when the crew working in the same area/chainage for upstream blanket work.

2.2 Drilling and Grouting of Upstream Holes

Casing Installations:

- Advancing casings between Stations 0+750 and 0+520 at locations provided.
- The Primary, Secondary and Tertiary Casing shall be installed at split spacing as per Specifications and design drawings.

Bedrock Drilling and Grouting:

- Primary and Secondary Holes are mandatory.
- In general, Primary Hole shall be drilled and grouted prior to Secondary Hole being drilled, unless approved by the grouting engineer.
- Rock drilling and grouting shall be carried out in a 5m stage unless otherwise instructed by the Engineer based on rock conditions.
- Rock Grouting shall start with Mix B and thickening as required.
- Backfill grout hole with Mix C to 1/3 to 1/2 of the casing length upon completion of blanket grouting to facilitate future hole deepening for curtain grouting.

Tertiary Holes:

- Tertiary Holes shall be carried out as required, based on the results of Primary and Secondary Hole grouting.

3.0 Assessment of Results

After the completion of the above sequence of the works or at the call of the GC, a GC meeting shall be held to assess the success of the work carried out against the objective and discuss further work required.

In the case that the seepage reduction objective is not met upon completion the above work, further actions will be taken based on grouting results to achieve the required seepage reduction.

4.0 Hole Depening for Curtain Grouting

Based on the assessment of downstream grouting results, additional holes in the upstream and/or deepening of the current upstream row of grout holes for Curtain Grouting may become necessary to mitigate deep seated seepage.

Downstream blanket holes may also need to be re-drilled and extended in priority areas/chainages to create a two-rows deep curtain which is subject to further discussion at future GC meeting.

SNC will provide priority areas/chainages and further instruction for deep curtain grouting based on the Dam Site Geotechnical investigation, Seepage Investigation Report and WTD as-built records for Grouting and Secant Pile Cut-off Wall Installations.

AGNICO EAGLE SNC·LAVALIN	**FIELDWORK INSTRUCTION SHEET** **669034-2000-60NV-0001**	FWI-001

PROJECT NAME: REMEDIAL WORK FOR WTD SEEPAGE

Date : 2019-12-07

Revision : 00

CONTRACTOR: TCG

WORK DECRIPTIONS:

This site instruction applies to Grouting and Re-grouting of Primary Holes that had been drilled per 5 m Stage. The site instruction will be updated as per the progress of the site construction.

1. REGROUTING OF PRIMARY HOLES:

Step-1: Check the hole conditions including the grout depth in the hole, water depth from ground surface. If the grout depth in the hole below bottom of the casing, hole need to be re-grouted.

Step-2: Start injection with Mix C (W/C=0.5, 2% Calcium Chloride), adding 3% of Cellbex (by Cement Weight) through Open Throat Pump during injection.

Step-3: Increase Cellbex by 2% (to 5% Cellbex) after 200L been injected without refusal at design grouting pressure.

Step-4: Repeat Step-3 until refusal or the maximum capacity of the pump is reached.

Step-5: Leave the hole and wait for further instructions.

2. INITIAL GROUTING OF PRIMARY HOLES:

Step-1: Check the hole conditions including hole depth, water depth belowground surface.

Step-2: Hole cleaning as necessary.

Step-3: Start injection with Mix C (W/C=0.5, 2% Calcium Chloride) without Cellbex.

Step-4: Add 3% of Cellbex (by Dry Cement Weight) to Mix C through Open Throat Pump after 400L been injected without refusal.

Step-5: Continue grouting with Mix C with 3% Cellbex until refusal or Vmax is reached.

Step-6: If Vmax reached, increase Cellbex by 2% and grout for a maximum volume of 400L.
If without reaching refusal at design grouting pressure,

Step-7: Leave the hole and wait for further instructions.

Muhammad Saleem, P.Eng Prepared by : The Engineer DATE: 2019-12-07	Tom Xue, P.Eng Nina Quan signed for Approved by (SLI) DATE: 2019-12-07	AEM Coordinator Approved by: DATE:

AGNICO EAGLE / SNC·LAVALIN	FIELDWORK INSTRUCTION SHEET	FWI-001
	669034-2000-60NV-0001	

PROJECT NAME: REMEDIAL WORK FOR WTD SEEPAGE

Date: 2019-12-09

Revision: 01

CONTRACTOR: TCG

WORK DECRIPTIONS:

This site instruction applies to Grouting and Re-grouting of Primary Holes that had been drilled per 5 m Stage. The site instruction will be updated as per the progress of the site construction.

1. REGROUTING OF PRIMARY HOLES:

Step-1: Check the hole conditions including the grout depth in the hole, water depth from ground surface. If the grout depth in the hole below bottom of the casing, hole need to be re-grouted.

Step-2: Start injection with Mix C (W/C=0.5, 2% Calcium Chloride), adding 0.3% of Celbex (by Cement Weight) through Open Throat Pump during injection.

Step-3: Increase Celbex by 0.2% (to 0.5%) after 200L been injected without refusal at design grouting pressure.

Step-4: Repeat Step-3 until refusal or the maximum capacity of the pump is reached.

Step-5: Leave the hole and wait for further instructions.

2. INITIAL GROUTING OF PRIMARY HOLES:

Step-1: Check the hole conditions including hole depth, water depth below ground surface.

Step-2: Hole cleaning as necessary.

Step-3: Start injection with Mix C (W/C=0.5, 2% Calcium Chloride) without Celbex.

Step-4: After 400L been injected without refusal at design grouting pressure, start injection with Mix D (W/C = 0.5 with 1% Calcium Chloride and 500 ml (per 120 kg of dry cement) Rheomac UW450. As proposed, this step is a trial and will be skipped if the effectiveness of Mix D is not satisfactory.

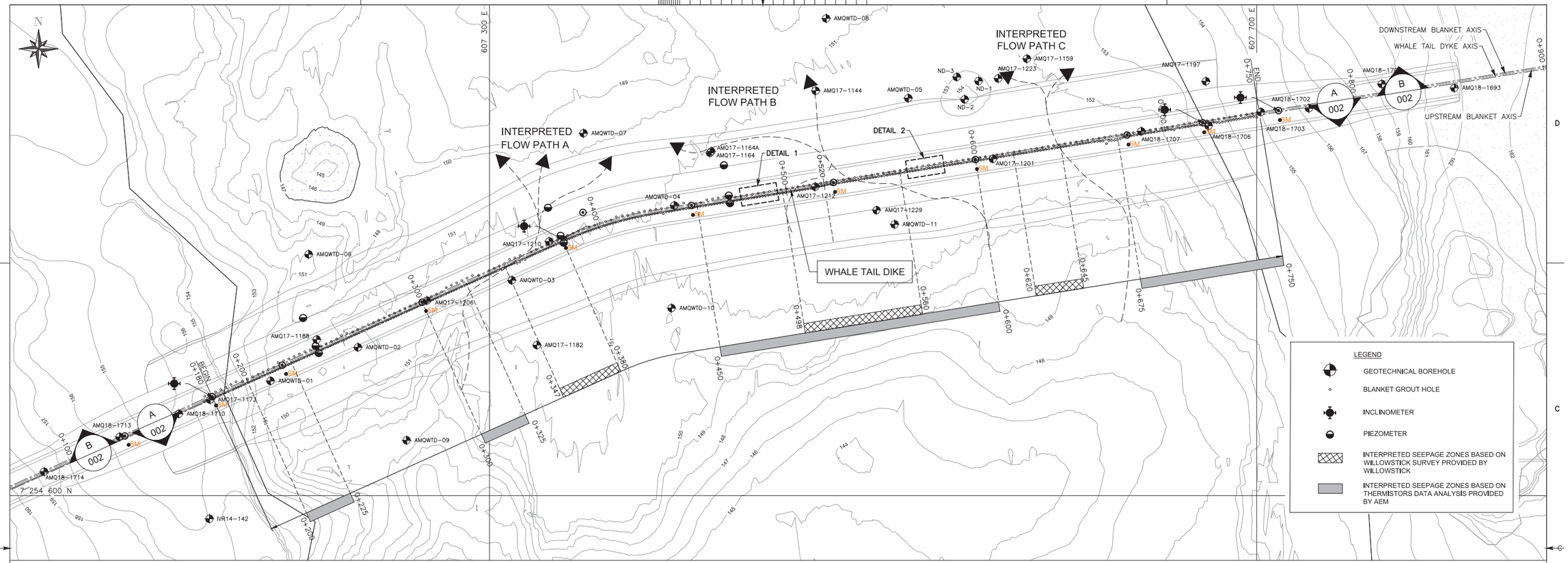
Step-5: Add 0.2% of Celbex (by Dry Cement Weight) to Mix C after 400L Mix D been injected without refusal.

Step-6: Continue grouting with Mix C with 0.2% Celbex until refusal or Vmax is reached.

Step-7: If Vmax reached and possible to continue grouting same time follow step 2 to 5 in re-grouting section and if re-grouting later follow step 1 to 5 in re-grouting section.

Muhammad Saleem, P.Eng Prepared by: The Engineer DATE: 2019-12-09	Tom Xue, P.Eng Abdellah El Bensi, P.Geo. Approved by (SLI) DATE: 2019-12-09	AEM Coordinator Approved by: DATE:

Appendix A-3: Drawings



PLAN VIEW
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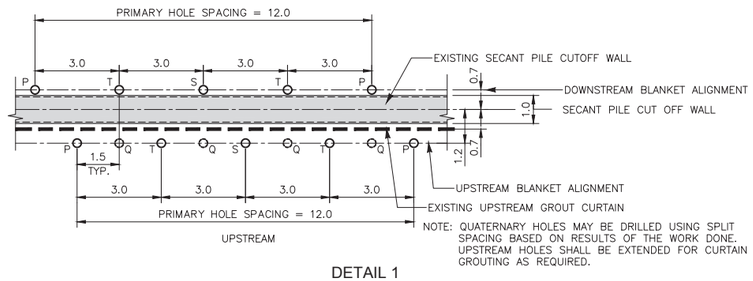

DETAIL 1
UPSTREAM AND DOWNSTREAM BLANKETS BETWEEN STATIONS 0+170 AND 0+520
FOR INSTRUMENTATION ZONE SEE TABLE 1 (DWG-003)
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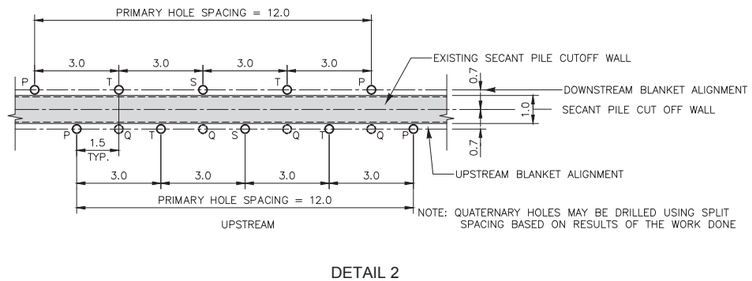

DETAIL 2
UPSTREAM AND DOWNSTREAM BLANKETS BETWEEN STATIONS 0+520 AND 0+750
FOR INSTRUMENTATION ZONE SEE TABLE 1 (DWG-003)
SCALE: 1:100

NOTES

ALL GROUTING AND ASSOCIATED WORK SHOULD BE CARRIED OUT PER THE TECHNICAL SPECIFICATIONS. SUPPLEMENTARY CLAUSES FOLLOW:

1. THE BLANKET GROUT HOLES SHALL BE DRILLED FROM THE CREST OF THE DIKE WITH AN OFFSET AS SHOWN ON DETAILS 1 AND 2. IN THE INSTRUMENTATION ZONES SHOWN ON DRAWING 003, TABLE 1, THE OFFSET IS VARIABLE; REFER TO PROVIDED EXCEL FILE: CASING LOCATION.
2. THE SET OUT OF HOLE LOCATIONS SHALL BE ESTABLISHED BY SURVEY TIED TO THE PROJECT CONTROL POINTS AND APPROVED BY THE ENGINEER REPRESENTATIVE PRIOR TO DRILLING.
3. THE CASING SHALL BE SOCKETED 300 TO 500 mm MAXIMUM PROVIDED AS BUILT BEDROCK LEVEL AND SEALED WITH CEMENT GROUT PLUG AT THE BOTTOM OF THE CASING TO PREVENT GROUT LEAKAGE AROUND THE CASING. EITHER TREMIE GROUTING OR PACKER GROUTING METHODS CAN BE USED TO GROUT THE CASING PLUG.
4. THE FINAL ELEVATION OF THE CASING SHOE AFTER BEING SOCKETED INTO BEDROCK SHOULD BE VERIFIED BY THE SURVEYOR AND REPORTED TO THE ENGINEER REPRESENTATIVE.
5. ANY ABNORMALITIES IN GROUND CONDITIONS, GROUND WATER, INGRESS OF FINE FILTER MATERIALS INTO CASING, FROZEN GROUND, AND CASING ADVANCE NEED TO BE DOCUMENTED AND REPORTED TO ENGINEER.
6. IF THE CASING STRIKES THE SECANT PILE, ITS ELEVATION SHALL BE RECORDED WITH ACCURACY. ANY PRESENCE OF MUD OR UNSET SLURRY ENCOUNTERED DURING CASING DRILLING SHOULD BE RECORDED AND BROUGHT TO THE ENGINEER REPRESENTATIVE ATTENTION.
7. THE MAXIMUM PERMITTED INACCURACY OF GROUT HOLE CASING POSITIONING IS 50 MM IN ANY DIRECTION. THE ALIGNMENT OF DRILL HOLE CASINGS SHALL BE VERIFIED AT ALL TIMES. MAXIMUM VERTICAL DEVIATION OF A DRILL HOLE CASING SHALL NOT EXCEED 0.5% OF ITS DRILLED LENGTH.
8. EACH CASING SHALL BE PROTECTED FROM ANY CLOGGING OR OBSTRUCTION BY MEANS OF A TEMPORARY CAP OR OTHER SUITABLE DEVICE AT THE COLLAR. ANY HOLE OBSTRUCTED SHALL BE CLEANED OUT OR RE-DRILLED BY THE CONTRACTOR.
9. THE CASING DRILLING RECORDS AND SURVEY DATA TO BE SUBMITTED TO THE ENGINEER REPRESENTATIVE AT THE END OF THE SHIFT.
10. BLANKET GROUTING LIMITS SHALL BE CONFIRMED BASED ON THE FIELD OBSERVATIONS.

ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
01	00	2019-12-12	ISSUED FOR FOR CONSTRUCTION

ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE

REVISION REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**
3	WHALE TAIL DIKE DRAFT REPORT.DOCX FROM WILLOWSTICK TECHNOLOGIES, LLC			
2	KIVALLIQ – PROFILE SECANT PILES AS-BUILT 02-12-2018			
1	AMARUQ TOPOGRAPHY RECEIVED ON 2015-09-15			

INITIALS: * DESIGNED ** APPROVED

REFERENCE DRAWINGS

PROFESSIONAL SEAL

LICENSED PROFESSIONAL ENGINEER T. XUE 100020142 PROVINCE OF ONTARIO

Xue, Tom
Jan 7 2020 11:03 AM

DocuSign

REGISTERED PROFESSIONAL ENGINEER H.U. BABA LICENSEE NWT/NU

PERMIT TO PRACTICE SNC-LAVALIN INC.
Signature NAME Hafeez Baba
Date DATE 01-07-2020
PERMIT NUMBER: P 260
The Association of Professional Engineers, Geologists and Geophysicists of NWT/NU

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PREPARATION		APPROVAL	
DESIGNED	T. XUE	ENGINEERING MANAGER	H. BABA
DRAWN	D. SOBIERAJSKI	PROJECT MANAGER	N. QUAN
CHECKED	A. EL-BENSI	CLIENT	
DATE	2019-12-11		
SCALE	AS SHOWN		

CLIENT: AGNICO EAGLE

PROJECT: AGNICO EAGLE – MEADOWBANK DIVISION AMARUQ PROJECT

TITLE: REMEDIAL WORK DOWNSTREAM AND UPSTREAM BLANKETS PLAN VIEW AND DETAILS

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
669034	2000	4G | DD	0001	00

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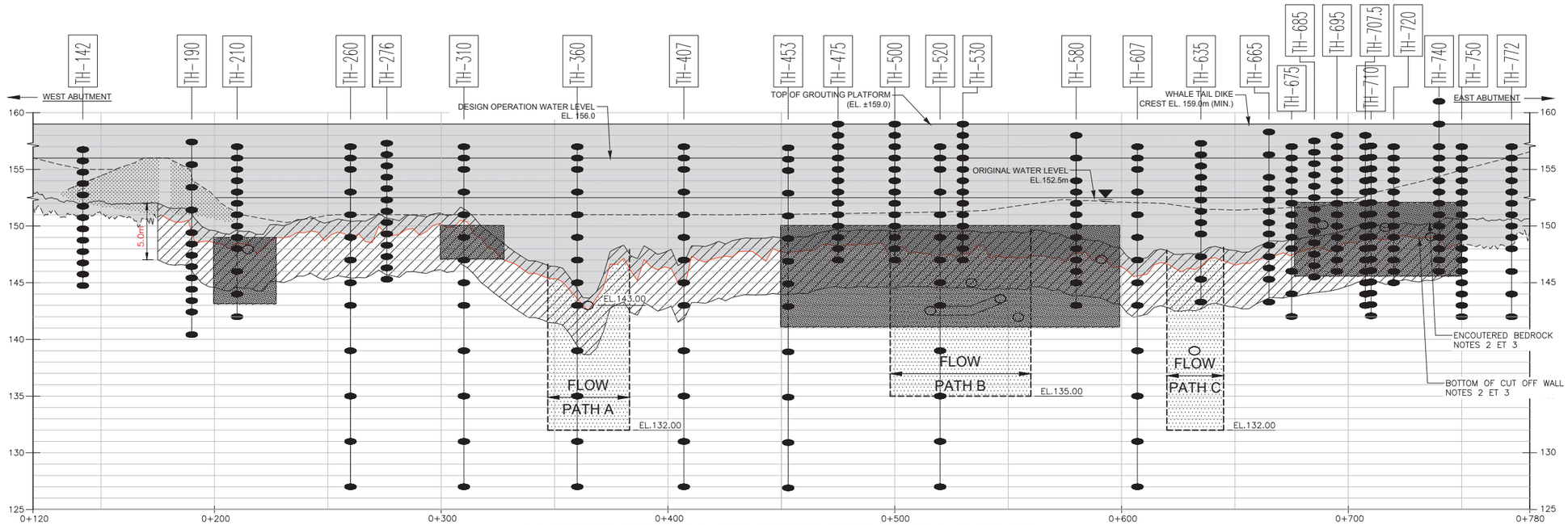

LONGITUDINAL SECTION A-A - DOWNSTREAM BLANKET (STATION 0+180 TO 0+750)

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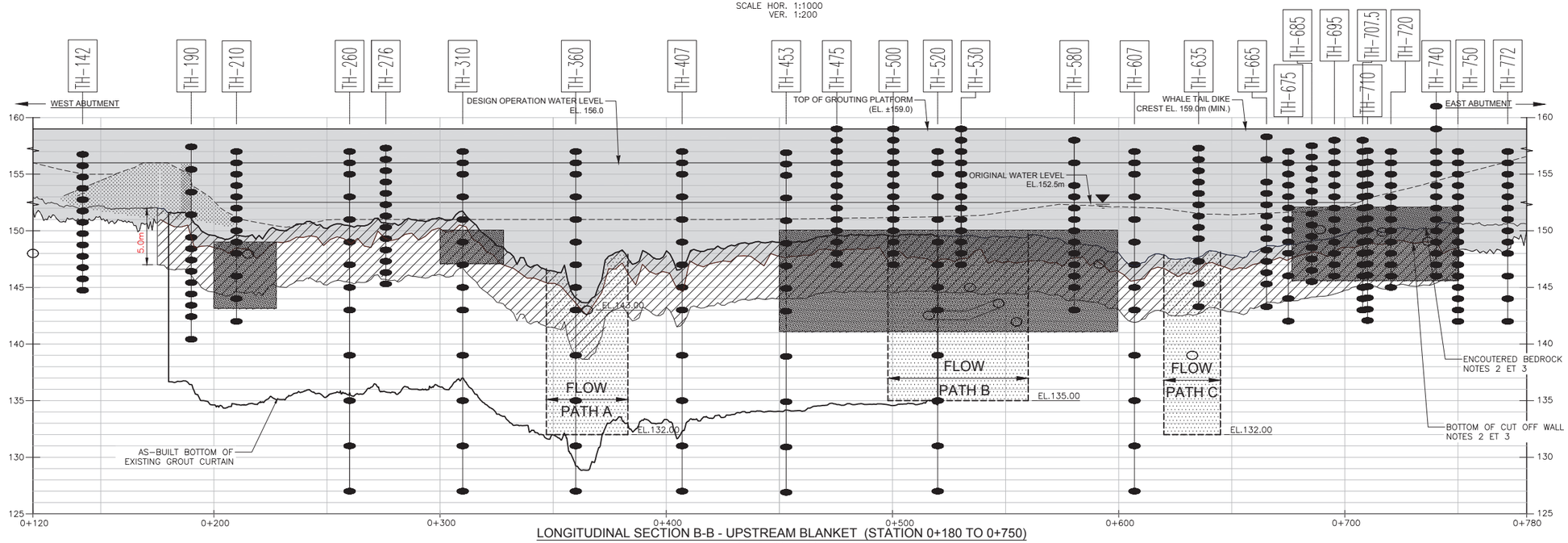
VER. 1:200



LONGITUDINAL SECTION B-B - UPSTREAM BLANKET (STATION 0+180 TO 0+750)

SCALE HOR. 1:1000
VER. 1:200

NOTES

1. ALL GROUTING AND ASSOCIATED WORK SHOULD BE CARRIED OUT PER THE TECHNICAL SPECIFICATIONS.
2. BEDROCK AND BOTTOM OF CUT-OFF WALL PROFILES WERE PRODUCED BASED ON AS-BUILT DATA PROVIDED BY AEM.
3. ROCK AND BOTTOM OF CUT-OFF WALL PROFILES AT THE LOCATION OF THE SECTION ARE THE PROJECTION OF THE PROFILES ON THE WTD AXIS.

LEGEND

- SECANT PILE ROCK SOCKET
- BLANKET GROUTING
- INTERPRETED SEEPAGE ZONE BASED ON WILLOSTICK SURVEY PROVIDED BY WILLOSTICK
- INTERPRETED SEEPAGE ZONE BASED ON THERMISTORS DATA ANALYSIS PROVIDED BY AEM
- ASSUMED LOCATION OF POTENTIAL HIGH SEEPAGE

ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
01	00	2019-12-12	ISSUED FOR CONSTRUCTION

ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE

REVISION REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**	No
3	WHALE TAIL DIKE DRAFT REPORT.DOCX FROM WILLOWSTICK TECHNOLOGIES, LLC				3
2	KIVALLIQ – PROFILE SECANT PILES AS-BUILT 02-12-2018				2
1	AMARUQ TOPOGRAPHY RECEIVED ON 2015-09-15				1

INITIALS: * DESIGNED ** APPROVED

REFERENCE DRAWINGS

PROFESSIONAL SEAL

LICENSED PROFESSIONAL ENGINEER — T. XUE — 100102242 — PROVINCE OF ONTARIO

Xue, Tom
Jan 7 2020 11:03 AM

DocuSign

H.M. BABA — LICENSEE — NWT/NU

PERMIT TO PRACTICE
SNC-LAVALIN INC.
Signature NAME Hafeez-Baba
Date DATE 01-07-2020
PERMIT NUMBER: P 260
The Association of Professional Engineers, Geologists and Geophysicists of NWT/NU

SNC·LAVALIN
Mining & Metallurgy
5500, des Galeries Blvd., bur. 200, Quebec (Quebec), Canada G2K 2E2
Telephone: (418) 621-3500, Fax: (418) 621-8887

PREPARATION		APPROVAL	
DESIGNED	T. XUE	ENGINEERING MANAGER	H. BABA
DRAWN	D. SOBIERAJSKI	PROJECT MANAGER	N. QUAN
CHECKED	A. EL-BENSI	CLIENT	
DATE	2019-12-11		
SCALE	AS SHOWN		

CLIENT: AGNICO EAGLE

PROJECT
AGNICO EAGLE – MEADOWBANK DIVISION
AMARUQ PROJECT

TITLE
WHALE TAIL DIKE
DOWNSTREAM AND UPSTREAM - REMEDIAL WORK
LONGITUDINAL SECTIONS

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
669034	2000	4G|DD	0002	00

A1-HOR-FRAME-EN (SI)

LAST SAVE: 2020/01/07 – 10:10am
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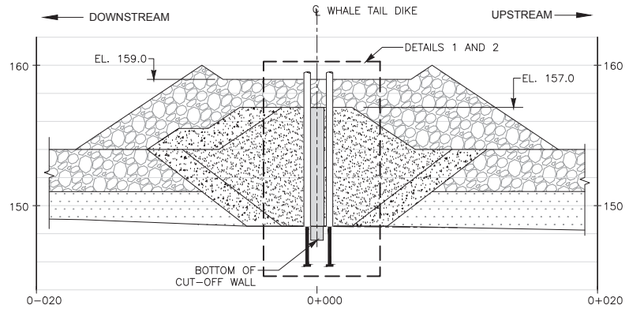
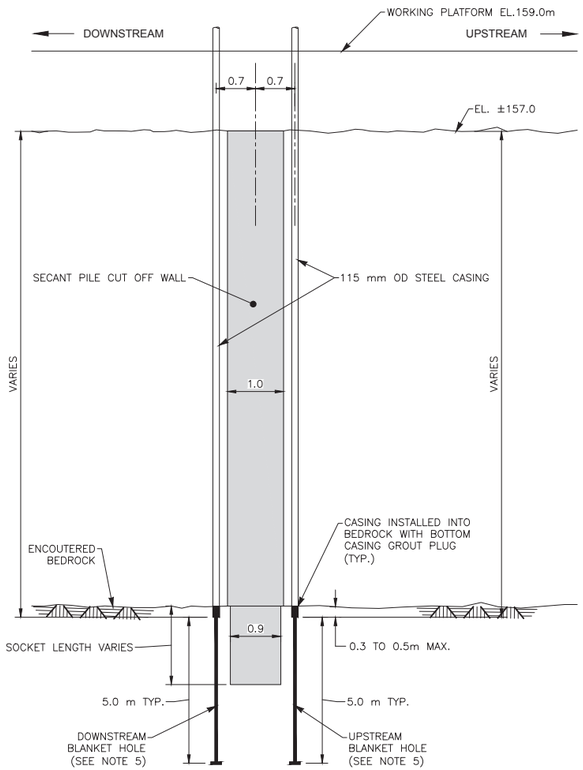


WHALE TAIL DIKE TYPICAL SECTION

SCALE: 1:200

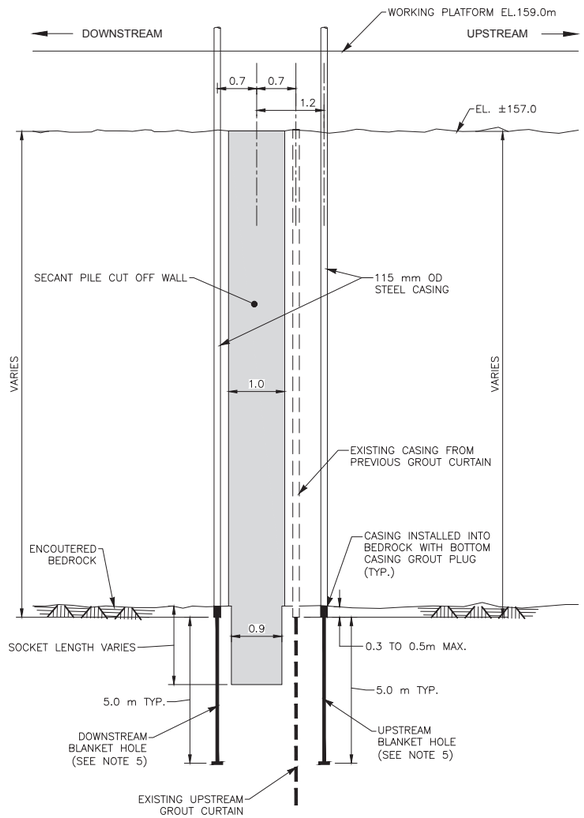
NOTES

1. DOWNSTREAM BLANKET HOLES SHALL BE DRILLED AND GROUTED FIRST PRIOR TO START THE UPSTREAM BLANKET HOLES.
2. GROUT HOLE CASINGS SHALL BE SOCKETED TO A TYPICAL DEPTH OF 300 mm MIN. TO 500 mm MAX. BELOW PROVIDED AS–BUILT BEDROCK LEVEL AND SHALL BE SEALED BY CEMENTIOUS GROUT.
3. PRIMARY, SECONDARY AND TERTIARY HOLES ARE MANDATORY AT SPACING OF 12.0; 6.0 AND 3.0 M RESPECTIVELY. QUATERNARY GROUT HOLES SHALL BE DRILLED AND GROUTED ALONG THE UPSTREAM BLANKET ROW USING SPLIT SPACING BASED ON THE RESULTS OF WORK DONE.
4. DOWNSTREAM BLANKET ROW SHALL BE LOCATED 0.7 M DOWNSTREAM OF THE SECANT PILE CENTRELINE.THE UPSTREAM BLANKET ROW SHALL BE LOCATED 0.7 M UPSTREAM SECANT PILE CENTRELINE EAST OF 0+520 AND 1.2 M WEST OF 0+520.
   IN THE INSTRUMENTATION ZONES, INDICATED IN TABLE 1, THE OFFSET OF UPSTREAM AND DOWNSTREAM BLANKET ROWS IS VARIABLE, REFER TO PROVIDED CASING LOCATION EXCEL FILE.
5. DOWNSTREAM AND UPSTREAM BLANKET HOLES ARE TYPICALLY 5.0 M LENGTH AND SHALL BE GROUTED IN ONE STAGE OR IN TWO SHORT STAGES OF 1.5 M AND 3.5 M RESPECTIVELY ACCORDING TO SITE CONDITION USING DOWNSTAGE GROUTING METHOD.



DETAIL 1
UPSTREAM AND DOWNSTREAM BLANKETS BETWEEN STATION 0+520 AND 0+750

FOR INSTRUMENTATION ZONE SEE TABLE 1
SCALE: 1:50



DETAIL 2
UPSTREAM AND DOWNSTREAM BLANKETS BETWEEN STATION 0+170 AND 0+520

FOR INSTRUMENTATION ZONE SEE TABLE 1
SCALE: 1:50

TABLE 1
INSTRUMENTATION ZONES (NOTE 4)

UPSTREAM BLANKET	DOWNSTREAM BLANKET
0+254 TO 0+261	0+176 TO 0+195
0+353 to 0+360	0+206.5
0+434 TO 0+439.5	0+218 TO 0+237
0+560.5	0+254 TO 0+261
0+663.5 TO 0+678	0+314 TO 0+330
0+702 TO 0+707	0+350 TO 0+366
0+725 TO 0+749	0+410 TO 0+471
	0+560 TO 0+594
	0+671 TO 0+675
	0+707 TO 0+720

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
01	00	2019-12-12	ISSUED FOR CONSTRUCTION

ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE

ISSUE REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**
2	KIVALLIQ – PROFILE SECANT PILES AS–BUILT 02–12–2018			
1	AMARUQ TOPOGRAPHY RECEIVED ON 2015–09–15			

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REFERENCE DRAWINGS

REFERENCE DRAWINGS

PROFESSIONAL SEAL

Xue, Tom
Jan 10 2020 4:11 PM

DocuSigned by:

PERMIT TO PRACTICE
SNC-LAVALIN INC.
Signature NAME Hafeez-Baba¶
Date DATE 01-07-2020¶
PERMIT NUMBER: P 260
The Association of Professional Engineers, Geologists and Geophysicists of NWT/NU

SNC·LAVALIN
Mining & Metallurgy
5000, des Galeries Blvd., bur. 200, Quebec (Quebec), Canada G2K 2E2
Telephone: (418) 621–5500, Fax: (418) 621–8887

PREPARATION	APPROVAL
DESIGNED T. XUE	ENGINEERING MANAGER H. BABA
DRAWN M. SYKES	PROJECT MANAGER N. QUAN
CHECKED A. EL–BENSI	CLIENT
DATE 2019–12–11	

CLIENT: AGNICO EAGLE

PROJECT
AGNICO EAGLE – MEADOWBANK DIVISION
AMARUQ PROJECT

TITLE
WHALE TAIL DIKE
REMEDIAL WORK
UPSTREAM AND DOWNSTREAM BLANKETS
SECTIONS AND DETAILS

SCALE: AS SHOWN

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
669034	2000	4G | DD	0003	00

A1–HOR–FRAME–EN (SI)

LAST SAVE: 2020/01/10 – 8:12am
PATH: T:\669034 Remedi Whale Tail Dike Seepage\40_DD_DESSINS\0000\00\669034–2000–4GDD–0003_00.dwg

Appendix A-4:

List of Changes on Technical Specifications, Simplified Work Instructions and Field Work Instructions

Whale Tail Dike Remedial Grouting Sepecifications and Design Drawings Changes Tracking

Document	Revision	Date Issued	Subject
TECHNICAL SPECIFICATIONS FOR THE WHALE TAIL DIKE FOUNDATION ROCK GROUTING Document Number: 611913-E531-40EF-0001	PC	2019-10-03	Technical Specifications for Whale Tail Dike Remedial Drilling and Grouting Works Rev. PC was issued for AEM and Grouting Committee's (GC) review and comments. The document was the main topic of the discussion in the Grouting Committee Meeting No.3 held on Oct. 17th, 2019 in Montreal.
TECHNICAL SPECIFICATIONS FOR THE WHALE TAIL DIKE FOUNDATION BLANKET GROUTING Document Number: 669034-0000-40EF-0001	PD	2019-10-28	As per discussions and recommendations from GC Meeting No.3, Technical and Specifications had been updated to Rev PD. Reference can be made to meeting minutes 669034-0000-30MC-0001 for details of the comments and recommendations to the designs.
TECHNICAL SPECIFICATIONS FOR THE WHALE TAIL DIKE FOUNDATION BLANKET GROUTING Document Number: 669034-0000-40EF-0001	PE	2019-11-27	Rev. PD had been updated to Rev PE based on recommendations presented in GC's letter Dated Oct. 25, 2019 and further discussions with AME engineers and site staff to implement the simplified approach and path forward proposed by the GC. Phased approach adopated starting with two rows of Blanket Grouting (Phase I) and based on the results of Blanket Grouting to decide the requirement of deepen the Upstream Blanket holes for Curtain Grouting (Phase II)
TECHNICAL SPECIFICATIONS FOR THE WHALE TAIL DIKE FOUNDATION BLANKET GROUTING Document Number: 669034-0000-40EF-0001	00	2020-01-10	Document Rev. PE had been updated based on comments on received and the discussions and recommendations from GC Meeting No.5 held on December 5, 2019.

Whale Tail Dike Remedial Grouting Site Instructions Changes Tracking

Document	Revision	Date Issued	Subject
SITE INSTRUCTIONS FOR DRILLING AND BLANKET GROUTING (Document Number: 669034-0000-40CA-0001 Rev. 00)	Rev 00	2019-11-19	A technical memo - Site Instructions for Drilling and Blanket Grouting Rev PB was issued on November 19, 2019. The objective of this document is to provide key instructions to the drilling and grouting of the Blanket Holes at the WTD foundation to allow work to start timely before Design Drawings and Specifications are ready and approved. The Site Instructions were prepared based on discussions and comments on Technical Specs Rev PD, Grouting Committee's Letter dated October 25, 2019 and in alignment with the objective of 40 to 50% seepage deduction with simplfied and phased project approach. This document may require update based on the progress and results of the field work.
	Rev 01	2020-01-08	The Site Instructions Rev 00 was updated to Rev 01 to incorporate: (1) modification of the Mix C+ by reducing the Calcium Chloride dosage (2)conditions for drilling and grouting the hole in two stages

Whale Tail Dike Remedial Grouting Fieldwork Instructions Changes Tracking

Document	Date Issued	Subject	Notes
Fieldwork Instruction No.1 (Email)	2019-12-03	Subject: 669034 - Rock Grouting on Grout Mix Change Procedures	This Fieldwork Instruction provide by email dated Dec. 03, 2019 on Subject: **Grout mix change procedures during the Blanket Hole Grouting and Regrouting** (prior to Open Throat Pump is available) based on the on site trial mix results and ground response on grout take and grouting pressure.
Fieldwork Instruction No.2 (FWI 001 Rev 00)	2019-12-07	FIELDWORK INSTRUCTION SHEET FWI-001 Document Number: 669034-2000-60NV-0001 Rev. 00	This Fieldwork instruction applies to Grouting and Re-grouting of Primary Holes with the application of Celbex using Open Throat Pump as recommended by Grouting Committee (Meeting No. 5 on December 05 2019) that had been drilled per 5 m Stage. The site instruction will be updated as per the progress of the site construction.
Fieldwork Instruction No.3 (FWI 001 Rev. 01)	2019-12-09	FIELDWORK INSTRUCTION SHEET FWI-001 Document Number: 669034-2000-60NV-0001 Rev. 01	The fieldwork instruction No.2 was updated to introduce Mix D

Whale Tail Dike Remedial Grouting Sepecification and Design Drawings Changes Tracking

Document	Date Issued	Date Re-issued	Subject	Notes
Site Instruction #1 (Technical Memo)	2019-11-19	2019-10-28	SITE INSTRUCTIONS FOR DRILLING AND BLANKET GROUTING (Technical Memo) Document Number: 669034-0000-40CA-0001 Rev. 00	A technical memo - Site Instructions for Drilling and Blanket Grouting was prepared on November 19, 2019 to provide brief instructions to the drilling and grouting of the Blanket Holes at the WTD foundation to allow work to start timely before Design Drawings and Specifications are ready and approved. The Site Instructions were based on discussions and comments on Design Specs Rve PD issued and Grouting Committee's Letter dated October 25, 2019 and in alignment with the objective of 40 to 50% seepage deduction with simplfied and phased project approach. The Site Instructions will be updated based on the progress and results of the field work.
Site Instruction #2	2019-12-03	NA	Subject: 669034 - Rock Grouting on Grout Mix Change Procedures	This Site Instruction provide by email dated Dec. 03, 2019 on Subject: **Grout mix change procedures during the Blanket Hole Grouting and Regrouting** (prior to Open Throat Pump is available) based on the on site tria mix results and ground response on grout take and grouting pressure.
Site Instruction #3 (FWI 001 Rev 00)	2019-12-07	2019-12-09	FIELDWORK INSTRUCTION SHEET FWI-001 Document Number: 669034-2000-60NV-0001 Rev. 00	This site instruction applies to Grouting and Re-grouting of Primary Holes with the application of Celbex using Open Throat Pump as recommended by Grouting Committee that had been drilled per 5 m Stage. The site instruction will be updated as per the progress of the site construction.
Site Instruction #4 (FWI 001 Rev. 01)	2019-12-09	NA	FIELDWORK INSTRUCTION SHEET FWI-001 Document Number: 669034-2000-60NV-0001 Rev. 01	This site instruction applies to Grouting and Re-grouting of Primary Holes with the application of Celbex using Open Throat Pump that had been drilled per 5 m Stage. The site instruction will be updated as per the progress of the site construction.
Site Instruction#1 (Technical Memo)	2019-12-09	NA	SITE INSTRUCTIONS FOR DRILLING AND BLANKET GROUTING (Technical Memo) Document Number: 669034-0000-40CA-0001 Rev. 01	Reissued to to allow the using of Mix D for Initail Grouting on a trial base and using Open Throat Pump with Celbex on Re-grouting.

Deviation List for Remedial Grouting At Whale Tail Dike

Deviation #	Date Received	Date Responded	Status	Subject	Location/Address	Notes
001	2019-11-10		AEM will manage the situation	QC did not use centerlizer to monitor inclination	multiple locations	Daily Report - Contractor informed that they will use inclino meter without centerlizer as they did last winter but AEM will look if they can findout centerlizer for 4.6” casing.
002	2019-11-14		waiting for apparatus and training	QC did not have Vicat apparatus and did not know how to use filtration apparatus	during Trial mix	Vicat apparatus received and fist vicat test performed on Dec 5, 2029
003	2019-12-06			Inclination check in bedrock holes are not been checked. AEM said inclination check is not necessary in the rock hole during daily construction meeting on Dec 6, 2019 and captured on weekly report for week end Dec 07, 2019		As per specs. "Deviation from vertical in the bedrock section of the hole shall not exceed 2% of drilled length."
004	2020-01-13			Drilling of tertiary holes prior to grouted secondary holes	T611.5, T617.5, T623.5, T629.5	Tertiary holes drilled while secondary holes S614.5 and S626.5 were not been grouted yet. As per spec. Tertiary holes shall be drilled in rock after secondary holes has been grouted and grout reached its final set time.
005	2020-01-12			Continuous drilling and grouting of tertiary holes	WTD Tertiary holes	Consective tertiary holes has been drilled and grouted (6 m distance). As per spec. minimum distance between two drilled holes in bedrock is 12 m
006	2020-02-13	2020-02-13	accepted	Use of Mix B in Tertiary Holes	WTD Tertiary holes	AEM and SNC agreed with the KCG proposal of using Mix B in Tertiary holes.
007	2020-03-10			change in Mix C	WTD injection	Changed water cement ratio to 0.55 and calcium chloride to 1% due to issues with cement quality.

Appendix A- 5: RFI Email Communications

Saleem, Muhammad

From: Jesse Clark <jesse.clark@agnicoeagle.com>
Sent: November 30, 2019 10:25 AM
To: Du, Jin Dong; Xue, Tom; El Bensi, Abdellah; Quan, Nina
Cc: Ken Lachance; Pier-Eric McDonald; Patrice Gagnon; Frederick Bolduc; Alexandre Lavallee; Thomas Lepine
Subject: RE: [EXTERNAL] RE: Discrepancies on grout mix for bedrock injection

Great thank you for the quick response. That clarifies things for us.

Thanks,

Jesse Clark
460.6837

From: Du, Jin Dong <JinDong.Du@snclavalin.com>
Sent: Saturday, November 30, 2019 9:24 AM
To: Jesse Clark <jesse.clark@agnicoeagle.com>; Xue, Tom <Tom.Xue@snclavalin.com>; El Bensi, Abdellah <Abdellah.ElBensi@snclavalin.com>; Quan, Nina <Nina.Quan@snclavalin.com>
Cc: Ken Lachance <Ken.Lachance@GroupeGilbert.com>; Pier-Eric McDonald <pier-eric.mcdonald@agnicoeagle.com>; Patrice Gagnon <patrice.gagnon@agnicoeagle.com>; Frederick Bolduc <frederick.bolduc@agnicoeagle.com>; Alexandre Lavallee <alexandre.lavallee@agnicoeagle.com>; Thomas Lepine <thomas.lepine@agnicoeagle.com>
Subject: [EXTERNAL] RE: Discrepancies on grout mix for bedrock injection

CAUTION: EXTERNAL

Hi Jesse,

I have talked to the designer who agrees with your suggestion. The recommendations are:
We can start with Mix C without celbex. When injection volume reaches 400L without pressure building up, Cellbex will be added according to the specifications.

Regards,

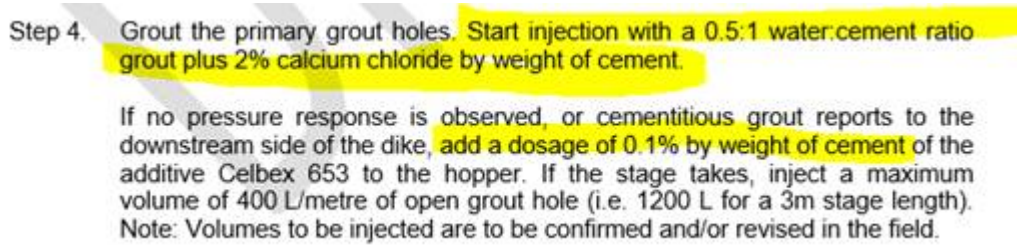
Jin Dong

From: Jesse Clark <jesse.clark@agnicoeagle.com>
Sent: November 30, 2019 10:05 AM
To: Du, Jin Dong <JinDong.Du@snclavalin.com>; Xue, Tom <Tom.Xue@snclavalin.com>; El Bensi, Abdellah <Abdellah.ElBensi@snclavalin.com>; Quan, Nina <Nina.Quan@snclavalin.com>
Cc: Ken Lachance <Ken.Lachance@GroupeGilbert.com>; Pier-Eric McDonald <pier-eric.mcdonald@agnicoeagle.com>; Patrice Gagnon <patrice.gagnon@agnicoeagle.com>; Frederick Bolduc <frederick.bolduc@agnicoeagle.com>; Alexandre Lavallee <alexandre.lavallee@agnicoeagle.com>; Thomas Lepine <thomas.lepine@agnicoeagle.com>
Subject: Discrepancies on grout mix for bedrock injection
Importance: High

Hi Jin-Dong,

As we discussed we require clarification on the grout mix for starting injection. The evolution of the mix throughout all the previous documents is as follows:

1. Grout Committee Letter



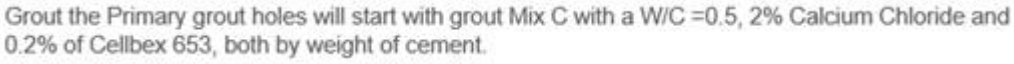
Step 4. Grout the primary grout holes. Start injection with a 0.5:1 water:cement ratio grout plus 2% calcium chloride by weight of cement.

If no pressure response is observed, or cementitious grout reports to the downstream side of the dike, add a dosage of 0.1% by weight of cement of the additive Celbex 653 to the hopper. If the stage takes, inject a maximum volume of 400 L/metre of open grout hole (i.e. 1200 L for a 3m stage length). Note: Volumes to be injected are to be confirmed and/or revised in the field.

2. Specification from SNC

This spec called for starting with A and moving to C and C plus celebex. Initially we had an issue with this approach but after discussion with SNC we decided it was safer to start thinner and work towards mix C and then mix C plus celebex. As discussed it was clear that after grouting a few holes we would no the right initial mix.

3. Simplified instructions from SNC



Grout the Primary grout holes will start with grout Mix C with a W/C =0.5, 2% Calcium Chloride and 0.2% of Cellbex 653, both by weight of cement.

Although we were quite happy with this document, when reviewing this we were concerned it deviated from the grout committee letter by starting thicker than the committee recommendations and the previous conversations on the specification. I asked this question and was told it was supported by field data. After speaking with the field team there is no field data to support this mix.

4. Latest specification from SNC

Grout Mix Design for Rock Grou	
w/c Ratio	0.50
Specific gravity	1.7-1.85
Marsh Time	70-80s
Portland Cement HE (Type 30)	120 kg
Water	60 liters

This indicates Mix already has 0.3% celbex already. This also doesn't appear consistent with the previous 3 documents and the conversations that we've had previously on the subject.

As the client we were concerned about the discrepancy of the first issued specification with the committee letter. The conversations with SNC convinced us that starting thinner would more advantageous then starting thicker, as we would know after injecting several holes what was the right mix. However, the latest field instructions are to start thicker than all previously proposed initial mixes. Unless there is data to back this up we don't agree with this approach.

We are comfortable to start with Mix C with no celbex. We would also be comfortable to start with mix A or B for the first few holes to confirm what is the best initial mix.

Thanks very much. Let me know if you have any questions.

Jesse Clark | Geotechnical Coordinator
jesse.clark@agnicoeagle.com | Direct 819.759.3555 460.6837 |
Agnico Eagle Mines Limited - Meadowbank Division, Suite 540 - Baker Lake, Nunavut, Canada X0C 0A0
agnicoeagle.com

Saleem, Muhammad

From: Du, Jin Dong
Sent: November 30, 2019 2:13 PM
To: Jesse Clark; Marion Habersetzer; Pier-Eric McDonald
Cc: Xue, Tom; El Bensi, Abdellah; Quan, Nina; Saleem, Muhammad
Subject: 669034-modification of the locations of the boreholes at 434.5m and 254.5m

Hi Jesse,

As discovered by AEM, the boreholes at 434.5m and 254.5m are too close to the instrumentation shacks, and the casings cannot be installed. AEM proposed to offset the two boreholes on the downstream side. AEM proposed the new distance from the dike centerline to the two boreholes at Stations 434.5m and 254.5m to be 1.8m and 2.15m respectively.

SNC-Lavalin design team agrees with the above--mentioned changes.

Regards,

Jin Dong

Jin Dong Du
Senior Geotechnical Engineer
Mining & Metallurgy

Tel.: +1(416)252-5315 x 54392

SNC-Lavalin INC.

Saleem, Muhammad

From: Quan, Nina
Sent: November 30, 2019 9:44 PM
To: Jesse Clark; Xue, Tom; El Bensi, Abdellah; Du, Jin Dong
Cc: Ken Lachance; Patrice Gagnon; Pier-Eric McDonald; Frederick Bolduc; Thomas Lepine; Alexandre Lavallee
Subject: RE: [EXTERNAL] RE: Two issues with casing drilling to be rectified by the designer

Hi Jesse

Packer Tests or Water Pressure Tests are used to assess the hydraulic conductivity of the bedrock (Lugeon values) which had been removed from the Specs as per AEM's request to simplify the process of grouting work.

Using Packer testing to decide if grout plug is required or not may not be practical and time consuming as most of the holes (we believe) will take water and we will need the do the grout plug after the water pressure test anyway. It may not save time and efforts at the end.

We are okay if AEM and the contractor both agree to give it a try.

Best Regards

Nina Quan, *P. Eng.*
Ingénieur en Géotechnique/Geotechnical Engineer
Capital de mantien/Sustainable Capital Toronto Office
Mines et métallurgie/Mining & Metallurgy

Tel.: (416) 252-5315 x 54162
Cell.: (416) 434-1851
Fax: (416) 231-5336

SNC-Lavalin
195 The West Mall
Toronto | Ontario | Canada | M9C 5K1

From: Jesse Clark <jesse.clark@agnicoeagle.com>
Sent: November 30, 2019 7:22 AM
To: Quan, Nina <Nina.Quan@snclavalin.com>; Xue, Tom <Tom.Xue@snclavalin.com>; El Bensi, Abdellah <Abdellah.ElBensi@snclavalin.com>; Du, Jin Dong <JinDong.Du@snclavalin.com>
Cc: Ken Lachance <Ken.Lachance@GroupeGilbert.com>; Patrice Gagnon <patrice.gagnon@agnicoeagle.com>; Pier-Eric McDonald <pier-eric.mcdonald@agnicoeagle.com>; Frederick Bolduc <frederick.bolduc@agnicoeagle.com>; Thomas Lepine <thomas.lepine@agnicoeagle.com>; Alexandre Lavallee <alexandre.lavallee@agnicoeagle.com>
Subject: RE: [EXTERNAL] RE: Two issues with casing drilling to be rectified by the designer

Hi Nina,

For issue 1 if we can find a way to do a pressure test of the hole would this be sufficient? If it holds pressure equivalent or higher than the injection pressures it shouldn't need the grout plug.

That makes sense about Issue 2. Thanks for your help.

Jesse Clark
460.6837

From: Quan, Nina <Nina.Quan@snclavalin.com>
Sent: Friday, November 29, 2019 7:29 PM
To: Jesse Clark <jesse.clark@agnicoeagle.com>; Xue, Tom <Tom.Xue@snclavalin.com>; El Bensi, Abdellah <Abdellah.ElBensi@snclavalin.com>; Du, Jin Dong <JinDong.Du@snclavalin.com>
Cc: Ken Lachance <Ken.Lachance@GroupeGilbert.com>; Patrice Gagnon <patrice.gagnon@agnicoeagle.com>; Pier-Eric McDonald <pier-eric.mcdonald@agnicoeagle.com>; Frederick Bolduc <frederick.bolduc@agnicoeagle.com>; Thomas Lepine <thomas.lepine@agnicoeagle.com>; Alexandre Lavallee <alexandre.lavallee@agnicoeagle.com>
Subject: [EXTERNAL] RE: Two issues with casing drilling to be rectified by the designer

---

Hello Jesse
Our reply as follows:
Issue 1:
It is not reliable to depend on fine filter material to seal the annulus space due to the properties of granular material. Therefore, grout plug should be carried out as per Specs.
Issue 2:
We agree to extend the casings that did not reach bedrock to 0.3 to 0.5 m below weathered bedrock surface before grout plug be carried out. Care must be taken when advancing to depth close the anticipated bedrock surface to avoid over drill (drill too deep in bedrock surface). SNC engineer should be consulted if any uncertainty occurs. Drilling and grouting in the bedrock shall start only when casing grout plug be completed and grout reach final set.

We would like to have a discussion with AEM on Monday morning to explain our approach and the risks related to execution uncertainties.

Best Regards

Nina Quan, *P. Eng.*
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Capital de mantien/Sustainable Capital Toronto Office
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From: Jesse Clark <jesse.clark@agnicoeagle.com>
Sent: November 29, 2019 2:16 PM
To: Quan, Nina <Nina.Quan@snclavalin.com>; Xue, Tom <Tom.Xue@snclavalin.com>; El Bensi, Abdellah <Abdellah.ElBensi@snclavalin.com>; Du, Jin Dong <JinDong.Du@snclavalin.com>
Cc: Ken Lachance <Ken.Lachance@GroupeGilbert.com>; Patrice Gagnon <patrice.gagnon@agnicoeagle.com>; Pier-Eric McDonald <pier-eric.mcdonald@agnicoeagle.com>; Frederick Bolduc <frederick.bolduc@agnicoeagle.com>; Thomas Lepine <thomas.lepine@agnicoeagle.com>; Alexandre Lavallee <alexandre.lavallee@agnicoeagle.com>
Subject: Two issues with casing drilling to be rectified by the designer

Hi Nina,

As discussed on the phone we have two issues we require clarification on.

Issue 1:
We are finding many of the casings during the drilling are having the anulus of the casing seal naturally when the fine filter material packs around the casing. This means we have effectively sealed the annulus of the casing without any grout injection. When we've gone to inject grout for the plug it takes very little grout. Can we instead do a pressure test of the casing to confirm an effective seal so that the contractor doesn't have to mobilize the grout plant until after injection drilling?

Issue 2:
At the start of the program with the max cut and the holes that finished in the max cut we are finding there is a lot of time wasted taking the Tamrock to drill only to find out we need to deepen the casing. The tamrock drilling in the fine filter material isn't good because the bit gets gummed up with swelling bentonite mixed with water. We would like to take holes where we finished on the max cut, and where log shows that we are not yet in bedrock and deepen the casing to bedrock prior to starting the injection drilling work. This is more logical and efficient for us and I don't see any reason in the spec that prevents us from doing this as the max cut has been removed from the spec. Therefore all those holes that finished on max cut with-out reaching bedrock haven't reached target according to the specification and so we should be able to deepen that casing before starting injection drilling.

A quick response on both items would be much appreciated.

Thanks,

AGNICO EAGLE

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jesse.clark@agnicoeagle.com | Direct 819.759.3555 460.6837 |
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Saleem, Muhammad

From: Pier-Eric McDonald <pier-eric.mcdonald@agnicoeagle.com>
Sent: December 3, 2019 12:17 PM
To: William Lavoie; Jeannot Gagnon; Audrey Bilodeau Groupe Gilbert; Alex Penney; Ken Lachance
Cc: Alexandre Lavallee; Thomas Lepine; Yannick Simard; Jean-Francois Beland; Jesse Clark; Frederick Bolduc; Xue, Tom; El Bensi, Abdellah; Quan, Nina; Saleem, Muhammad; Du, Jin Dong; Marion Habersetzer; Patrice Gagnon
Subject: Clarified Grouting steps from SNC
Attachments: Bedrock Grouting.pdf

Importance: High

Hi KCG,

Please revise and present to field crew some clarifications about chronological steps to follow for high volume take holes. See the attached document as well as clarificatications outlined in communication below.
I think its clear and simple and we don't have to redrill in any case which may have been a logistical problem putting delays.

KCG, especially Ken, let us know if there is any concern with this.
Ken please consider that we'll have to gear up and get ready for Sodium Silicate mix injection.

Regards,

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From: Pier-Eric McDonald <pier-eric.mcdonald@agnicoeagle.com>
Sent: December 3, 2019 11:23 AM
To: Quan, Nina <Nina.Quan@snclavalin.com>; Jesse Clark <jesse.clark@agnicoeagle.com>
Cc: Frederick Bolduc <frederick.bolduc@agnicoeagle.com>; Patrice Gagnon <patrice.gagnon@agnicoeagle.com>; Alexandre Lavallee <alexandre.lavallee@agnicoeagle.com>; Pascal Lavoie <pascal.lavoie@agnicoeagle.com>; Du, Jin Dong <JinDong.Du@snclavalin.com>; El Bensi, Abdellah <Abdellah.ElBensi@snclavalin.com>; Xue, Tom <Tom.Xue@snclavalin.com>; Saleem, Muhammad <Muhammad.Saleem@snclavalin.com>
Subject: RE: [EXTERNAL] RE: Path forward on injection over the next few days

Hi Nina,

Thanks for the procedure, we are please since it is clear and simple. Few clarifications we'd like to know:

- When we are talking about re-grout in steps 4 and 5, is it re-grouting regardless of previously "set" grout elevation meaning we just insert packers and regrout or it involves re-drill and re-cleaning (which might be logistically very hard). I think this details merits further clarification.
  SNC: No re-drill is required, if set grout elevation is within casing, no re-grout is required.
- Is the target pressure kept the same despite the packer being 1m above casing shoe?
  SNC: the target pressure should be calculated/adjusted with referencing the measure "set grout" elevation in the holes to be re-grouted and packer elevation.
- 5c: "stop injection for further instruction", does this mean the potential use of sodium silicate that we are not ready for yet? I want to have the designer point of view as if reaching step 5c is satisfactory and we can keep the primaries as is at this point and solve with secondaries and tertiaries, OR we would have to come back to redrill and inject mixes such as sodium silicate?
  SNC: If no refusal is reached during re-grout with Mix D/Mix E, flush set grout with the application of sodium silicate will be required. Further discussions are needed regarding KCG's preparedness on this.

Once this is clarified, we'll forward it to the contractor. Please note as well I've pressed the contractor to synchronize with Jin Dong to get Vicat set time tests today.

Regards,

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Sent from Amaruq

From: Quan, Nina [mailto:Nina.Quan@snclavalin.com]
Sent: December 3, 2019 9:45 AM
To: Jesse Clark <jesse.clark@agnicoeagle.com>
Cc: Frederick Bolduc <frederick.bolduc@agnicoeagle.com>; Patrice Gagnon <patrice.gagnon@agnicoeagle.com>; Pier-Eric McDonald <pier-eric.mcdonald@agnicoeagle.com>; Alexandre Lavallee <alexandre.lavallee@agnicoeagle.com>; Pascal Lavoie <pascal.lavoie@agnicoeagle.com>; Du, Jin Dong <JinDong.Du@snclavalin.com>; El Bensi, Abdellah <Abdellah.ElBensi@snclavalin.com>; Xue, Tom <Tom.Xue@snclavalin.com>; Saleem, Muhammad <Muhammad.Saleem@snclavalin.com>
Subject: RE: [EXTERNAL] RE: Path forward on injection over the next few days

Hello Jesse and Pier-Eric

Tom updated the grout mix procedures and the updated procedures was also forwarded to Jin Dong and Saleem to follow (see the attached file).
Please let us know if you still would like to have a discussion. In the mean time, we focus on the preparation of the presentation for the Grouting Committee since we have very short time to prepare for it.
Best Regards

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Capital de mantien/Sustainable Capital Toronto Office
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Saleem, Muhammad

From: Du, Jin Dong
Sent: December 3, 2019 3:08 PM
To: Pier-Eric McDonald
Cc: Yannick Simard; Jesse Clark; Xue, Tom; Quan, Nina; El Bensi, Abdellah; Saleem, Muhammad; William Lavoie
Subject: RE: [EXTERNAL] Daily Report -Dec 02 2019

Hi Pier-Eric,

I did asked SNC-Lavalin design team if it is ok to re-grout these holes tomorrow in our meeting yesterday afternoon; they were ok for this.

Regards,

Jin Dong

From: Pier-Eric McDonald <pier-eric.mcdonald@agnicoeagle.com>
Sent: December 3, 2019 2:50 PM
To: Du, Jin Dong <JinDong.Du@snclavalin.com>
Cc: Yannick Simard <Yannick.Simard@agnicoeagle.com>; Jesse Clark <jesse.clark@agnicoeagle.com>; Xue, Tom <Tom.Xue@snclavalin.com>; Quan, Nina <Nina.Quan@snclavalin.com>; El Bensi, Abdellah <Abdellah.ElBensi@snclavalin.com>; Saleem, Muhammad <Muhammad.Saleem@snclavalin.com>; William Lavoie <William.Lavoie@groupegilbert.com>
Subject: RE: [EXTERNAL] Daily Report -Dec 02 2019

Makes sense to me if SNC is comfortable as well.

From: Du, Jin Dong [mailto:JinDong.Du@snclavalin.com]
Sent: December 3, 2019 1:48 PM
To: Pier-Eric McDonald <pier-eric.mcdonald@agnicoeagle.com>
Cc: Yannick Simard <Yannick.Simard@agnicoeagle.com>; Jesse Clark <jesse.clark@agnicoeagle.com>; Xue, Tom <Tom.Xue@snclavalin.com>; Quan, Nina <Nina.Quan@snclavalin.com>; El Bensi, Abdellah <Abdellah.ElBensi@snclavalin.com>; Saleem, Muhammad <Muhammad.Saleem@snclavalin.com>; William Lavoie <William.Lavoie@groupegilbert.com>
Subject: RE: [EXTERNAL] Daily Report -Dec 02 2019

Hi Pier-Eric,

I just discussed this with KCG. The casing plugs they planned to grout today are for the secondary and tertiary holes within the current bedrock grouting section which AEM wants to finish the full grouting first. KCG thinks it is more efficient to finish the casing plugs for these holes in this section first because these holes will be grouted for the bedrock soon and the casing plugs need some time to set.
They said the re-grouting for those high intake low pressure holes can be started tomorrow.

Regards,

Jin Dong

From: Du, Jin Dong
Sent: December 3, 2019 12:33 PM
To: 'Pier-Eric McDonald' <pier-eric.mcdonald@agnicoeagle.com>
Cc: Yannick Simard <Yannick.Simard@agnicoeagle.com>; Jesse Clark <jesse.clark@agnicoeagle.com>; Xue, Tom <Tom.Xue@snclavalin.com>; Quan, Nina <Nina.Quan@snclavalin.com>; El Bensi, Abdellah <Abdellah.ElBensi@snclavalin.com>; Saleem, Muhammad <Muhammad.Saleem@snclavalin.com>
Subject: RE: [EXTERNAL] Daily Report -Dec 02 2019

Hi Pier-Eric,

The grouting of the casing plugs has started after the bedrock grouting was completed at P668.5 this morning. I will talk to KCG now to see what the best option is and to see if they are prepared to re-gout the holes. The re-grouting needs some measurements of the hole which I believe they are taking in the field now. I will get back to you after I discuss this with KCG.

Regards,

Jin Dong

From: Pier-Eric McDonald <pier-eric.mcdonald@agnicoeagle.com>
Sent: December 3, 2019 12:24 PM
To: Du, Jin Dong <JinDong.Du@snclavalin.com>
Cc: Yannick Simard <Yannick.Simard@agnicoeagle.com>; Jesse Clark <jesse.clark@agnicoeagle.com>
Subject: RE: [EXTERNAL] Daily Report -Dec 02 2019

Hi Jin Dong,

We just have the final steps by Tom Xue. Before moving in to the plugs today (or at the same time if we are nearby) , do you intent to follow the steps outlined in Toms document to continue grouting following his approach for the outstanding holes that reached Vmax?

What would be your proposal?

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agnicoeagle.com
Sent from Amaruq

From: Du, Jin Dong [mailto:JinDong.Du@snclavalin.com]
Sent: December 3, 2019 11:16 AM
To: Xue, Tom <Tom.Xue@snclavalin.com>; El Bensi, Abdellah <Abdellah.ElBensi@snclavalin.com>; Thomas Lepine <thomas.lepine@agnicoeagle.com>; Alexandre Lavallee <alexandre.lavallee@agnicoeagle.com>; Jesse Clark <jesse.clark@agnicoeagle.com>; Frederick Bolduc <frederick.bolduc@agnicoeagle.com>; Marion Habersetzer <marion.habersetzer@agnicoeagle.com>; Patrice Gagnon <patrice.gagnon@agnicoeagle.com>; Saleem, Muhammad

<Muhammad.Saleem@snclavalin.com>; Quan, Nina <Nina.Quan@snclavalin.com>; Baba, Hafeez <Hafeez.Baba@snclavalin.com>; Pier-Eric McDonald <pier-eric.mcdonald@agnicoeagle.com>; Yannick Simard <Yannick.Simard@agnicoeagle.com>
Subject: [EXTERNAL] Daily Report -Dec 02 2019

CAUTION: EXTERNAL

Hi All,

Please find attached daily field report for Dec. 02, 2019.

Regards,

Jin Dong

Jin Dong Du
Senior Geotechnical Engineer
Mining & Metallurgy

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SNC-Lavalin INC.

Saleem, Muhammad

From: Quan, Nina
Sent: December 4, 2019 12:58 PM
To: Du, Jin Dong
Cc: Xue, Tom; El Bensi, Abdellah; Saleem, Muhammad
Subject: RE: Tremie method proposal for flushing water - AEM comments

Hi Jin-Dong
Tom agreed to remove the last bullet regarding tremie grouting. Please re-issue of the instruction for the re-grouting of the high take holes with removing the last bullet (in red).

Here are some more recommendations on the re-grout of high take holes:

- For re-grout a hole that did not reach refusal with Mix C in the same day, the recommendation is starting with Mix D.
- For re-grout a hole grouted previous day/days, the recommendation is to start with Mix C and thickening the grout as required.
- For all the holes with standing water, tremie grouting should be carried out from the bottom of the hole to displace the water from the hole) before packer is inflated.

Regards
Nina

From: Pier-Eric McDonald <pier-eric.mcdonald@agnicoeagle.com>
Sent: December 4, 2019 11:45 AM
To: Du, Jin Dong <JinDong.Du@snclavalin.com>; Quan, Nina <Nina.Quan@snclavalin.com>
Cc: Patrice Gagnon <patrice.gagnon@agnicoeagle.com>; Jesse Clark <jesse.clark@agnicoeagle.com>; Frederick Bolduc <frederick.bolduc@agnicoeagle.com>; Alexandre Lavallee <alexandre.lavallee@agnicoeagle.com>; Yannick Simard <Yannick.Simard@agnicoeagle.com>; Thomas Lepine <thomas.lepine@agnicoeagle.com>
Subject: Tremie method proposal for flushing water - AEM comments

Ji Jin Dong,

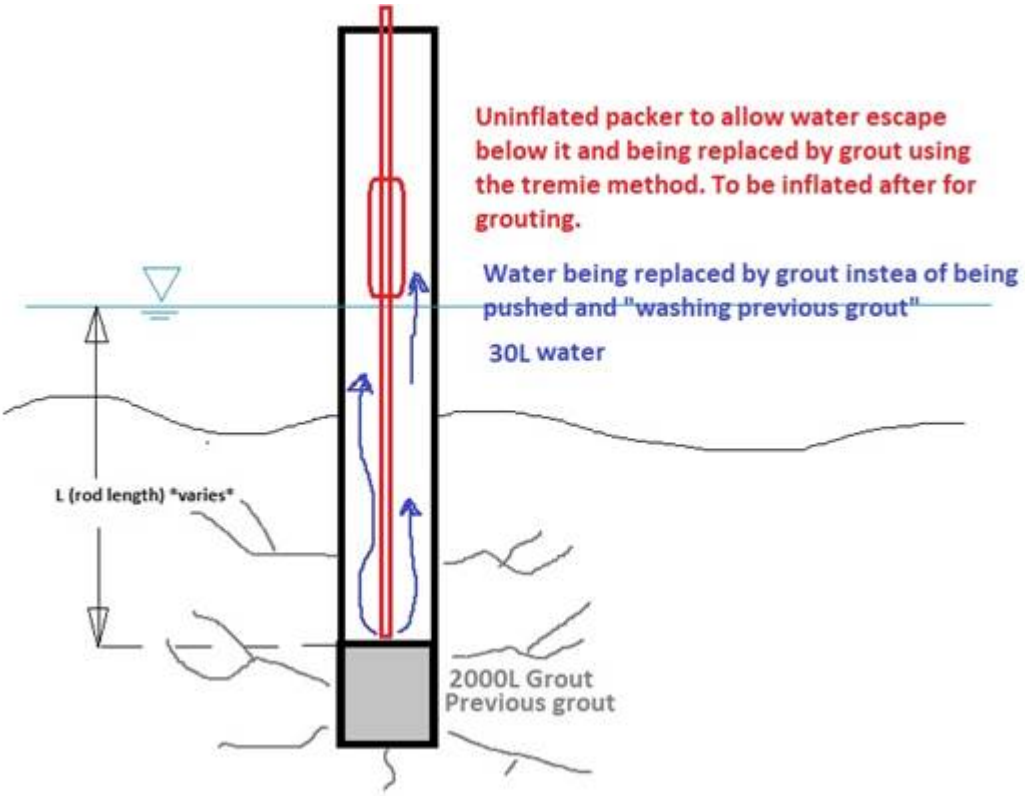
As discussed during our morning meeting, SNC came up with the proposal to carry an extra step prior re-grouting every hole which is an add to the specifications as well as Mix use directives issued yesterday.
It consists of set upping the packer above the water table with a specific rod length below to reach the previous grout elevation and then tremie grout. The theory being this is to flush the water in the casing out of the hole as opposed to push it with grout within the fractures as this may wash the previous injected grout if set time is not reached.

AEM is challenging this concept as it would evolve an extra packer arrangement and delays on every hole in order to solve this:

1. I don't think flushing 30L of water out of the hole by tremie method prevents this 30L from washing the >2000L grout injected >24hr before… Also if that small volume actually "washes" it, it will be replaced right away by grout that will be imminently injected ;
2. This potential problem wasn't a concern in phase 1 grouting where it is the same phenomena and there would have been a concern washing out stage 1 below when injecting stage 2 by upstage method.
3. Even if this is done, you only tremie out 30L within the casing and it doesn't solve all the water present in the rock mass below the water table since water is present in every fracture and may also "wash" previously injected grout but you cannot do anything for this water which volume may actually be quite more significant than what you can flush out of the casing by tremie

4. A special custom setup is required very hole and may be impossible to do since “L” (see sketch below) varies from hole to hole and rod lengths available are fixed, thus it may not be possible to effectively tremie the water out where rod would ideally be right above the previous grout.

All in all, when adding extra steps adding more time and costs, AEM wants to make sure there is significant added value in doing so and I am not convinced at this point.



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Appendix A- 6: List of Casing Locations

STA	HOLE GENERATION	P T S Q	# OF THE HOLE	EASTING	NORTHING	CURRENT PLATFORM EL (masl)	BOTTOM CASING EL (m)	TOTAL LENGTH OF CASING FROM THE PLATFORM (m)	ELEVATION OF ROCK SOCKET (masl)	MAXIMUM LENGHT OF THE CASING FROM THE PLATFORM (m)
176.5	PRIMARY	P	P-176.5	607151.4831	7254651.724	159	151.97	7.03	150.978	7.522
179.5	TERTIARY	T	T-179.5	607154.2604	7254652.919	159	151.62	7.38	150.634	7.866
182.5	SECONDARY	S	S-182.5	607157.0265	7254654.077	159	151.54	7.46	150.352	8.148
185.5	TERTIARY	T	T-185.5	607159.793	7254655.236	159	151.6	7.4	150.338	8.162
188.5	PRIMARY	P	P-188.5	607162.4546	7254656.374	159	151.5	7.5	150.501	7.999
191.5	TERTIARY	T	T-191.5	607165.0873	7254657.923	159	150.63	8.37	148.487	10.013
193.0	QUATERNARY	Q	Q-193	607166.4184	7254658.609					
194.5	SECONDARY	S	S-194.5	607167.7494	7254659.296	159	149.98	9.02	148.636	9.864
196.5	QUATERNARY	Q	Q-196.5	607170.0921	7254659.11					
197.5	TERTIARY	T	T-197.5	607171.0046	7254659.52	159	149.65	9.35	148.672	9.828
199.0	QUATERNARY	Q	Q-199	607172.3733	7254660.133					
200.5	PRIMARY	P	P-200.5	607173.742	7254660.747	159	149.58	9.42	148.489	10.011
203.5	TERTIARY	T	T-203.5	607176.4794	7254661.975	159	149.36	9.64	148.377	10.123
206.5	SECONDARY	S	S-206.5	607179.3024	7254663.251	159	149.27	9.73	148.007	10.493
209.5	TERTIARY	T	T-209.5	607181.9541	7254664.43	159	149.63	9.37	148.479	10.021
212.5	PRIMARY	P	P-212.5	607184.6915	7254665.657	159	149.53	9.47	148.409	10.091
215.5	TERTIARY	T	T-215.5	607187.4289	7254666.885	159	149.53	9.47	148.412	10.088
218.5	SECONDARY	S	S-218.5	607189.769	7254669.197	159	149.27	9.73	147.561	10.939
220.0	QUATERNARY	Q	Q-220	607191.174	7254669.711					
221.5	TERTIARY	T	T-221.5	607192.5791	7254670.226	159	149.27	9.73	147.964	10.536
223.0	QUATERNARY	Q	Q-223	607193.953	7254670.736					
224.5	PRIMARY	P	P-224.5	607195.327	7254671.247	159	150.12	8.88	148.627	9.873
227.5	TERTIARY	T	T-227.5	607198.0505	7254672.505	159	150.13	8.87	149.007	9.493
230.5	SECONDARY	S	S-230.5	607200.7735	7254673.763	159	150.02	8.98	148.953	9.547
233.5	TERTIARY	T	T-233.5	607203.6443	7254674.926	159	150.22	8.78	149.107	9.393
236.5	PRIMARY	P	P-236.5	607206.4893	7254675.805	159	150.58	8.42	149.444	9.056
239.5	TERTIARY	T	T-239.5	607209.3279	7254676.705	159	150.59	8.41	149.415	9.085
242.5	SECONDARY	S	S-242.5	607212.0653	7254677.932	159	150.84	8.16	149.56	8.94
245.5	TERTIARY	T	T-245.5	607214.8027	7254679.16	159	150.48	8.52	149.462	9.038
248.5	PRIMARY	P	P-248.5	607217.5401	7254680.387	159	150.25	8.75	148.696	9.804
251.5	TERTIARY	T	T-251.5	607220.2775	7254681.615	159	150.41	8.59	149.241	9.259
254.5	SECONDARY	S	S-254.5	607222.7984	7254683.334	159	150.62	8.38	149.47	9.03
257.5	TERTIARY	T	T-257.5	607225.5843	7254684.451	159	150.51	8.49	149.305	9.195
260.5	PRIMARY	P	P-260.5	607228.6701	7254685.386	159	150.41	8.59	148.85	9.65
263.5	TERTIARY	T	T-263.5	607231.227	7254686.525	159	150.46	8.54	149.333	9.167
266.5	SECONDARY	S	S-266.5	607233.9644	7254687.752	159	150.43	8.57	148.645	9.855
269.5	TERTIARY	T	T-269.5	607236.7018	7254688.98	159	150.71	8.29	148.523	9.977
272.5	PRIMARY	P	P-272.5	607239.4391	7254690.207	159	151.12	7.88	149.978	8.522
275.5	TERTIARY	T	T-275.5	607242.1765	7254691.435	159	150.72	8.28	149.359	9.141
278.5	SECONDARY	S	S-278.5	607244.9139	7254692.662	159	150.61	8.39	149.141	9.359
281.5	TERTIARY	T	T-281.5	607247.6513	7254693.889	159	150.47	8.53	149.287	9.213
284.5	PRIMARY	P	P-284.5	607250.3887	7254695.117	159	150.94	8.06	149.688	8.812
287.5	TERTIARY	T	T-287.5	607253.1261	7254696.344	159	150.98	8.02	149.787	8.713
290.5	SECONDARY	S	S-290.5	607255.8634	7254697.572	159	150.9	8.1	149.179	9.321
292.0	QUATERNARY	Q	Q-292	607257.2321	7254698.186					
293.5	TERTIARY	T	T-293.5	607258.6008	7254698.799	159	150.82	8.18	149.513	8.987
295.0	QUATERNARY	Q	Q-295	607259.9695	7254699.413					

296.5	**PRIMARY**	**P**	**P-296.5**	607261.3382	7254700.027	159	151.06	7.94	150.062	8.438
299.5	**TERTIARY**	T	**T-299.5**	607264.0756	7254701.254	159	151.16	7.84	150.238	8.262
302.5	**SECONDARY**	S	**S-302.5**	607266.813	7254702.482	159	150.91	8.09	149.877	8.623
305.5	**TERTIARY**	T	**T-305.5**	607269.5504	7254703.709	159	151	8	149.928	8.572
308.5	**PRIMARY**	**P**	**P-308.5**	607272.2877	7254704.937	159	151.68	7.32	150.511	7.989
311.5	**TERTIARY**	T	**T-311.5**	607275.0251	7254706.164	159	151.33	7.67	150.359	8.141
314.5	**SECONDARY**	S	**S-314.5**	607277.3327	7254708.361	159	150.75	8.25	149.258	9.242
317.5	**TERTIARY**	T	**T-317.5**	607280.0787	7254709.577	159	150.03	8.97	148.933	9.567
320.5	**PRIMARY**	**P**	**P-320.5**	607282.8251	7254710.785	159	149.57	9.43	148.145	10.355
323.5	**TERTIARY**	T	**T-323.5**	607285.5304	7254711.987	159	149.07	9.93	147.893	10.607
326.5	**SECONDARY**	S	**S-326.5**	607288.2272	7254713.299	159	148.63	10.37	147.118	11.382
329.5	**TERTIARY**	T	**T-329.5**	607290.9237	7254714.61	159	148.16	10.84	146.873	11.627
332.5	**PRIMARY**	**P**	**P-332.5**	607294.1868	7254714.757	159	147.71	11.29	146.672	11.828
335.5	**TERTIARY**	T	**T-335.5**					0		
338.5	**SECONDARY**	S	**S-338.5**	607299.6616	7254717.212	159	146.94	12.06	145.822	12.678
341.5	**TERTIARY**	T	**T-341.5**	607302.3989	7254718.439	159	146.92	12.08	145.826	12.674
344.5	**PRIMARY**	**P**	**P-344.5**	607305.1363	7254719.667	159	146.74	12.26	145.61	12.89
347.5	**TERTIARY**	T	**T-347.5**	607307.8737	7254720.894	159	146.48	12.52	145.359	13.141
350.5	**SECONDARY**	S	**S-350.5**	607310.3993	7254723.063	159	146.43	12.57	145.353	13.147
353.5	**TERTIARY**	T	**T-353.5**	607313.1287	7254723.833	159	146.29	12.71	145.088	13.412
356.5	**PRIMARY**	**P**	**P-356.5**	607315.8606	7254725.073	159	145.52	13.48	144.387	14.113
359.5	**TERTIARY**	T	**T-359.5**					0		
362.5	**SECONDARY**	S	**S-362.5**	607321.5606	7254727.032	159	143.68	15.32	142.531	15.969
365.5	**TERTIARY**	T	**T-365.5**	607324.256	7254728.353	159	143.65	15.35	141.007	17.493
368.5	**PRIMARY**	**P**	**P-368.5**	607327.0354	7254729.487	159	144.21	14.79	139.415	19.085
371.5	**TERTIARY**	T	**T-371.5**	607329.7728	7254730.714	159	145.67	13.33	144.559	13.941
374.5	**SECONDARY**	S	**S-374.5**	607332.5101	7254731.942	159	147.75	11.25	146.659	11.841
377.5	**TERTIARY**	T	**T-377.5**	607335.2475	7254733.169	159	148.07	10.93	146.611	11.889
380.5	**PRIMARY**	**P**	**P-380.5**	607337.9861	7254734.394	159	148.31	10.69	147.154	11.346
383.5	**TERTIARY**	T	**T-383.5**	607340.7392	7254735.586	159	147.39	11.61	146.087	12.413
386.5	**SECONDARY**	S	**S-386.5**	607343.5097	7254736.736	159	147.13	11.87	145.213	13.287
389.5	**TERTIARY**	T	**T-389.5**	607346.2972	7254737.845	159	148.26	10.74	147.044	11.456
392.5	**PRIMARY**	**P**	**P-392.5**	607349.1009	7254738.913	159	147.91	11.09	146.409	12.091
395.5	**TERTIARY**	T	**T-395.5**	607351.9203	7254739.938	159	147.5	11.5	146.154	12.346
398.5	**SECONDARY**	S	**S-398.5**	607354.7547	7254740.921	159	147.68	11.32	146.402	12.098
401.5	**TERTIARY**	T	**T-401.5**	607357.6034	7254741.861	159	147.94	11.06	146.261	12.239
404.5	**PRIMARY**	**P**	**P-404.5**	607360.4659	7254742.759	159	146.52	12.48	145.007	13.493
407.5	**TERTIARY**	T	**T-407.5**	607363.3415	7254743.614	159	146.88	12.12	144.629	13.871
410.5	**SECONDARY**	S	**S-410.5**	607365.9818	7254745.202	159	148.25	10.75	147.339	11.161
413.5	**TERTIARY**	T	**T-413.5**	607369.0729	7254745.811	159	148.25	10.75	146.997	11.503
416.5	**PRIMARY**	**P**	**P-416.5**	607372.0255	7254746.081	159	148.19	10.81	146.815	11.685
419.5	**TERTIARY**	T	**T-419.5**	607374.7321	7254747.072	159	148.38	10.62	147.082	11.418
422.5	**SECONDARY**	S	**S-422.5**	607377.7994	7254747.74	159	148.65	10.35	147.218	11.282
425.5	**TERTIARY**	T	**T-425.5**	607380.7478	7254748.292	159	148.41	10.59	147.336	11.164
428.5	**PRIMARY**	**P**	**P-428.5**	607383.736	7254748.791	159	148.71	10.29	147.268	11.232
431.5	**TERTIARY**	T	**T-431.5**	607386.7116	7254749.135	159	148.84	10.16	147.754	10.746
434.5	**SECONDARY**	S	**S-434.5**	607389.6699	7254749.564	159	148.95	10.05	147.79	10.71
437.5	**TERTIARY**	T	**T-437.5**	607392.6634	7254749.845	159	148.91	10.09	147.749	10.751
440.5	**PRIMARY**	**P**	**P-440.5**					0		
443.5	**TERTIARY**	T	**T-443.5**	607398.3706	7254751.503	159	148.93	10.07	146.899	11.601

446.5	**SECONDARY**	S	**S-446.5**	607401.2107	7254752.377	159	149.06	9.94	147.988	10.512
449.5	**TERTIARY**	T	**T-449.5**	607404.51	7254751.757	159	148.98	10.02	147.773	10.727
452.5	**PRIMARY**	**P**	**P-452.5**	607407.4717	7254752.235	159	148.97	10.03	147.633	10.867
455.5	**TERTIARY**	T	**T-455.5**	607410.1499	7254752.666	159	149	10	147.732	10.768
458.5	**SECONDARY**	S	**S-458.5**	607413.2579	7254754.096	159	149.07	9.93	147.758	10.742
461.5	**TERTIARY**	T	**T-461.5**	607416.2239	7254754.545	159	149.04	9.96	147.857	10.643
464.5	**PRIMARY**	**P**	**P-464.5**	607419.1399	7254755.042	159	149.28	9.72	147.829	10.671
467.5	**TERTIARY**	T	**T-467.5**	607422.0801	7254755.628	159	149.46	9.54	148.322	10.178
470.5	**SECONDARY**	S	**S-470.5**	607425.0203	7254756.214	159	149.54	9.46	148.396	10.104
473.5	**TERTIARY**	T	**T-473.5**	607428.2033	7254755.581	159	149.68	9.32	148.3	10.2
476.5	**PRIMARY**	**P**	**P-476.5**	607431.165	7254756.06	159	149.59	9.41	148.217	10.283
478.0	**QUATERNARY**	Q	**Q-478**	607432.6458	7254756.299					
479.5	**TERTIARY**	T	**T-479.5**	607434.1267	7254756.538	159	149.54	9.46	148.356	10.144
481.0	**QUATERNARY**	Q	**Q-481**	607435.6076	7254756.777					
482.5	**SECONDARY**	S	**S-482.5**	607437.0883	7254757.016	159	149.62	9.38	148.353	10.147
485.5	**TERTIARY**	T	**T-485.5**	607440.05	7254757.494	159	149.67	9.33	148.416	10.084
488.5	**PRIMARY**	**P**	**P-488.5**	607443.0117	7254757.972	159	149.6	9.4	148.321	10.179
491.5	**TERTIARY**	T	**T-491.5**	607445.9733	7254758.45	159	149.59	9.41	148.463	10.037
494.5	**SECONDARY**	S	**S-494.5**	607448.935	7254758.928	159	149.66	9.34	148.52	9.98
497.5	**TERTIARY**	T	**T-497.5**	607451.8967	7254759.406	159	149.58	9.42	147.519	10.981
500.5	**PRIMARY**	**P**	**P-500.5**	607454.8583	7254759.884	159	149.5	9.5	148.067	10.433
503.5	**TERTIARY**	T	**T-503.5**	607457.82	7254760.362	159	149.65	9.35	148.172	10.328
506.5	**SECONDARY**	S	**S-506.5**	607460.7817	7254760.84	159	149.66	9.34	147.604	10.896
509.5	**TERTIARY**	T	**T-509.5**	607463.7433	7254761.318	159	149.65	9.35	147.713	10.787
512.5	**PRIMARY**	**P**	**P-512.5**	607466.705	7254761.796	159	149.65	9.35	147.6	10.9
515.5	**TERTIARY**	T	**T-515.5**	607469.6667	7254762.274	159	149.65	9.35	147.532	10.968
518.5	**SECONDARY**	S	**S-518.5**	607472.6283	7254762.752	159	149.55	9.45	147.201	11.299
521.5	**TERTIARY**	T	**T-521.5**	607475.59	7254763.23	159	149.56	9.44	147.487	11.013
523.0	**QUATERNARY**	Q	**Q-523**	607477.0708	7254763.469					
524.5	**PRIMARY**	**P**	**P-524.5**	607478.5516	7254763.708	159	149.53	9.47	147.521	10.979
526.0	**QUATERNARY**	Q	**Q-526**	607480.0324	7254763.947					
527.5	**TERTIARY**	T	**T-527.5**	607481.5133	7254764.187	159	149.55	9.45	147.272	11.228
530.5	**SECONDARY**	S	**S-530.5**	607484.475	7254764.665	159	149.53	9.47	147.557	10.943
533.5	**TERTIARY**	T	**T-533.5**	607487.4366	7254765.143	159	149.59	9.41	147.585	10.915
536.5	**PRIMARY**	**P**	**P-536.5**	607490.3983	7254765.621	159	149.53	9.47	148.243	10.257
539.5	**TERTIARY**	T	**T-539.5**	607493.36	7254766.099	159	149.39	9.61	148.354	10.146
542.5	**SECONDARY**	S	**S-542.5**	607496.3216	7254766.577	159	149.43	9.57	147.108	11.392
545.5	**TERTIARY**	T	**T-545.5**	607499.2833	7254767.055	159	149.54	9.46	147.424	11.076
548.5	**PRIMARY**	**P**	**P-548.5**	607502.245	7254767.533	159	149.42	9.58	147.17	11.33
551.5	**TERTIARY**	T	**T-551.5**	607505.2066	7254768.011	159	149.52	9.48	147.309	11.191
554.5	**SECONDARY**	S	**S-554.5**	607508.1683	7254768.489	159	149.44	9.56	147.14	11.36
557.5	**TERTIARY**	T	**T-557.5**	607511.13	7254768.967	159	149.38	9.62	147.233	11.267
560.5	**PRIMARY**	**P**	**P-560.5**	607514.0916	7254769.445	159	149.64	9.36	147.352	11.148
563.5	**TERTIARY**	T	**T-563.5**	607517.047	7254769.952	159	149.64	9.36	147.368	11.132
566.5	**SECONDARY**	S	**S-566.5**	607519.9703	7254770.602	159	149.53	9.47	147.365	11.135
569.5	**TERTIARY**	T	**T-569.5**	607522.9231	7254771.221	159	149.32	9.68	147.146	11.354
572.5	**PRIMARY**	**P**	**P-572.5**	607525.8869	7254771.685	159	149.38	9.62	147.207	11.293
575.5	**TERTIARY**	T	**T-575.5**	607528.8508	7254772.149	159	149.05	9.95	146.838	11.662
578.5	**SECONDARY**	S	**S-578.5**	607531.8147	7254772.614	159	148.83	10.17	147.517	10.983
581.5	**TERTIARY**	T	**T-581.5**	607534.7823	7254773.066	159	148.86	10.14	147.626	10.874

584.5	**PRIMARY**	**P**	**P-584.5**	607537.7489	7254773.51	159	148.82	10.18	147.663	10.837
587.5	**TERTIARY**	T	**T-587.5**	607540.7157	7254773.955	159	148.71	10.29	146.924	11.576
590.5	**SECONDARY**	S	**S-590.5**	607543.6842	7254774.394	159	148.7	10.3	147.347	11.153
593.5	**TERTIARY**	T	**T-593.5**	607546.6532	7254774.82	159	148.45	10.55	146.932	11.568
596.5	**PRIMARY**	**P**	**P-596.5**	607549.6316	7254775.182	159	148.14	10.86	146.342	12.158
599.5	**TERTIARY**	T	**T-599.5**	607552.5933	7254775.66	159	148.12	10.88	146.466	12.034
602.5	**SECONDARY**	S	**S-602.5**	607555.5549	7254776.138	159	147.36	11.64	146.113	12.387
605.5	**TERTIARY**	T	**T-605.5**	607558.5166	7254776.616	159	146.95	12.05	145.544	12.956
608.5	**PRIMARY**	**P**	**P-608.5**					0		
611.5	**TERTIARY**	T	**T-611.5**	607564.4399	7254777.572	159	147.23	11.77	145.756	12.744
614.5	**SECONDARY**	S	**S-614.5**	607567.4016	7254778.05	159	147.82	11.18	146.579	11.921
617.5	**TERTIARY**	T	**T-617.5**	607570.3633	7254778.528	159	147.97	11.03	146.788	11.712
620.5	**PRIMARY**	**P**	**P-620.5**	607573.3249	7254779.006	159	147.82	11.18	146.649	11.851
623.5	**TERTIARY**	T	**T-623.5**	607576.2866	7254779.484	159	147.51	11.49	146.297	12.203
626.5	**SECONDARY**	S	**S-626.5**	607579.2483	7254779.962	159	147.5	11.5	145.957	12.543
628.0	**QUATERNARY**	Q	**Q-628**	607580.7291	7254780.201					
629.5	**TERTIARY**	T	**T-629.5**	607582.2099	7254780.441	159	147.58	11.42	146.299	12.201
632.5	**PRIMARY**	**P**	**P-632.5**	607585.1716	7254780.919	159	147.53	11.47	146.163	12.337
635.5	**TERTIARY**	T	**T-635.5**	607588.1333	7254781.397	159	147.69	11.31	146.501	11.999
638.5	**SECONDARY**	S	**S-638.5**	607591.0949	7254781.875	159	148.1	10.9	147.086	11.414
641.5	**TERTIARY**	T	**T-641.5**	607594.0566	7254782.353	159	148.21	10.79	147.201	11.299
644.5	**PRIMARY**	**P**	**P-644.5**	607597.0182	7254782.831	159	148.05	10.95	146.953	11.547
647.5	**TERTIARY**	T	**T-647.5**	607599.9799	7254783.309	159	147.89	11.11	146.772	11.728
650.5	**SECONDARY**	S	**S-650.5**	607602.9416	7254783.787	159	147.84	11.16	146.547	11.953
653.5	**TERTIARY**	T	**T-653.5**	607605.9032	7254784.265	159	147.68	11.32	146.73	11.77
656.5	**PRIMARY**	**P**	**P-656.5**	607608.8649	7254784.743	159	147.72	11.28	146.685	11.815
659.5	**TERTIARY**	T	**T-659.5**	607611.8266	7254785.221	159	148.13	10.87	147.024	11.476
662.5	**SECONDARY**	S	**S-662.5**	607614.7882	7254785.699	159	148.39	10.61	147.135	11.365
664.0	**QUATERNARY**	Q	**Q-664**	607616.269	7254785.938					
665.5	**TERTIARY**	T	**T-665.5**	607617.7499	7254786.177	159	148.7	10.3	147.454	11.046
667.0	**QUATERNARY**	Q	**Q-667**	607619.2308	7254786.416					
668.5	**PRIMARY**	**P**	**P-668.5**	607620.7116	7254786.655	159	148.68	10.32	147.419	11.081
671.5	**TERTIARY**	T	**T-671.5**	607623.6272	7254787.116	159	148.65	10.35	147.645	10.855
674.5	**SECONDARY**	S	**S-674.5**	607626.6349	7254787.611	159	148.8	10.2	147.383	11.117
677.5	**TERTIARY**	T	**T-677.5**	607629.5966	7254788.089	159	148.81	10.19	147.662	10.838
680.5	**PRIMARY**	**P**	**P-680.5**	607632.5582	7254788.568	159	148.98	10.02	147.843	10.657
682.0	**QUATERNARY**	**Q**	**Q-682**	607634.039	7254788.807					
683.5	**TERTIARY**	T	**T-683.5**	607635.5199	7254789.046	159	149.06	9.94	148.013	10.487
685.0	**QUATERNARY**	Q	**Q-685**	607637.0008	7254789.285					
686.5	**SECONDARY**	S	**S-686.5**	607638.4816	7254789.524	159	149.15	9.85	148.134	10.366
688.0	**QUATERNARY**	Q	**Q-688**	607639.9624	7254789.763					
689.5	**TERTIARY**	T	**T-689.5**	607641.4432	7254790.002	159	149.21	9.79	148.006	10.494
691.0	**QUATERNARY**	Q	**Q-691**	607642.924	7254790.241					
692.5	**PRIMARY**	**P**	**P-692.5**	607644.4049	7254790.48	159	149.29	9.71	147.718	10.782
694.0	**QUATERNARY**	**Q**	**Q-694**	607645.8858	7254790.719					
695.5	**TERTIARY**	T	**T-695.5**	607647.3666	7254790.958	159	149.42	9.58	148.163	10.337
697.0	**QUATERNARY**	Q	**Q-697**	607648.8474	7254791.197					
698.5	**SECONDARY**	S	**S-698.5**	607650.3282	7254791.436	159	149.62	9.38	148.507	9.993
701.5	**TERTIARY**	T	**T-701.5**	607653.2899	7254791.914	159	149.8	9.2	148.553	9.947
704.5	**PRIMARY**	**P**	**P-704.5**	607656.2516	7254792.392	159	150.07	8.93	148.514	9.986

707.5	**TERTIARY**	T	**T-707.5**	607659.1911	7254792.978	159	150.2	8.8	148.776	9.724
710.5	**SECONDARY**	S	**S-710.5**	607662.1364	7254793.566	159	150.21	8.79	149.076	9.424
713.5	**TERTIARY**	T	**T-713.5**	607665.0904	7254794.088	159	150.08	8.92	148.83	9.67
716.5	**PRIMARY**	**P**	**P-716.5**	607668.0444	7254794.609	159	149.86	9.14	148.809	9.691
719.5	**TERTIARY**	T	**T-719.5**	607671.0368	7254795.023	159	149.91	9.09	148.909	9.591
722.5	**SECONDARY**	S	**S-722.5**	607674.0215	7254795.26	159	150.15	8.85	149.151	9.349
725.5	**TERTIARY**	T	**T-725.5**	607676.9832	7254795.738	159	150.28	8.72	149.164	9.336
728.5	**PRIMARY**	**P**	**P-728.5**	607679.9449	7254796.216	159	150.13	8.87	148.996	9.504
731.5	**TERTIARY**	T	**T-731.5**	607682.9065	7254796.695	159	150.08	8.92	148.881	9.619
733.0	**QUATERNARY**	Q	**Q-733**	607684.3874	7254796.934					
734.5	**SECONDARY**	S	**S-734.5**	607685.8682	7254797.173	159	150.21	8.79	149.022	9.478
736.0	**QUATERNARY**	Q	**Q-736**	607687.349	7254797.412					
737.5	**TERTIARY**	T	**T-737.5**	607688.8299	7254797.651	159	150.18	8.82	149.003	9.497
739.0	**QUATERNARY**	Q	**Q-739**	607690.3108	7254797.89					
740.5	**PRIMARY**	**P**	**P-740.5**	607691.7915	7254798.129	159	150.41	8.59	149.113	9.387
743.5	**TERTIARY**	T	**T-743.5**	607694.7532	7254798.607	159	150.73	8.27	147.97	10.53
746.5	**SECONDARY**	S	**S-746.5**	607697.7149	7254799.085	159	150.65	8.35	148.295	10.205
749.5	**TERTIARY**	T	**T-749.5**	607700.6765	7254799.563	159	150.6	8.4	148.428	10.072

STA	HOLE GENERATION	P T S Q	# OF THE HOLE	EASTING	NORTHING	CURRENT PLATFORM EL (masl)	BOTTOM CASING EL (m)	TOTAL LENGTH OF CASING FROM THE PLATFORM (m)	DEPTH OF ROCK SOCKET (m)	MAXIMUM LENGHT OF THE CASING FROM THE PLATFORM (m)	SURVEYED HOLE (EASTING)	SURVEYED HOLE (NORTHING)
175	PRIMARY	P	P-175	607151.0471	7254649.036	159	152.01	6.99	150.689	7.811		
176.5	QUATERNARY	Q	Q-176,5	607152.4157	7254649.65	159	151.97	7.03	150.978	7.522		
178	TERTIARY	T	T-178	607153.7844	7254650.264	159	151.95	7.05	150.908	7.592		
179.5	QUATERNARY	Q	Q-179,5	607155.1531	7254650.877	159	151.62	7.38	150.634	7.866		
181	SECONDARY	S	S-181	607156.7264	7254651.035	159	151.6	7.4	150.519	7.981		
182.5	QUATERNARY	Q	Q-182,5	607158.0951	7254651.649	159	151.54	7.46	150.352	8.148		
184	TERTIARY	T	T-184	607159.4638	7254652.262	159	151.61	7.39	150.657	7.843		
185.5	QUATERNARY	Q	Q-185,5	607160.8325	7254652.876	159	151.6	7.4	150.338	8.162		
187	PRIMARY	P	P-187	607162.2012	7254653.49	159	151.62	7.38	150.235	8.265		
188.5	QUATERNARY	Q	Q-188,5	607163.5699	7254654.104	159	151.5	7.5	150.501	7.999		
190	TERTIARY	T	T-190					0				
191.5	QUATERNARY	Q	Q-191,5	607166.3072	7254655.331	159	150.63	8.37	148.487	10.013		
193	SECONDARY	S	S-193	607167.6759	7254655.945	159	150.44	8.56	149.535	8.965		
194.5	QUATERNARY	Q	Q-194,5	607169.0446	7254656.559	159	149.98	9.02	148.636	9.864		
196	TERTIARY	T	T-196	607170.4133	7254657.172	159	149.81	9.19	148.588	9.912		
197.5	QUATERNARY	Q	Q-197,5	607171.782	7254657.786	159	149.65	9.35	148.672	9.828		
199	PRIMARY	P	P-199	607173.1507	7254658.4	159	149.61	9.39	148.529	9.971		
200.5	QUATERNARY	Q	Q-200,5	607174.5194	7254659.014	159	149.58	9.42	148.489	10.011		
202	TERTIARY	T	T-202	607175.8881	7254659.627	159	149.41	9.59	148.148	10.352		
203.5	QUATERNARY	Q	Q-203,5	607177.2568	7254660.241	159	149.36	9.64	148.377	10.123		
205	SECONDARY	S	S-205	607178.6255	7254660.855	159	149.23	9.77	148.095	10.405		
206.5	QUATERNARY	Q	Q-206,5	607179.9941	7254661.468	159	149.27	9.73	148.007	10.493		
208	TERTIARY	T	T-208	607181.3628	7254662.082	159	149.4	9.6	148.017	10.483		
209.5	QUATERNARY	Q	Q-209,5	607182.7315	7254662.696	159	149.63	9.37	148.479	10.021		
211	PRIMARY	P	P-211	607184.1002	7254663.31	159	149.59	9.41	147.928	10.572		
212.5	QUATERNARY	Q	Q-212,5	607185.4689	7254663.923	159	149.53	9.47	148.409	10.091		
214	TERTIARY	T	T-214	607186.8376	7254664.537	159	149.49	9.51	148.514	9.986		
215.5	QUATERNARY	Q	Q-215,5	607188.2063	7254665.151	159	149.53	9.47	148.412	10.088		
217	SECONDARY	S	S-217	607189.575	7254665.765	159	149.65	9.35	148.331	10.169		
218.5	QUATERNARY	Q	Q-218,5	607190.9437	7254666.378	159	149.27	9.73	147.561	10.939		
220	TERTIARY	T	T-220	607192.3124	7254666.992	159	149.59	9.41	148.349	10.151		
221.5	QUATERNARY	Q	Q-221,5	607193.6811	7254667.606	159	149.27	9.73	147.964	10.536		
223	PRIMARY	P	P-223	607195.0498	7254668.22	159	149.73	9.27	148.362	10.138		
224.5	QUATERNARY	Q	Q-224,5	607196.4184	7254668.833	159	150.12	8.88	148.627	9.873		
226	TERTIARY	T	T-226	607197.7871	7254669.447	159	150.3	8.7	148.991	9.509		
227.5	QUATERNARY	Q	Q-227,5	607199.1558	7254670.061	159	150.13	8.87	149.007	9.493		
229	SECONDARY	S	S-229	607200.5245	7254670.675	159	150.04	8.96	148.852	9.648		
230.5	QUATERNARY	Q	Q-230,5	607201.8932	7254671.288	159	150.02	8.98	148.953	9.547		
232	TERTIARY	T	T-232	607203.2619	7254671.902	159	149.99	9.01	148.741	9.759		
233.5	QUATERNARY	Q	Q-233,5	607204.6306	7254672.516	159	150.22	8.78	149.107	9.393		
235	PRIMARY	P	P-235	607205.9993	7254673.13	159	150.34	8.66	149.192	9.308		
236.5	QUATERNARY	Q	Q-236,5	607207.368	7254673.743	159	150.58	8.42	149.444	9.056		
238	TERTIARY	T	T-238	607208.7367	7254674.357	159	150.6	8.4	149.426	9.074		
239.5	QUATERNARY	Q	Q-239,5	607210.1054	7254674.971	159	150.59	8.41	149.415	9.085		
241	SECONDARY	S	S-241	607211.474	7254675.585	159	150.81	8.19	149.658	8.842		
242.5	QUATERNARY	Q	Q-242,5	607212.8427	7254676.198	159	150.84	8.16	149.56	8.94		
244	TERTIARY	T	T-244	607214.2114	7254676.812	159	150.67	8.33	149.552	8.948		

245.5	QUATERNARY	Q	Q-245,5	607215.5801	7254677.426	159	150.48	8.52	149.462	9.038
247	PRIMARY	P	P-247	607216.9488	7254678.04	159	150.54	8.46	149.102	9.398
248.5	QUATERNARY	Q	Q-248,5	607218.3175	7254678.653	159	150.25	8.75	148.696	9.804
250	TERTIARY	T	T-250	607219.6862	7254679.267	159	150.2	8.8	149.074	9.426
251.5	QUATERNARY	Q	Q-251,5	607221.0549	7254679.881	159	150.41	8.59	149.241	9.259
253	SECONDARY	S	S-253	607222.4236	7254680.495	159	150.54	8.46	149.247	9.253
254.5	QUATERNARY	Q	Q-254,5	607223.871	7254680.932	159	150.62	8.38	149.47	9.03
256	TERTIARY	T	T-256	607225.2398	7254681.546	159	150.61	8.39	149.408	9.092
257.5	QUATERNARY	Q	Q-257,5	607226.5296	7254682.336	159	150.51	8.49	149.305	9.195
259	PRIMARY	P	P-259	607227.8983	7254682.95	159	150.48	8.52	148.959	9.541
260.5	QUATERNARY	Q	Q-260,5	607229.5325	7254683.69	159	150.41	8.59	148.85	9.65
262	TERTIARY	T	T-262	607230.6357	7254684.177	159	150.32	8.68	148.848	9.652
263.5	QUATERNARY	Q	Q-263,5	607232.0044	7254684.791	159	150.46	8.54	149.333	9.167
265	SECONDARY	S	S-265	607233.3731	7254685.405	159	150.43	8.57	149.319	9.181
266.5	QUATERNARY	Q	Q-266,5	607234.7418	7254686.018	159	150.43	8.57	148.645	9.855
268	TERTIARY	T	T-268	607236.1105	7254686.632	159	150.52	8.48	149.215	9.285
269.5	QUATERNARY	Q	Q-269,5	607237.4792	7254687.246	159	150.71	8.29	148.523	9.977
271	PRIMARY	P	P-271	607238.8479	7254687.86	159	151.08	7.92	149.877	8.623
272.5	QUATERNARY	Q	Q-272,5	607240.2166	7254688.473	159	151.12	7.88	149.978	8.522
274	TERTIARY	T	T-274	607241.5853	7254689.087	159	150.72	8.28	149.429	9.071
275.5	QUATERNARY	Q	Q-275,5	607242.9539	7254689.701	159	150.72	8.28	149.359	9.141
277	SECONDARY	S	S-277	607244.3226	7254690.315	159	150.65	8.35	149.4	9.1
278.5	QUATERNARY	Q	Q-278,5	607245.6913	7254690.928	159	150.61	8.39	149.141	9.359
280	TERTIARY	T	T-280	607247.06	7254691.542	159	150.65	8.35	149.514	8.986
281.5	QUATERNARY	Q	Q-281,5	607248.4287	7254692.156	159	150.47	8.53	149.287	9.213
283	PRIMARY	P	P-283	607249.7974	7254692.77	159	150.63	8.37	149.424	9.076
284.5	QUATERNARY	Q	Q-284,5	607251.1661	7254693.383	159	150.94	8.06	149.688	8.812
286	TERTIARY	T	T-286	607252.5348	7254693.997	159	151.1	7.9	150.082	8.418
287.5	QUATERNARY	Q	Q-287,5	607253.9035	7254694.611	159	150.98	8.02	149.787	8.713
289	SECONDARY	S	S-289	607255.2722	7254695.225	159	150.96	8.04	149.812	8.688
290.5	QUATERNARY	Q	Q-290,5	607256.6409	7254695.838	159	150.9	8.1	149.179	9.321
292	TERTIARY	T	T-292	607258.0095	7254696.452	159	150.88	8.12	148.841	9.659
293.5	QUATERNARY	Q	Q-293,5	607259.3782	7254697.066	159	150.82	8.18	149.513	8.987
295	PRIMARY	P	P-295	607260.7469	7254697.68	159	150.88	8.12	149.257	9.243
296.5	QUATERNARY	Q	Q-296,5	607262.1156	7254698.293	159	151.06	7.94	150.062	8.438
298	TERTIARY	T	T-298	607263.4843	7254698.907	159	151.07	7.93	149.858	8.642
299.5	QUATERNARY	Q	Q-299,5	607264.853	7254699.521	159	151.16	7.84	150.238	8.262
301	SECONDARY	S	S-301	607266.2217	7254700.135	159	151.07	7.93	149.856	8.644
302.5	QUATERNARY	Q	Q-302,5	607267.5904	7254700.748	159	150.91	8.09	149.877	8.623
304	TERTIARY	T	T-304	607268.9591	7254701.362	159	150.91	8.09	149.921	8.579
305.5	QUATERNARY	Q	Q-305,5	607270.3278	7254701.976	159	151	8	149.928	8.572
307	PRIMARY	P	P-307	607271.6965	7254702.589	159	151.42	7.58	150.269	8.231
308.5	QUATERNARY	Q	Q-308,5	607273.0651	7254703.203	159	151.68	7.32	150.511	7.989
310	TERTIARY	T	T-310	607274.4338	7254703.817	159	151.74	7.26	150.714	7.786
311.5	QUATERNARY	Q	Q-311,5	607275.8025	7254704.431	159	151.33	7.67	150.359	8.141
313	SECONDARY	S	S-313	607277.1712	7254705.044	159	151.01	7.99	149.773	8.727
314.5	QUATERNARY	Q	Q-314,5	607278.5399	7254705.658	159	150.75	8.25	149.258	9.242
316	TERTIARY	T	T-316	607279.9086	7254706.272	159	150.5	8.5	149.372	9.128
317.5	QUATERNARY	Q	Q-317,5	607281.2773	7254706.886	159	150.03	8.97	148.933	9.567
319	PRIMARY	P	P-319	607282.646	7254707.499	159	149.78	9.22	148.387	10.113

320.5	QUATERNARY	Q	Q-320,5	607284.0147	7254708.113	159	149.57	9.43	148.145	10.355
322	TERTIARY	T	T-322	607285.3834	7254708.727	159	149.3	9.7	147.614	10.886
323.5	QUATERNARY	Q	Q-323,5	607286.7521	7254709.341	159	149.07	9.93	147.893	10.607
325	SECONDARY	S	S-325	607288.1208	7254709.954	159	148.69	10.31	147.505	10.995
326.5	QUATERNARY	Q	Q-326,5	607289.4894	7254710.568	159	148.63	10.37	147.118	11.382
328	TERTIARY	T	T-328	607290.8581	7254711.182	159	148.55	10.45	147.369	11.131
329.5	QUATERNARY	Q	Q-329,5	607292.2268	7254711.796	159	148.16	10.84	146.873	11.627
331	PRIMARY	P	P-331	607293.5955	7254712.409	159	148.03	10.97	146.811	11.689
332.5	QUATERNARY	Q	Q-332,5	607294.9642	7254713.023	159	147.71	11.29	146.672	11.828
334	TERTIARY	T	T-334	607296.3329	7254713.637	159	147.03	11.97	145.918	12.582
335.5	QUATERNARY	Q	Q-335,5	607297.7016	7254714.251	159	147.64	11.36	145.765	12.735
337	SECONDARY	S	S-337	607299.0703	7254714.864	159	147.62	11.38	143.139	15.361
338.5	QUATERNARY	Q	Q-338,5	607300.439	7254715.478	159	146.94	12.06	145.822	12.678
340	TERTIARY	T	T-340	607301.8077	7254716.092	159	146.76	12.24	144.143	14.357
341.5	QUATERNARY	Q	Q-341,5	607303.1764	7254716.706	159	146.92	12.08	145.826	12.674
343	PRIMARY	P	P-343	607304.545	7254717.319	159	147	12	145.314	13.186
344.5	QUATERNARY	Q	Q-344,5	607305.9137	7254717.933	159	146.74	12.26	145.61	12.89
346	TERTIARY	T	T-346	607307.2824	7254718.547	159	146.64	12.36	144.045	14.455
347.5	QUATERNARY	Q	Q-347,5	607308.6511	7254719.161	159	146.48	12.52	145.359	13.141
349	SECONDARY	S	S-349	607310.0198	7254719.774	159	146.48	12.52	143.841	14.659
350.5	QUATERNARY	Q	Q-350,5	607311.3885	7254720.388	159	146.43	12.57	145.353	13.147
352	TERTIARY	T	T-352	607312.7572	7254721.002	159	146.33	12.67	145.237	13.263
353.5	QUATERNARY	Q	Q-353,5	607314.3634	7254721.083	159	146.29	12.71	145.088	13.412
355	PRIMARY	P	P-355	607315.7428	7254721.698	159	146.97	12.03	142.939	15.561
356.5	QUATERNARY	Q	Q-356,5	607316.8633	7254722.843	159	145.52	13.48	144.387	14.113
358	TERTIARY	T	T-358	607318.4397	7254722.977	159	144.65	14.35	142.164	16.336
359.5	QUATERNARY	Q	Q-359,5	607319.6006	7254724.071	159	144.14	14.86	141.591	16.909
361	SECONDARY	S	S-361	607320.9693	7254724.684	159	143.94	15.06	142.325	16.175
362.5	QUATERNARY	Q	Q-362,5	607322.338	7254725.298	159	143.68	15.32	142.531	15.969
364	TERTIARY	T	T-364	607323.7067	7254725.912	159	143.65	15.35	141.243	17.257
365.5	QUATERNARY	Q	Q-365,5	607325.0754	7254726.526	159	143.65	15.35	141.007	17.493
367	PRIMARY	P	P-367	607326.4441	7254727.139	159	144.03	14.97	140.59	17.91
368.5	QUATERNARY	Q	Q-368,5	607327.8128	7254727.753	159	144.21	14.79	139.415	19.085
370	TERTIARY	T	T-370	607329.1815	7254728.367	159	145.09	13.91	139.698	18.802
371.5	QUATERNARY	Q	Q-371,5	607330.5502	7254728.981	159	145.67	13.33	144.559	13.941
373	SECONDARY	S	S-373	607331.9189	7254729.594	159	147.4	11.6	146.253	12.247
374.5	QUATERNARY	Q	Q-374,5	607333.2876	7254730.208	159	147.75	11.25	146.659	11.841
376	TERTIARY	T	T-376	607334.6563	7254730.822	159	147.87	11.13	145.706	12.794
377.5	QUATERNARY	Q	Q-377,5	607336.0249	7254731.436	159	148.07	10.93	146.611	11.889
379	PRIMARY	P	P-379	607337.3936	7254732.049	159	148.15	10.85	147.194	11.306
380.5	QUATERNARY	Q	Q-380,5	607338.7635	7254732.66	159	148.31	10.69	147.154	11.346
382	TERTIARY	T	T-382	607340.1379	7254733.261	159	147.96	11.04	146.117	12.383
383.5	QUATERNARY	Q	Q-383,5	607341.5168	7254733.852	159	147.39	11.61	146.087	12.413
385	SECONDARY	S	S-385	607342.9	7254734.432	159	147.04	11.96	145.018	13.482
386.5	QUATERNARY	Q	Q-386,5	607344.2876	7254735.002	159	147.13	11.87	145.213	13.287
388	TERTIARY	T	T-388	607345.6795	7254735.561	159	147.32	11.68	145.054	13.446
389.5	QUATERNARY	Q	Q-389,5	607347.0756	7254736.109	159	148.26	10.74	147.044	11.456
391	PRIMARY	P	P-391	607348.4757	7254736.648	159	148.1	10.9	146.256	12.244
392.5	QUATERNARY	Q	Q-392,5	607349.8799	7254737.175	159	147.91	11.09	146.409	12.091
394	TERTIARY	T	T-394	607351.288	7254737.692	159	147.64	11.36	146.447	12.053

395.5	QUATERNARY	Q	Q-395,5	607352.6999	7254738.198	159	147.5	11.5	146.154	12.346
397	SECONDARY	S	S-397	607354.1157	7254738.694	159	147.5	11.5	145.945	12.555
398.5	QUATERNARY	Q	Q-398,5	607355.5351	7254739.179	159	147.68	11.32	146.402	12.098
400	TERTIARY	T	T-400	607356.9582	7254739.653	159	148.23	10.77	147.079	11.421
401.5	QUATERNARY	Q	Q-401,5	607358.3848	7254740.117	159	147.94	11.06	146.261	12.239
403	PRIMARY	P	P-403	607359.8149	7254740.569	159	147.35	11.65	145.832	12.668
404.5	QUATERNARY	Q	Q-404,5	607361.2483	7254741.011	159	146.52	12.48	145.007	13.493
406	TERTIARY	T	T-406	607362.685	7254741.442	159	146.58	12.42	145.322	13.178
407.5	QUATERNARY	Q	Q-407,5	607364.125	7254741.862	159	146.88	12.12	144.629	13.871
409	SECONDARY	S	S-409	607365.568	7254742.272	159	147.43	11.57	146.107	12.393
410.5	QUATERNARY	Q	Q-410,5	607367.0141	7254742.67	159	148.25	10.75	147.339	11.161
412	TERTIARY	T	T-412	607368.4632	7254743.058	159	148.36	10.64	146.48	12.02
413.5	QUATERNARY	Q	Q-413,5	607369.9152	7254743.434	159	148.25	10.75	146.997	11.503
415	PRIMARY	P	P-415	607371.3699	7254743.8	159	148.17	10.83	147.01	11.49
416.5	QUATERNARY	Q	Q-416,5	607372.8274	7254744.154	159	148.19	10.81	146.815	11.685
418	TERTIARY	T	T-418	607374.2875	7254744.498	159	148.34	10.66	147.355	11.145
419.5	QUATERNARY	Q	Q-419,5	607375.7502	7254744.831	159	148.38	10.62	147.082	11.418
421	SECONDARY	S	S-421	607377.2153	7254745.152	159	148.39	10.61	147.339	11.161
422.5	QUATERNARY	Q	Q-422,5	607378.6828	7254745.463	159	148.65	10.35	147.218	11.282
424	TERTIARY	T	T-424	607380.1527	7254745.762	159	148.44	10.56	147.301	11.199
425.5	QUATERNARY	Q	Q-425,5	607381.6247	7254746.05	159	148.41	10.59	147.336	11.164
427	PRIMARY	P	P-427	607383.0989	7254746.327	159	148.62	10.38	147.399	11.101
428.5	QUATERNARY	Q	Q-428,5	607384.5751	7254746.593	159	148.71	10.29	147.268	11.232
430	TERTIARY	T	T-430	607386.0533	7254746.848	159	148.66	10.34	147.492	11.008
431.5	QUATERNARY	Q	Q-431,5	607387.5333	7254747.092	159	148.84	10.16	147.754	10.746
433	SECONDARY	S	S-433	607389.0142	7254747.331	159	148.91	10.09	147.669	10.831
434.5	QUATERNARY	Q	Q-434,5	607390.5955	7254746.908	159	148.95	10.05	147.79	10.71
436	TERTIARY	T	T-436	607391.9758	7254747.809	159	148.85	10.15	147.709	10.791
437.5	QUATERNARY	Q	Q-437,5	607393.4566	7254748.048	159	148.91	10.09	147.749	10.751
439	PRIMARY	P	P-439	607394.9284	7254748.138	159	149.01	9.99	147.601	10.899
440.5	QUATERNARY	Q	Q-440,5	607396.4183	7254748.526	159	149.05	9.95	147.909	10.591
442	TERTIARY	T	T-442	607397.8991	7254748.765	159	148.96	10.04	147.856	10.644
443.5	QUATERNARY	Q	Q-443,5	607399.38	7254749.004	159	148.93	10.07	146.899	11.601
445	SECONDARY	S	S-445	607400.8608	7254749.243	159	148.98	10.02	147.59	10.91
446.5	QUATERNARY	Q	Q-446,5	607402.3416	7254749.482	159	149.06	9.94	147.988	10.512
448	TERTIARY	T	T-448	607403.8225	7254749.721	159	148.99	10.01	147.874	10.626
449.5	QUATERNARY	Q	Q-449,5	607405.3033	7254749.96	159	148.98	10.02	147.773	10.727
451	PRIMARY	P	P-451	607406.7841	7254750.2	159	148.96	10.04	146.677	11.823
452.5	QUATERNARY	Q	Q-452,5	607408.265	7254750.439	159	148.97	10.03	147.633	10.867
454	TERTIARY	T	T-454	607409.7458	7254750.678	159	149.03	9.97	147.865	10.635
455.5	QUATERNARY	Q	Q-455,5	607411.2266	7254750.917	159	149	10	147.732	10.768
457	SECONDARY	S	S-457	607412.7075	7254751.156	159	149	10	147.603	10.897
458.5	QUATERNARY	Q	Q-458,5	607414.1883	7254751.395	159	149.07	9.93	147.758	10.742
460	TERTIARY	T	T-460	607415.6691	7254751.634	159	149.03	9.97	147.97	10.53
461.5	QUATERNARY	Q	Q-461,5	607417.15	7254751.873	159	149.04	9.96	147.857	10.643
463	PRIMARY	P	P-463	607418.6308	7254752.112	159	149.2	9.8	147.938	10.562
464.5	QUATERNARY	Q	Q-464,5	607420.1116	7254752.351	159	149.28	9.72	147.829	10.671
466	TERTIARY	T	T-466	607421.5925	7254752.59	159	149.43	9.57	148.294	10.206
467.5	QUATERNARY	Q	Q-467,5	607423.0733	7254752.829	159	149.46	9.54	148.322	10.178
469	SECONDARY	S	S-469	607424.5541	7254753.068	159	149.51	9.49	148.096	10.404

470.5	QUATERNARY	Q	Q-470,5	607426.035	7254753.307	159	149.54	9.46	148.396	10.104
472	TERTIARY	T	T-472	607427.5158	7254753.546	159	149.57	9.43	148.575	9.925
473.5	QUATERNARY	Q	Q-473,5	607428.9966	7254753.785	159	149.68	9.32	148.3	10.2
475	PRIMARY	P	P-475	607430.4775	7254754.024	159	149.61	9.39	148.45	10.05
476.5	QUATERNARY	Q	Q-476,5	607431.9583	7254754.263	159	149.59	9.41	148.217	10.283
478	TERTIARY	T	T-478	607433.4391	7254754.502	159	149.53	9.47	148.13	10.37
479.5	QUATERNARY	Q	Q-479,5	607434.92	7254754.741	159	149.54	9.46	148.356	10.144
481	SECONDARY	S	S-481	607436.4008	7254754.98	159	149.7	9.3	148.188	10.312
482.5	QUATERNARY	Q	Q-482,5	607437.8816	7254755.219	159	149.62	9.38	148.353	10.147
484	TERTIARY	T	T-484	607439.3625	7254755.458	159	149.62	9.38	148.227	10.273
485.5	QUATERNARY	Q	Q-485,5	607440.8433	7254755.697	159	149.67	9.33	148.416	10.084
487	PRIMARY	P	P-487	607442.3241	7254755.936	159	149.62	9.38	148.196	10.304
488.5	QUATERNARY	Q	Q-488,5	607443.805	7254756.175	159	149.6	9.4	148.321	10.179
490	TERTIARY	T	T-490	607445.2858	7254756.414	159	149.59	9.41	148.043	10.457
491.5	QUATERNARY	Q	Q-491,5	607446.7666	7254756.653	159	149.59	9.41	148.463	10.037
493	SECONDARY	S	S-493	607448.2475	7254756.892	159	149.64	9.36	148.131	10.369
494.5	QUATERNARY	Q	Q-494,5	607449.7283	7254757.131	159	149.66	9.34	148.52	9.98
496	TERTIARY	T	T-496	607451.2091	7254757.37	159	149.66	9.34	148.184	10.316
497.5	QUATERNARY	Q	Q-497,5	607452.6899	7254757.609	159	149.58	9.42	147.519	10.981
499	PRIMARY	P	P-499	607454.1708	7254757.848	159	149.55	9.45	148.168	10.332
500.5	QUATERNARY	Q	Q-500,5	607455.6516	7254758.087	159	149.5	9.5	148.067	10.433
502	TERTIARY	T	T-502	607457.1324	7254758.327	159	149.53	9.47	147.544	10.956
503.5	QUATERNARY	Q	Q-503,5	607458.6133	7254758.566	159	149.65	9.35	148.172	10.328
505	SECONDARY	S	S-505	607460.0941	7254758.805	159	149.66	9.34	147.48	11.02
506.5	QUATERNARY	Q	Q-506,5	607461.5749	7254759.044	159	149.66	9.34	147.604	10.896
508	TERTIARY	T	T-508	607463.0558	7254759.283	159	149.7	9.3	147.581	10.919
509.5	QUATERNARY	Q	Q-509,5	607464.5366	7254759.522	159	149.65	9.35	147.713	10.787
511	PRIMARY	P	P-511	607466.0174	7254759.761	159	149.62	9.38	147.549	10.951
512.5	QUATERNARY	Q	Q-512,5	607467.4983	7254760	159	149.65	9.35	147.6	10.9
514	TERTIARY	T	T-514	607468.9791	7254760.239	159	149.64	9.36	147.369	11.131
515.5	QUATERNARY	Q	Q-515,5	607470.4599	7254760.478	159	149.65	9.35	147.532	10.968
517	SECONDARY	S	S-517	607471.732	7254761.19	159	149.71	9.29	147.531	10.969
518.5	QUATERNARY	Q	Q-518,5	607473.2128	7254761.429	159	149.55	9.45	147.201	11.299
520	TERTIARY	T	T-520	607474.6937	7254761.668	159	149.52	9.48	147.52	10.98
521.5	QUATERNARY	Q	Q-521,5	607476.1745	7254761.907	159	149.56	9.44	147.487	11.013
523	PRIMARY	P	P-523	607477.6553	7254762.146	159	149.59	9.41	148.216	10.284
524.5	QUATERNARY	Q	Q-524,5	607479.1362	7254762.385	159	149.53	9.47	147.521	10.979
526	TERTIARY	T	T-526	607480.617	7254762.624	159	149.52	9.48	148.48	10.02
527.5	QUATERNARY	Q	Q-527,5	607482.0978	7254762.863	159	149.55	9.45	147.272	11.228
529	SECONDARY	S	S-529	607483.5787	7254763.102	159	149.52	9.48	148.354	10.146
530.5	QUATERNARY	Q	Q-530,5	607485.0595	7254763.341	159	149.53	9.47	147.557	10.943
532	TERTIARY	T	T-532	607486.5403	7254763.58	159	149.57	9.43	148.529	9.971
533.5	QUATERNARY	Q	Q-533,5	607488.0212	7254763.819	159	149.59	9.41	147.585	10.915
535	PRIMARY	P	P-535	607489.502	7254764.058	159	149.59	9.41	148.497	10.003
536.5	QUATERNARY	Q	Q-536,5	607490.9828	7254764.297	159	149.53	9.47	148.243	10.257
538	TERTIARY	T	T-538	607492.4637	7254764.536	159	149.43	9.57	148.259	10.241
539.5	QUATERNARY	Q	Q-539,5	607493.9445	7254764.775	159	149.39	9.61	148.354	10.146
541	SECONDARY	S	S-541	607495.4253	7254765.014	159	149.37	9.63	147.97	10.53
542.5	QUATERNARY	Q	Q-542,5	607496.9062	7254765.253	159	149.43	9.57	147.108	11.392
544	TERTIARY	T	T-544	607498.387	7254765.492	159	149.5	9.5	148.276	10.224

545.5	QUATERNARY	Q	Q-545,5	607499.8678	7254765.731	159	149.54	9.46	147.424	11.076
547	PRIMARY	P	P-547	607501.3487	7254765.97	159	149.45	9.55	148.256	10.244
548.5	QUATERNARY	Q	Q-548,5	607502.8295	7254766.209	159	149.42	9.58	147.17	11.33
550	TERTIARY	T	T-550	607504.3103	7254766.448	159	149.47	9.53	148.192	10.308
551.5	QUATERNARY	Q	Q-551,5	607505.7912	7254766.687	159	149.52	9.48	147.309	11.191
553	SECONDARY	S	S-553	607507.272	7254766.926	159	149.47	9.53	148.177	10.323
554.5	QUATERNARY	Q	Q-554,5	607508.7528	7254767.165	159	149.44	9.56	147.14	11.36
556	TERTIARY	T	T-556	607510.2337	7254767.404	159	149.38	9.62	147.943	10.557
557.5	QUATERNARY	Q	Q-557,5	607511.7145	7254767.643	159	149.38	9.62	147.233	11.267
559	PRIMARY	P	P-559	607513.1953	7254767.882	159	149.4	9.6	148.367	10.133
560.5	QUATERNARY	Q	Q-560,5	607514.6762	7254768.121	159	149.64	9.36	147.352	11.148
562	TERTIARY	T	T-562	607516.157	7254768.36	159	149.67	9.33	148.22	10.28
563.5	QUATERNARY	Q	Q-563,5	607517.6378	7254768.599	159	149.64	9.36	147.368	11.132
565	SECONDARY	S	S-565	607519.1187	7254768.839	159	149.6	9.4	148.102	10.398
566.5	QUATERNARY	Q	Q-566,5	607520.5995	7254769.078	159	149.53	9.47	147.365	11.135
568	TERTIARY	T	T-568	607522.0803	7254769.317	159	149.41	9.59	148.05	10.45
569.5	QUATERNARY	Q	Q-569,5	607523.5612	7254769.556	159	149.32	9.68	147.146	11.354
571	PRIMARY	P	P-571	607525.042	7254769.795	159	149.3	9.7	148.071	10.429
572.5	QUATERNARY	Q	Q-572,5	607526.5228	7254770.034	159	149.38	9.62	147.207	11.293
574	TERTIARY	T	T-574	607528.0036	7254770.273	159	149.25	9.75	147.975	10.525
575.5	QUATERNARY	Q	Q-575,5	607529.4845	7254770.512	159	149.05	9.95	146.838	11.662
577	SECONDARY	S	S-577	607530.9653	7254770.751	159	148.82	10.18	147.444	11.056
578.5	QUATERNARY	Q	Q-578,5	607532.4461	7254770.99	159	148.83	10.17	147.517	10.983
580	TERTIARY	T	T-580	607533.927	7254771.229	159	148.9	10.1	147.21	11.29
581.5	QUATERNARY	Q	Q-581,5	607535.4078	7254771.468	159	148.86	10.14	147.626	10.874
583	PRIMARY	P	P-583	607536.8886	7254771.707	159	148.83	10.17	147.559	10.941
584.5	QUATERNARY	Q	Q-584,5	607538.3695	7254771.946	159	148.82	10.18	147.663	10.837
586	TERTIARY	T	T-586	607539.8503	7254772.185	159	148.75	10.25	147.078	11.422
587.5	QUATERNARY	Q	Q-587,5	607541.3311	7254772.424	159	148.71	10.29	146.924	11.576
589	SECONDARY	S	S-589	607542.812	7254772.663	159	148.71	10.29	147.501	10.999
590.5	QUATERNARY	Q	Q-590,5	607544.2928	7254772.902	159	148.7	10.3	147.347	11.153
592	TERTIARY	T	T-592	607545.7736	7254773.141	159	148.54	10.46	146.929	11.571
593.5	QUATERNARY	Q	Q-593,5	607547.2545	7254773.38	159	148.45	10.55	146.932	11.568
595	PRIMARY	P	P-595	607548.7353	7254773.619	159	148.16	10.84	147.105	11.395
596.5	QUATERNARY	Q	Q-596,5	607550.2161	7254773.858	159	148.14	10.86	146.342	12.158
598	TERTIARY	T	T-598	607551.697	7254774.097	159	148.16	10.84	146.668	11.832
599.5	QUATERNARY	Q	Q-599,5	607553.1778	7254774.336	159	148.12	10.88	146.466	12.034
601	SECONDARY	S	S-601	607554.6586	7254774.575	159	147.73	11.27	145.941	12.559
602.5	QUATERNARY	Q	Q-602,5	607556.1395	7254774.814	159	147.36	11.64	146.113	12.387
604	TERTIARY	T	T-604	607557.6203	7254775.053	159	147.08	11.92	145.853	12.647
605.5	QUATERNARY	Q	Q-605,5	607559.1011	7254775.292	159	146.95	12.05	145.544	12.956
607	PRIMARY	P	P-607	607560.582	7254775.531	159	146.9	12.1	145.699	12.801
608.5	QUATERNARY	Q	Q-608,5	607562.0628	7254775.77	159	146.97	12.03	145.675	12.825
610	TERTIARY	T	T-610	607563.5436	7254776.009	159	147.17	11.83	145.606	12.894
611.5	QUATERNARY	Q	Q-611,5	607565.0245	7254776.248	159	147.23	11.77	145.756	12.744
613	SECONDARY	S	S-613	607566.5053	7254776.487	159	147.66	11.34	146.683	11.817
614.5	QUATERNARY	Q	Q-614,5	607567.9861	7254776.726	159	147.82	11.18	146.579	11.921
616	TERTIARY	T	T-616	607569.467	7254776.966	159	147.96	11.04	146.954	11.546
617.5	QUATERNARY	Q	Q-617,5	607570.9478	7254777.205	159	147.97	11.03	146.788	11.712
619	PRIMARY	P	P-619	607572.4286	7254777.444	159	147.89	11.11	146.844	11.656

620.5	QUATERNARY	Q	Q-620,5	607573.9095	7254777.683	159	147.82	11.18	146.649	11.851
622	TERTIARY	T	T-622	607575.3903	7254777.922	159	147.55	11.45	146.386	12.114
623.5	QUATERNARY	Q	Q-623,5	607576.8711	7254778.161	159	147.51	11.49	146.297	12.203
625	SECONDARY	S	S-625	607578.352	7254778.4	159	147.48	11.52	146.215	12.285
626.5	QUATERNARY	Q	Q-626,5	607579.8328	7254778.639	159	147.5	11.5	145.957	12.543
628	TERTIARY	T	T-628	607581.3136	7254778.878	159	147.49	11.51	146.47	12.03
629.5	QUATERNARY	Q	Q-629,5	607582.7945	7254779.117	159	147.58	11.42	146.299	12.201
631	PRIMARY	P	P-631	607584.2753	7254779.356	159	147.63	11.37	146.383	12.117
632.5	QUATERNARY	Q	Q-632,5	607585.7561	7254779.595	159	147.53	11.47	146.163	12.337
634	TERTIARY	T	T-634	607587.2369	7254779.834	159	147.59	11.41	146.242	12.258
635.5	QUATERNARY	Q	Q-635,5	607588.7178	7254780.073	159	147.69	11.31	146.501	11.999
637	SECONDARY	S	S-637	607590.1986	7254780.312	159	147.8	11.2	146.754	11.746
638.5	QUATERNARY	Q	Q-638,5	607591.6794	7254780.551	159	148.1	10.9	147.086	11.414
640	TERTIARY	T	T-640	607593.1603	7254780.79	159	148.25	10.75	147.176	11.324
641.5	QUATERNARY	Q	Q-641,5	607594.6411	7254781.029	159	148.21	10.79	147.201	11.299
643	PRIMARY	P	P-643	607596.1219	7254781.268	159	148.18	10.82	146.983	11.517
644.5	QUATERNARY	Q	Q-644,5	607597.6028	7254781.507	159	148.05	10.95	146.953	11.547
646	TERTIARY	T	T-646	607599.0836	7254781.746	159	147.98	11.02	146.704	11.796
647.5	QUATERNARY	Q	Q-647,5	607600.5644	7254781.985	159	147.89	11.11	146.772	11.728
649	SECONDARY	S	S-649	607602.0453	7254782.224	159	147.85	11.15	146.664	11.836
650.5	QUATERNARY	Q	Q-650,5	607603.5261	7254782.463	159	147.84	11.16	146.547	11.953
652	TERTIARY	T	T-652	607605.0069	7254782.702	159	147.78	11.22	146.489	12.011
653.5	QUATERNARY	Q	Q-653,5	607606.4878	7254782.941	159	147.68	11.32	146.73	11.77
655	PRIMARY	P	P-655	607607.9686	7254783.18	159	147.59	11.41	146.221	12.279
656.5	QUATERNARY	Q	Q-656,5	607609.4494	7254783.419	159	147.72	11.28	146.685	11.815
658	TERTIARY	T	T-658	607610.9303	7254783.658	159	148.19	10.81	147.023	11.477
659.5	QUATERNARY	Q	Q-659,5	607612.4111	7254783.897	159	148.13	10.87	147.024	11.476
661	SECONDARY	S	S-661	607613.8919	7254784.136	159	148.23	10.77	146.981	11.519
662.5	QUATERNARY	Q	Q-662,5	607615.3728	7254784.375	159	148.39	10.61	147.135	11.365
664	TERTIARY	T	T-664	607616.8536	7254784.614	159	148.52	10.48	147.43	11.07
665.5	QUATERNARY	Q	Q-665,5	607618.3391	7254784.652	159	148.7	10.3	147.454	11.046
667	PRIMARY	P	P-667	607619.841	7254784.704	159	148.68	10.32	147.655	10.845
668.5	QUATERNARY	Q	Q-668,5	607621.621	7254783.321	159	148.68	10.32	147.419	11.081
670	TERTIARY	T	T-670	607622.8256	7254784.901	159	148.61	10.39	147.447	11.053
671.5	QUATERNARY	Q	Q-671,5	607624.316	7254785.01	159	148.65	10.35	147.645	10.855
673	SECONDARY	S	S-673	607625.8063	7254785.118	159	148.78	10.22	147.79	10.71
674.5	QUATERNARY	Q	Q-674,5	607627.2966	7254785.227	159	148.8	10.2	147.383	11.117
676	TERTIARY	T	T-676	607628.816	7254785.81	159	148.81	10.19	147.694	10.806
677.5	QUATERNARY	Q	Q-677,5	607630.2223	7254786.511	159	148.81	10.19	147.662	10.838
679	PRIMARY	P	P-679	607631.6619	7254787.005	159	148.83	10.17	147.677	10.823
680.5	QUATERNARY	Q	Q-680,5	607633.1428	7254787.244	159	148.98	10.02	147.843	10.657
682	TERTIARY	T	T-682	607634.6236	7254787.483	159	149.02	9.98	147.963	10.537
683.5	QUATERNARY	Q	Q-683,5	607636.1044	7254787.722	159	149.06	9.94	148.013	10.487
685	SECONDARY	S	S-685	607637.5853	7254787.961	159	149.14	9.86	147.832	10.668
686.5	QUATERNARY	Q	Q-686,5	607639.0661	7254788.2	159	149.15	9.85	148.134	10.366
688	TERTIARY	T	T-688	607640.5469	7254788.439	159	149.19	9.81	148.023	10.477
689.5	QUATERNARY	Q	Q-689,5	607642.0278	7254788.678	159	149.21	9.79	148.006	10.494
691	PRIMARY	P	P-691	607643.5086	7254788.917	159	149.23	9.77	147.996	10.504
692.5	QUATERNARY	Q	Q-692,5	607644.9894	7254789.156	159	149.29	9.71	147.718	10.782
694	TERTIARY	T	T-694	607646.4702	7254789.395	159	149.34	9.66	148.172	10.328

695.5	QUATERNARY	Q	Q-695,5	607647.9511	7254789.634	159	149.42	9.58	148.163	10.337
697	SECONDARY	S	S-697	607649.4319	7254789.873	159	149.54	9.46	148.537	9.963
698.5	QUATERNARY	Q	Q-698,5	607650.9127	7254790.112	159	149.62	9.38	148.507	9.993
700	TERTIARY	T	T-700	607652.3936	7254790.351	159	149.75	9.25	148.74	9.76
701.5	QUATERNARY	Q	Q-701,5	607653.8744	7254790.59	159	149.8	9.2	148.553	9.947
703	PRIMARY	P	P-703	607655.3884	7254790.623	159	150	9	149.028	9.472
704.5	QUATERNARY	Q	Q-704,5	607656.9254	7254790.515	159	150.07	8.93	148.514	9.986
706	TERTIARY	T	T-706	607658.3419	7254791.597	159	150.06	8.94	148.867	9.633
707.5	QUATERNARY	Q	Q-707,5	607659.7977	7254791.546	159	150.2	8.8	148.776	9.724
709	SECONDARY	S	S-709	607661.2786	7254791.785	159	150.26	8.74	148.885	9.615
710.5	QUATERNARY	Q	Q-710,5	607662.7594	7254792.024	159	150.21	8.79	149.076	9.424
712	TERTIARY	T	T-712	607664.2402	7254792.263	159	150.14	8.86	148.957	9.543
713.5	QUATERNARY	Q	Q-713,5	607665.7211	7254792.502	159	150.08	8.92	148.83	9.67
715	PRIMARY	P	P-715	607667.2019	7254792.741	159	149.93	9.07	148.641	9.859
716.5	QUATERNARY	Q	Q-716,5	607668.6827	7254792.98	159	149.86	9.14	148.809	9.691
718	TERTIARY	T	T-718	607670.1636	7254793.22	159	149.84	9.16	148.643	9.857
719.5	QUATERNARY	Q	Q-719,5	607671.6444	7254793.459	159	149.91	9.09	148.909	9.591
721	SECONDARY	S	S-721	607673.1252	7254793.698	159	150.05	8.95	148.625	9.875
722.5	QUATERNARY	Q	Q-722,5	607674.6061	7254793.937	159	150.15	8.85	149.151	9.349
724	TERTIARY	T	T-724	607676.0869	7254794.176	159	150.26	8.74	149.063	9.437
725.5	QUATERNARY	Q	Q-725,5	607677.5677	7254794.415	159	150.28	8.72	149.164	9.336
727	PRIMARY	P	P-727	607679.1047	7254794.306	159	150.21	8.79	148.898	9.602
728.5	QUATERNARY	Q	Q-728,5	607680.6236	7254794.309	159	150.13	8.87	148.996	9.504
730	TERTIARY	T	T-730	607682.098	7254794.588	159	150.14	8.86	148.868	9.632
731.5	QUATERNARY	Q	Q-731,5	607683.5714	7254794.873	159	150.08	8.92	148.881	9.619
733	SECONDARY	S	S-733	607685.0447	7254795.159	159	150.24	8.76	149.07	9.43
734.5	QUATERNARY	Q	Q-734,5	607686.5307	7254795.447	159	150.21	8.79	149.022	9.478
736	TERTIARY	T	T-736	607687.9925	7254795.723	159	150.18	8.82	148.99	9.51
737.5	QUATERNARY	Q	Q-737,5	607689.4733	7254795.962	159	150.18	8.82	149.003	9.497
739	PRIMARY	P	P-739	607690.9541	7254796.201	159	150.19	8.81	149.138	9.362
740.5	QUATERNARY	Q	Q-740,5	607692.435	7254796.44	159	150.41	8.59	149.113	9.387
742	TERTIARY	T	T-742	607693.9158	7254796.679	159	150.69	8.31	148.333	10.167
743.5	QUATERNARY	Q	Q-743,5	607695.3975	7254796.912	159	150.73	8.27	147.97	10.53
745	SECONDARY	S	S-745	607696.8796	7254797.157	159	150.71	8.29	147.94	10.56
746.5	QUATERNARY	Q	Q-746,5	607698.3616	7254797.375	159	150.65	8.35	148.295	10.205
748	TERTIARY	T	T-748	607699.9465	7254796.969	159	150.61	8.39	148.459	10.041
749.5	QUATERNARY	Q	Q-749,5					0		

Appendix B

Grouting Committee Meetings and Recommendations

Grouting Committee Meetings No. 4

Meeting Minutes

SNC-LAVALIN INC.
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MINUTES OF MEETING

Certifiée ISO 9001

Minutes N° :	01	**Ref. :**	669034-0000-30MC-0001
Prepared by :	A. Arbaiza	**Date :**	2019-10-18
Meeting date :	2019-10-17	**Time :**	8:30 to 4:00 PM EDT
Location :	Marriot Hotel, Dorval, QC	**Project :**	Amaruq WTD remediation works
Subject :	Technical grouting committee for WTD remediation works		
Presents :	**AEM**: Thomas Lépine, Alexandre Lavallée, Pascal Lavoie, Michel Julien, Frédérick Bolduc, Pier-Éric McDonald. **Technical Grouting Committee:** Grant Bonin, Donald Bruce, Peter White. **KCG:** Ken Lachance, Bernard Vachon. **SNC-Lavalin**: Yohan Jalbert, Tom Xue, Abdellah El Bensi, Angie Arbaiza.		
Distribution :	All above		

MINUTES

Point N°	Description	Action by	Date
1	**Reduction criteria**		
	AEM communicates that the actual measured seepage that has been collected downstream of Whale Tail Dike (WTD) is about 300 m^3/h. This seepage is mostly concentrated at the east section of the dike. However, the flow estimated from the water balance is of 600 m^3/h. According to the geophysical survey, the seepage is only at the bedrock. The main risk would be pit crest overtopping by WTN basin, which is an operational risk. MJ states that we cannot conclude that 100% of seepage is on bedrock. There may be some seepage at the cutoff wall that has not been captured from the geophysical survey. There are some anomalies that have been captured from the thermistor data located downstream of the cutoff and that may indicate some seepage from the cutoff wall. According to the comments from the MDRB, the cutoff wall is not erodible therefore its stability is not threatened. GB supports MJ comment and adds that a geophysical survey is only a tool and does not differentiate between a “worst case scenario” and a “bad scenario”. The anomalies from the thermistor data should still be considered. TL adds that the only thermistor that shows an anomaly at the cutoff wall is at station 0+675. However, the thermistor is		

Point N°	Description	Action by	Date
	placed at the downstream side, making it difficult to conclude that there is a problem at the wall. PEM adds that the MDRB stated that since the seepage flow has not increased, this gives an indication that the cutoff is not compromised. AL states that if seepage is 600 m3/h, it could still be manageable but not during spring. Water from seepage is not being transferred to South Whale Tail Lake (SWTL) due to turbidity (permitting issues). AEM explains that the assumed maximum storage capacity in North Whale Tail Lake (NWTL), which is at the attenuation pond, is of 150 000 m3. The treatment capacity is of 1360 m3/h (1600 m3/h of 85% mechanical availability). Considering runoff of 1000 m3/h and a seepage rate of 600 m3/h (according to water balance), the volume of seepage would have to be reduced from 600 m3/h to 360 m3/h (reduction of 240 m3/h), which represents a reduction target of 40%. Ideally, the reduction target would be of 65% but implies a lot of work. DB suggests that the target should be compatible to grouting activities and should be practical to achieve. The challenge would be in sealing main flow paths that are present in the bedrock foundation (and not just with respect to the permeability of the bedrock). AEM explains that the lower the inflow is during freshet, better the capability to manage the water. For now, based on the capacity and capability of the system, there is only 360 m3/h of seepage that can be managed (1360 m3/h - 1000 m3/h). Furthermore, there are a lot of uncertainties such as the geotechnical aspects under that attenuation pond, freshet, etc. Also, the calculations are based on an 85% mechanical availability. If the worst time of the year is considered, the capability can be very low (i.e. breakdown). Assuming these numbers, grouting program is mandatory for the mining operation of Amaruq. GB suggests that the pH of the water should also be considered. For now, the pH is around 8 which is relatively clean. However, the pH during and immediately after grouting activities may increase, comprising the capability of the water treatment. Usually it doesn't take long to bring it down but AEM needs the necessary products on site. PL states that the present water treatment plant would be able to manage higher pH values in water. Nonetheless, toxicity will be verified. The technical committee suggests to inject fluorescent dye to the water during the water pressure tests before injecting		

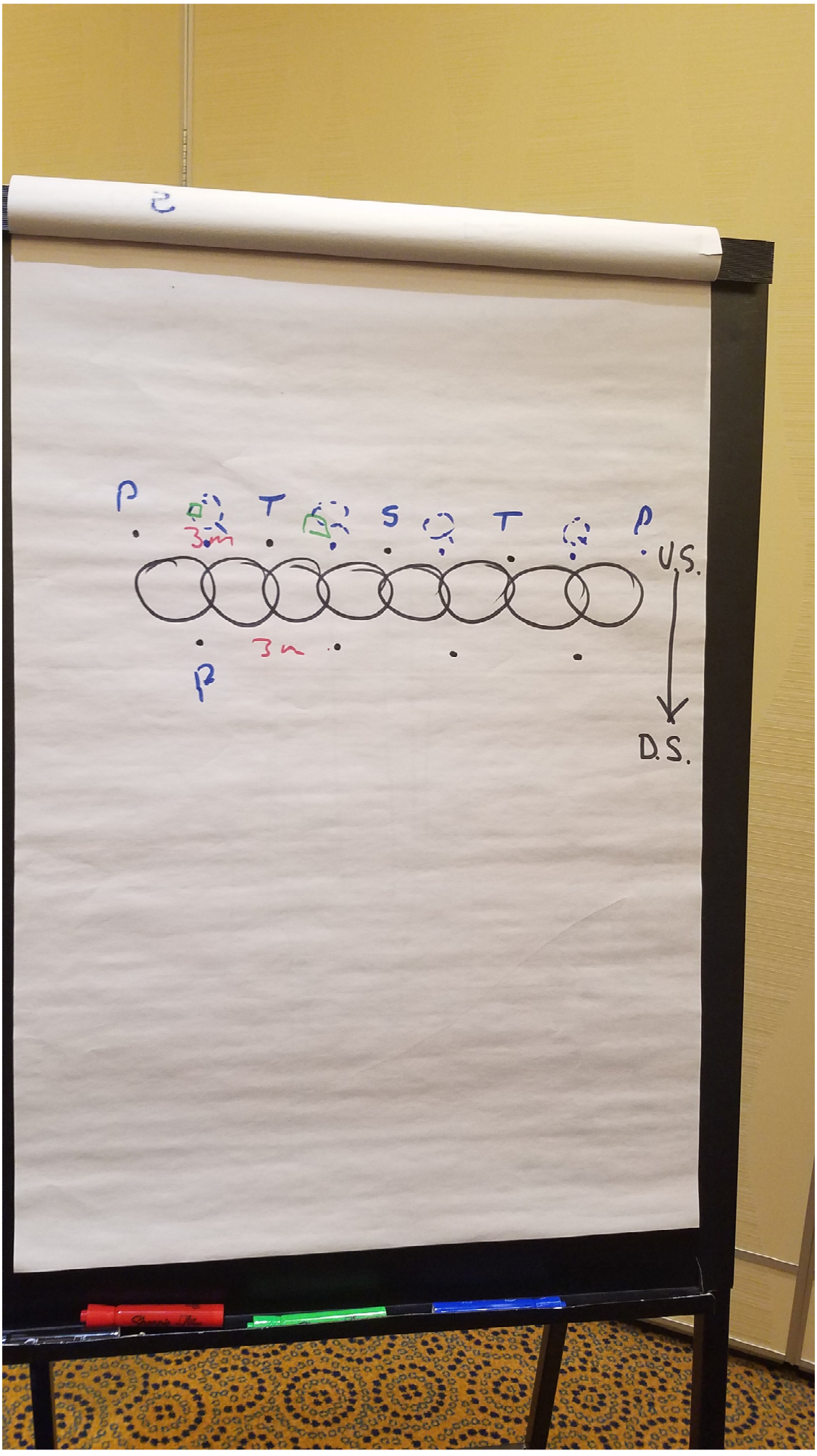
Point N°	Description	Action by	Date
	grout. This way it is more visual before getting to the water treatment plant. This product degrades quite fast as well. AEM explains that the winter management strategy for now is to reduce the SWTL water level of 0.5 m per month up to its original water elevation (152.5m) by pumping towards Mammoth Lake.		
2	**Investigation results**		
	AEM presents the results of the geophysical survey: Flow Path A: According to the geophysical survey, this is the strongest flow. However, the seepage was not monitored with thermistors. This flow may be seeping deeper the thermistor string and may be in accordance to the water balance (600 m3/h compared to only 300 m3/h that is being collected on site). The flow depth is of 25 m from the top of WTD. At this location, the bedrock surface is at its deepest (from WTD alignment). SNC-Lavalin explains that during the construction some drops of CB were seen within the casing. Also, at some locations, the interface may not have been interlocked properly at the rock socket (1 m within bedrock). DB explains that consolidation can take about 48 hours. It seems that for the CB mix design, no API (pressure filtration parameter) was evaluated. These drops can be explained due to water seeping and not necessarily to quality of the rock. AEM would want to install deeper thermistors in this sector and all agreed that this is required. Flow Path B: Very wide compared to flow A. Flow Path C: At the east abutment sector. At the moment there are no thermistors that matches the geophysical anomaly. There are some inconsistencies still but if thermistor data is compared to lake temperature, a normal pattern can be seen. These thermistors would be kept during grouting activities.		
3	**Design work**		
	SNC-Lavalin presents the excel file: Committee comments and recommendation compilation meeting #3.xlsx. Refer to this file to see the comments during the meeting. Main actions are presented in these minutes. The communication chart will have to be prepared by SNC-Lavalin and each role would have to be clarified.	SNC-Lavalin SNC-Lavalin	October October

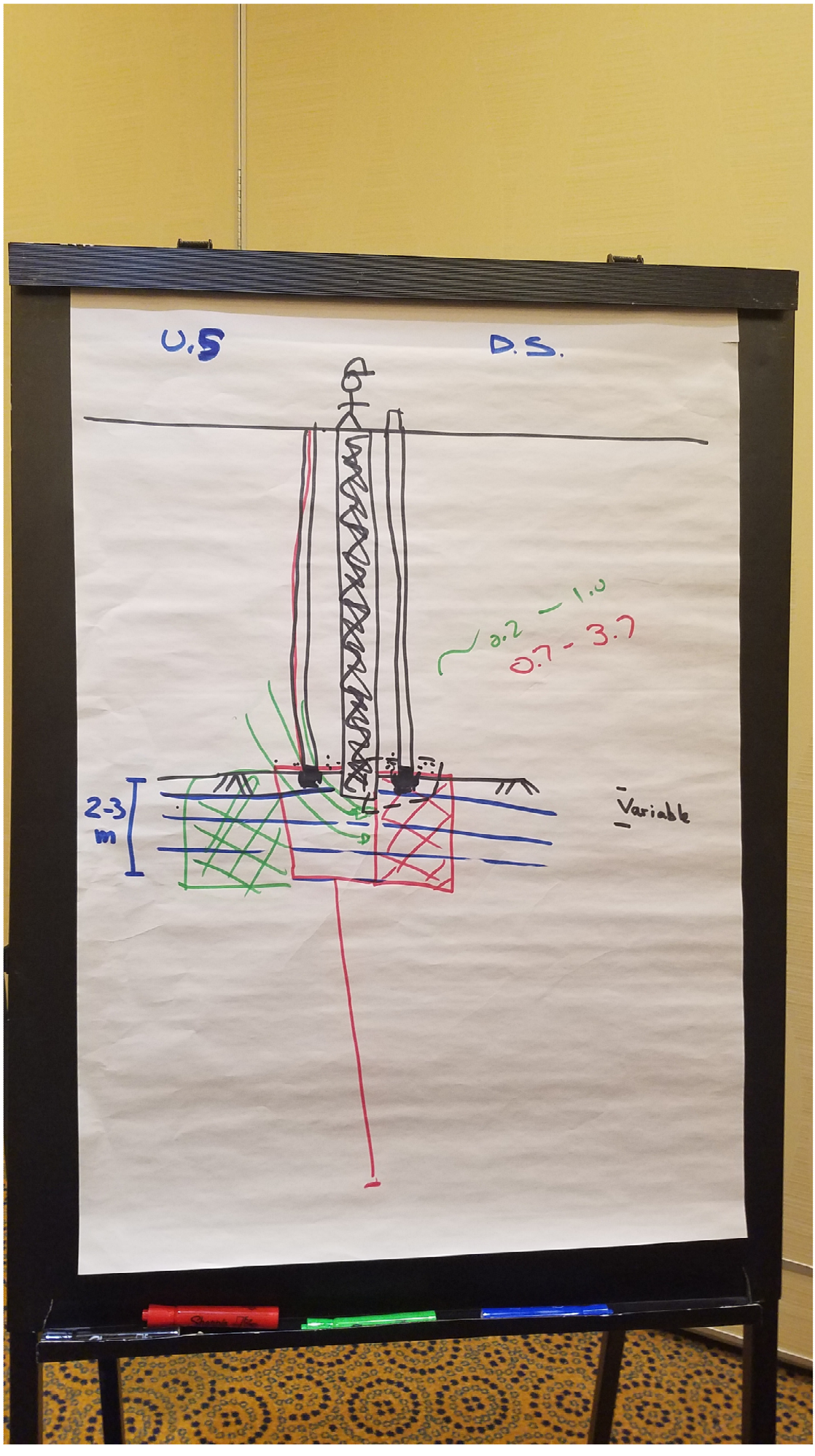
Point N°	Description	Action by	Date
	KCG to send equipment specifications before final version of technical specification. The technical committee suggests modifying the drawings in order to show the area of the grouting based on thermistor data (not only based on geophysical survey). The committee recommends that SNC-Lavalin establishes the target residual permeability for the starting position.	KCG SNC-Lavalin	
4	**Work procedure**		
	KCG presents their equipment. They also communicate that they have 5 000 m of casing on site and 2 000 m coming with the barges. KCG explains that the deviation of the casings is measured after and not while drilling. The installation of inclined casing will be difficult, and this may lead to hole deviation. Based on geological data, no inclined hole would be necessary for the grout curtain, only vertical holes. Everyone agreeing on this. AEM recommends using the rock socket as a guidance. The technical committee recommends that KCG share their data to see the anomalies between fine filter and bedrock differences while drilling. Controls would be mandatory (as for the other dewatering dikes at Meadowbank) to confirm the bedrock depth / final depth and other observations that can be collected during the casing installation. SNC-Lavalin will offer to be present on site for this control (other staff than the proposed grouting specialists). The committee recommends starting with the easiest sector to get comfortable and then move towards the more difficult areas.	SNC-Lavalin	October
5	**Committee final comments**		
	The committee wants to increase the awareness about the difficulty of this job. The mixes should be kept simple. The committee explains that the geological model of the site is common to Northern Canada. Ice can be seen, exfoliation from glacial, a combination of ice and silt. A geological implication in the exfoliation joints: fractured rock mass. This cannot be seen with the diamond drilling. It can be seen more in televiewer and acoustic.In order to get to the 40% reduction target, the big discontinuities will have to be targeted. Contact area between secant piles and rock foundation is a critical area. Rock socket depth varies between 0.7 m to 3.7 m;		

Point Nº	Description	Action by	Date
	thus, the target area should be between 3 to 5 m depth. Contact grouting shall be done by downstage grouting. Grouting of downstream blanket and the contact grouting at the upstream side of the secant piles should be done by downstaging grouting method. Grouting can be done with simplified mixes (lower C/W ratio). The committee assumes that the water flow is high. No need to go deep until a good seal in the contact area is obtained. SNC has some reserves on the downstream blanket because of the effectiveness from seepage control in the downstream side and also because of the direction of the high flow that will wash and push the grout far from the secant pile rock socket contact area. The committee agreed with SNC's concerns but wants to keep the downstream blanket. The committee's decision is supported by MJ (AEM) arguing that every effort should be deployed to ensure that the cut of wall contact area is well grouted. The committee recommends plugging the bottom end of the casing (by tremie method) to ensure the tightness of the rock interface prior to start drilling the hole in bedrock foundation. This can be done once all the casings are installed. This adds only just one step into the sequence. The packer can be inside the casing. Based on what KCG has seen, this could have to be down staged about 4 times. The committee recommends embedding the casing from 0.2 to 1.0 m. Depending on rock socket variability (0.7 to 3.7). Casing embedment of 0.3 m in rock is acceptable. The downstream blanket should be first and then the upstream grout curtain. To keep the work progression rate, the grouting should be done in at least two areas to comply with the minimal required space between two simultaneously grouted holes. Drilling and grouting holes at the downstream blanket will be P at 12 m, S at 6 m, T at 3m, while in the upstream Q will be required at 1.5 m. No super primaries for the holes in the D/S blanket. The work sequence will be as follow: 1) Start drilling all downstream blanket holes first; Casing to be embedded 0.3 m in rock. 2) Grout the casing bottom plug. Do not wait too long to place the plug just to avoid material inside the casing.		

Point Nº	Description	Action by	Date
	If this happens, you can blow water to clear it before placing the plug. 3) Drill the hole 3 to 5 m in bedrock from the bottom of the casing. 4) Grout mix according to the conditions. Grout: 0.5:1 +Calcium Chloride+ Celbex (if necessary). 5) Flow rate recommendation: fast as possible, do not pause. You want to be consistent. Agitating tank is full, all the volume you can put, consistent and high rate, 40L/min for example. 6) Split spacing method to be used. For the upstream grout curtain. Contact stage should be done by downstage method following the same steps as the downstream blanket. After completion of the contact grouting, the hole should be deepened to the required depth and grouted using upstage method. If the holes collapse, the strategy may change to go downstage grouting. To be evaluated on site by the Grouting Specialist (SNC-Lavalin). The committee thinks that sand may not be required after everything that they have heard from today's meeting. Committee to send a memo to all (in conjunction). Periodically meetings for all is proposed during construction. Documents to be revised based on the suggestions of this meeting. All agreed that the final performance of the grout curtain (40% of target) is not 100%. However, all efforts shall be made to reduce as much as possible the seepages through the foundation for the mining operations. Health and Safety: AEM focus on the health and safety of this work. JHA has to be well prepared and all on the same page for the risk associated with this operation (drilling and pressure grouting activities in this remote site).	Technical committee SNC-Lavalin	28-29 Oct.

P, S, T
12, 6, 3, 1.5
U.S.
D.S.
P, S, T
12, 6, 3
REPEAT
1. TO 7 FOR U/S
ASSESS
MOVE FORW. U/S ONLY
1. DS HL CASING
2. BOTTOM PLUG
3. D/S DRIV VARIES
0.3m
3m?
5m
REPEAT 2 & 5 TWICE * CONSIDER? HOW MANY?
REPEAT 5. COMPLETE REMARKS
RATES. DEPTH 0.5:1 + CH + WHEN NEED DRILLEX


P
T
S
T
P
3m
U.S.
3m
P
D.S.


U.S
D.S.
~0.2 – 1.0
0.7 - 3.7
2-3 m
Variable

Grouting Committee Meetings No. 5

Presentation

Meeting Minutes

PEOPLE
DRIVE
RESULTS

Our vision

We strive to be the premier engineering solutions partner, committed to delivering complex projects from vision to reality for a sustainable lifespan.

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Whale Tail Dike Remedial Grouting

1. **Technical Specifications Evolvements**
2. **Drilling and Grouting**
3. **Observations and Discussions**

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Amaruq Mine Project Layout

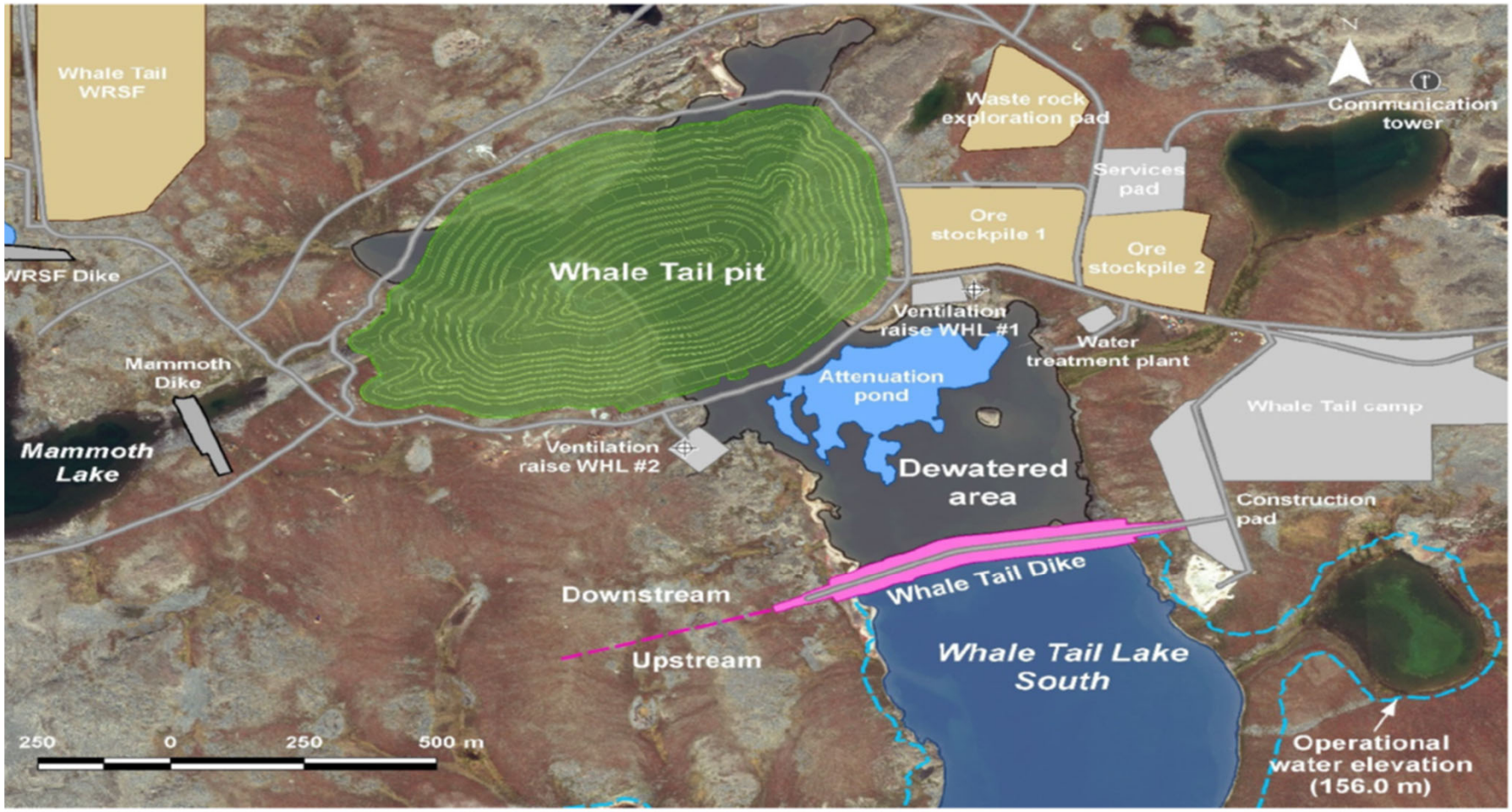

Figure 1-2 : Amaruq project mine layout

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Whale Tail Dike Construction

CB Secant Piles Cutoff Wall Construction

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WTD Bedrock Conditions (2017 Geotechnical Investigation)

Four joint Sets (13 Boreholes along the WTD Axis)

Joint set no. 1 is the most dominant joint set in the WTD area. Its average orientation is 48°/150°;

Joint set no. 2 and 4 are subvertical;

Joint set no. 3 is slightly inclined to the West

Joint set no.		1	2	3	4
Dip (°)		48	86	34	80
Dip direction (°)		150	256	279	017
Total joint count		1561	201	284	113
Closed joint count	Count	1197	164	204	91
	%	77	82	72	81
Slightly open joints	Count	274	31	56	20
	%	18	15	20	18
Open joints	Count	83	6	24	2
	%	5	3	8	2
	Aperture max (mm)	54	11	16	1
Fractured zones	Count	7	0	0	0
	Max thickness (mm)	2113	--	--	--

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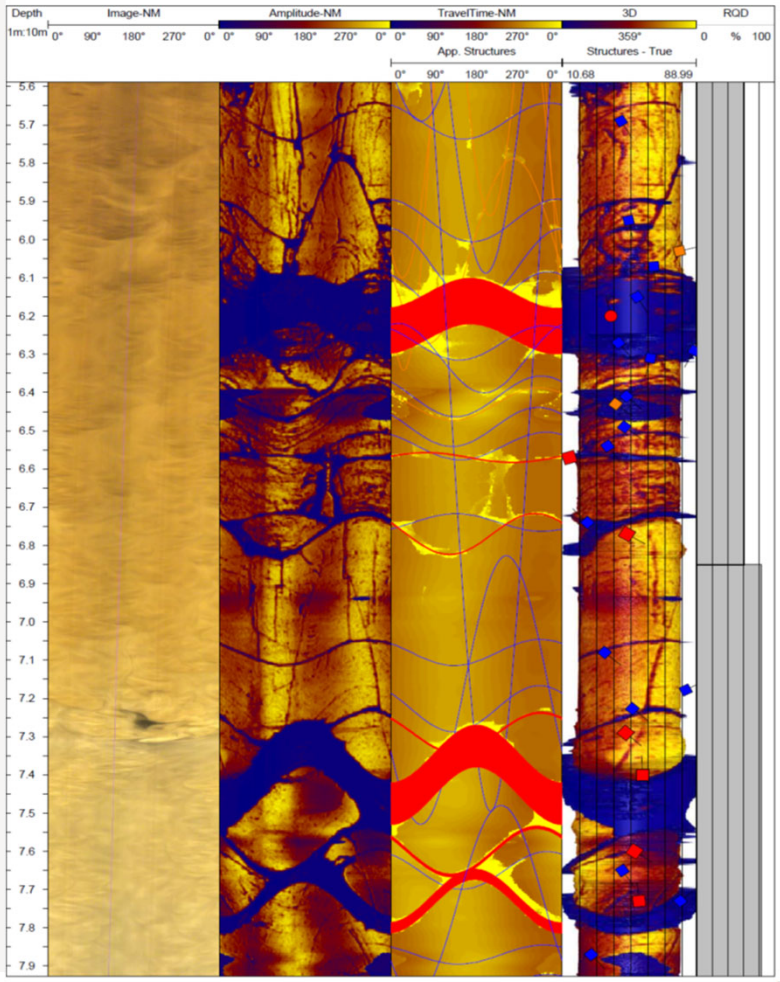
Geotechnical Conditions

Borehole core photos (AMQ17-1156/DD-WTD-2017-112)



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WTD Foundation Curtain Grouting (2018.11-2019.02, Schedule driven program)

WTD Remediation Grouting (2019)

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WTD Grouting Casing Drilling

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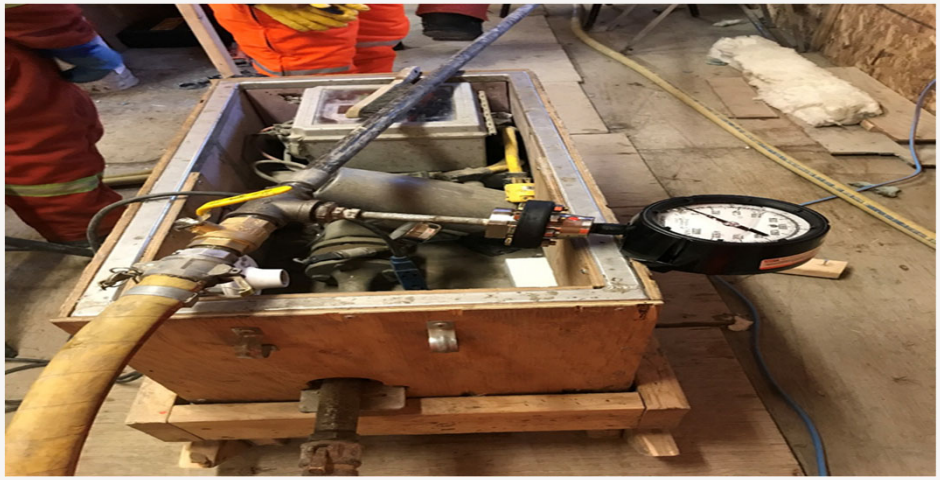
WTD Grouting Unit



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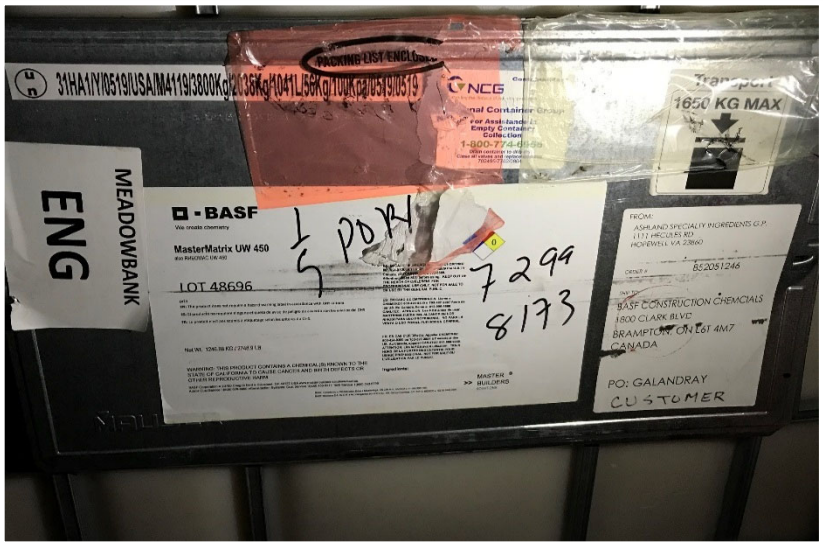
Trial Mix on Site

Trial Mix at Site Nov. 14 &17, 2019Seven grout mixes were trial mixed;
Details & properties per Table -1;

Limitations: testing equipment and material frozen



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Trial Mix on Site

Trial Mixing was performed on **Nov. 14 and Nov. 17, 2019**;
Seven (7) different mixes were tested with W/C= 0.5 to 0.7:1 and admixtures to produce grout mixes with different properties;
A summary of the trial mixes is presented in Table 1.

Table 1: Summary of trial mixe testings

Ingredient	Unit	Mix A	Mix A+	Mix B	Mix B+	Mix C	Mix D	Mix E
Water	Litre	84	84	72	72	60	60	60
Cement Type III	kg	120	120	120	120	120	120	120
Calcium Chloride (2% by weight)	kg	2.4	2.4	2.4	2.4	2.4	1.2	2.4
Celbex (0.2% by weight)	kg	-		-		0.24		
Glenium 3030	ml		480		480			
Rheomac 450	ml						500	250
Property								
Marsh Funnel time	second	30	30	41	32	77	154	163
Specific Gravity	g/cm^3	1.62	1.62	1.73	1.67	1.8	1.75	1.75
Bleeding after 2 hours	%	5	2	1	4	0	-	-
Filtration coefficient	min-1/2		0.02					

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QC/QA Testing of Grout Mixes

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Technical Specifications Evolvements

Evolvement of Specs:

- Technical Specifications for Whale Tail Dike Remedial Drilling and Grouting Works Rev. PC, dated October 3rd, 2019 for AEM and GC review; which was discussed in Montreal GC Meeting held on Oct. 17th;
- Revised Technical Specifications Rev. PD, dated October 28th, 2019 been submitted for AEM further Review and Comments;
- Revised Technical Specifications Rev. PE, dated November 27th, 2019 been submitted for AEM and GC Review and Comments based on comments and discussion on site with AEM engineers
- Site Instructions dated Nov. 19, 2019 provided to simplify and provide guidance to site at the early stage constructions before updated Specs approval:
  - Based on GC Recommendations and
  - Construction data and ground response

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Technical Specifications Evolvements

Logistics for the Changes:

- To be in align with GC recommendations in Technical Letter dated Oct. 28 to simplify the Specs and work procedures;
- Objective of seepage control – seepage reduction of 40-50%;
- Phased approach of the Seepage Control: Blanket Grouting (First Phase) and Assessment of Curtain Grouting (Second Phase) required; and
- Constructions data obtained and engineering judgement since the start of casing drilling in early November.

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Technical Specifications Evolvements

Major Changes in Rev PE:

- Added the objective of seepage reduction of 40% in Section 1.0 INTRODUCTION reflecting Oct. 17 GC Montreal meeting discussion and GC letter dated Oct. 25, 2019;
- Removed contents related to Curtain Grouting and Staged Grouting (downstage/upstage grouting) from Section 2.2 Definitions and from Drawings;
- Add definition of Blanket Grouting in Section 2.2;
- Revised team and organization chart in Section 2.3;
- Updated Section 2.4 Reference Standards and Procedures
- Simplified grout mixture components, with removal of use of Sand and Bentonite in Section 3.4 and 3.5;
- Removed Water Pressure Testing from Section 4.2;

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Technical Specifications Evolvements

Major Changes in Rev PE:

- Changed Section 5.1 Drilling bullet point 3 from “Casing shall be socketed 300 mm minimum in bedrock to “ Casing shall be advanced to 300 to 500 mm maximum below provided bedrock as-built level….Advancement of casing to more than 500 mm below bedrock as-built level shall be first approved by Engineer.
- Removed Water Pressure Testing from Section 5.2;
- Grout Mixes Design using site available material Section 5.3;
- Updated QC Control Testing Method and Frequency in Section 5.2.4;
- Section 5.5 Grouting Operation, changed Vmax from 500L/m to 400L/m when no pressure built-up or refusal;
- Section 5.8 Adding upstream holes shall be capped or partially backfilled for future curtain grouting.

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Construction - Drilling and Grouting

The main construction activities for Blanket Grouting:

- Survey and Stake up Grout Hole Locations
- Casing Drilling
- Casing Plugging
- Bedrock Drilling
- Bedrock Grouting
- Backfill of Grout Hole/Casing

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Construction - Drilling and Grouting

Casing Drilling and Plugging

- Drilling from WTD crest downstream side, at spacing c/c = 3.0m ;
- **Casing advanced into bedrock 300 to 500 mm, holes drilled early not reach bedrock had been deepened**;
- Casing drillings started in Nov. 3, 2019 from East Abutment and moving to the West;
- Completed downstream casing drilling 189/192 (98%), casing plugging 84/192 (44%) upto Dec. 04 2019;
- Casing plug by pressure grouting or tremie with Mix C W/C =0.5 with 0.2% of Cellbex;,
- **Casing plug grouting volume changing significantly depending casing bottom condition (if socketed in bedrock, rock/casing contact), Stop at Vamx = 160L if no pressure response.**

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Bedrock Drilling

Drilling in bedrock through casing installed;

One stage drilling to 5.0m below bottom of casing with water flushing;

Advancing Primary Holes first at 12m Spacing c/c, offset from 0.7m from Centerline;

Advancing Secondary and Tertiary Holes by Split Spacing to produce grout holes spacing of c/c = 3.0m;

Logging during drilling, obstructions, water return, abnormalities during drilling;

Measure water level upon finish drilling;

Measure drilled hole depth, water level and deviation;

It is noted that casing deviation is much higher than max 0.5% as per spec.

KGC mentions that the equipment accuracy is 35% and equipment may not be good to use if the temperature goes below -10C.

Note that they are using inclinometer without centralizer.

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Bedrock Grouting

- Check drilled hole conditions depth, water level in side the casing;
- Flushing cleaning hole with water;
- Lower packer to bottom of Casing or between bottom of Casing and Bedrock (No Casing Plug or ineffective casing Plug;
- Pumping 30 to 40 L Mix C, (W/C = 0.5, 2% Calcium Chloride) into hole prior to Inflate the Packer;
- Inflate packer and start pressure grouting with Mix C (W/C = 0.5:1 with 2% Calcium Chloride, without Cellbex);
- Grouting pressure: Gauge Pressure = Effective P at midpoint of Hole Length + 1.0 Bar (pressure loss due to viscosity of grout tested on site);
- Thicken the grout to Mix C with 0.2% Cellbex after injecting 400L of Mix C without Cellbex without pressure response;
- Change to Mix D (W/C = 0.5, 2% Calcium Chloride, Rheomac 450) after total injection volume reaching 1600L, if no pressure building up, stop and re-grout at a later time;
- Re-grout will start with Mix C with Cellbex changes to Mix D, control Vmax to 1000L;

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Bedrock Grouting

Summary of the Rock Grouting Results (Dec. 4, 2019)

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Hole ID	Casing Length (m)	Casing into bedrock (m)	Water depth (m)	Casing Plug				Bedrock drilling				Bedrock grouting									Second grouting											Third grouting								
				Date	Grout Type	Grout Taken (L)	Pressure (Bar)	Date	Bedrock depth (m)	Final hole depth (m)	Bedrock length (m)	Date	Grouting Length (m)	Target Pmax (bar)	Gauge Pressure (bar)	Volume Injected (L)	Mix	Comments	Depth of grout (m)	Empty Length after grouting (m)	Date	Grouting Length (m)	Target Pmax (bar)	Target Volume (L)	Gauge Pressure (bar)	Volume Injected (L)	Depth of grout (m)	Empty Length after grouting (m)	Mix	Date	Grouting Length (m)	Target Pmax (bar)	Target Volume (L)	Gauge Pressure (bar)	Volume Injected (L)	Depth of grout (m)	Empty Length after grouting (m)	Mix
P-668.5	10.94	0.3	6	2019-11-20	C	28.3	1.8		10.64	16.6	5.96	2019-12-03	5.66	3.61	2.76	2327	Mix C without Cellbex, Cellbex was added after about 400L injected		16.37	5.43																			
P-680.5	12.09	0.34	6.61	No casing plug				2019-12-01	11.75	17.6	5.85	2019-12-02	5.51	3.61	1.2	2064	Mix C without Cellbex, Cellbex was added after about 400L injected		17.08	4.99																			
P-692.5	10.85	0.3	6.48	2019-11-20	C	9.6	3	2019-12-01	10.55	16	5.45	2019-12-02	5.15	3.41	1.12	2076	Mix C without Cellbex, Cellbex was added after about 400L injected		10.66	-0.19																			
P-704.5	9.99	0.45	6.17	2019-11-20	C	*168.5	0.92	2019-11-30	9.4	14.8	5.4	2019-12-01	4.81	3.04	0.72	1901	Mix C no Cellbex, Mix C +Cellbex at about 400L	Half of the packer in the casing	10.3	0.31																			
P-716.5	11.93	0.3	6.15	No casing plug				2019--11-28	11.63	16.6	4.97	2019-12-01	4.67	3.3	0.47	1958	Mix C no Cellbex, Mix C +Cellbex at about 400L	No casing plug; half of the packer in the casing	15.37	3.44	2019-12-04	3.44	3.2	1200	1.48	1247	11.3	-0.63	Mix C no Cellbex, Mix C +Cellbex at about 400L, Mix D at 800L									
P-728.5	11.14	0.06	6.02	2019-11-19	C	#4.6	3	2019--11-28	11.08	16.2	5.12	2019-12-01	5.06	3.45	3.45	728.5	Mix C without Cellbex	Casing plug is likely not effective due to 4.6L intake and additional casing being pushed down to reach bedrock; half of the packer in the casing	Backfilled																			
P-740.5	9.4	casing at the rock surface	6.82	2019-11-19	C	62.8	1.68	2019-11-26	9.4	14.5	5.1	2019-11-30	5.1	3.21	0.15	2079	Mix C no Cellbex, Mix C +Cellbex at about 400L		13.35	3.95	2019-12-04 morning	3.95	2.87	1200	1.86	1401	13.1	3.7	Cellbex at about 400L, Mix D at 800L	2019-12-04 afternoon	3.7	2	520	1.05	445	13..5(measured right after grouting)	3.6	Mix D

Note:

(#) very small intake <10 L

Observations and Discussions

- **Casing Depth: Socket into bedrock vs fixed length/max cut ?**
  - ***Casing without reaching or socketed into bedrock, the following effects observe:***
  - ***Casing can't be plugged properly with high take under low pressure;***
  - ***Difficulties in rock drilling: no water return, washout fine filter material***
  - ***Blow back of mud, CB in casing;***
  - ***Difficulties to grout bedrock, exceesive grout take at low pressure***
- **Casing Plugs: Tremie or pressure grouting ?**
  - ***Both acceptable;***
  - ***Preferable pressure grouted as a test if the contact is tight for drilling and grouting;***
  - ***Can this be saved with packer half way in casing and bedrock?***

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Observations and Discussions

Rock Grouting

Starting Mix C W/C =0.5, with 2% Calcium Chloride;

Mix changes or not and When?

Grouting started from East Abutment toward West,

Potential seepage zone, high water level in casing, mud/CB in casing;

High take at low pressures about 2000L at less than 2 bars;

Had to re-grout more than one time due to grout drop and leaving 3-4 m hole empty;

Refusal criteria may not feasible and reasonable in the Specs?

Flush set grouting currently is not ready at the site, which is required as per Specs;

How the effectiveness to be monitored and assessed?

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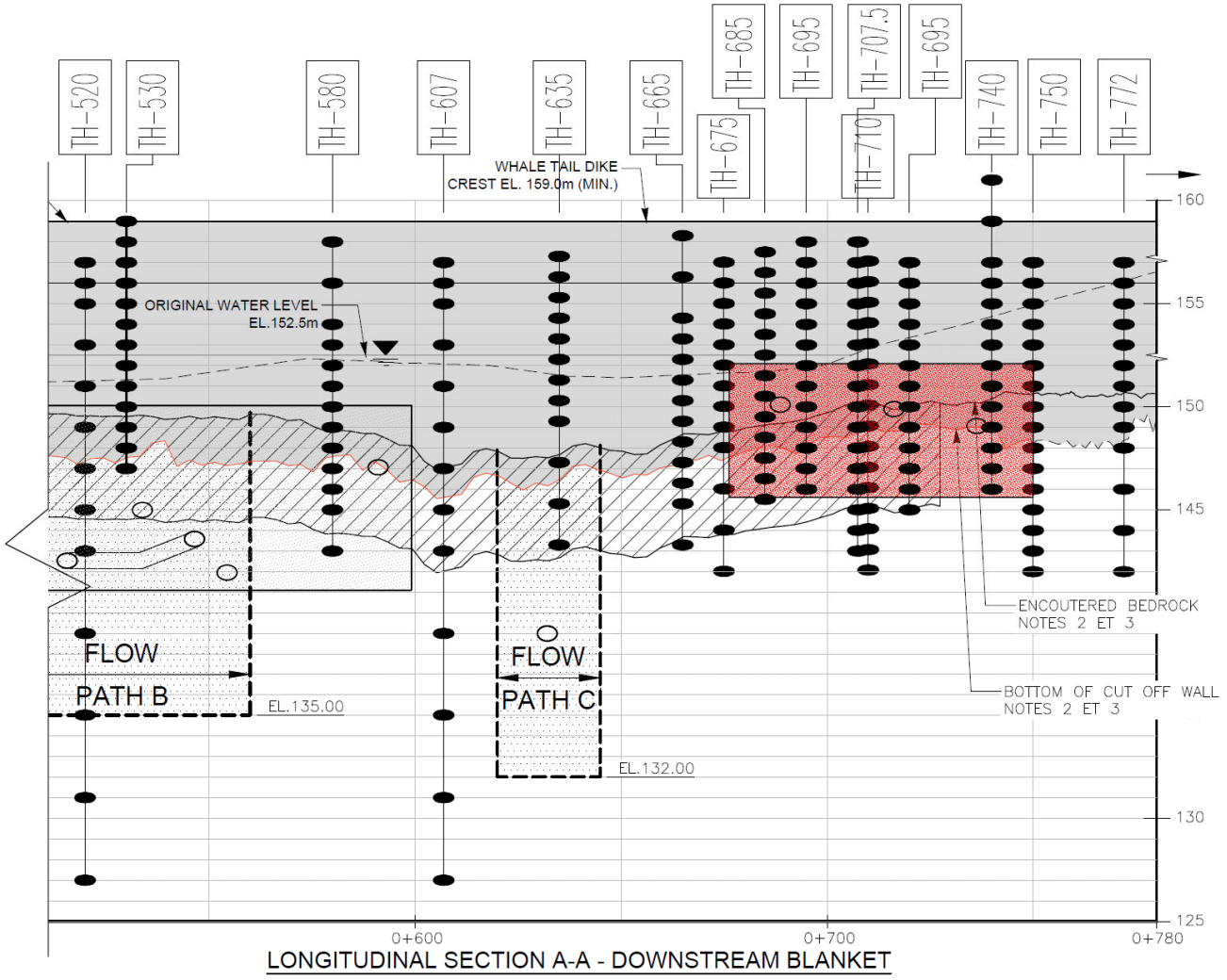
Drilling and Grouting Starting Location



LONGITUDINAL SECTION A-A - DOWNSTREAM BLANKET

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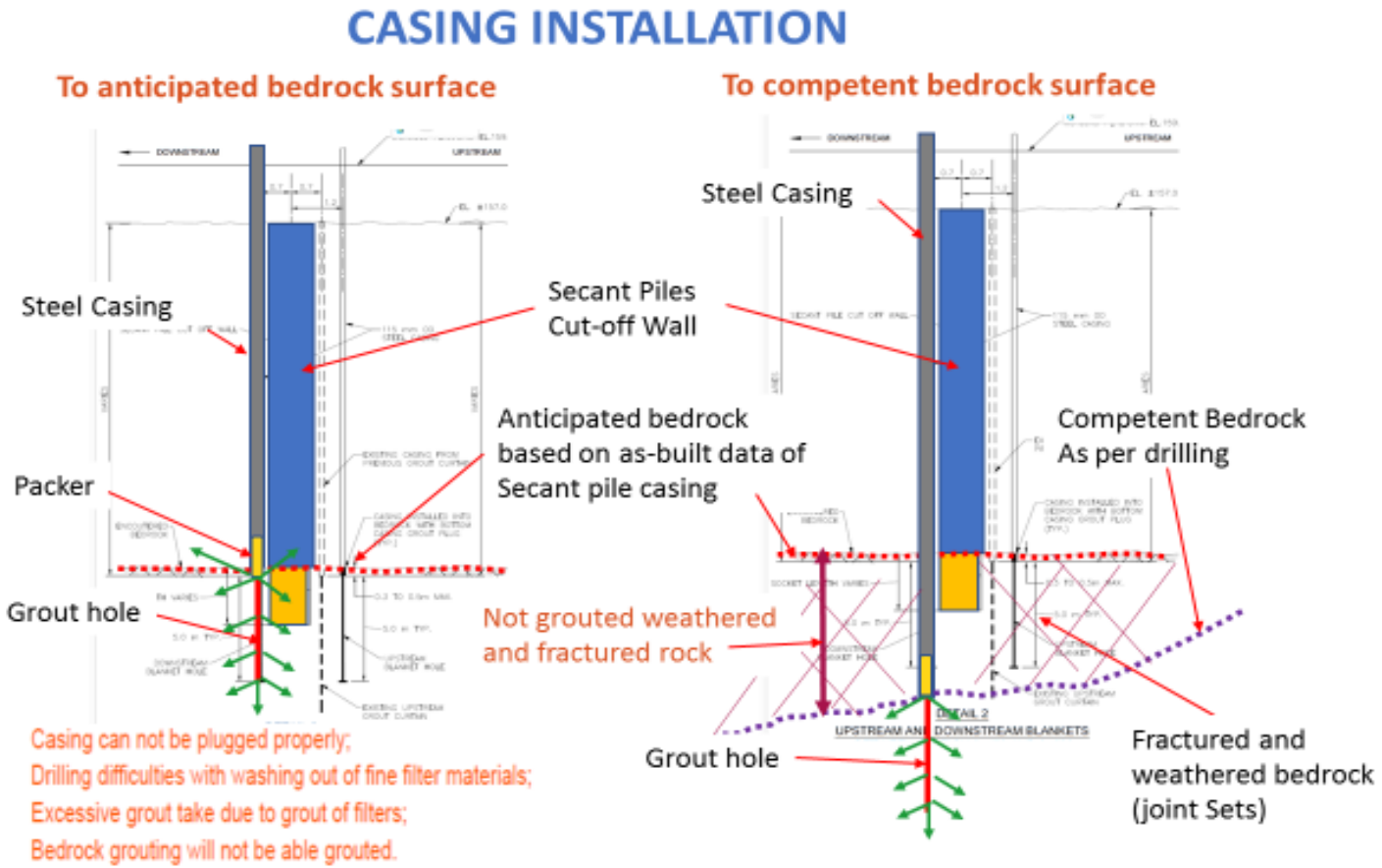
Casing Drilling – Fixed Length vs Socket into Bedrock?



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Our values are the essence of our company's identity. They represent how we act, speak and behave together, and how we engage with our clients and stakeholders.

SAFETY

We put safety at the heart of everything we do, to safeguard people, assets and the environment.

INTEGRITY

We do the right thing, no matter what, and are accountable for our actions.

COLLABORATION

We work together and embrace each other's unique contribution to deliver amazing results for all.

INNOVATION

We redefine engineering by thinking boldly, proudly and differently.

SNC·LAVALIN

Saleem, Muhammad

From: Jesse Clark <jesse.clark@agnicoeagle.com>
Sent: December 9, 2019 9:11 PM
To: Pier-Eric McDonald; Patrice Gagnon; Frederick Bolduc; Alexandre Lavallee; Thomas Lepine; Pascal Lavoie; Michel Julien; Quan, Nina; El Bensi, Abdellah; Xue, Tom; Du, Jin Dong; Grant Bonin; Peter White; GeosystemsLP; Ken Lachance; Baba, Hafeez; Jerome Collard
Subject: Grout Committee Meeting Minutes from December 5, 2019
Attachments: 669034_Remedial Work for WTD Seepage Presentation_Grouting Committee.pdf

Hello All,

Thank you for joining the grout committee meeting held last week. The following presents a summary on the discussion and actions from that meeting.

Discussion:

- SNC presented the findings thus far and challenges encountered (see attached)
- Discussion was held around the discrepancy on drilling depth for the casings. Approximately 16 casings were deepened passed the max depth as there was too much bentonite and fine filter material within the fractured bedrock. The drilling with water caused holes to plug and the onsite team made the decision to deepen casings. As it was only 16 casings, the committee recommended documenting the casings in case there were any issues later that would potentially require re-drills.
- The mix table was presented to the committee. The following points were made by the committee:
    - The committee felt the project had not fully utilized celbex to its potential
    - They felt rheonach is not a good substitute for celbex. Even with Rheonach's anti wash-out properties, a thickening thixotropic grout will ultimately be way more effective.
    - The problem with the current set up is that the Celbex sets too quickly when mixed in the tank limiting the total Celbex to 0.2%.
    - The committee recommends the use of an open throat pump to add Celbex inline to increase percentages of Celbex.
- KCG feared issues with sampling requirements with the open throat pump, with having to sample at the end of the system.
    - The committee stated that sampling is normally done before the Celbex is added with the open throat pump
- The committee felt it would not be a worthwhile exercise grouting in high flow zones without the open throat pump
- The question was brought up for Sectorization and whether different areas can be prioritized
    - The committee felt sectorization couldn't be properly reviewed until primaries and secondaries on the DS are completed, at a minimum

Actions:

- The blanket program should switch to down-stage grouting. An initial stage of 1.5m below the casing followed by injection. Once the grout sets the hole can be drilled to target depth.
- The team needs to utilize the open throat pump to inject celbex in-line with the grout pump, so that higher percentages of celbex can be injected.
- The onsite team needs to document any holes that may have had the casing pushed to below 300mm of the secant pile
- The grout committee to issue a letter in response to the meeting

Thanks,

Jesse Clark | Geotechnical Coordinator
jesse.clark@agnicoeagle.com | Direct 819.759.3555 460.6837 |
Agnico Eagle Mines Limited - Meadowbank Division, Suite 540 - Baker Lake, Nunavut, Canada X0C 0A0
agnicoeagle.com

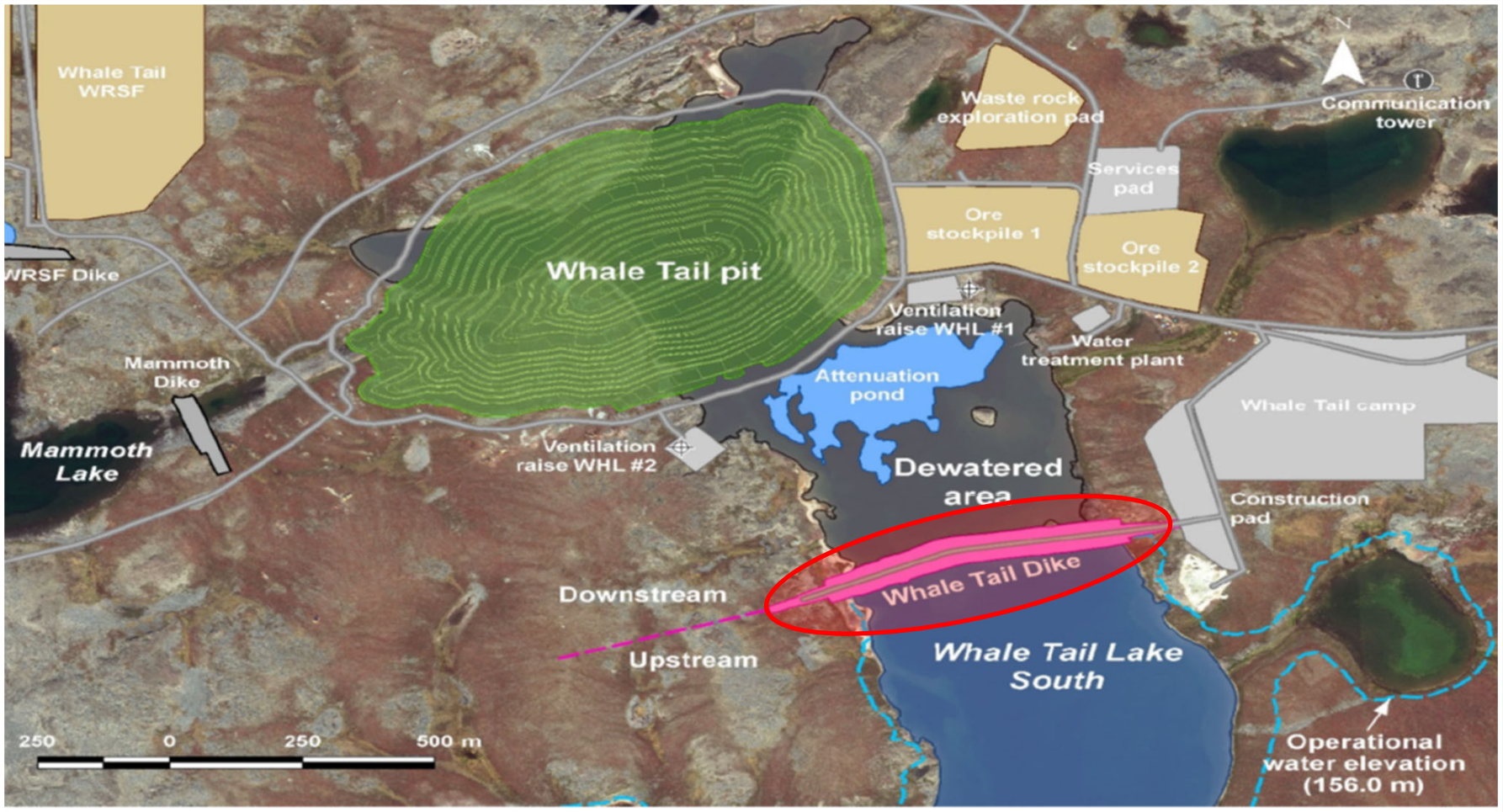
Grouting Committee Meetings No. 6

Presentation

Meeting Minutes

PEOPLE.
DRIVE.
RESULTS.

Amaruq Mine Project Layout – WTD Location



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WTD Remedial Grouting – Work Progress

1. **CASING INSTALLATION**
2. **CASING PLUG GROUTING**
3. **ROCK DRILLING**
4. **ROCK GROUTING**
5. **CHALLENGES AND MITIGATIONS**
6. **TOPICS FOR DISCUSSIONS**

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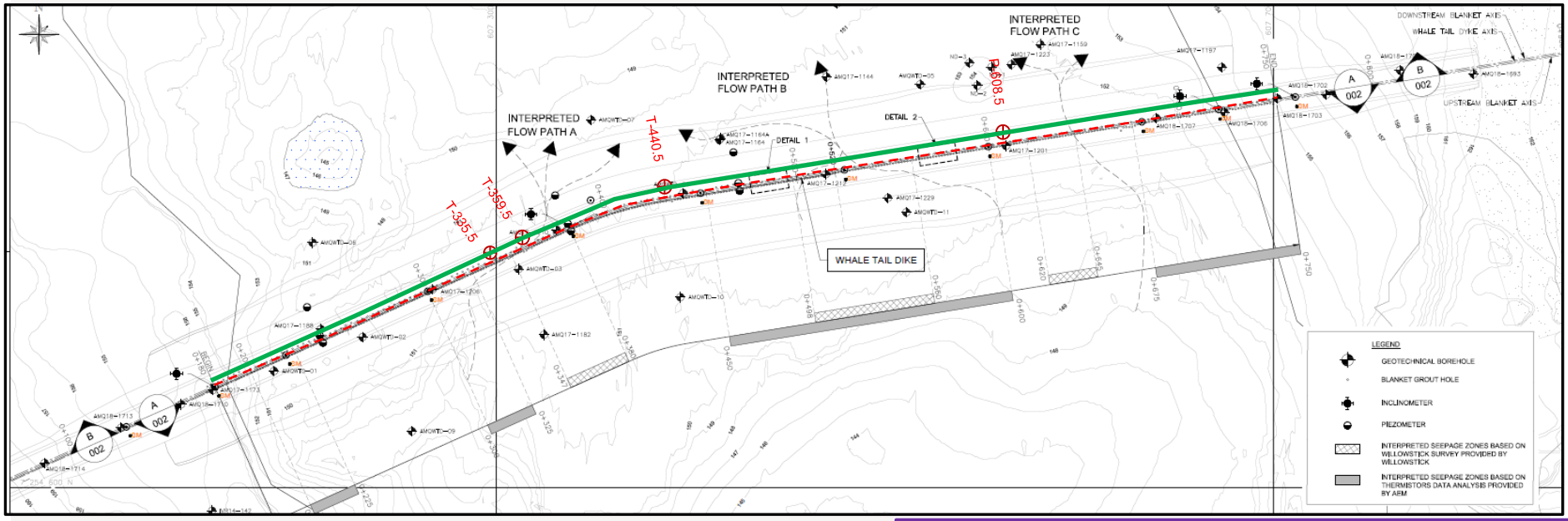
1 – CASING INSTALLATION



Downstream Blanket
Planned : 192 casing (P, S. T)
Casing Installed : 188 casing
Outstanding: 4 casing

T-335.5 ⊕ **Outstanding Casings due to burried instrument cables**

Upstream Blanket
Planned : 384 casing (P, S, T and Q if required)
Installed : 0 casings

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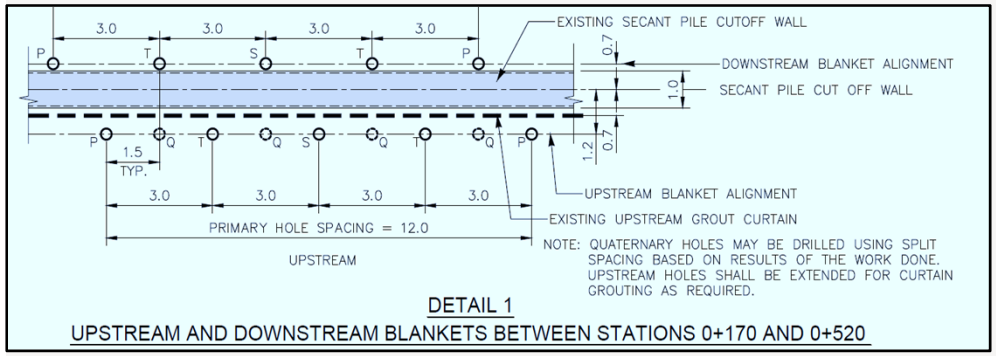
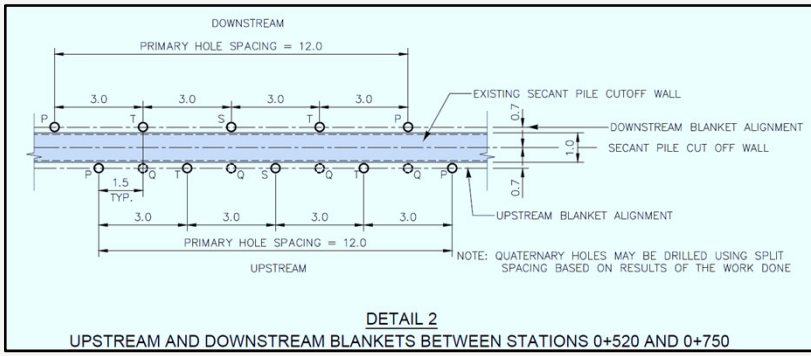
1 – CASING INSTALLATION – CONT'D



DETAIL 1

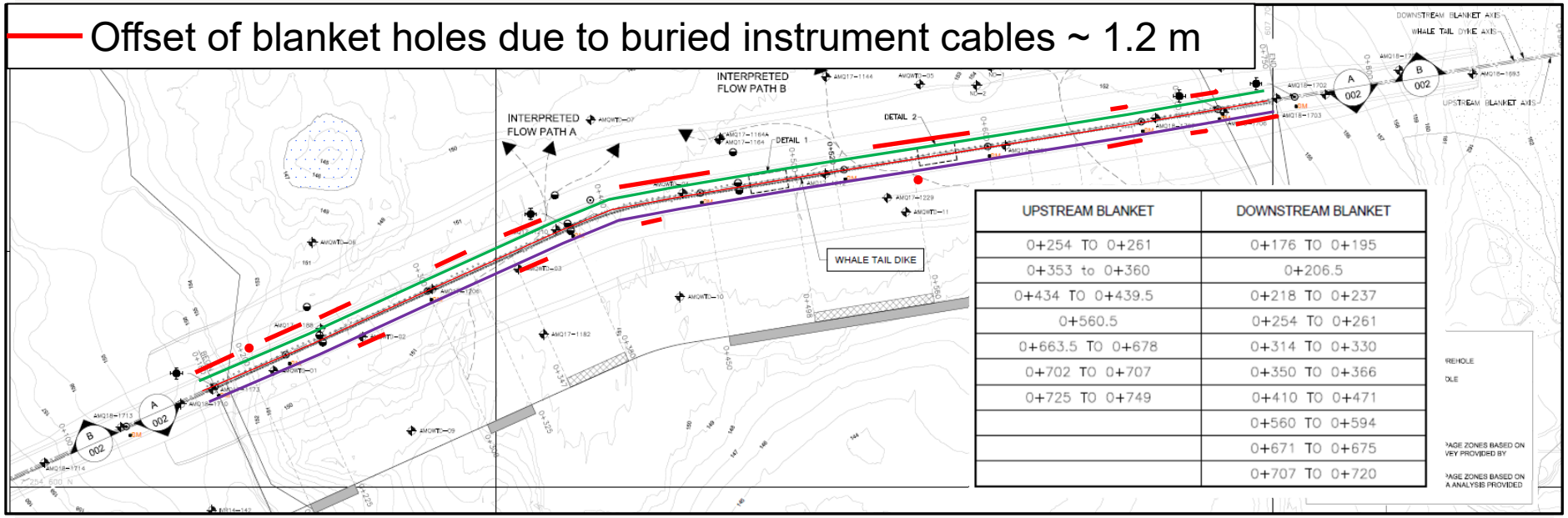
UPSTREAM AND DOWNSTREAM BLANKETS BETWEEN STATIONS 0+170 AND 0+520



DETAIL 2

UPSTREAM AND DOWNSTREAM BLANKETS BETWEEN STATIONS 0+520 AND 0+750

Offset of blanket holes due to buried instrument cables ~ 1.2 m



UPSTREAM BLANKET	DOWNSTREAM BLANKET
0+254 TO 0+261	0+176 TO 0+195
0+353 to 0+360	0+206.5
0+434 TO 0+439.5	0+218 TO 0+237
0+560.5	0+254 TO 0+261
0+663.5 TO 0+678	0+314 TO 0+330
0+702 TO 0+707	0+350 TO 0+366
0+725 TO 0+749	0+410 TO 0+471
	0+560 TO 0+594
	0+671 TO 0+675
	0+707 TO 0+720

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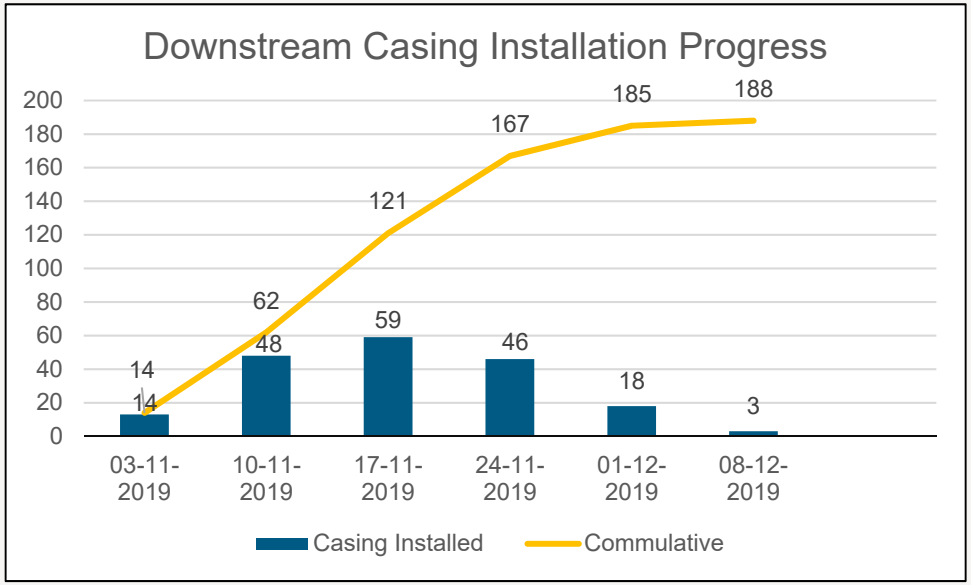
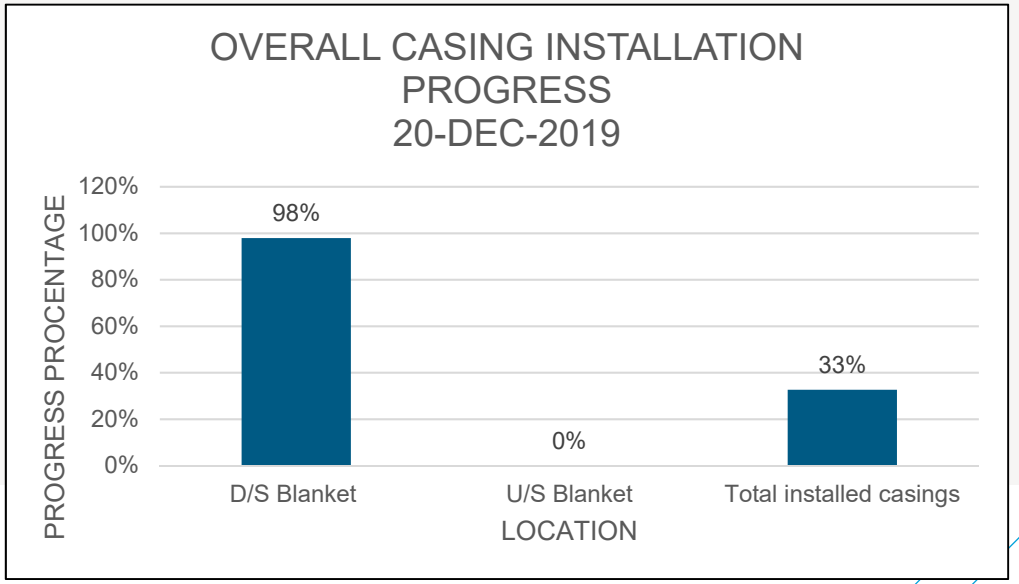
1 – CASING INSTALLATION – CONT'D



Casing Installation	Planned	Installed	%
Downstream Blanket	192	188	98%
Upstream Blanket	384	0	0%
Total	576	188	33%



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1- CASING INSTALLATION - PHOTOGRAPHS

Installation of casings

Casing offset due to buried instrumentations

Control of casing deviation

Drilling of new hole where obstruction occurred

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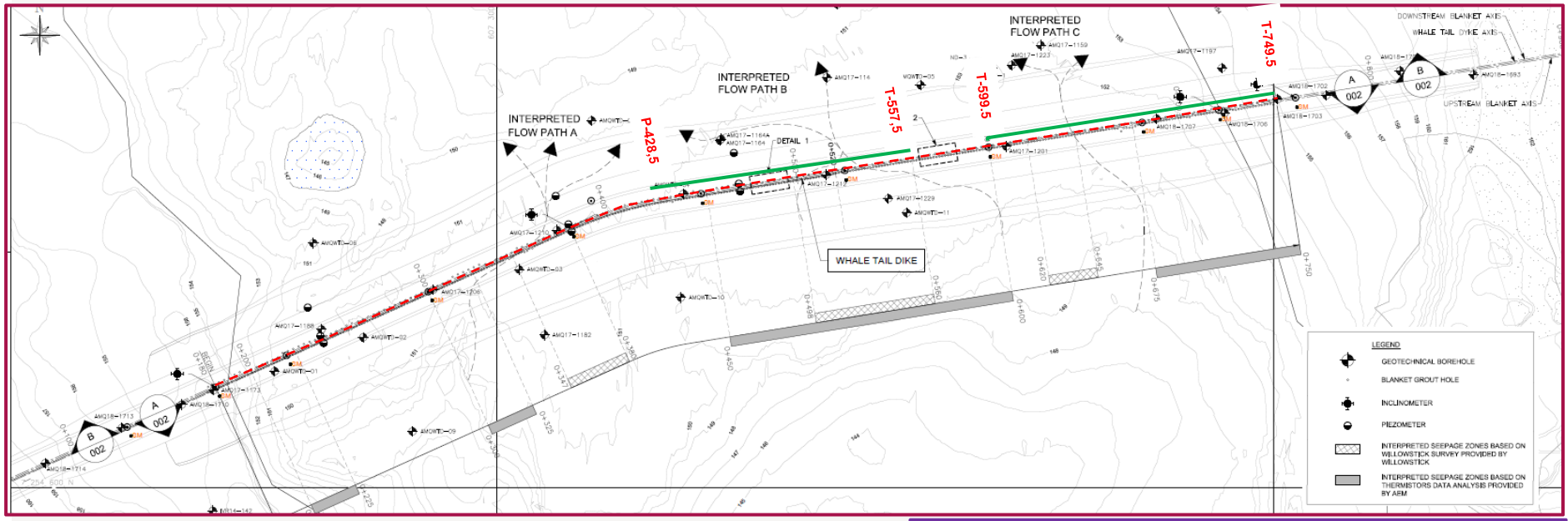
2 – CASING PLUG GROUTING



Downstream Blanket
Planned : 192 casing plugs (P, S. T)
Casing Plug Grouted : 85 casing plugs
Outstanding: 107 casing plugs

Upstream Blanket
Planned : 384 casings (P, S, T and Q if required)
Grouted : 0 casings

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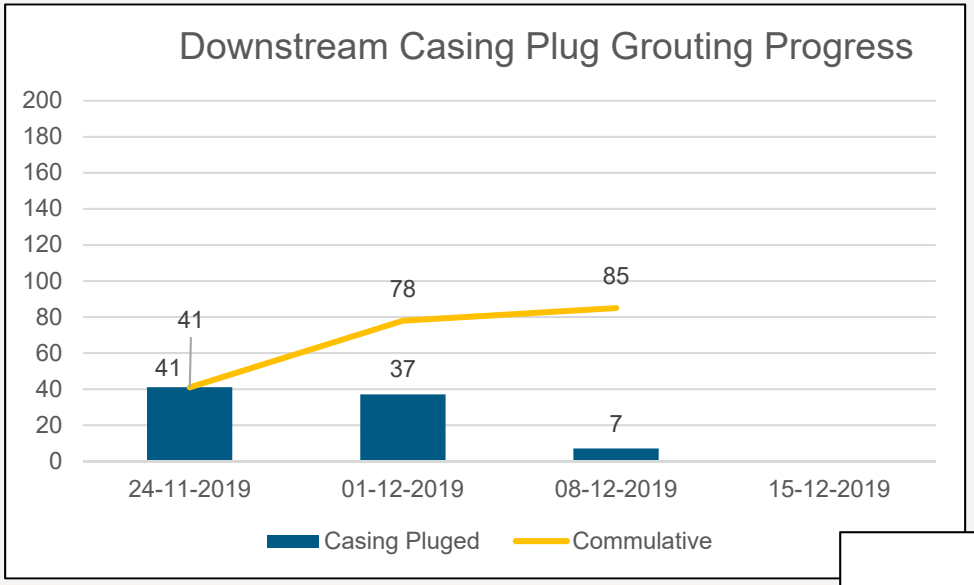
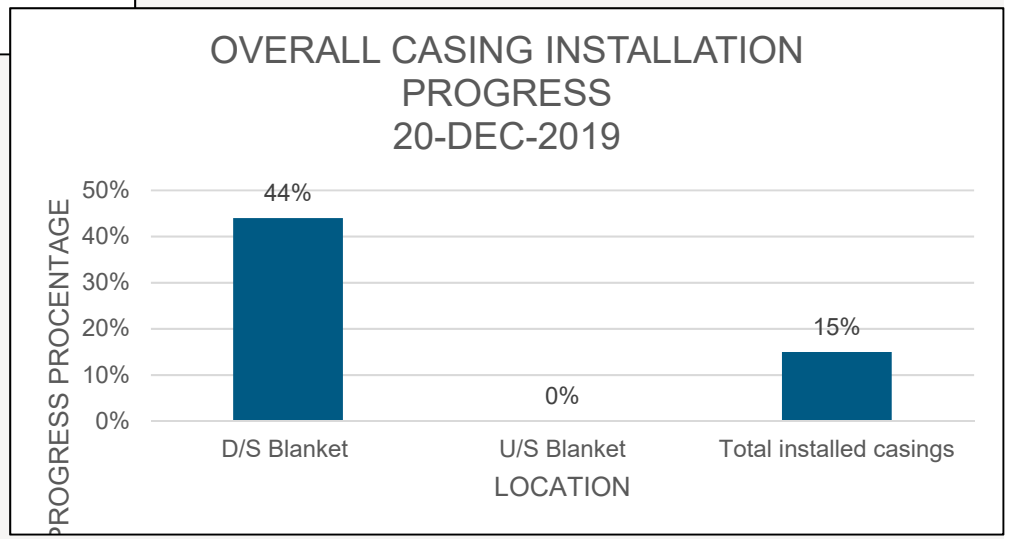
2– CASING PLUG GROUTING – CONT'D



Casing Plug	Planned	Grouted	%
Downstream Blanket	192	85	44%
Upstream Blanket	384	0	0%
Total	576	85	15%



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2– CASING PLUG GROUTING – CONT'D

Grout Mix for Casing Plug - Mix C	
W/C Ratio	0.5
Calcium Chloride	2%
Celbex 653	0.2%

Casing Plug Grouting Details	
Minimum Grout Volume (Liters)	0.6 *
Average Grout Volume (Liters/Plug)	44
Maximum Grout Volume (liters)	200
Maximum pressure (Bars)	2
Total Volume of Injected grout (liters)	3 716

* Very low grout volumes were injected in the holes where Cement Bentonite mud was encountered

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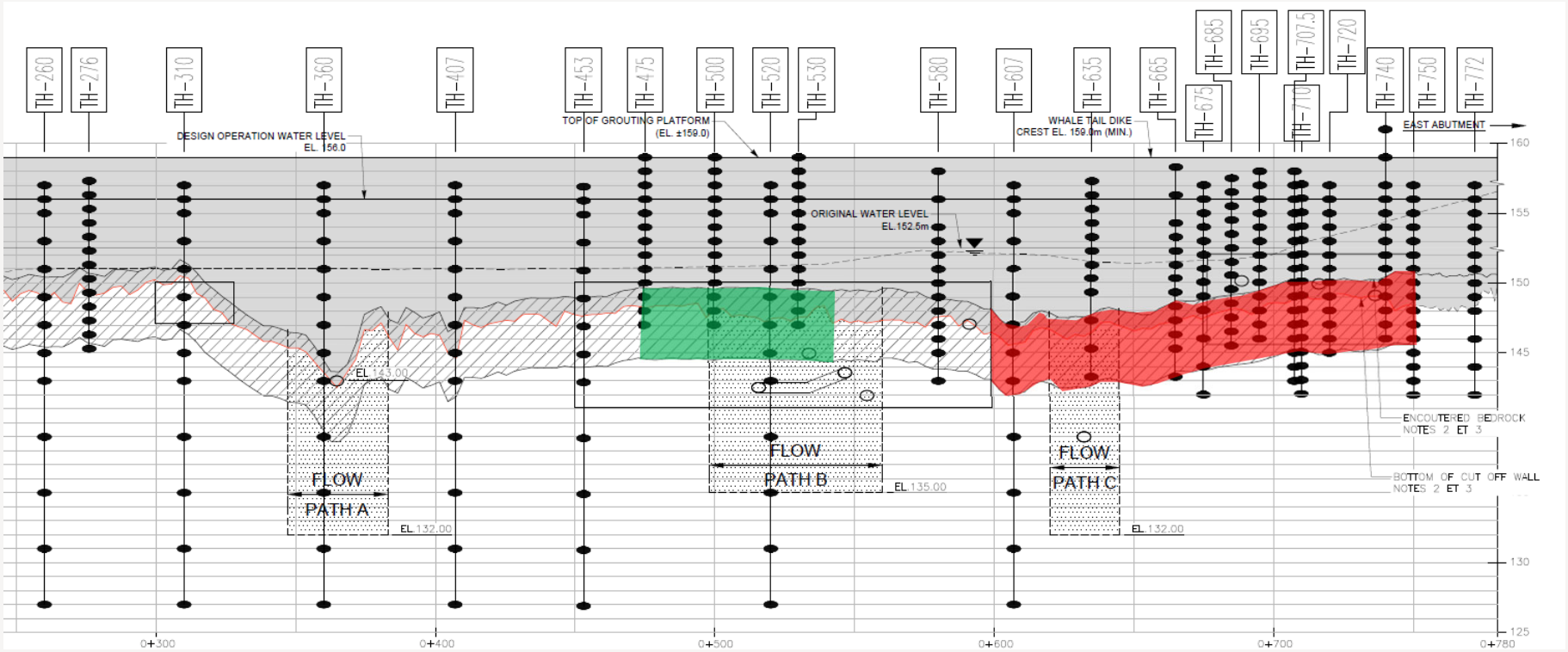
3- ROCK DRILLING



25 Holes were drilled between 0+746 and 0+596

- 12 Primary holes drilled in 1 stage of 5.0 m
- 13 Secondary holes drilled in 2 stages of 1.5 /3.5 m
- All holes are grouted except S-602.5
- Total drilled length = 142 m

6 Holes were drilled between 0+536 and 0+476

- 6 Primary holes drilled in 1 stage of 5.0 m
- All holes are NOT grouted
- Total drilled length = 31.5 m

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4- ROCK GROUTING – Grout Mixes

Grout Mixes used in the Primary and Secondary holes grouting are indicated In the following Table:

Material	Mix C	Mix C+	Mix D
Water (Kg)	60	60	60
Cement (Kg)	120	120	120
Calcium Chloride 2% (Kg)	2.4	2.4	1.2
Celbex 653 (kg)	--	0.24 (note1)	--
Rheomac 450 (ml)	--	--	500

- Grouting of the hole started with Mix C
- If high take , Mix C is change to Mix D
- Mix C+ (with Celbex) is used only when the grout take exceeded Vmax of the stage and in re-grouting of the hole.

Note 1

- Celbex is added manually directly into the Open Throat Pump (increment of 0.2% per 200 L of injected grout)

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4- ROCK GROUTING – Grout Mixes CONT'D

Adding Celbex manually into the open throat pump

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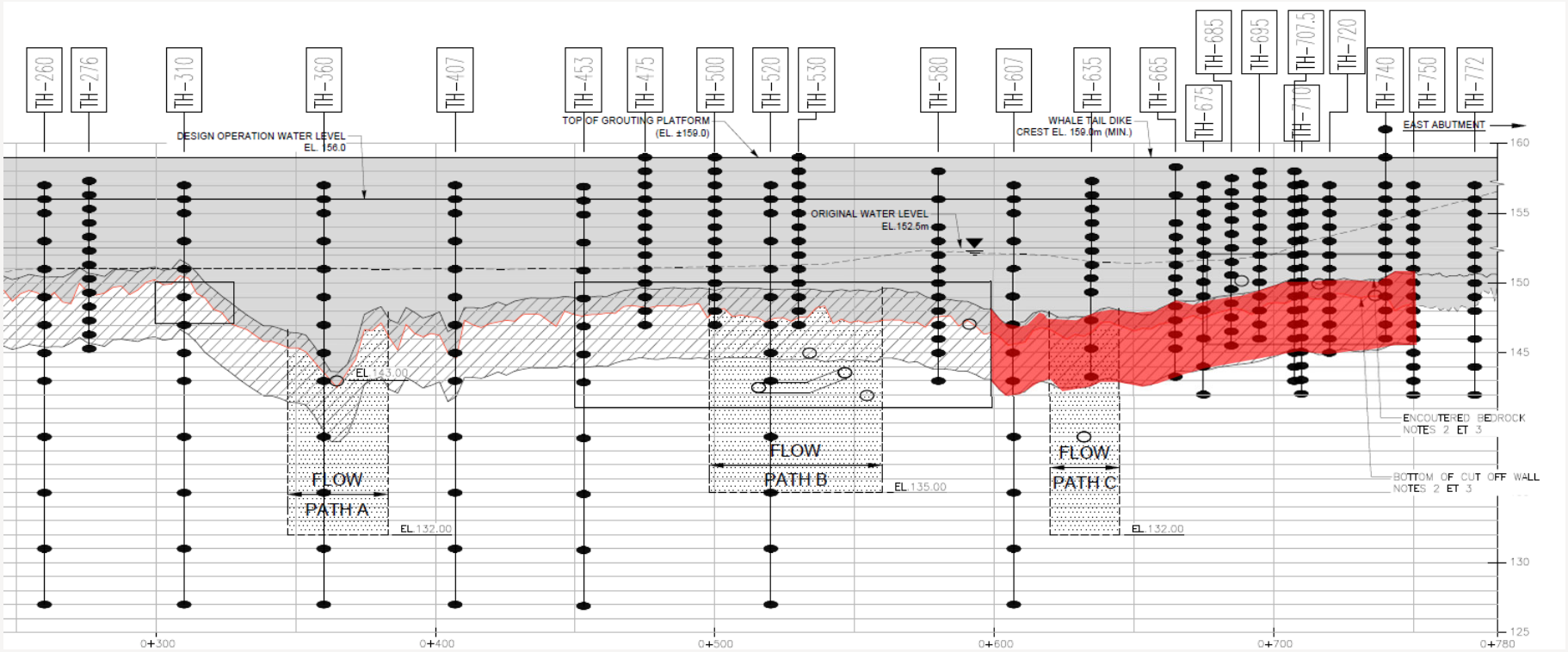
4- ROCK GROUTING



24 Holes were grouted between 0+746 and 0+596

- 12 Primary holes were grouted in 1 stage of 5.0 m
- 12 Secondary holes were grouted in 2 stages of 1.5 /3.5 m.
- Total grout volume = 32 906 Liters

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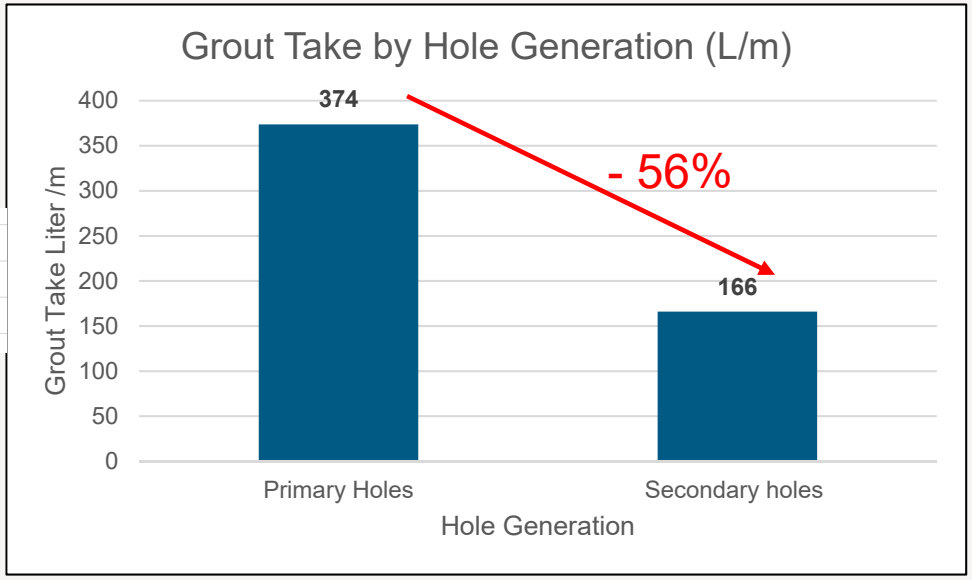
4- ROCK GROUTING – CONT'D

	DRILLING	GROUTING Volume in Liters					
Holes generation	**0-5m**	**0-5.0 m for P 0-1.5 m for S**	**1.5 - 3.5 for S**	**Re-grouting - 1**	**Re-grouting - 1**	**Re-grouting-3**	**Total Volume (L)**
Primary Holes	63	17,205		5,316	788	236	**23,545**
Secondary Holes	58	1,208	6,098	1,984			**9,290**

	Total drilling	Total Grout	Liter/m
Primary Holes	63	23545	374
Secondary holes	44	7306	166



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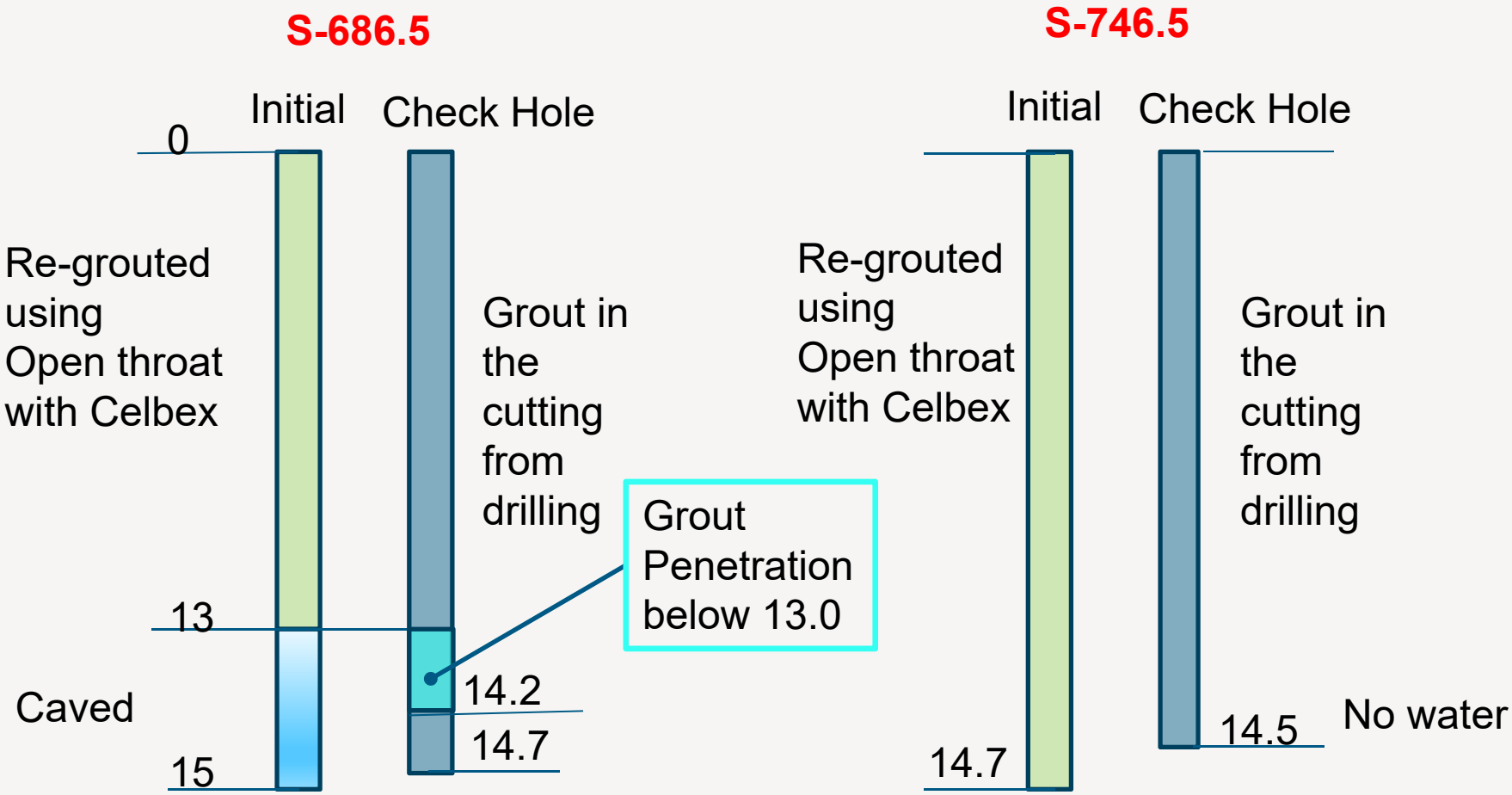
4- ROCK GROUTING – CHECK HOLES

Two pre-grouted holes were re-dilled S686.5 and S746.5



5. CHALLENGES AND MITIGATIONS

Use of Celbex issues:

1. System cannot pump the grout with Celbex under a flow of 15 L/min. grout becomes too thick and clogs the grouting system which becomes very hard to clean.
2. The rate of added Celbex in the open throat pump is difficult to control since it is added manually. The Celbex is not appropriately mixed with the grout
3. Temperature of the grout changed after adding calcium Chloride, this may impact Celbex behavior.
4. Fluctuation in the grouting pressure showing very high pressure on the gauge. High pressure combined with high grout flow will cause hydro-jacking of the foundation.
5. Refusal criteria are not applicable

Mitigations:

1. Grouting flow rate was maintained above 15 L/min.
2. Try to carry out tests and build a learning curve to establish the good procedure.
3. It is agreed to perform few tests to verify Calcium Chloride and Celbex compatibility by reducing Calcium Chloride dosage from 2% to 1% or less when using Celbex.
4. Establish a pressure of 10 bar as a Pmax threshold .
5. Refusal criteria for grouting with Mix C+ using open throat pump: if Pressure reaches 10 bars.

5. CHALLENGES AND MITIGATIONS (CONT'D)

Blanket hole in two stages - Issues

1. Drilling and grouting in two stages required more time, coordination and logistics.

1. Most of Secondary holes first stage between 0 to 1.5 m were closed by pressure without reaching Vmax of the stage.
2. Most of the Secondary holes stages between 1.5 to 5 m exceeded Vmax and were re-grouted

Blanket hole in two stages- Mitigations

The use of blanket drilling and grouting method in two stages will be limited to 2 following cases:

1. Where the water loss is noticed in the first 1.5 m
2. If the hole may be collapsed due to field conditions.

Otherwise, drilling and grouting of the blanket hole will be done in one stage of 5.0 m.

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6. TOPICS FOR DISCUSSIONS

Grout Mixes

1. Use of Celbex in Open Throat Pump.
   - ✓ Compatibility with calcium chloride
   - ✓ Pressure vs Flow
   - ✓ Refusal criteria
2. Use of Mix D.
   - ✓ Mix D showed a stable behavior during grouting. Most of the holes got refusal with Mix D.
   - ✓ No clogging problems of the system
   - ✓ Refusal criteria can be applicable

Drilling and Grouting of the blanket hole in two stages

- ✓ Use two stages where required only

Grouting Sequence of D/S and U/S blanket

- ✓ Systematic drilling and grouting of all planned holes

Or

- ✓ Drilling and grouting targeted areas based on the survey results.

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Saleem, Muhammad

From: Grant Bonin <grant_bonin@golder.com>
Sent: February 2, 2020 4:36 PM
To: Thomas Lepine; Alexandre Lavallee; Frederick Bolduc; Jesse Clark
Cc: Donald Bruce; peter.white@multiurethanes.com
Subject: [EXTERNAL] WTD_Meeting No. 6_Guidance
Attachments: Meeting No.6_reference slides.pdf

Follow Up Flag: Follow up
Flag Status: Flagged

Thomas / Frederick / Alex / Jesse;

DATA DOWNLOADED

Hi. Thank you for the large amount of data provided to the Technical Committee for review. While it is helpful, it is not our intention to sift through each daily and weekly report nor handwritten data collection sheet. That would take far too much time to allow expedient feedback to be provided to those carrying out the works. Concise, visual (when possible) and only the SNC grouting database + KCG quality control database as well as the items discussed below would be more effective.

Feedback to the grouting team from the Technical Committee should be easy to provide, allowing the site staff to make real-time decisions. On behalf of the Technical Committee, if necessary, it would be more cost effective to have a junior level engineer from Golder assist with the compilation of data for comparative purposes with what has been pulled together into the Excel spreadsheet by SNC and KCG.

ADDITIONAL COMMENTS

The data is not well enough presented visually to be entirely useful at the moment (more on that below). However from the grouting progress long-section, the following observations have been made:

- Grouting of the primary order holes between approximately sta. 0+536 and 0+570 has been completed.
- However, rather than split-space these holes and only complete the secondary order holes, drilling and grouting activities have circled back to complete tertiary order holes.

Regarding the use of Celbex. We understand that Celbex-assisted grout mixes are not consistently being used to close stages of injection.

- The process outlined previously was that if after injecting Mix C, the stage being injected was determined to be taking, that Celbex should be added to the open-throat hopper for injection – increased incrementally, as necessary, until refusal by either volume or if possible pressure.
- We note that even on 22 January 2020, while injecting the second downstage of primary hole P-572.5, after injecting Mix C and determining the stage to be accepting the initial mix, instead of switching to Mix C+ Celbex, a decision was made to switch to Mix D. Thereafter, instead of adding Celbex, an additional 1800+ L of Mix D was injected without reaching refusal.
- While stable and pressure filtration resistant, Mix D is not viewed to be a thixotropic grout and as such, is potentially subject to being washed out. This point has been previously highlighted during the Meeting No.5 conference call.

- If KCG and SNC believe that the use of 2% calcium chloride is (for some reason) interfering with use of the combination of Mix C+ Celbex then yes, reduce the dosage to 1% calcium chloride or even 0% calcium chloride when Celbex is required.

Regarding the SNC spreadsheet database (see slides 1 and 2):

- In collecting and reporting grouting data, we suggest that a separate line be used for reporting upon the volume of a given mix injected; and
- That at the end of injection or when switching from one mix to the next thickest mix, that the volume, pressure obtained and flow rate be reported.
    - This is particularly important to report upon at the end of injection, when grouting is halted or has reached refusal.
    - Refusal is the combination of (i) a low rate of injection at (ii) the specified target Pmax. IE. A stage closed with Mix D at a high rate of injection is not considered to be closed.
    - Given the information provided in the database, it will be necessary to go back to the graphical records of every stage of injection to capture what rate grouting was halted at – review the plots of pressure and volume with time in real-time – a time consuming process that can be eliminated by improving the data collected.
- We note that tertiary order grout holes T-695.5 and T-719.5 were not taken to refusal with Mix D, nor were Celbex-assisted grouts injected before halting injection. Additional quaternary order holes may be required on either side of these two holes (i.e. we agree with the highlighted in ”yellow” holes in the SNC spreadsheet database)
- We also agree that additional quaternary order holes on either side of T-731.5 and T-665.5 should be drilled and grouted. However, because of high to very high grout takes, quaternary order holes may also be required on either side of tertiary order holes with takes of greater than 200 L/m – T-683.5, T-689.5 and T-737.5.

The data collection and reporting between cross-shifts of staff needs to be more consistent:

- A QA program manager is necessary whom is on a different, longer shift that the day-to-day field staff is required to oversee all of the data collection.
- That QA managers responsibility is to ensure that no matter what, data collected and annotated upon on each shift is consistent.
    - For example, while after sealing the casings into bedrock, during the first downstage of drilling, the depth to water is reported by some, while not by others?
    - This is becoming an important part of the information collected, and may in the future be used as a potential measure of success of the works.
    - As such, after drilling but prior to injection, we suggest that an attempt to evacuate all the water from the stage drilled be carried out (i.e. using air) and upon mobilizing over the grout hole, the depth to inside the grout hole be measured with a water level meter.

Instead of sending all of the data on a periodic basis, the best use of the Technical Committee would be to send the detailed weekly report of casing installation, casing plugging, drilling, water level measurements inside drilled casing, and grouting activities, every week, as well as the updated grouting progress long-section with the additional details provided below.

- The provision of a weekly report + progress long-section will allow the Technical Committee to stay current with on-going site activities, rather than need to “catch-up”. The opinions to be provided should be based on current rather than dated activities.
- If possible, the weekly report should also include details regarding water seepage rates reporting to the downstream side of the dam - graphically, by zone of collection, as well as cumulatively.
- The weekly report should also provide pumping/extraction rates from the open pit. So that when weather prevents obtaining measurements of seepage rates from the trenches, at least for comparative purposes the pit pumpback rates can be monitored and a pattern established with time.

GROUTING PROGRESS LONG-SECTION

Moving forwards, we believe that a better approach would be to send a more detailed grouting progress long-section, as per the marked up version of that provided. Summary information that is currently missing from the one currently being compiled includes:

- Depth at which water was encountered, after sealing the casing into bedrock, and during each subsequent downstage of injection. A simple line of a different collar within the casing could be provided.
- Volume (L) / Pressure Obtained (bars) / Final Mix Injected that stage (#) = e.g. 210 / 3.4 / C+
- Grout take does not need to be written within each stage. That is typically expressed in colour, with a Legend, in terms of Litres / metre stage length.
- Symbols w/ connections between adjacent holes, communication with the grout surface, by-pass of the packer which reports up annular vs. inside casing etc.
- Some form of summary of amount of Celbex 653 used (i.e. C+, C++) with the low, water:cement ratio grout.
- Re-injections of the same stage must be shown on the grouting progress cross-section. The scale at which the grouting progress long-section is developed should allow for all re-injections to be shown, even if that means doubling horizontal to vertical ratio.

An example of the type of legend to be included at the bottom of each progress long-section is provided in the attached slide presentation (see Slide 3).

SYSTEMATIC GROUTING VS TARGETED GROUTING

Furthermore, the committee recommends systematic grouting of all primary holes, followed by grouting of all secondary holes on the downstream alignment. After evaluation of drilling and grouting data from primary and secondary holes, grouting of tertiary holes may be prioritized on a targeted basis.

CLOSURE

Given the above comments and concerns, we would like to have a conversation with AEM staff only regarding our observations of the works being carried out. Following that conference call, the points agreed upon can be provided to KCG and SNC, as necessary.

Regards; On behalf of Peter, Donald and Grant

Grant Bonin, MEng, PEng (BC, SK, NB)
Principal, Mining Geotechnical Engineer

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Work Safe, Home Safe

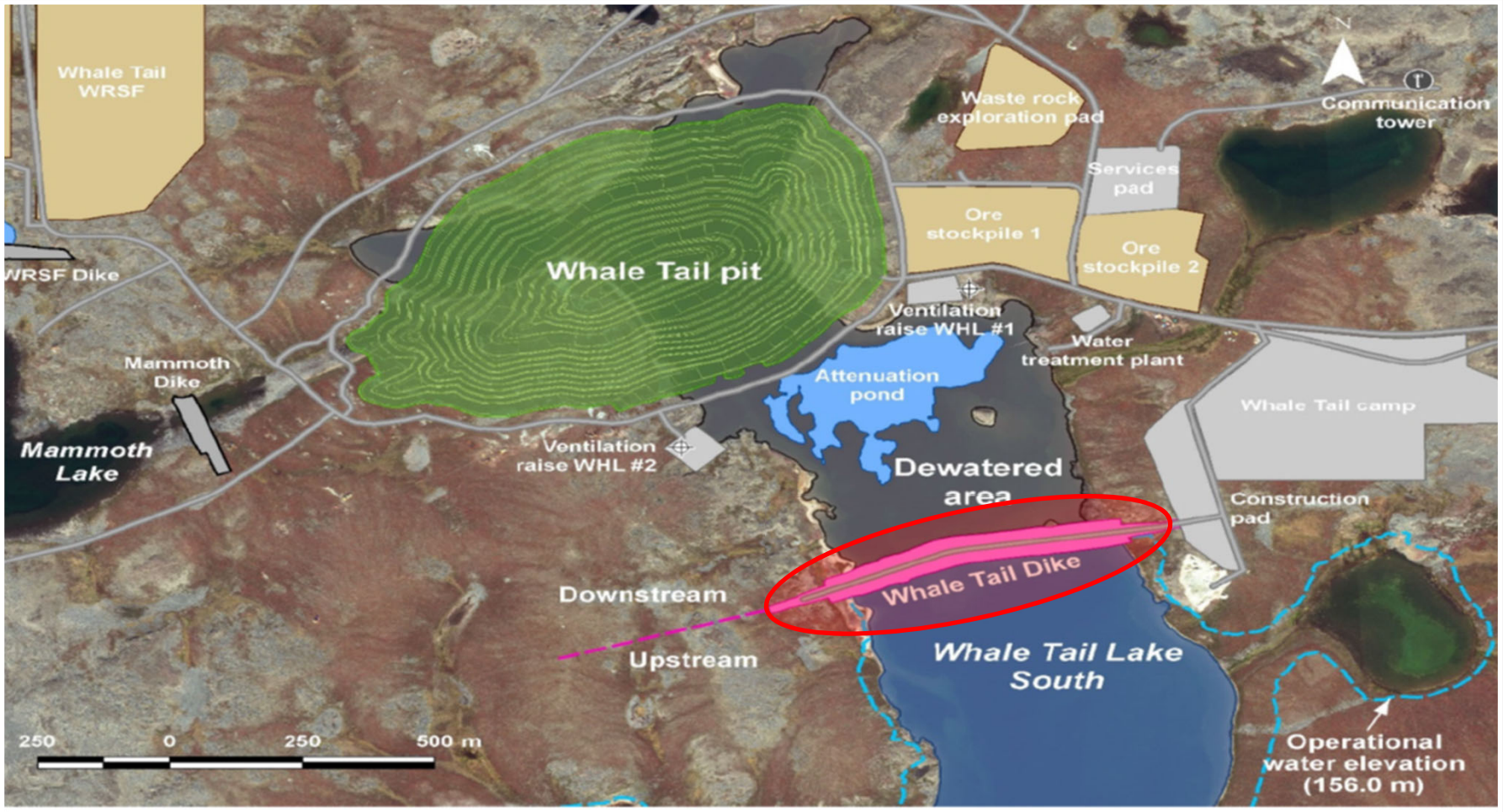
Grouting Committee Meetings No. 7

Presentation

Meeting Minutes

PEOPLE.
DRIVE.
RESULTS.

Amaruq Mine Project Layout – WTD Location



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WTD Remedial Grouting – Work Progress

1. **CASING INSTALLATION**
2. **CASING PLUG GROUTING**
3. **ROCK DRILLING**
4. **ROCK GROUTING**
5. **DOWNSTREAM BLANKET DATA COMPILATION**
6. **UPSTREAM BLANKET PROPOSED STRATEGY**

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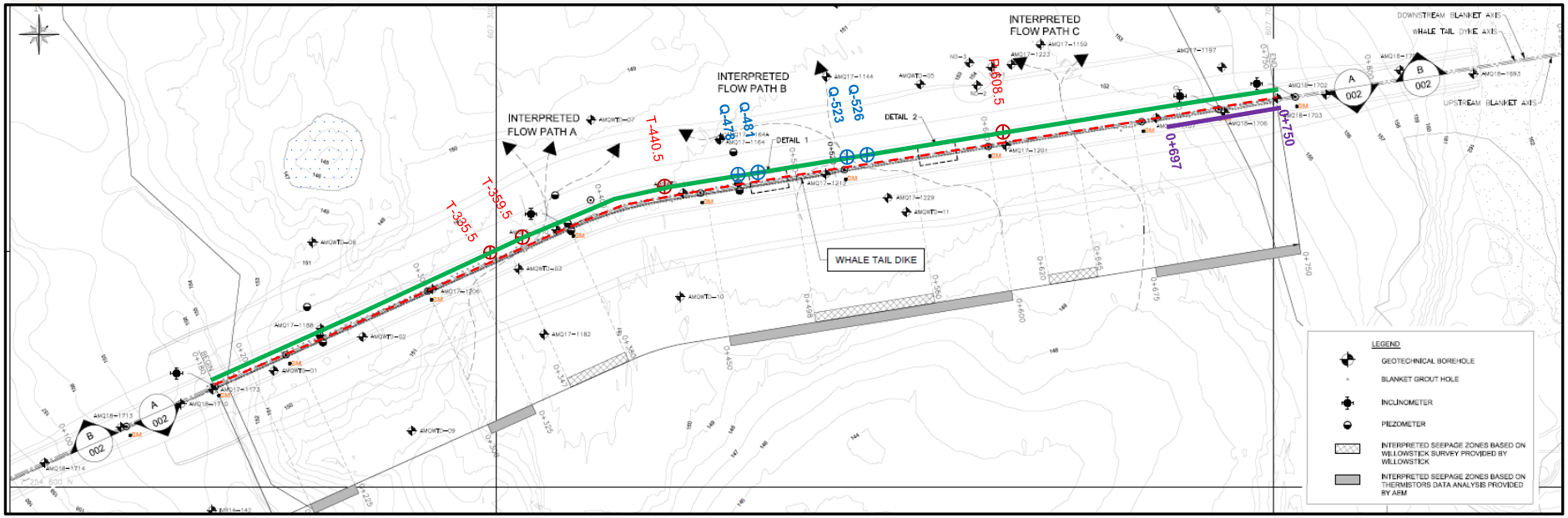
1 – CASING INSTALLATION



Downstream Blanket
Planned: 192 casings (P, S, T)
Additional: 17 casings (Q)
Revised Total: 209
Casing Installed : 201 casings
Outstanding: 8 casings

T-335.5 ⊕ **Outstanding Casings due to buried instrument cables**

Q-478 ⊕ **Quaternary Outstanding Casings**

Upstream Blanket
Planned : 384 casing (P, S, T and Q (if required))
Installed : 18 casings (P, S and T)

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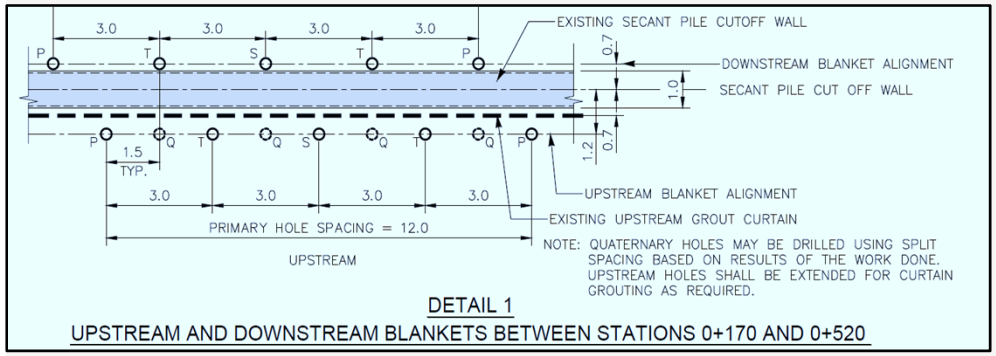
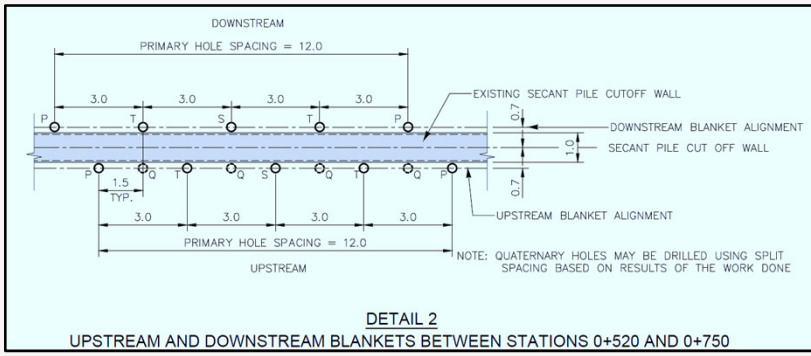
1 – CASING INSTALLATION – CONT'D



DETAIL 1

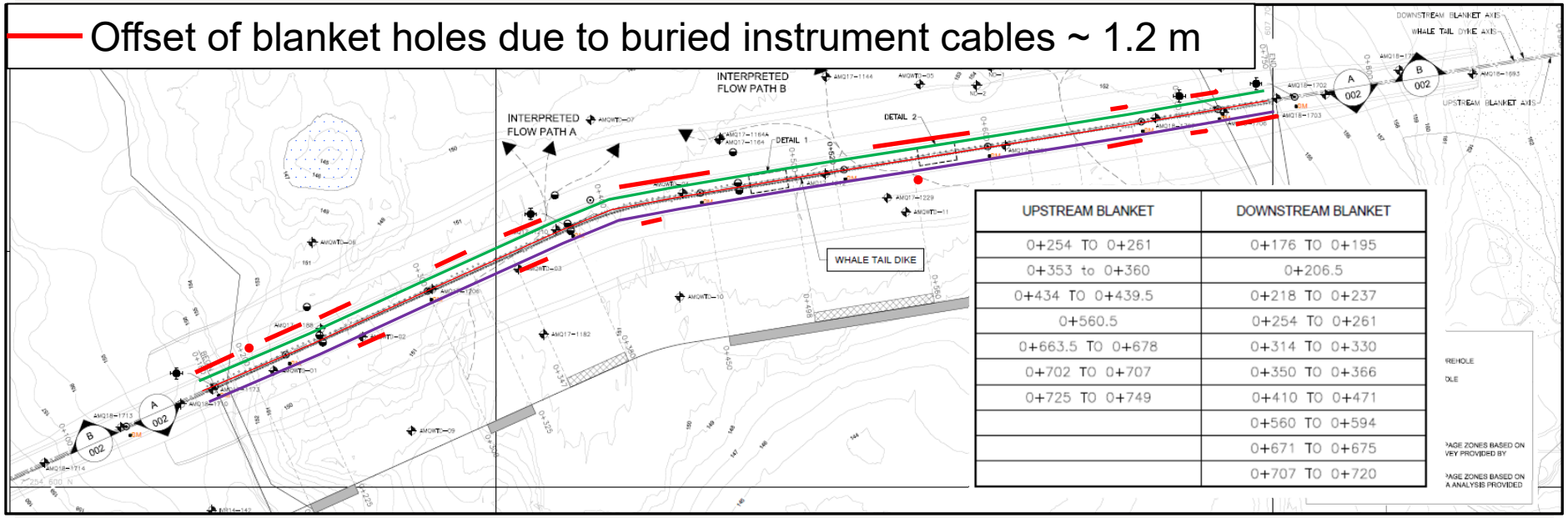
UPSTREAM AND DOWNSTREAM BLANKETS BETWEEN STATIONS 0+170 AND 0+520



DETAIL 2

UPSTREAM AND DOWNSTREAM BLANKETS BETWEEN STATIONS 0+520 AND 0+750

Offset of blanket holes due to buried instrument cables ~ 1.2 m



UPSTREAM BLANKET	DOWNSTREAM BLANKET
0+254 TO 0+261	0+176 TO 0+195
0+353 to 0+360	0+206.5
0+434 TO 0+439.5	0+218 TO 0+237
0+560.5	0+254 TO 0+261
0+663.5 TO 0+678	0+314 TO 0+330
0+702 TO 0+707	0+350 TO 0+366
0+725 TO 0+749	0+410 TO 0+471
	0+560 TO 0+594
	0+671 TO 0+675
	0+707 TO 0+720

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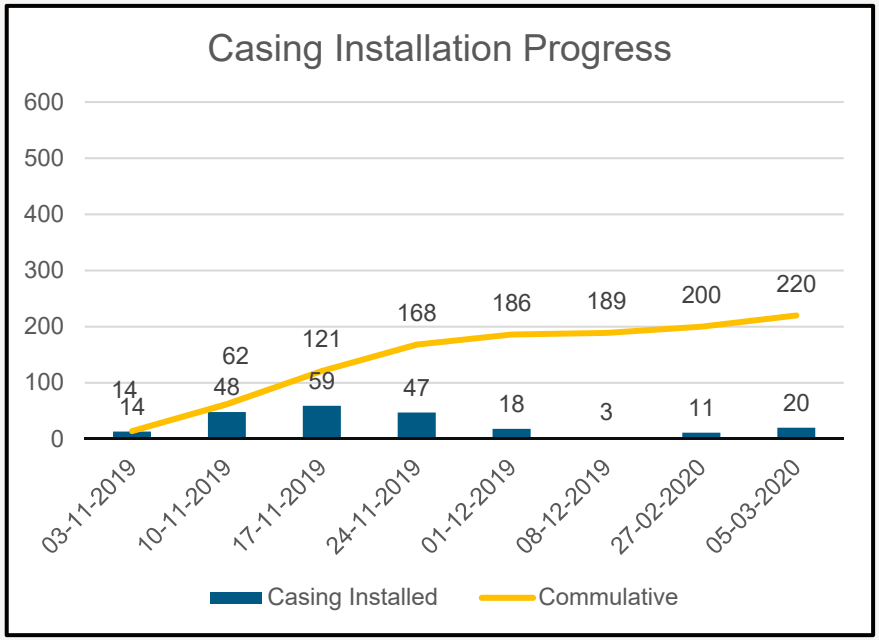
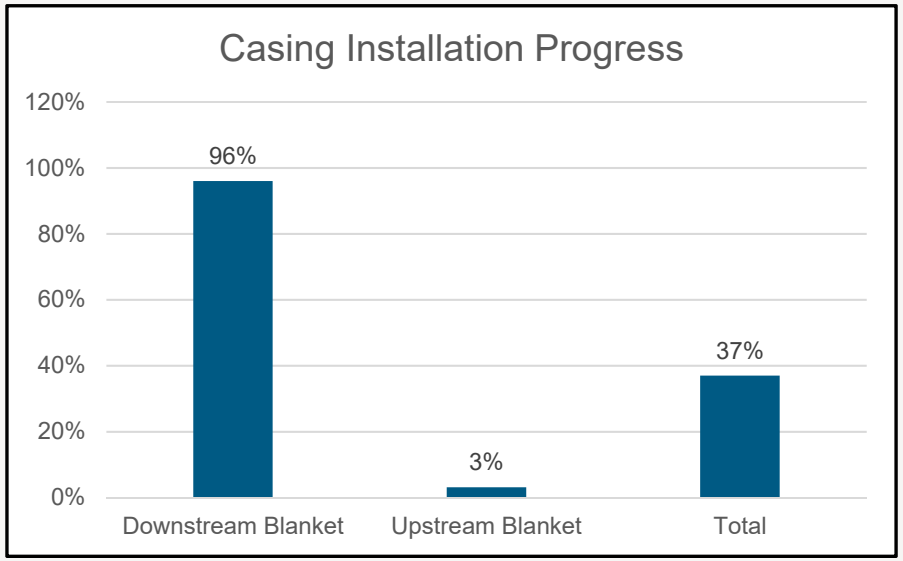
1 – CASING INSTALLATION – CONT'D



	Planned	Additional	Installed	%
Downstream Blanket	192	17	201	96%
Upstream Blanket	384	0	18	3%
Total	576	17	219	37%



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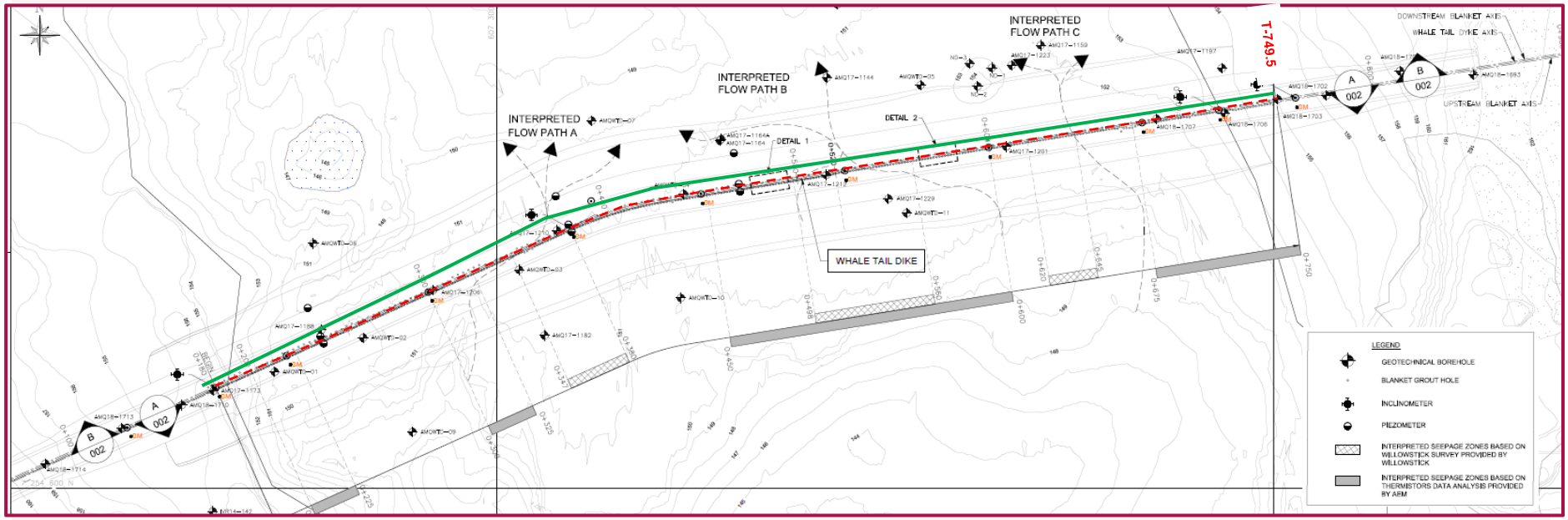
2 – CASING PLUG GROUTING



Downstream Blanket
Planned : 192 casing plugs (P, S,T)
Additional: 17 casing plugs (Q)
Total Revised Casing Plug: 209
Casing Plug Grouted: 185
Casing Plug NOT Grouted: 2
Outstanding: 22

Upstream Blanket
Planned : 384 casings (P, S, T and Q (if required))
Grouted : 0 casings

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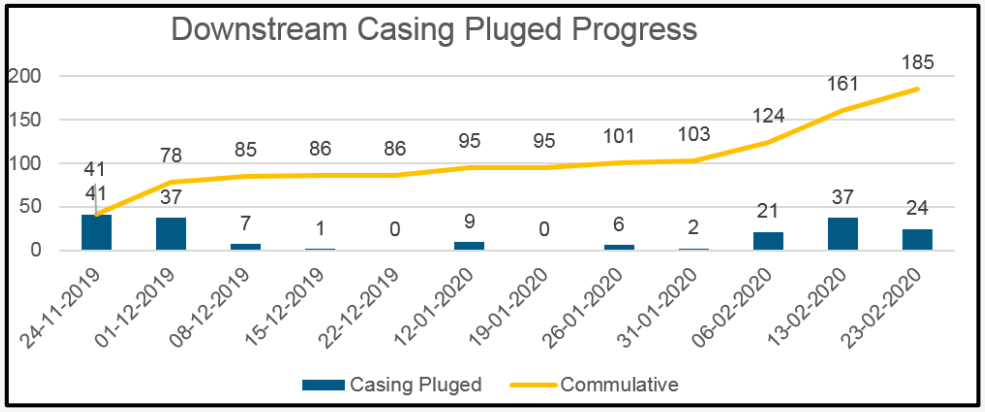
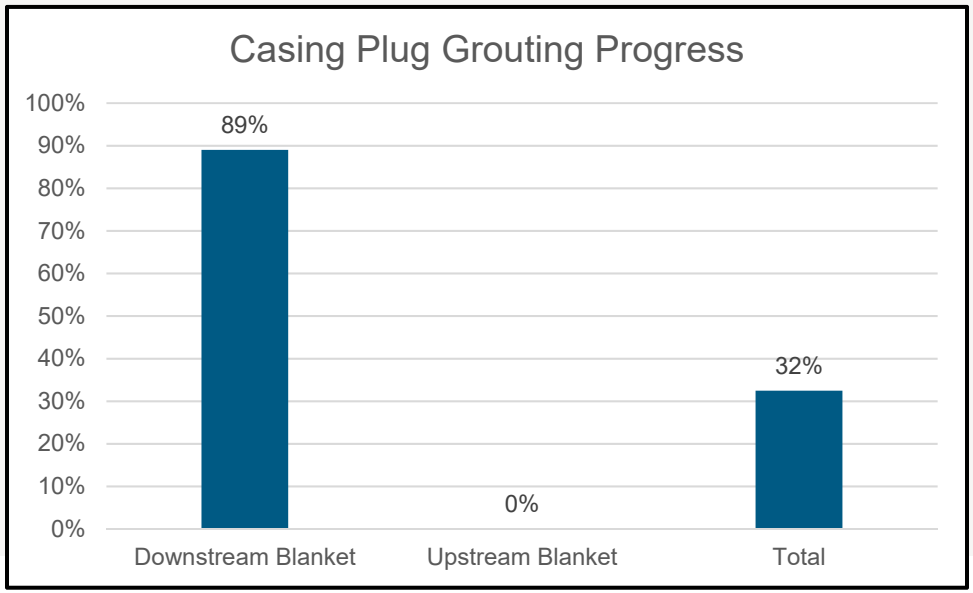
2– CASING PLUG GROUTING – CONT'D



	Planned	Additional	Installed	%
Downstream Blanket	192	17	187	89%
Upstream Blanket	384	0	0	0%
Total	576	17	185	32%

Note: 2 Boreholes were completed without grouting casing plug



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2– CASING PLUG GROUTING – CONT'D

Grout Mix for Casing Plug - Mix C	
W/C Ratio	0.5
Calcium Chloride	2%
Celbex 653	0.2%

Casing Plug Grouting Details	
Minimum Grout Volume (Liters)	0.6 *
Average Grout Volume (Liters/Plug)	52
Maximum Grout Volume (liters)	222
Maximum pressure (Bars)	3.3
Average pressure (Bars)	1.64
Total Volume of Injected grout (liters)	9 697

* Very low grout volumes were injected in the holes where Cement Bentonite mud was encountered

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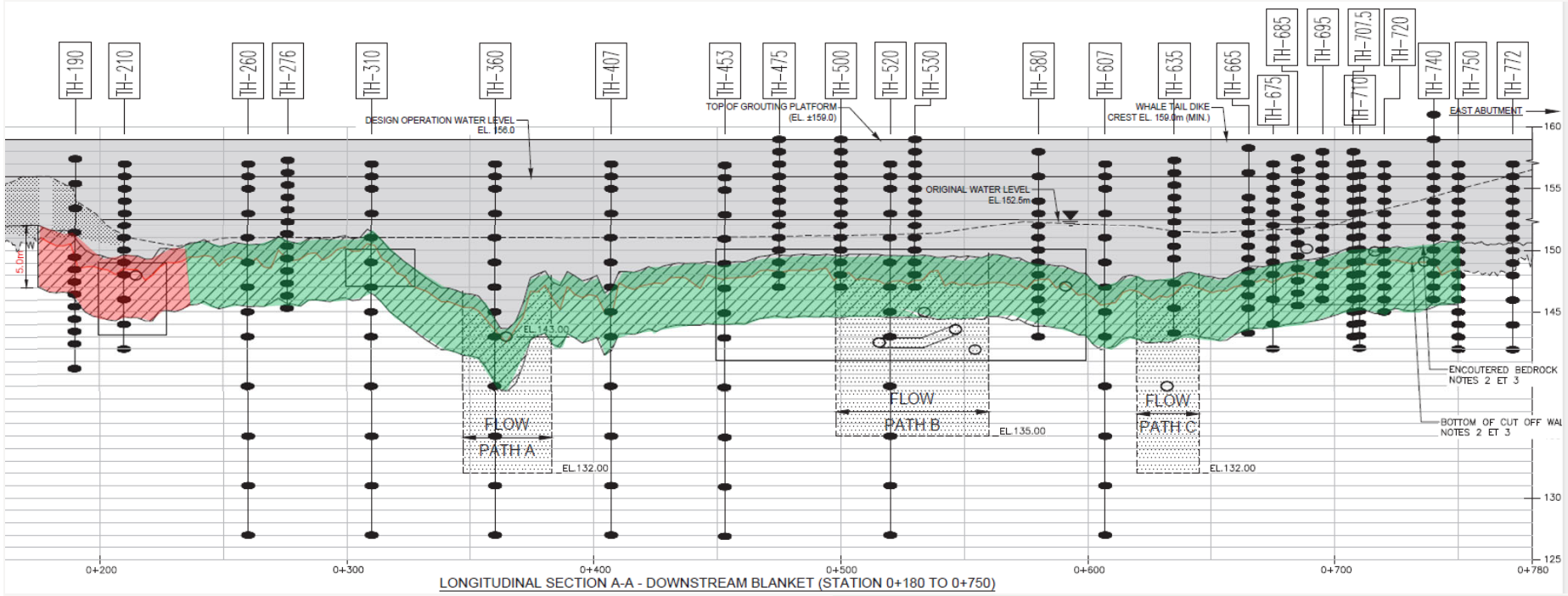
3- ROCK DRILLING (02-Mar-2020)



LONGITUDINAL SECTION A-A - DOWNSTREAM BLANKET (STATION 0+180 TO 0+750)

8 Holes were drilled between 0+176 and 0+224

- 4 Primary and 4 Secondary Holes were drilled and grouted
- Holes were drilled in 1 stage of 5.0 m
- Total drilled length = 43 m

172 Holes were drilled between 0+224 and 0+750

- **160** P, S and T holes were drilled in one stage of 5.0 m
- **12** Secondary holes were drilled in 2 stages 1.5 and 3.5m
- Total drilled length = 851 m

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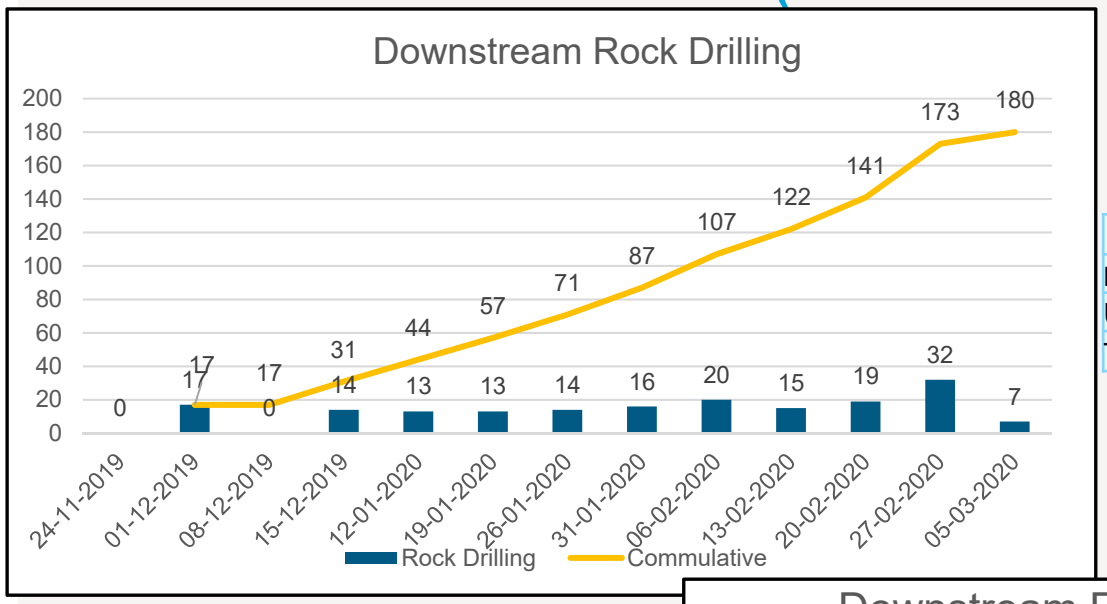
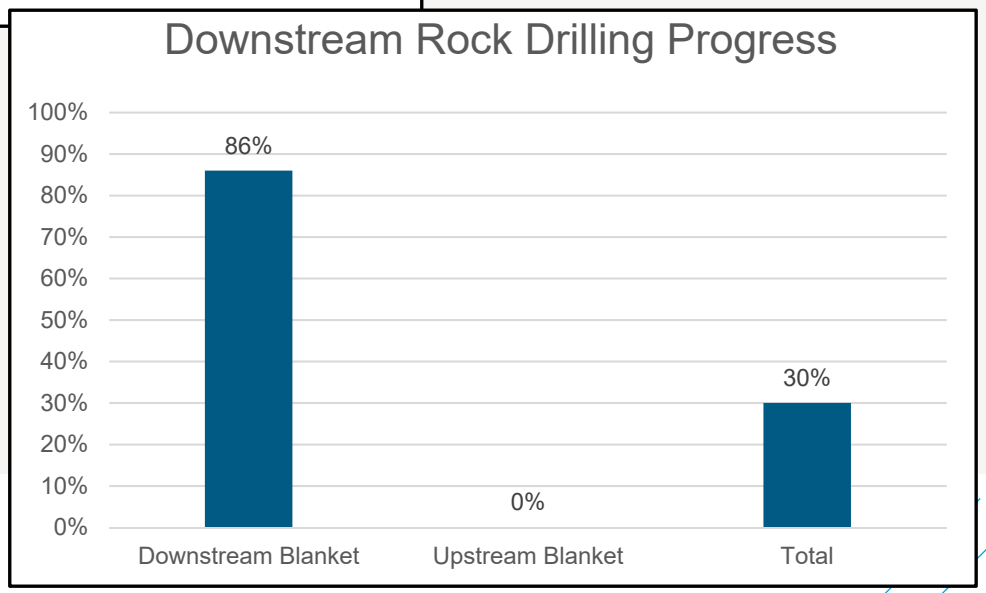
3- ROCK DRILLING, CONT'D (02-Mar-2020)



	Planned	Additional	Installed	%
Downstream Blanket	192	17	180	86%
Upstream Blanket	384	0	0	0%
Total	576	17	180	30%



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4- ROCK GROUTING
Grout Mixes

Grout Mixes used in the P, S and T holes grouting are indicated In the following Table:

Material	Mix C	Mix C+	Mix D
Water (Kg)	60	60	60
Cement (Kg)	120	120	120
Calcium Chloride 2% (Kg)	2.4	2.4	1.2
Celbex 653 (kg)	--	0.24 (note1)	--
Rheomac 450 (ml)	--	--	500

- Grouting of the hole started with Mix C
- If high take , Mix C is changed to Mix D
- Mix C+ (with Celbex) is used only when the grout take exceeded Vmax of the stage and in re-grouting of the hole.

Note 1

- Mix C++: Celbex is added manually directly into the Open Throat Pump (increment of 0.2% per 200 L of injected grout)

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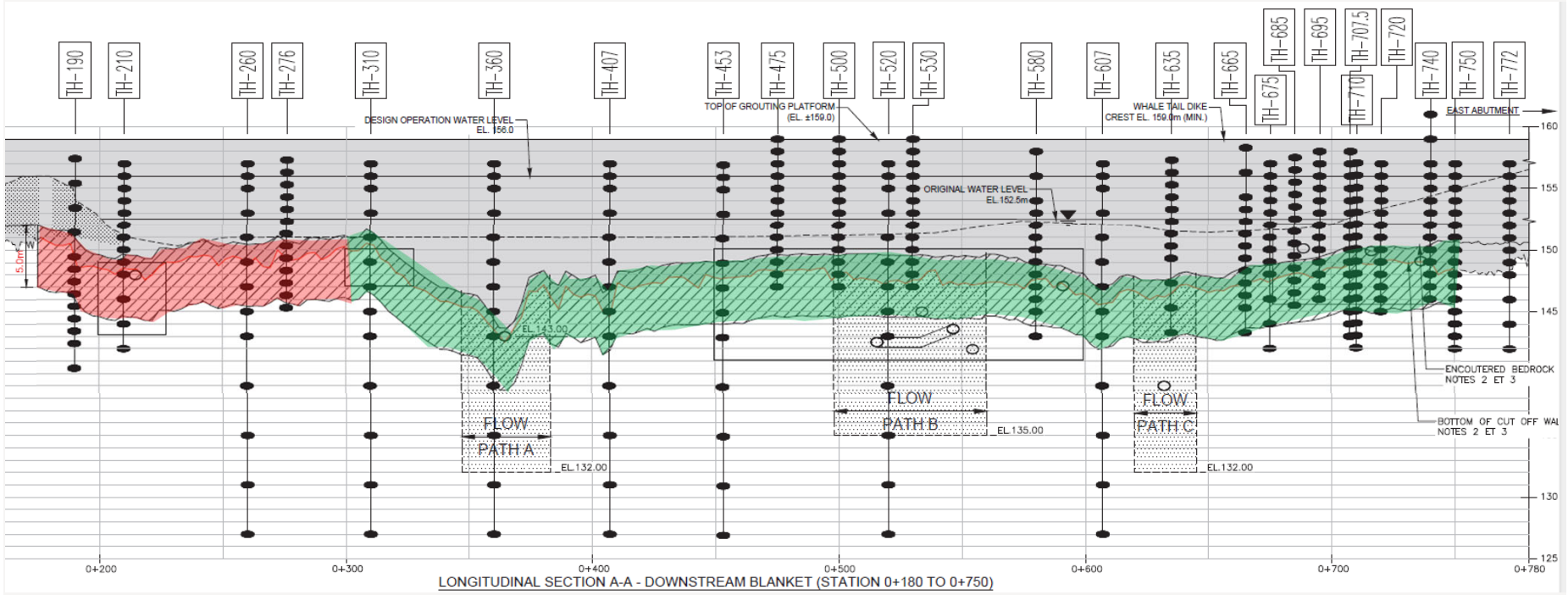
4- ROCK GROUTING (CONT'D) (02-Mar-2020)



LONGITUDINAL SECTION A-A - DOWNSTREAM BLANKET (STATION 0+180 TO 0+750)

20 Holes were grouted between 0+176 and 0+296

- **10** P and **10** S holes grouted
- Holes were grouted in 1 stage of 5.0 m
- Total grout volume = 5,338 L

148 Holes were grouted between 0+750 and 0+296

- **136** P, S and T holes were grouted in one stage of 5.0 m.
- **12** Secondary holes were grouted in 2 stages 1.5 and 3.5m.

20 T and **17** Q not grouted yet

Total grout volume = 77,192L

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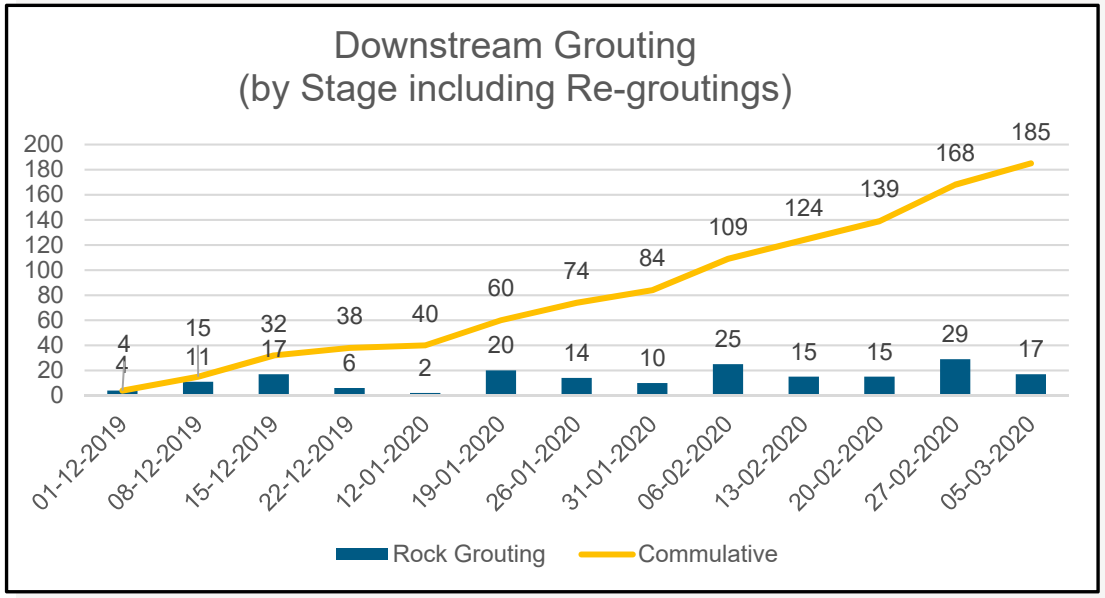
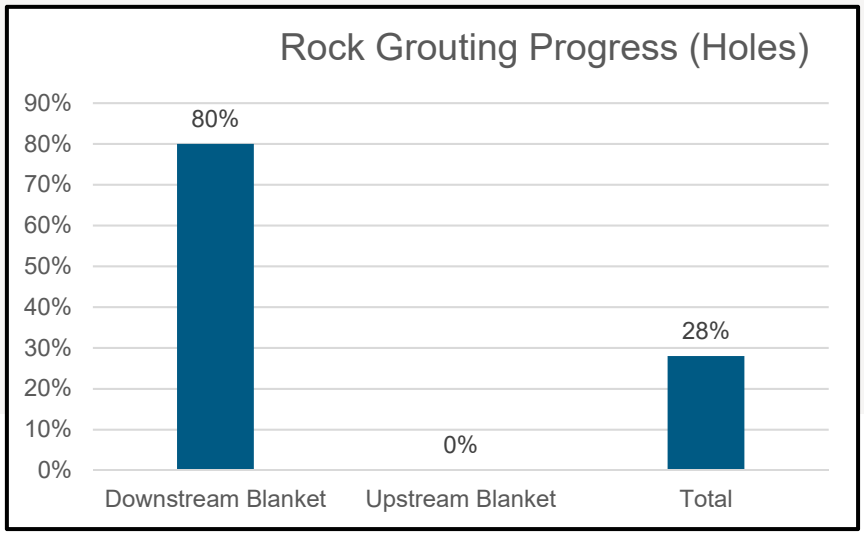
4- ROCK GROUTING (CONT'D) (02-Mar-2020)



	Planned	Additional	Installed	%
Downstream Blanket	192	17	168	80%
Upstream Blanket	384	0	0	0%
Total	576	17	168	28%



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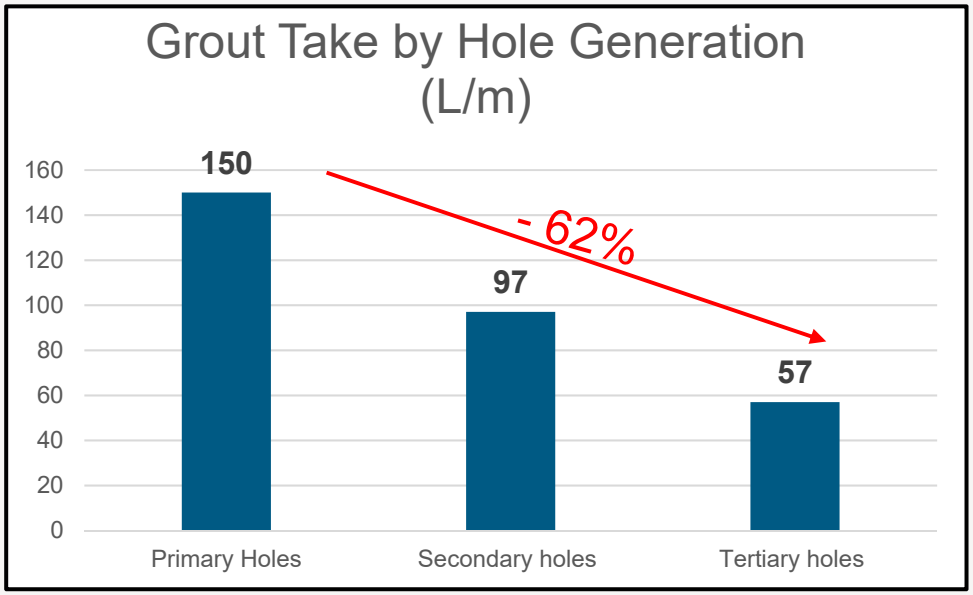
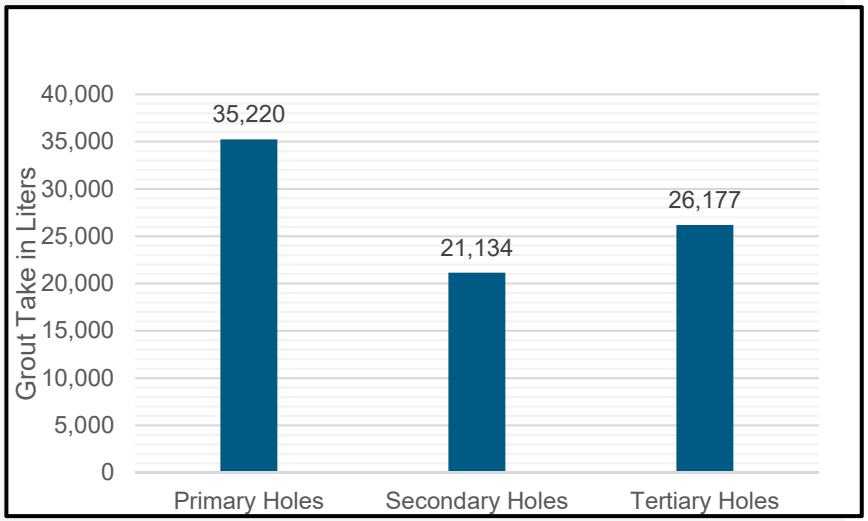
4- ROCK GROUTING (CONT'D)

	DRILLING	GROUTING Volume in Liters						
Holes Generation	0-5m	1 Stage	2 Stage	Re-grouting - 1	Re-grouting - 2	Re-grouting-3	Total Volume (L)	Re-grouting %
Primary Holes	235.55	24,514		9,682	788	236	35,220	30%
Secondary Holes	218.71	9,298	8,789	3,048			21,134	14%
Tertiary Holes	458.36	26,177					26,177	0%

	Total drilling	Total Grout	Liter/m
Primary Holes	235.55	35,220	150
Secondary holes	218.71	21,134	97
Tertiary holes	458.36	26,177	57

	Total Volume (L)
Primary Holes	35,220
Secondary Holes	21,134
Tertiary Holes	26,177





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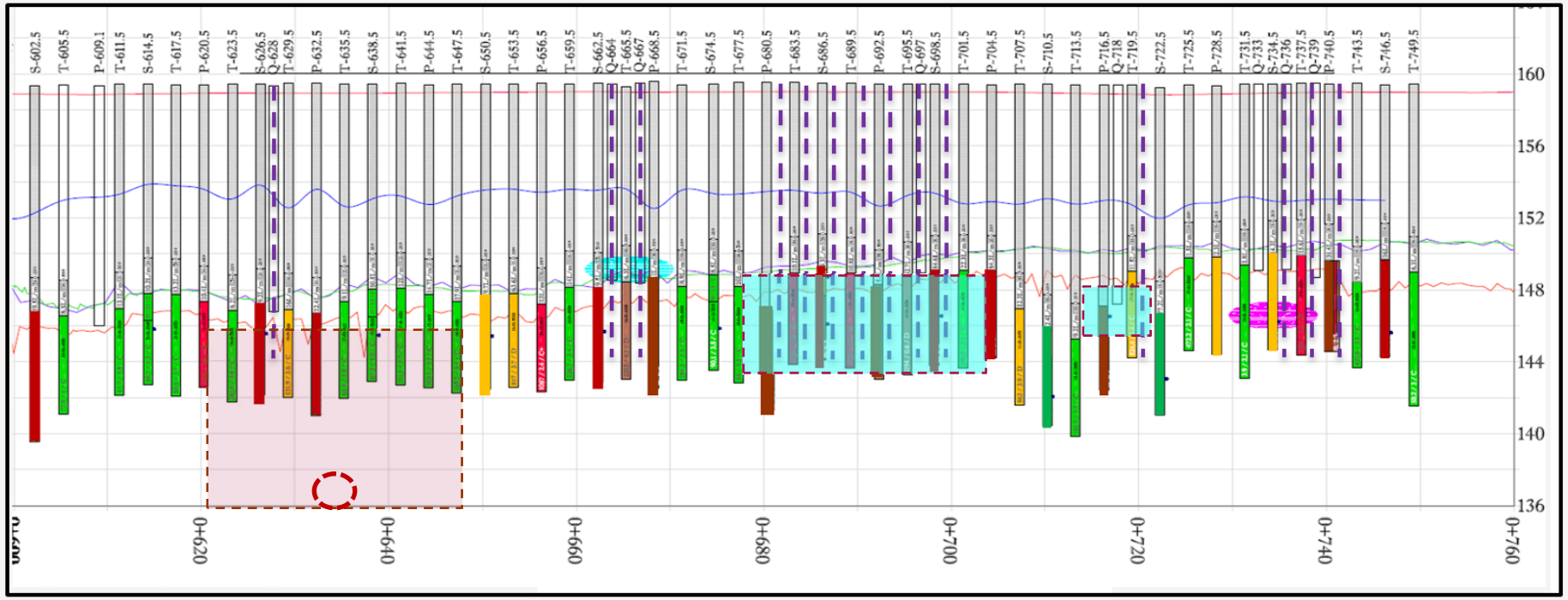
5. DOWNSTREAM DATA COMPILATION SECTION 0+750 TO 0+600



Thermistor Data Anomaly

Willowstick Survey Anomaly

Quaternary Holes

		TAKE : L/m
VOL / P	LOW	< 100
VOL / P	M.HIGH	100 < > 200
VOL / P	HIGH	200 < > 400
VOL / P	V.HIGH	> 400

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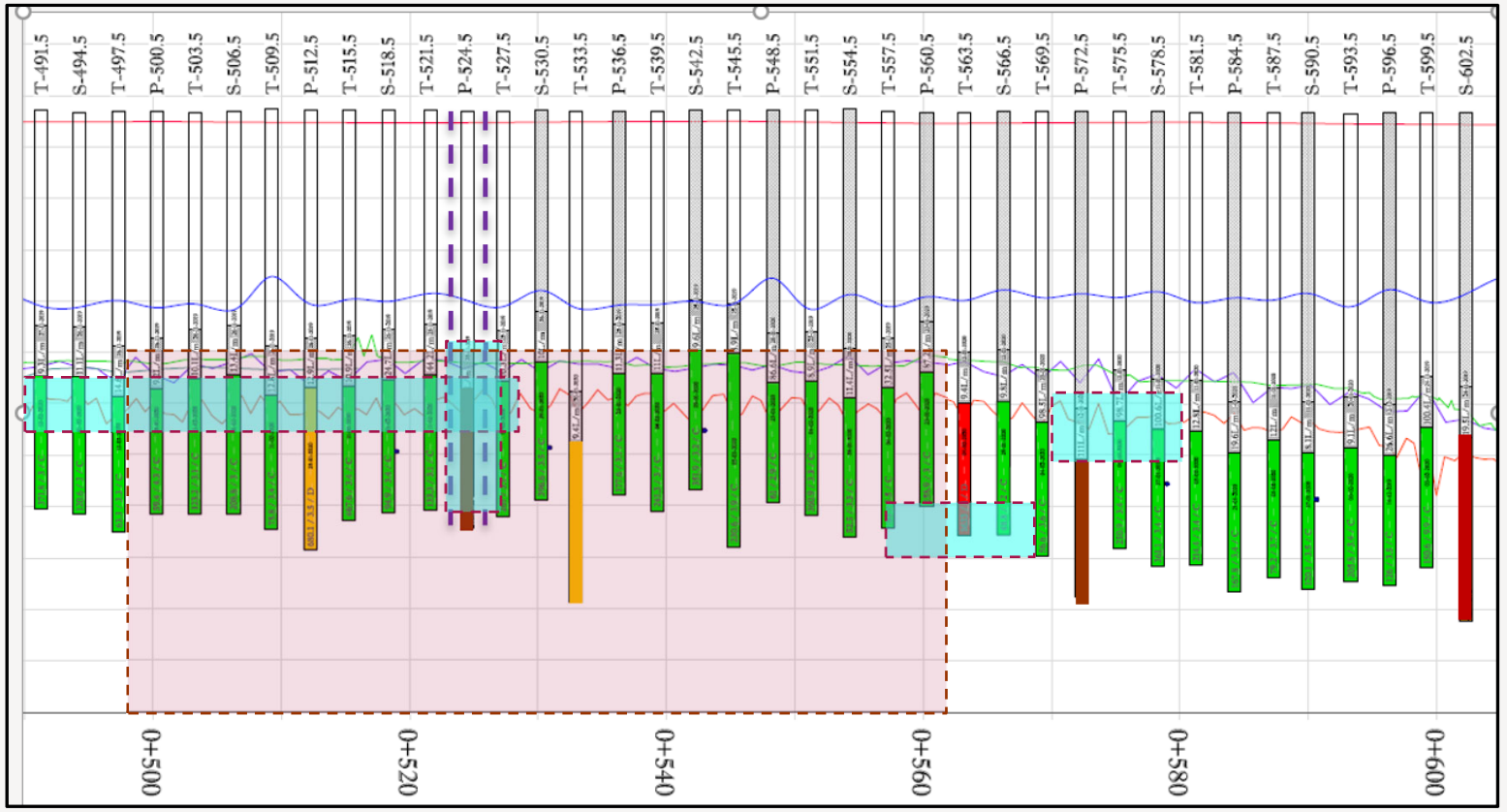
5. DOWNSTREAM DATA COMPILATION SECTION 0+600 TO 0+490



Thermistor Data Anomaly

Willowstick Survey Anomaly

Quaternary Holes

		TAKE : L/m
VOL / P	LOW	< 100
VOL / P	M.HIGH	100 < > 200
VOL / P	HIGH	200 < > 400
VOL / P	V.HIGH	> 400

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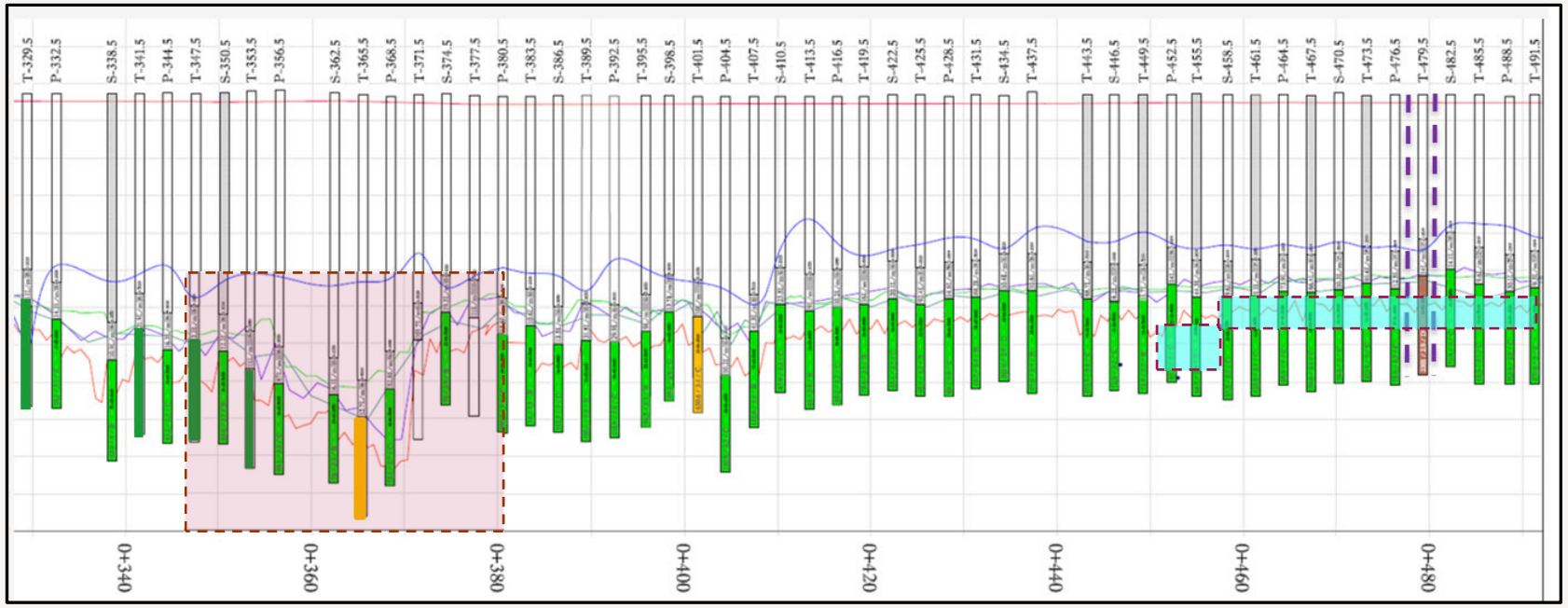
5. DOWNSTREAM DATA COMPILATION SECTION 0+490 TO 0+330



Thermistor Data Anomaly

Willowstick Survey Anomaly

Quaternary Holes

		TAKE : L/m
VOL / P	LOW	< 100
VOL / P	M.HIGH	100 < > 200
VOL / P	HIGH	200 < > 400
VOL / P	V.HIGH	> 400

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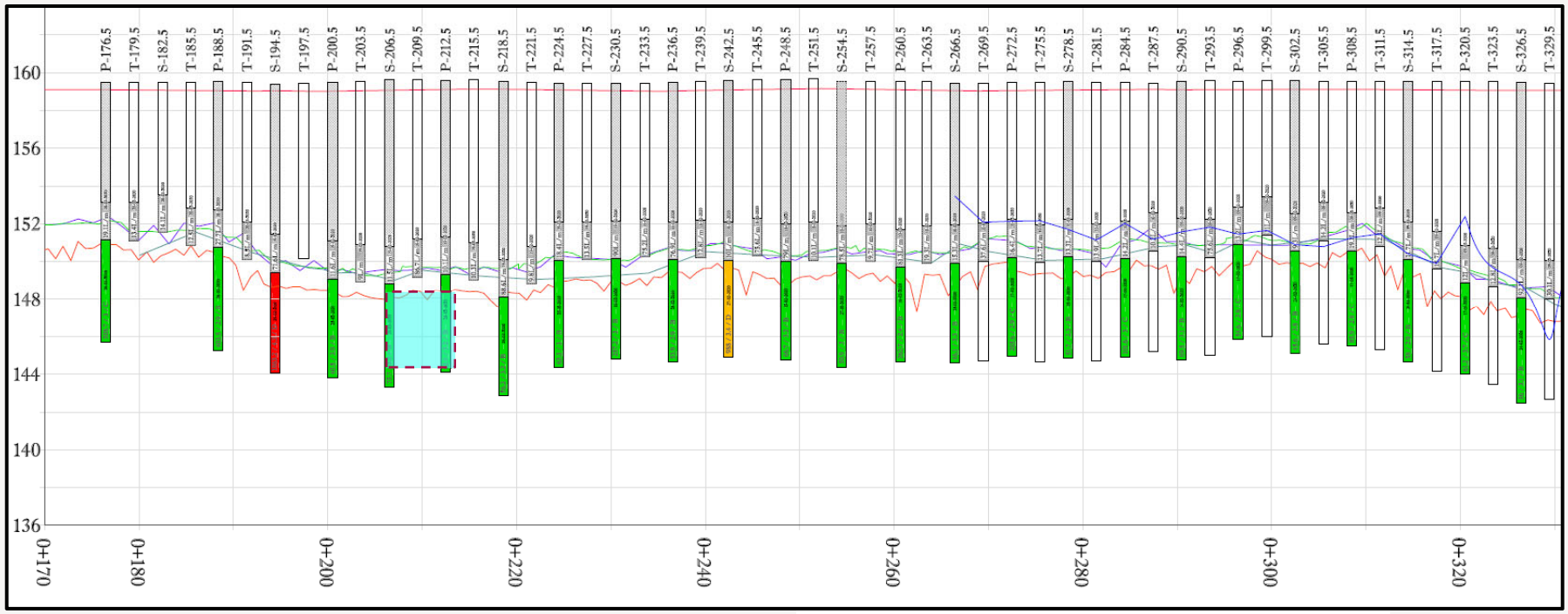
5. DOWNSTREAM DATA COMPILATION SECTION 0+330 TO 0+176



Thermistor Data Anomaly

Willowstick Survey Anomaly

		TAKE : L/m
VOL / P	LOW	< 100
VOL / P	M.HIGH	100 < > 200
VOL / P	HIGH	200 < > 400
VOL / P	V.HIGH	> 400

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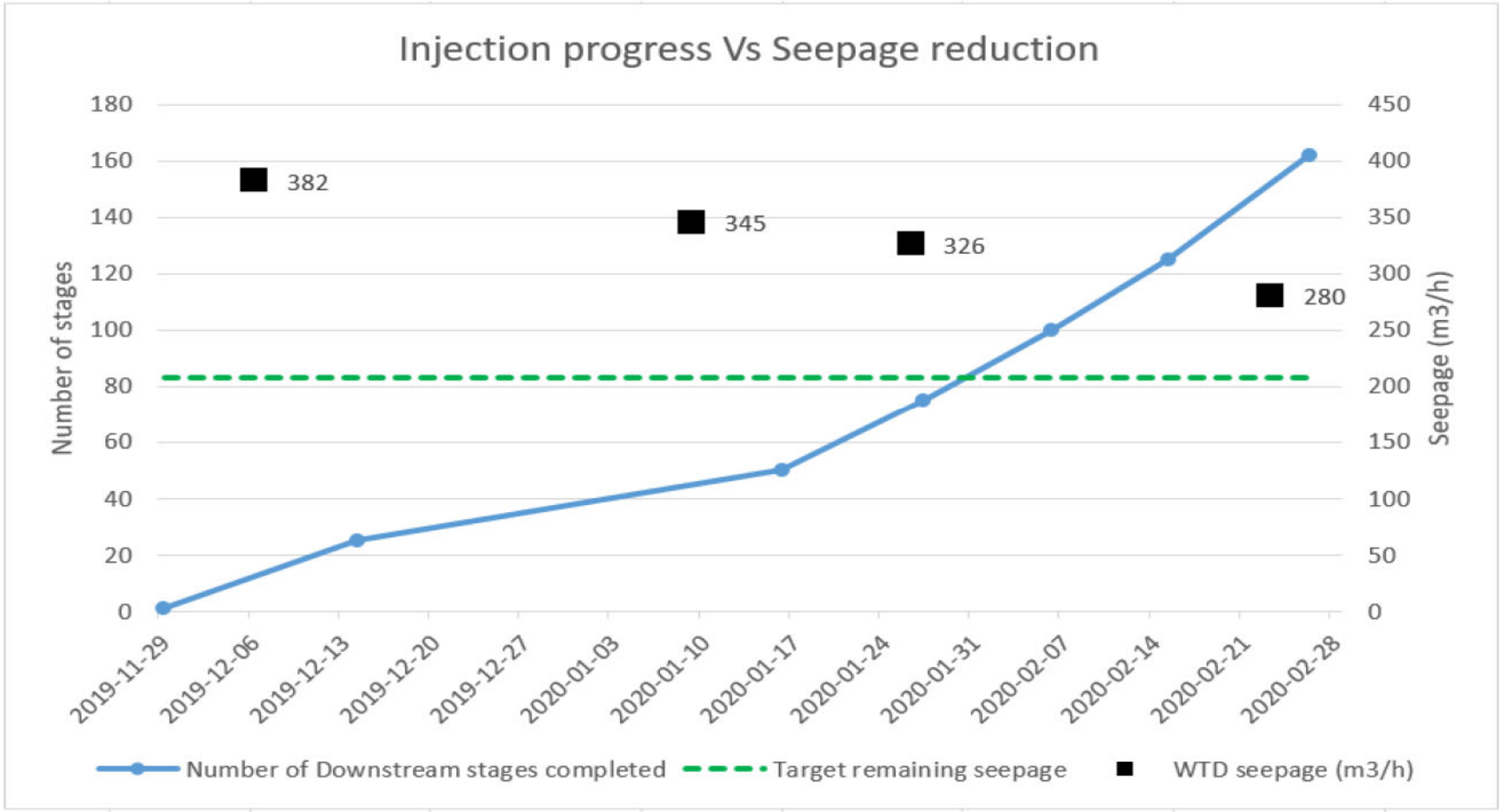
5. DOWNSTREAM DATA COMPILATION (CONT'D)



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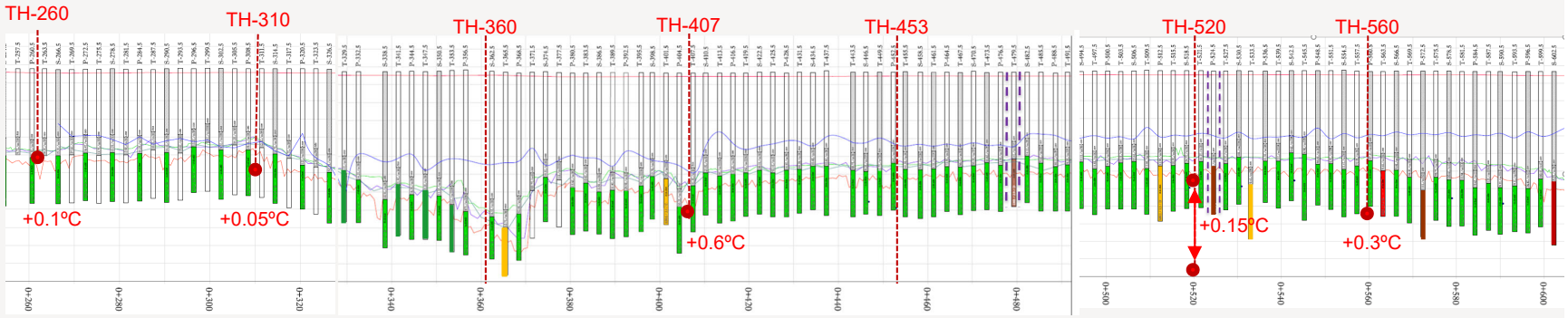
5. DOWNSTREAM DATA COMPILATION (CONT'D)

THERMISTORS REACTION



● +0.05ºC: Temperature variation due to grouting of nearby hole.

- **TH-260:** One of the lowest reaction zone along with 0+407 and 0+360 as per TH analysis to lake temperature. 0.1C reaction with grouting pf P-260.5 at that same date, located direct AT and slightly above bedrock interface for P-260.5. The surrounding tertiaries are not grouted yet.
- **TH-310**: identified as a low thermally conductive zone but not as low as 260, 360 or 407. Warmed up 0.05C reaction linked with grouting of P-308.5 in roughly the middle of the stage. The surrounding tertiaries are not grouted yet.
- **TH-360**: One of the lowest reaction zone along with 0+260 and 0+407 as per TH analysis of lake temperature. No reaction with nearby grout hole.
- **TH-407**: One of the lowest reaction zone along with 0+260 and 0+360 as per TH analysis of lake temperature. Warm up of 0.6C in the bottom half of the stage induced by T-407.5.
- **TH-453**: No reaction at all to grouting, contradicting the fact it was strongly related to lake temperature variations. No reaction with nearby grout hole.
- **TH-520**: Surprisingly, only a bead warm up of 0.15C all along 150 to 143. From all instruments, this was the most conductive beads to lake temperature variation from bedrock @ 149.5 to last bead @ 127 and subject to a Willowstick anomaly.
- **TH-560**: Is the one that reacted the most out of all thermistors across the dike to grouting (also one of the most linked to lake). 0.25C reaction for P-560.5 and 1.5C for T-563.5. This warm up is located BELOW the blanket depth, again suggesting that deeper holes around 0+560 are relevant.

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6- UPSTREAM GROUTING PROPOSED STRATEGY

Considerations for Upstream Grouting Strategy:

- Bedrock Conditions from Geotechnical Investigations (2017 & 2018)
- Seepage Investigation Results: Willowstick Survey and Thermal Instrumentation Data
- 2019-2020 Downstream Blanket Grouting Data
- 2018 As-Built Grouting Data

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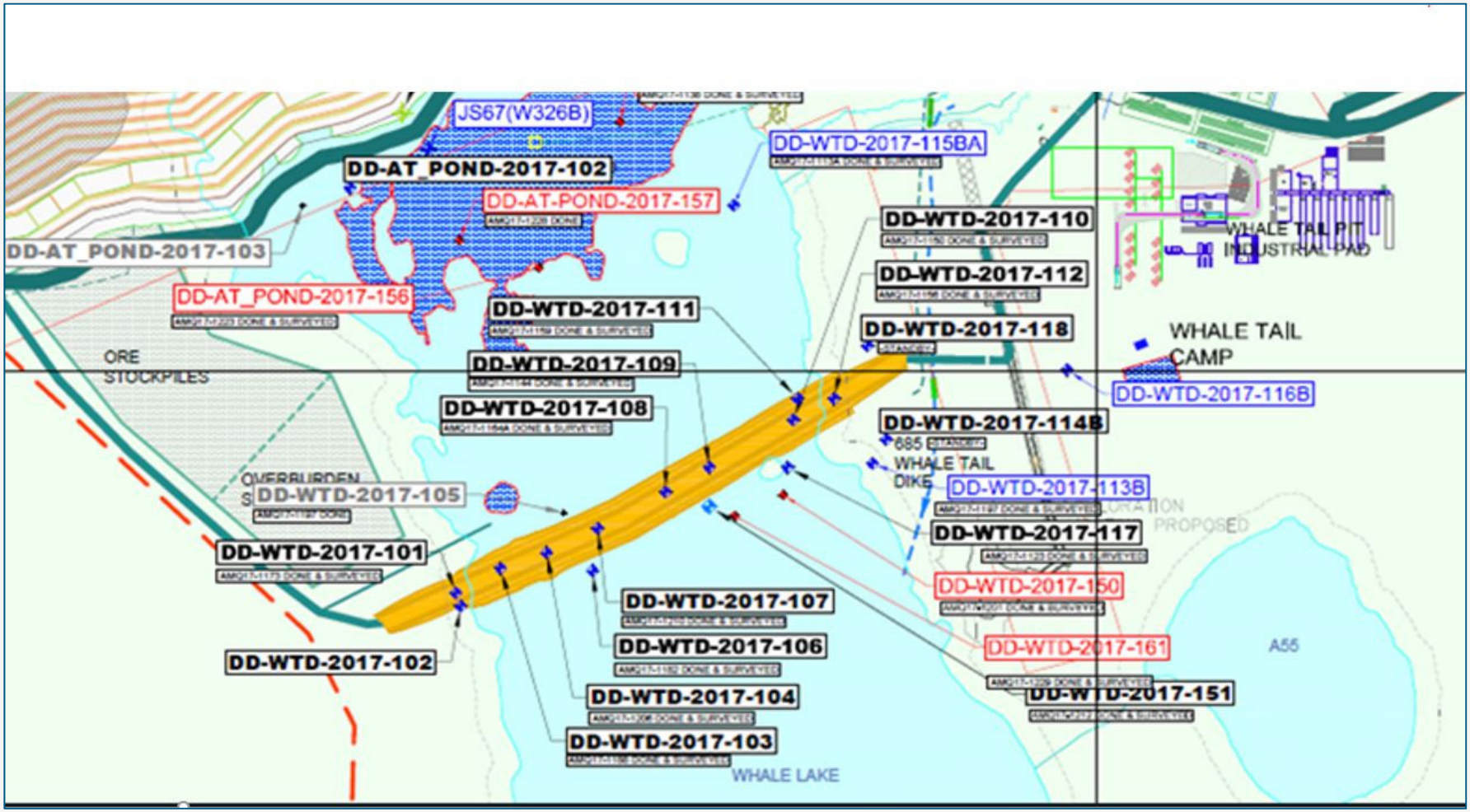
6- UPSTREAM GROUTING PROPOSED STRATEGY (CONT'D)



2017 Geotechnical Investigation for WTD Design

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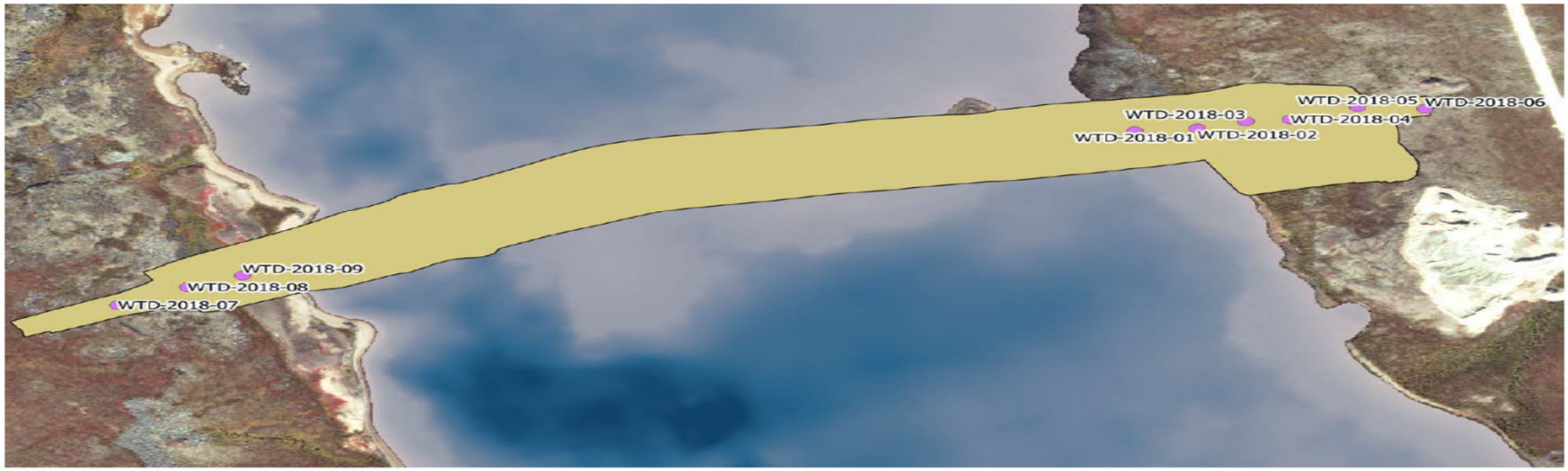
6- UPSTREAM GROUTING PROPOSED STRATEGY (CONT'D)

Figure 3 Location of boreholes drilled during the March 2018 investigation campaign at the Whale Tail Dike location



A total of 146 structures identified from 3 BHs at West Abutment, with joint frequency varies from 6.9 to 16.9 joints /meter;
Open to slightly open joints (18+39)/146 = 39%
Predominant joints are random 70/146 = 48%;
Joint Set #5 counts 21/146= 14%;
The apertures of open joints varies from 1.0 to 48.9 mm, generally less than 5.0mm.

A total of 523 joints and fractured zones in 6 BHs at East Abutment, with joint frequency17.7 to 25.5 joints/meter;
Four joint sets, main joint set (Set #1) has an average orientation of 47/162 (dip/dip direction);
Open joints, fracture zones and slightly open 30%
Three fractured zones identified in three (3) BHs AMQ 18-1700, 1703 and 1707; thickness 46.4 to 173.9 mm;
The apertures of open joints varies from 0.8 to 86.7 mm, generally less than 7.0mm.

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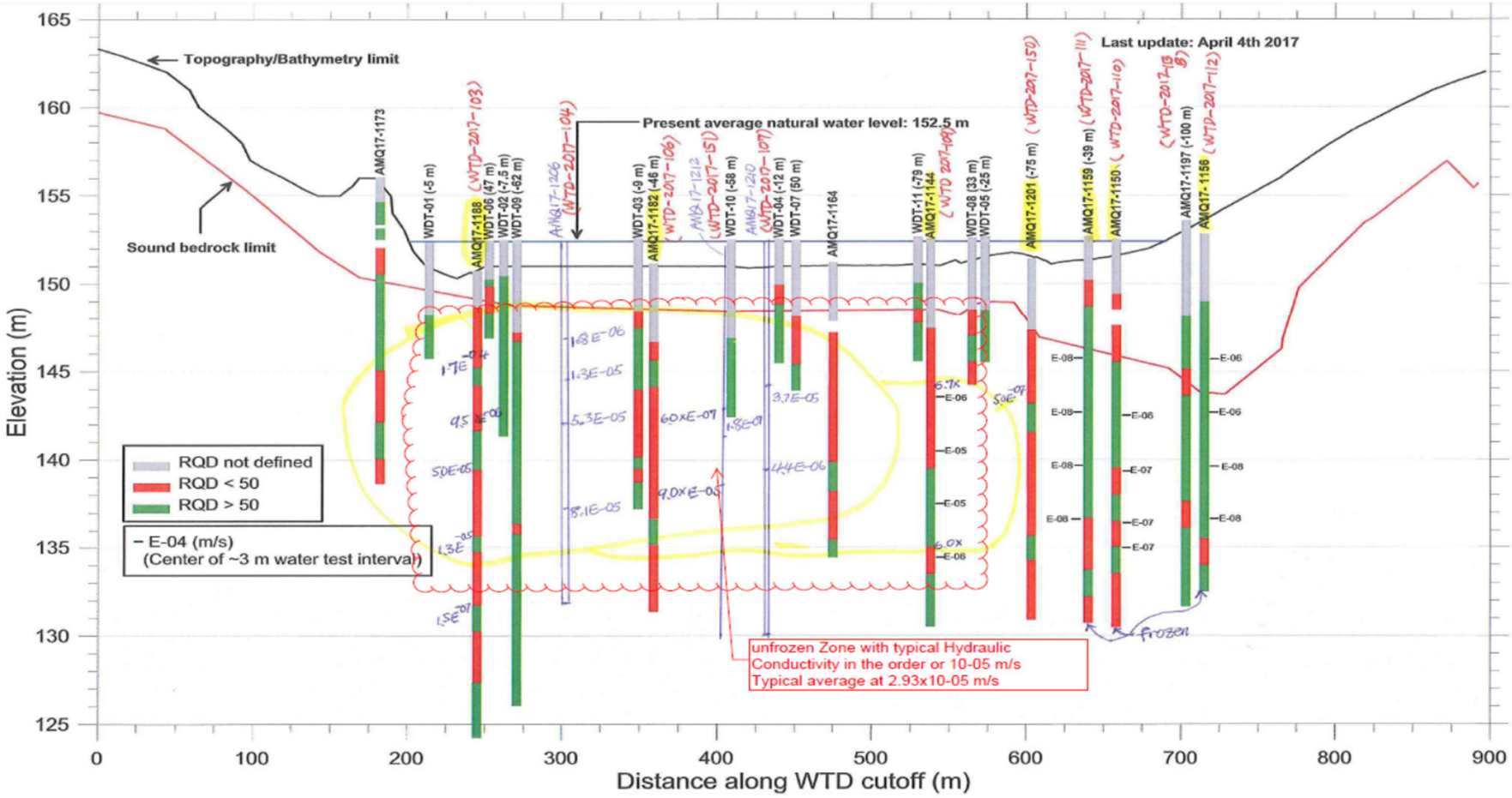
6- UPSTREAM GROUTING PROPOSED STRATEGY (CONT'D)



RQD and Packer Test Results 2017 Geotechnical Investigation

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6- UPSTREAM GROUTING PROPOSED STRATEGY (CONT'D)

Borehole no	Borehole ID	Depth (m)		Ground conditions	Absorption (Lugeon)	Estimated Hydraulic Conductivity (cm/s)	Remarks
		From	To				
AMQ17-1144	DD-WTD-2017-109	7.50	10.42	Unfrozen	62.0	6.67E-04	10 open joints aperture 0.78 to 54.22 mm
		10.50	13.42		113.0	1.20E-03	18 open joints, 0.55 to 13.48mm
		13.50	16.42		257.0	2.74E-03	12 open joints 0.58 to 41.6mm
		16.50	19.42		57.0	6.04E-04	13 open joints, 0.9 to 27.5
AMQ17-1182	DD-WTD-2017-106	6.80	9.72	Unfrozen	6.0	6.41E-05	1 open join 3.85 mm
		9.80	12.72		850.6	9.09E-03	1 open join 54.03mm
AMQ17-1188	DD-WTD-2017-103	7.40	10.32	Unfrozen	1575.0	1.68E-02	1 open joint 5.3 mm
		10.60	13.52		88.5	9.46E-04	1 open join 3.88mm
		12.40	15.32		467.7	5.00E-03	6 open joints, 1.6 to 10.88mm
		16.30	19.22		122.9	1.31E-03	4 open joints 1.32 to 3.07mm
		20.50	23.42		1.4	1.50E-05	no open join
		28.00	30.92		39.8	4.25E-04	no open join
		36.40	39.32		378.1	4.04E-03	2 open joints 8.9 and 17.95 mm
		44.80	47.72		3.8	4.04E-05	no open join
AMQ17-1201	DD-WTD-2017-150	7.00	20.53	Unfrozen	3.4	5.06E-05	Fractured zone at 11.6 to 12.7 m; b=288 to 576 mm
		10.20	20.53	Frozen	0.5	7.68E-06	
AMQ17-1206	DD-WTD-2017-104	3.10	6.02	Unfrozen	17.4	1.86E-04	No open join, veinlet
		6.10	9.02		121.1	1.30E-03	closed to slightly open joints
		9.10	12.02		491.8	5.26E-03	closed to slightly open joints
		12.10	17.55		659.2	8.12E-03	Fractured zones at 15.6 m (11.17mm) and 16.0m (102.88mm)
AMQ17-1210	DD-WTD-2017-107	7.50	23.30	Unfrozen	248.1	3.74E-03	at 8.0 m, b-11.43 mm;at 9.5 m fractured zones, b=2110mm
		13.50	23.30		31.5	4.35E-04	at 13.82m b=6.38mm;
		19.00	23.30		20.3	2.38E-04	at 16.86m b=19.87mm

Summary of Packer Test Results 2017 Geotechnical Investigation

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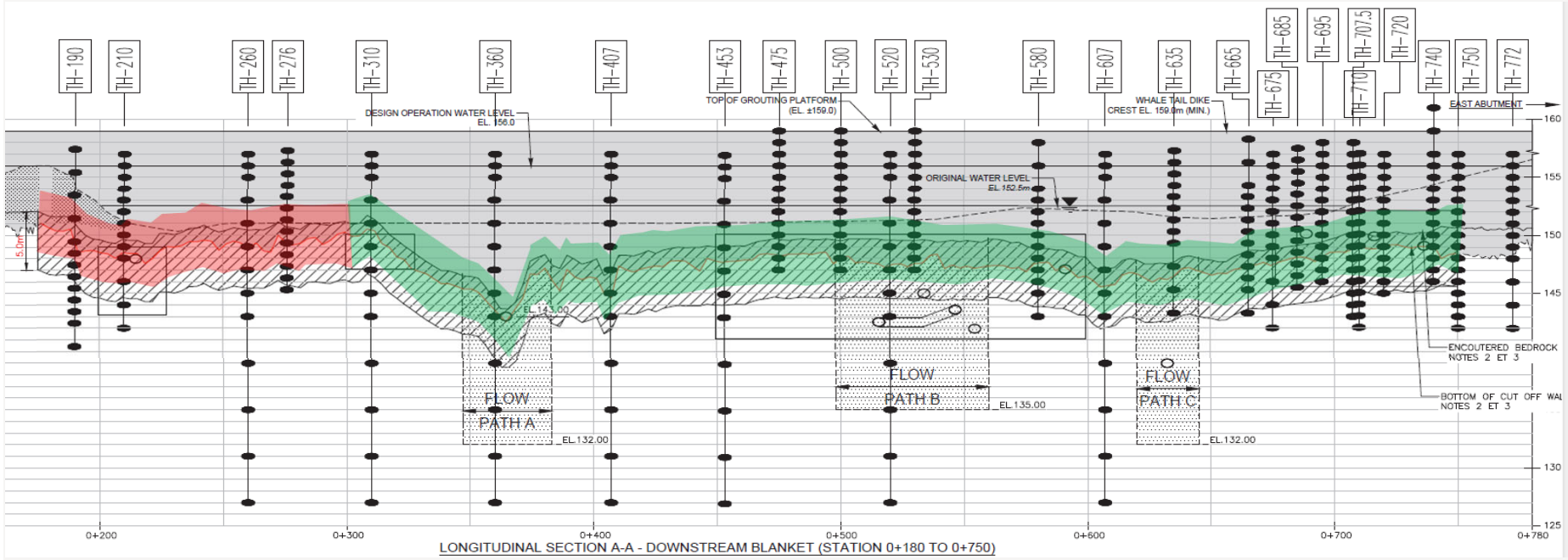
6- UPSTREAM GROUTING PROPOSED STRATEGY (CONT'D)

Seepage Zones vs Grouting Results



LONGITUDINAL SECTION A-A - DOWNSTREAM BLANKET (STATION 0+180 TO 0+750)

20 Holes were grouted between 0+176 and 0+296

- **10** P and 10 S holes grouted
- Holes were grouted in 1 stage of 5.0 m
- Total grout volume = 5,338 L (Average± 54 L/m)

148 Holes were grouted between 0+750 and 0+296

- **136** P, S and T holes were grouted in one stage of 5.0 m.
- **12** Secondary holes were grouted in 2 stages 1.5 and 3.5m.

20 T and 17 Q Not grouted yet

Total grout volume = 77,192L (Average ±104L/m)

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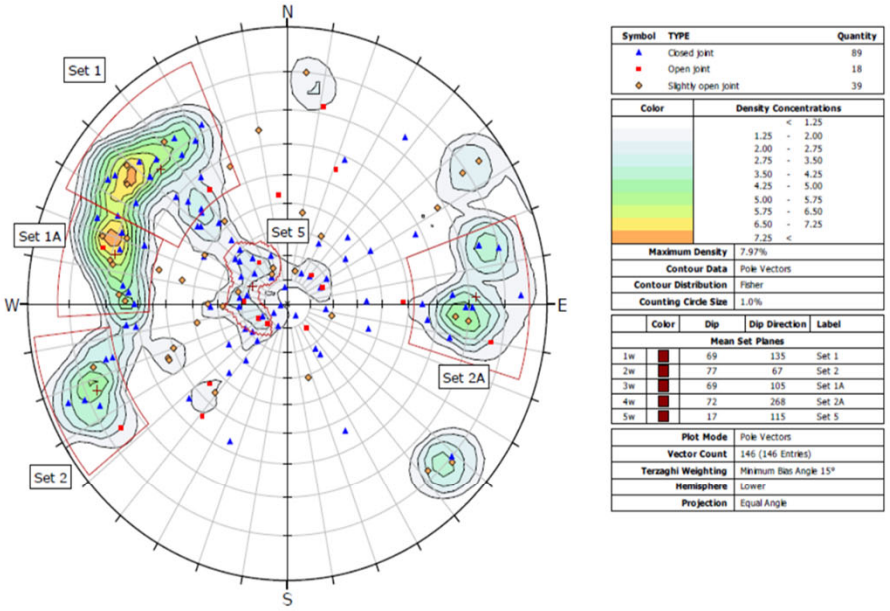
6- UPSTREAM GROUTING PROPOSED STRATEGY (CONT'D)

Figure 11 Stereographic projection of structures interpreted as closed joints, slightly open joints and open joints from the televiewer surveys carried out in boreholes AMQ18-1710, 1713 and 1714 at the Whale Tale Dike West abutment



Symbol	TYPE	Quantity
▲	Closed joint	89
■	Open joint	18
◆	Slightly open joint	39

Color	Density Concentrations
	< 1.25
	1.25 - 2.00
	2.00 - 2.75
	2.75 - 3.50
	3.50 - 4.25
	4.25 - 5.00
	5.00 - 5.75
	5.75 - 6.50
	6.50 - 7.25
	7.25 <

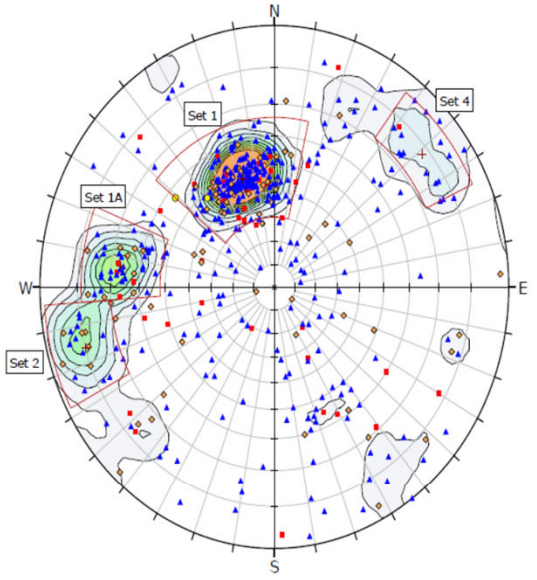
Maximum Density	7.97%
Contour Data	Pole Vectors
Contour Distribution	Fisher
Counting Circle Size	1.0%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1w		69	135	Set 1
2w		77	67	Set 2
3w		69	105	Set 1A
4w		72	268	Set 2A
5w		17	115	Set 5

Plot Mode	Pole Vectors
Vector Count	146 (146 Entries)
Terzaghi Weighting	Minimum Bias Angle 15°
Hemisphere	Lower
Projection	Equal Angle

Five joint sets were interpreted in this area. The average orientation of each joint set is indicated in figure 11. Figure 12 is a diagram showing joint count statistics for each joint set including randomly orientated joints. The aperture of open joints varies from 1.0 to 48.9 mm, but it is generally less than 5.0 mm.

Figure 9 Stereographic projection of structures interpreted as closed joints, slightly open joints, open joints and fractured zones from the televiewer surveys carried out in boreholes AMQ18-1693, 1700, 1702, 1703 and 1707 at the Whale Tale Dike East abutment



Symbol	TYPE	Quantity
▲	Closed joint	379
○	Fractured zone	3
■	Open joint	45
◇	Slightly open joint	96

Color	Density Concentrations
	< 1.25
	1.25 - 2.00
	2.00 - 2.75
	2.75 - 3.50
	3.50 - 4.25
	4.25 - 5.00
	5.00 - 5.75
	5.75 - 6.50
	6.50 - 7.25
	7.25 <

Maximum Density	16.93%
Contour Data	Pole Vectors
Contour Distribution	Fisher
Counting Circle Size	1.0%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1w		47	162	Set 1
2w		80	74	Set 2
3w		67	97	Set 1A
4w		78	231	Set 4

Plot Mode	Pole Vectors
Vector Count	523 (523 Entries)
Terzaghi Weighting	Minimum Bias Angle 15°
Hemisphere	Lower
Projection	Equal Angle

Four joint sets were interpreted in this area. The average orientation of each joint set is indicated in figure 9. Figure 10 is a diagram showing joint count statistics for each joint set including randomly orientated joints. Three fractured zones were identified as part of joint set no 3 in boreholes AMQ18-1700, 1703 and 1707. Their thickness varies from 46.4 (AMQ18-1700) to 173.9 mm (AMQ18-1707). The aperture of open joints varies from 0.8 to 86.7 mm, but it is generally less than 7.0 mm.

2018 Geotechnical Investigation at WTD

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6- UPSTREAM GROUTING PROPOSED STRATEGY (CONT.'D)

2018 Curtain Grouting As-Built - Section Sta.0+204 to 0+300

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6- UPSTREAM GROUTING PROPOSED STRATEGY (CONT'D)

2018 Curtain Grouting As-Built - Section Sta. 0+330 to 0+400

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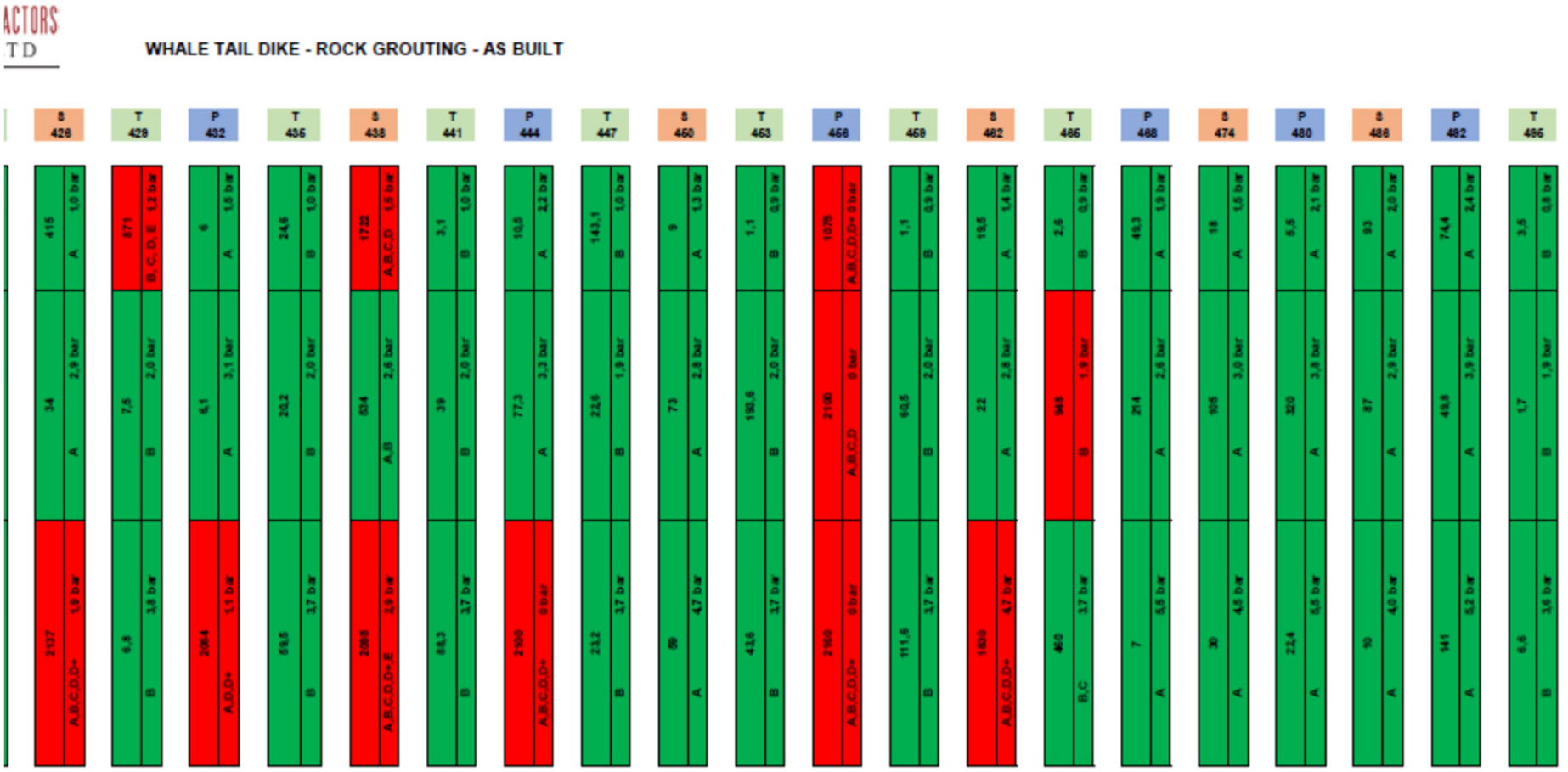
6- UPSTREAM GROUTING PROPOSED STRATEGY (CONT'D)



2018 Curtain Grouting As-Built - Section Sta. 0+430 to 0+500

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6- UPSTREAM GROUTING PROPOSED STRATEGY (CONT'D)

Proposed Strategies

Option A:

- Starting with the priority Section: Stations 0+520 to 0+750 m
  - Deepen all Primary holes to 10-15 m. Downstage or Upstage method can be done based on rock conditions
  - Length of Secondary holes and Tertiary holes will be determined based on the grout take in the primary hole stages
  - Quaternary holes may be added based on Tertiary holes grout take
- If the objective is not met after the completion of the above, the following is recommended:
  - Complete the upstream blanket for the remaining sections
  - Analyze the grouting data and re-assess the seepage rate
  - If the objective is still not met, further actions will be taken

Analyze the grouting data and assess the seepage rate regularly if the objective is met, grouting work will be terminated.

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6- UPSTREAM GROUTING PROPOSED STRATEGY (CONT'D)

Proposed Strategies

Option B:

- Complete the Upstream Blanket Grouting (P, S and T) as outlined in the current scope of work:
  1. Starting with the priority Section: Stations 0+520 m to 0+750 m (more critical based on downstream data analysis)
  2. Then move to remaining section from Stations 0+180 m to 0+520 m
- If the objective is not met after the completion of the above, the following is recommended:
  - Deepen Primary Holes (Super-primaries) from 10 m to 15m

Analyze the grouting data and assess the seepage rate regularly. If the objective is met, grouting work will be terminated.

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Our values are the essence of our company's identity. They represent how we act, speak and behave together, and how we engage with our clients and stakeholders.

SAFETY

We put safety at the heart of everything we do, to safeguard people, assets and the environment.

INTEGRITY

We do the right thing, no matter what, and are accountable for our actions.

COLLABORATION

We work together and embrace each other's unique contribution to deliver amazing results for all.

INNOVATION

We redefine engineering by thinking boldly, proudly and differently.

SNC·LAVALIN

Saleem, Muhammad

From: Alexandre Lavallee <alexandre.lavallee@agnicoeagle.com>
Sent: March 10, 2020 2:34 PM
To: Quan, Nina
Cc: Xue, Tom; El Bensi, Abdellah; Thomas Lepine
Subject: FW: [EXTERNAL] WTD_Meeting No. 7_Guidance

FYI

We can discuss further tomorrow during our weekly meeting.

Alexandre Lavallee
T: 819-860-0804

From: Bonin, Grant [mailto:Grant_Bonin@golder.com]
Sent: March 10, 2020 11:27 AM
To: Thomas Lepine <thomas.lepine@agnicoeagle.com>; Alexandre Lavallee <alexandre.lavallee@agnicoeagle.com>; Frederick Bolduc <frederick.bolduc@agnicoeagle.com>; Jesse Clark <jesse.clark@agnicoeagle.com>
Cc: Patrice Gagnon <patrice.gagnon@agnicoeagle.com>; Pier-Eric McDonald <pier-eric.mcdonald@agnicoeagle.com>; Donald Bruce <dabruce@geosystemsbruce.com>; Peter White <multiurethanes@gmail.com>
Subject: [EXTERNAL] WTD_Meeting No. 7_Guidance

Thomas / Alex / Fred / Jesse;

As discussed during the conference call on Thursday, March 5th , the following should be considered moving forwards:

- As a reminder, it should be recognised that the intent of the d/s + u/s blanket was initially not to prevent erosion of the base of the secant wall, but rather to (i) consolidate the upper portion of the potentially highly fractured, weathered bedrock on either side of the rock socket under a worsening seepage gradient and (ii) provide a cap to limit the upwards migration of grout and fines from within discontinuities (or otherwise) into the downstream filter materials, before deepening the grout curtain into bedrock.
    - The completed blanket will allow for grout to be injected effectively into the rock mass at higher pressures, at depth.
    - Thus, the closure of this blanket needs to be demonstrated (to some extent), on both sides of the secant cut-off.

- At the moment, as shown on Slides 16, 17, 18 and 19 of the Full_Version of the presentation, as pertains to the blanket being constructed, there seems to be a more relevant correlation between the thermistor data and observed grout takes than the Willowstick geophysical survey. This may be an indication of the Willowstick anomalies are deeper seated.

- We recognise that while it is still early March, the freshet is quickly approaching. Concerns regarding progressing the remedial grouting works as expediently as is appropriate have been raised. As such, we believe that a hybrid of Options A and Options B, presented in Slides 32 and 33 of the Full_Version should be progressed – as outlined below.

- Abbreviated Option B. Based on the observed grout takes along the downstream row of grout holes:
    - Only the drilling and grouting of primary and secondary order holes along the downstream blanket holes should be considered between sta. 0+176.5 and 0+266.5 – no tertiary holes.
    - After completing the requested quaternary order holes outlined on Slides 16 and 17, along the upstream row of blanket holes, particularly between sta. 0+520 and 0+750, we believe that at a minimum, the primary and secondary order of blanket holes should be completed to 5m depth into bedrock. If possible, logistically, all of the primary order holes should be completed before starting secondary order holes.
    - Whether or not the drilling and grouting of tertiary order holes along the upstream blanket holes are required will be based on observed grout takes. Casing should still be installed in the event that they are required.

- Targeted Option A. Thereafter, to investigate whether or not seepage is deeper seated (and potentially reduce the noted seepage), the downstream row of grout holes should be deepened – particularly between sta. 0+520 and 0+750 to a minimum of 15m depth below the installed casings. Targets should be selected to confirm noted potential flow paths based on:
    - Previous site investigation information presented in Slide 25;
    - Installed thermistor data trends;
    - The noted Willowstick profiling survey anomalies (i.e. Flow Paths B and C); and
    - Previous grouting programme information (i.e. high takes at the bottom of the previously completed work).

    - The extent of grouting works at depth to be completed along the downstream row is to be determined based on observed grout takes. It may be necessary to close the curtain between targets and/or deepen an upstream row of grout holes.

We trust that the information discussed above satisfies the current project requirements. If you have any questions or concerns regarding the above, please do not hesitate to contact us. We look forward to receiving updates regarding the on-going works on a weekly basis.

Regards; On behalf of Donald, Peter and Grant

Grant Bonin, MEng, PEng (BC, SK, NB)
Principal, Mining Geotechnical Engineer

GOLDER

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LinkedIn | Facebook | Twitter

Work Safe, Home Safe

From: Alexandre Lavallee <alexandre.lavallee@agnicoeagle.com>
Sent: Friday, March 6, 2020 8:29 AM
To: Bonin, Grant <Grant_Bonin@golder.com>; Donald Bruce <dabruce@geosystemsbruce.com>; Peter White <multiurethanes@gmail.com>
Cc: Quan, Nina <nina.quan@snclavalin.com>; Thomas Lepine <thomas.lepine@agnicoeagle.com>; Frederick Bolduc <frederick.bolduc@agnicoeagle.com>; Jesse Clark <jesse.clark@agnicoeagle.com>; Patrice Gagnon <patrice.gagnon@agnicoeagle.com>; Pier-Eric McDonald <pier-eric.mcdonald@agnicoeagle.com>
Subject: Committee Meeting #7 - SNC's presentation

EXTERNAL EMAIL

Hi,

You will find in attachment the presentation for this afternoon.

Please kindly note that we are sending you a full version of the presentation and the simplified version. Due to time constraint, SNC will present the simplified version at the meeting.

Thanks,

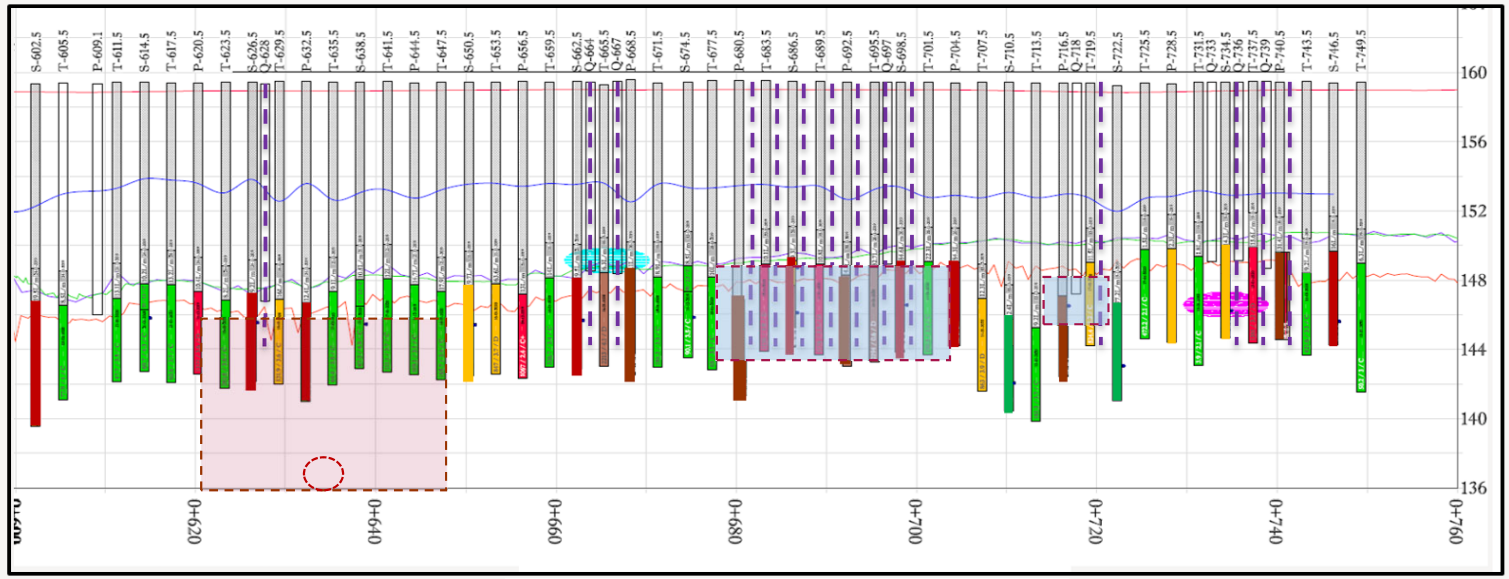
Alexandre Lavallee, P. Eng. | Project Lead – Water Management Infrastructures – Construction Group
alexandre.lavallee@agnicoeagle.com | Mobile 819.860.0804
Agnico Eagle Mines Limited - Meadowbank Division, Suite 540 - Baker Lake, Nunavut, Canada X0C 0A0
agnicoeagle.com

Grouting Committee Meetings No. 8

Presentation

Meeting Minutes

DOWNSTREAM DATA COMPILATION
SECTION 0+750 TO 0+600



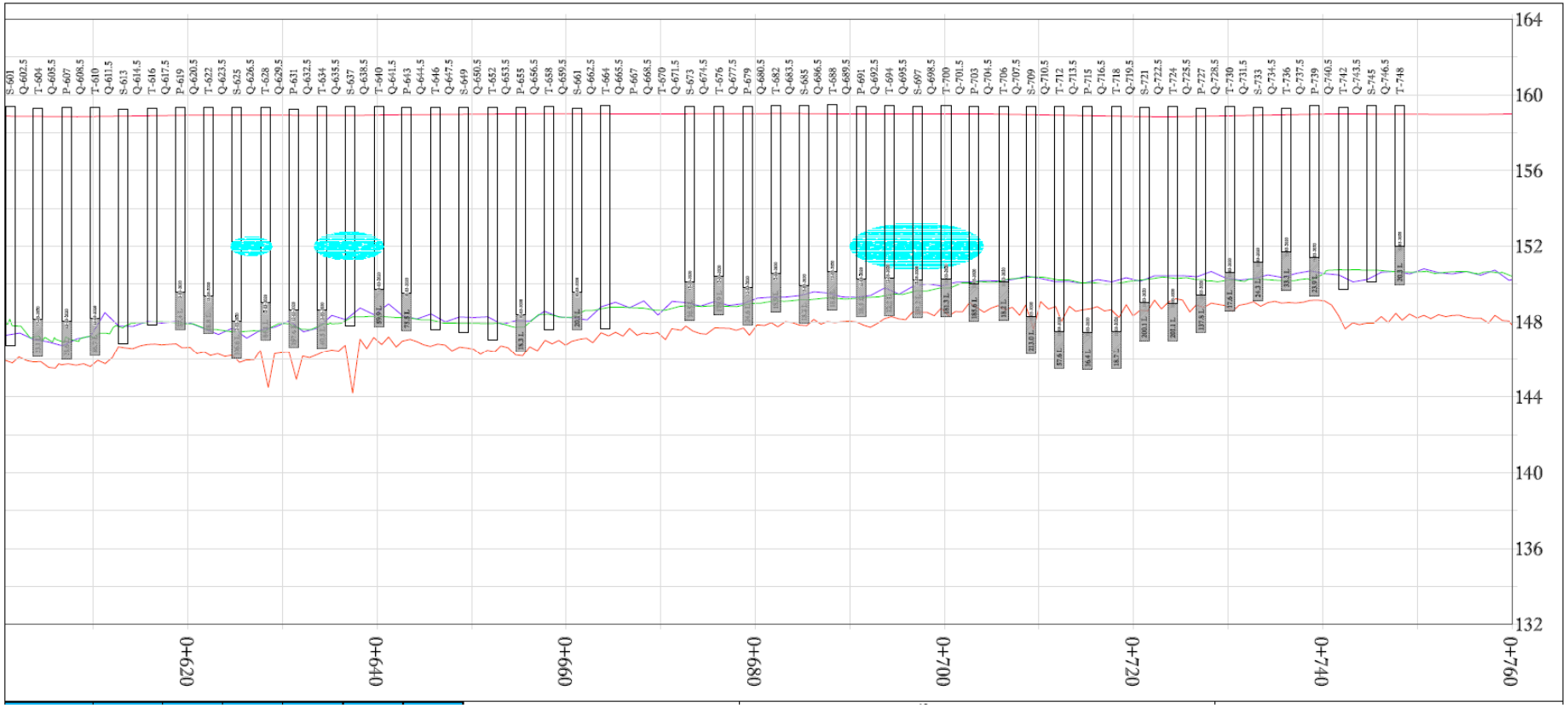
Thermistor Data Anomaly

Willowstick Survey Anomaly

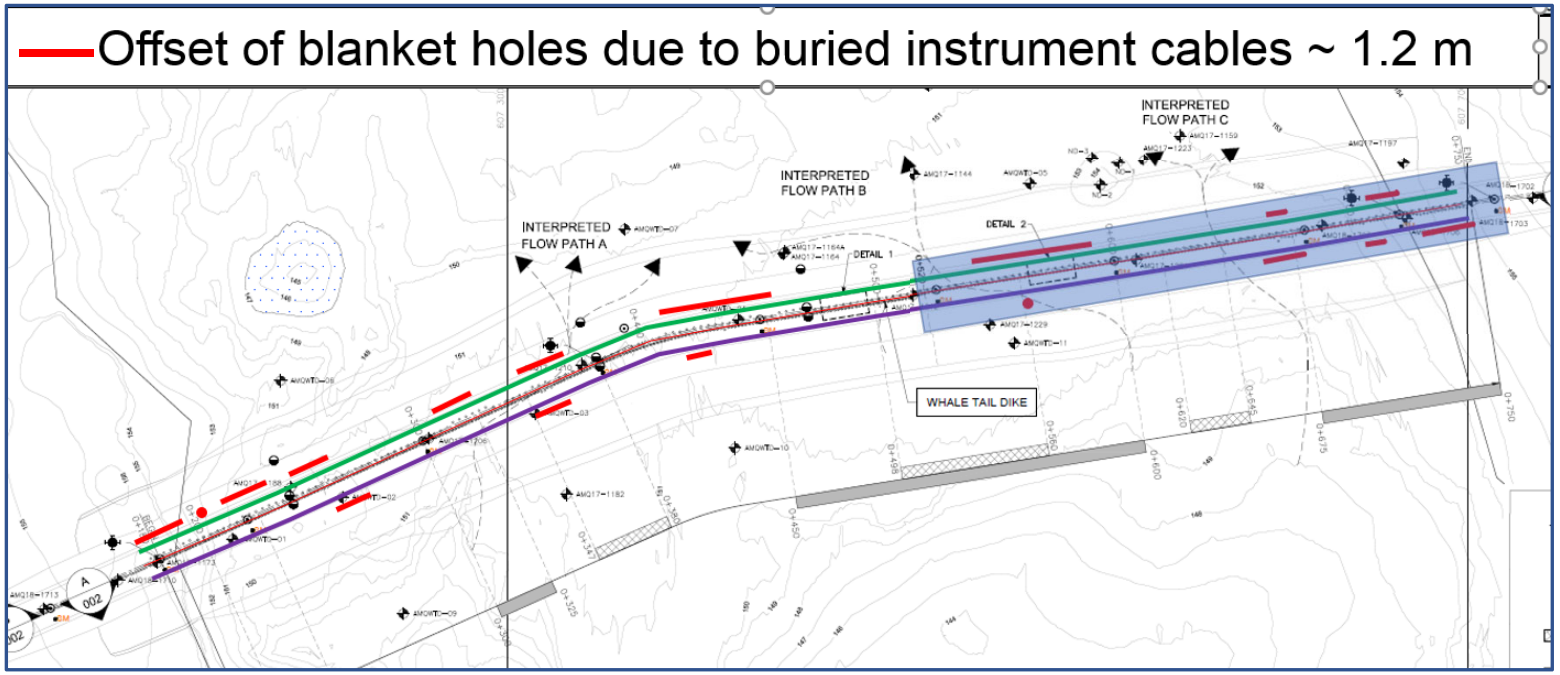
Quaternary Holes

		TAKE : L/m
VOL / P	LOW	< 100
VOL / P	M.HIGH	100 < > 200
VOL / P	HIGH	200 < > 400
VOL / P	V.HIGH	> 400

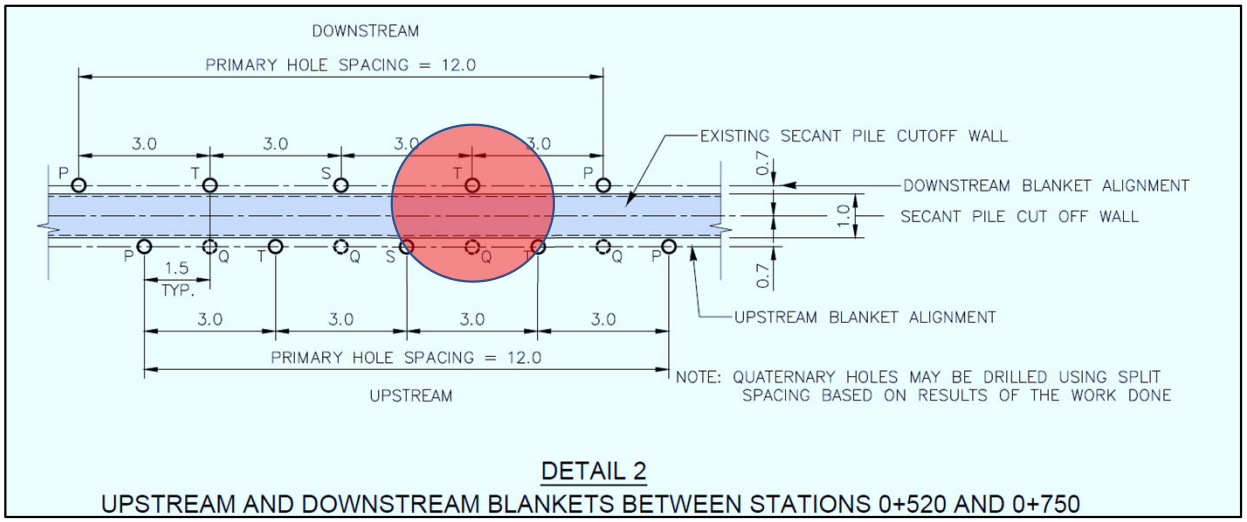
USTREAM BLANKET – CASING INSTALLTION
SECTION 0+750 TO 0+600



DRILLING AND GROUTING STRATEGY
SECTION 0+520 TO 0+750

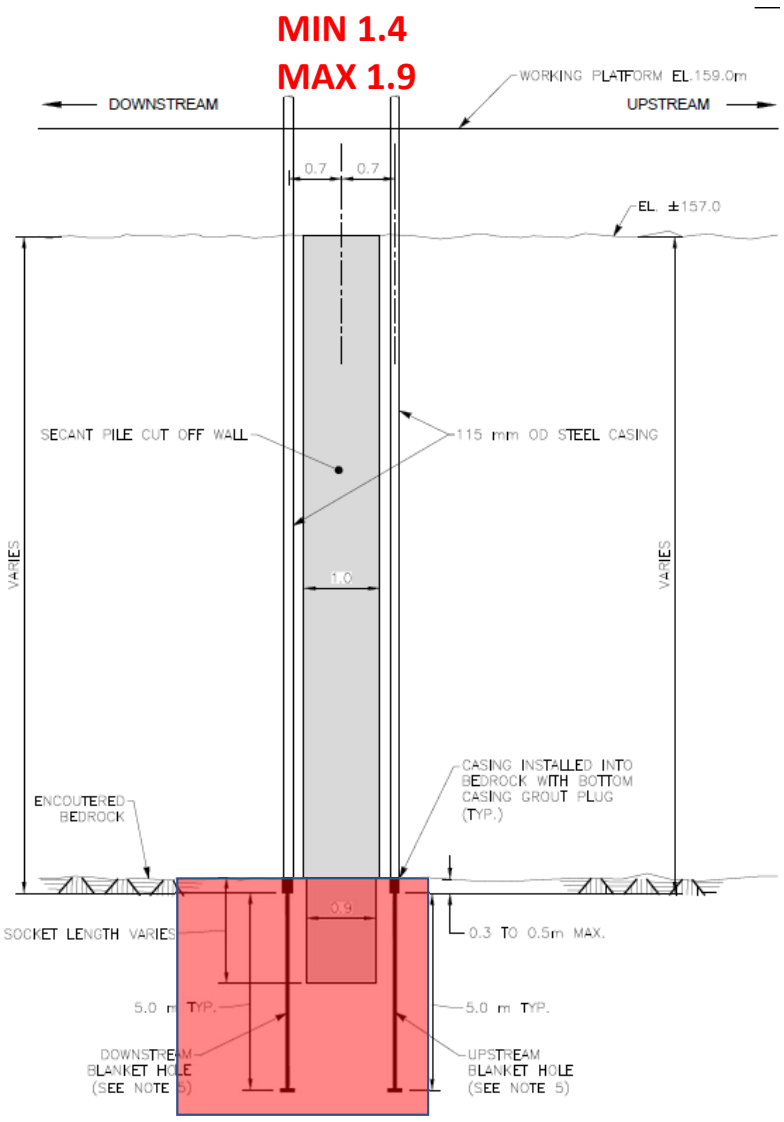


DRILLING AND GROUTING STRATEGY
SECTION 0+520 TO 0+750



DETAIL 2
UPSTREAM AND DOWNSTREAM BLANKETS BETWEEN STATIONS 0+520 AND 0+750

GROUTING OF DOWNSTREAM BLANKET CONSOLIDATED THE UPPER PORTION OF THE ROCK FOUNDATION OF THE UPSTREAM BLANKET BECAUSE OF THE CLOSE DISTANCE (1.4 TO 1.9 m) BETWEEN BLANKETS



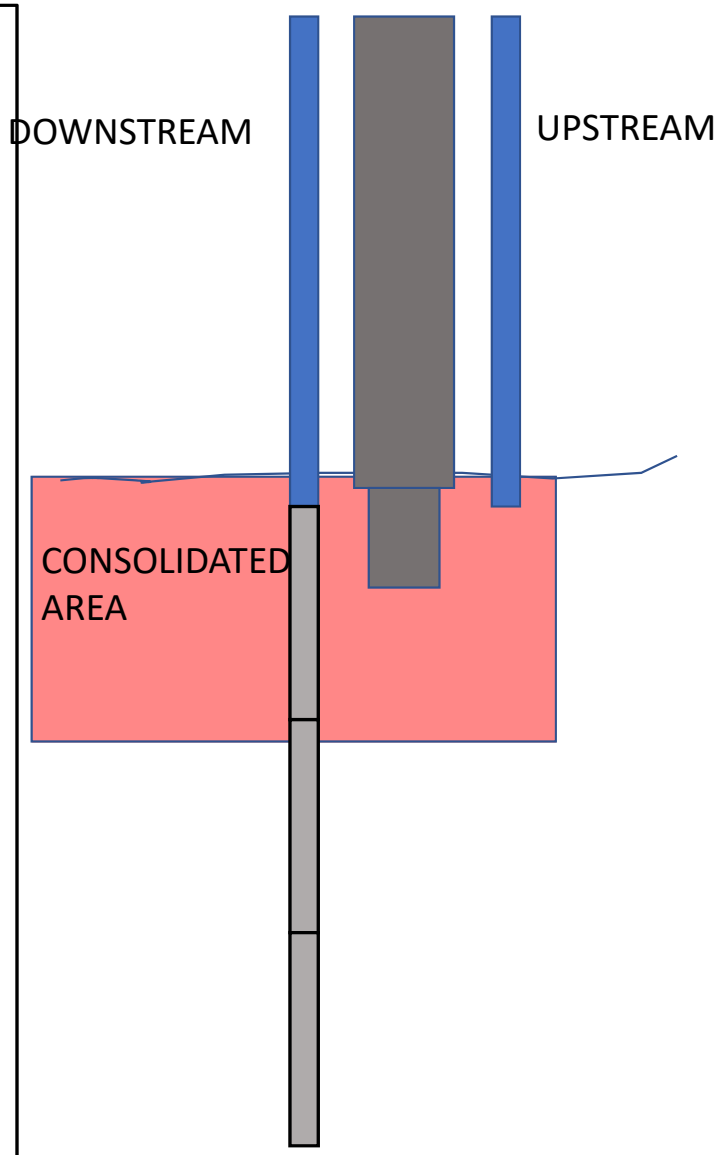
BASED ON THE FOLLOWING ARGUMENTS:

- DOWNSTREAM BLANKET ALREADY GROUTED
- UPSTREAM ROCK UPPER SECTION CONSOLIDATED
- BASED ON SURVEY AND THERMISTORS DATA, SEEPAGE PATH MAY BE DEEPER
- COMPLETE THE DOWNSTREAM CURTAIN BEFORE MOVING TO UPSTREAM
- SCHEDULE CONSTRAINT BECAUSE OF FRESHET – AVOID MOVING BACK AND FORTH BETWEEN UPSTREAM AND DOWNSTREAM

SNC RECOMMENDS:

OPTION A

- DRILL AND GROUT DOWNSTREAM CURTAIN HOLES P AND S 15 m IN ROCK. UPSTAGE WHERE POSSIBLE AND DOWNSTAGE IF HOLE IS CAVING. START WITH P THEN S.
- DRILL AND GROUT T HOLES . T LENGTH WILL BE BASED ON S HOLES MIN 10 m, MAX 15 m.
- DRILL AND GROUT Q HOLES BASED ON GROUT TAKE IN T HOLES, Q LENGTH WILL BE BASED ON T HIGH GROUT TAKE STAGE.



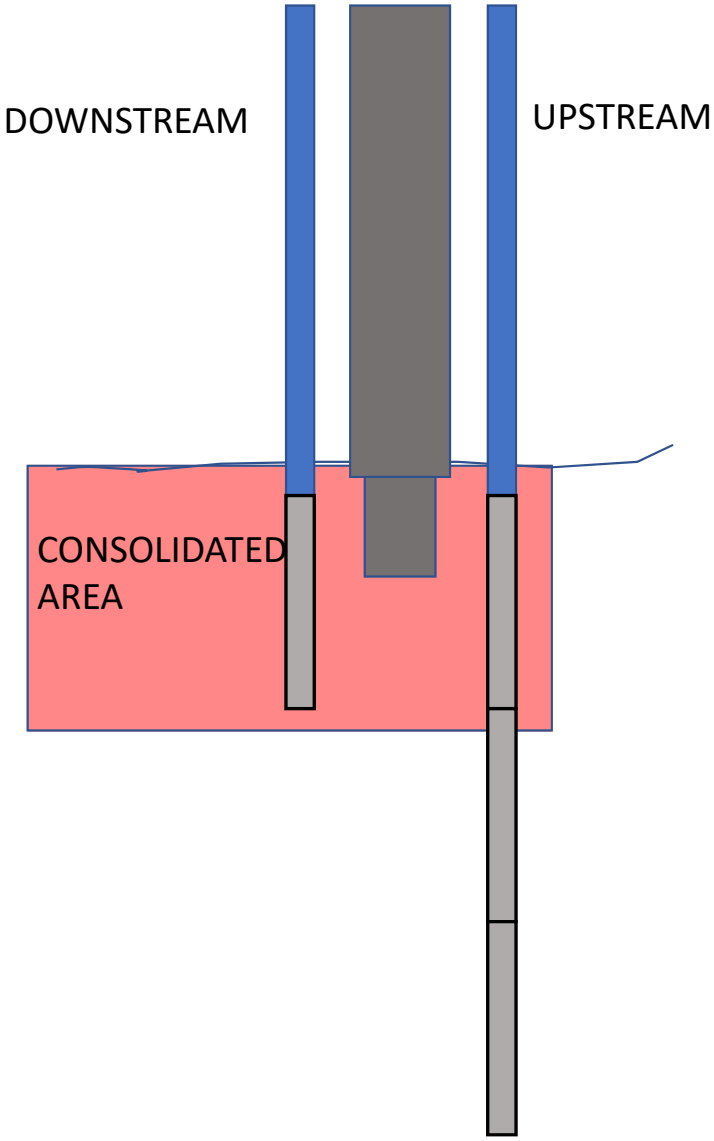
BASED ON THE FOLLOWING ARGUMENTS:

- DOWNSTREAM BLANKET ALREADY GROUTED AND ROCK UPPER SECTION CONSOLIDATED
- UPSTREAM CASING ALREADY INSTALLED AND CASING PLUG GROUTED
- DOWNSTREAM CASINGS ALREADY BACKFILLED WITH GROUT
- BETTER TO CUT SEEPAGE FROM UPSTREAM
- SCHEDULE CONSTRAINT BECAUSE OF FRESHET

SNC RECOMMENDS:

OPTION B

- DRILL AND GROUT UPSTREAM CURTAIN HOLES P AND S 15 m IN ROCK. UPSTAGE WHERE POSSIBLE AND DOWNSTAGE IF HOLE IS CAVING. START WITH P THEN S.
- DRILL AND GROUT T HOLES . T LENGTH WILL BE BASED ON S HOLES MIN 10 m, MAX 15 m.
- DRILL AND GROUT Q HOLES BASED ON GROUT TAKE IN T HOLES, Q LENGTH WILL BE BASED ON T HIGH GROUT TAKE STAGE.



Saleem, Muhammad

From: Alexandre Lavallee <alexandre.lavallee@agnicoeagle.com>
Sent: March 23, 2020 11:09 AM
To: Quan, Nina; Jesse Clark; Frederick Bolduc
Cc: Thomas Lepine; El Bensi, Abdellah; Xue, Tom
Subject: RE: [EXTERNAL] RE: Committee meeting #8 - Path forward

Hi Nina,

As discussed during the meeting, the committee will not provide minutes following this meeting. I am reading back the sentence of my original email (in yellow) and understand it was not so clear. Sorry for this.

We actually would like SNC to provide a short memo (site instruction) summarizing the path forward that was discussed in this meeting.

Thanks,

Alexandre Lavallee
T: 819-860-0804

From: Quan, Nina [mailto:Nina.Quan@snclavalin.com]
Sent: March 23, 2020 11:03 AM
To: Alexandre Lavallee <alexandre.lavallee@agnicoeagle.com>; Jesse Clark <jesse.clark@agnicoeagle.com>; Frederick Bolduc <frederick.bolduc@agnicoeagle.com>
Cc: Thomas Lepine <thomas.lepine@agnicoeagle.com>; El Bensi, Abdellah <Abdellah.ElBensi@snclavalin.com>; Xue, Tom <Tom.Xue@snclavalin.com>
Subject: [EXTERNAL] RE: Committee meeting #8 - Path forward

CAUTION: EXTERNAL

Hi Alex/Frederick/Jesse
I would like to follow up on the email below. Is there a Minutes of Meeting from the Grouting Meeting No.8 going to be available soon? We would like to have a copy of it for our archiving purpose.
Thank you in advance.
Best Regards

Nina Quan, *P. Eng.*
Ingénieur en Géotechnique/Geotechnical Engineer
Capital de mantien/Sustainable Capital Toronto Office
Mines et métallurgie/Mining & Metallurgy

Tel.: (416) 252-5315 x 54162
Cell.: (416) 434-1851
Fax: (416) 231-5336

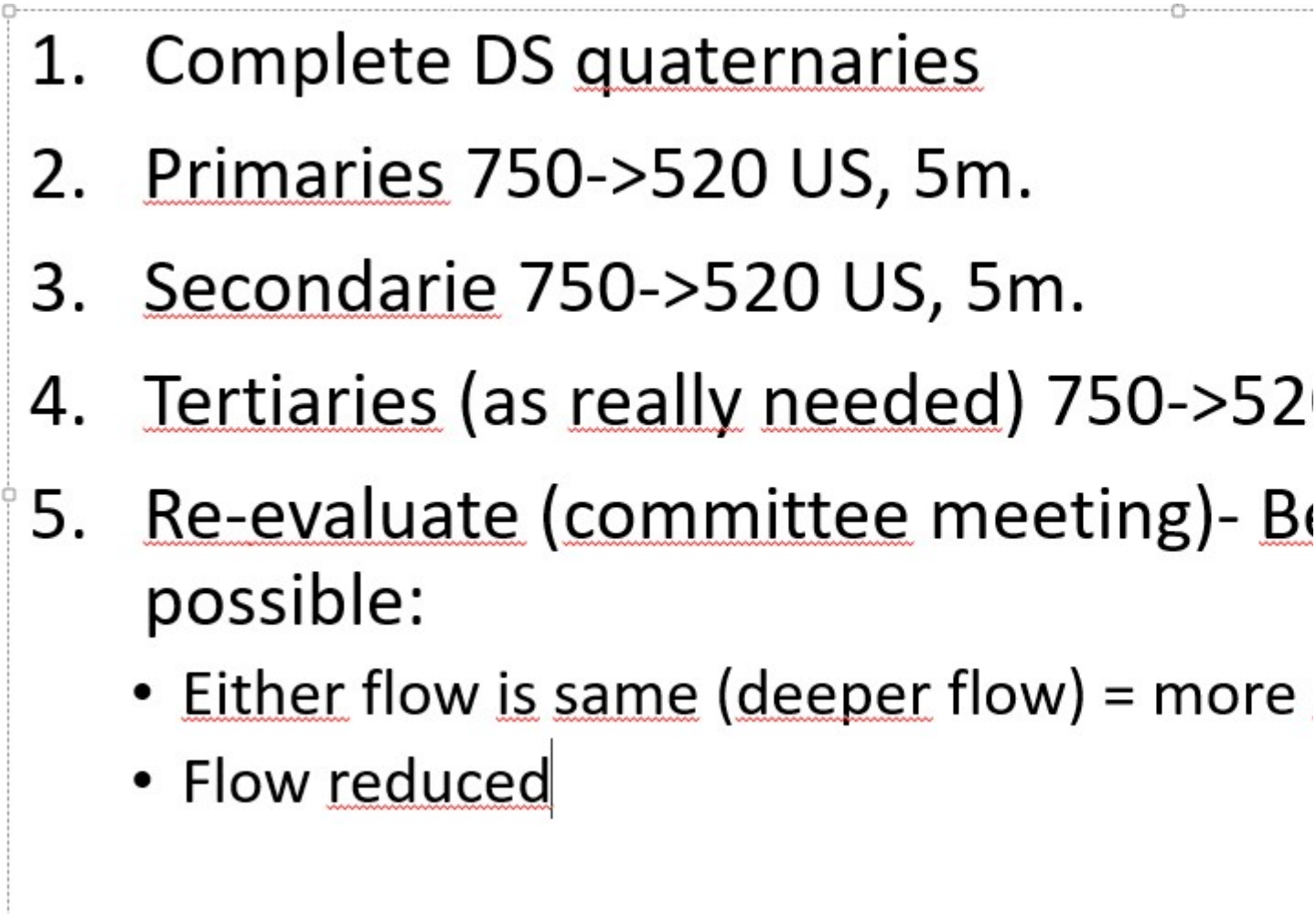
SNC-Lavalin
195 The West Mall

From: Alexandre Lavallee <alexandre.lavallee@agnicoeagle.com>
Sent: March 19, 2020 4:32 PM
To: El Bensi, Abdellah <Abdellah.ElBensi@snclavalin.com>; Xue, Tom <Tom.Xue@snclavalin.com>; Quan, Nina <Nina.Quan@snclavalin.com>
Cc: Thomas Lepine <thomas.lepine@agnicoeagle.com>; Jesse Clark <jesse.clark@agnicoeagle.com>; Frederick Bolduc <frederick.bolduc@agnicoeagle.com>
Subject: Committee meeting #8 - Path forward

Hi Abdellah,

Below is a printscreen of the discussion we had. I you could consolidate this into an email/memo (coming from SNC) that would be good.

Thanks



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Appendix C

QA Data (SNC Reports)

Appendix C- 1: QA Daily Reports

SNC·LAVALIN

SITE REPORT
(Detailed)

20191109
Document number

Date	Time (Start/End)	Project No.	Prepared by
09-11-2019	6 am 6 pm	669034	Muhammad Saleem

Project	Client
Whale Tail Dike Remedial Drilling and Grouting Works	Agnico Eagle

Consultant	Contractor
SNC-Lavalin	TCG

Weather : ☐ Sunny ☒ Cloudy ☐ Rain ☐ Storm ☐ Snow ☐ Glaze

Wind : ☐ None ☐ Light ☐ Moderate ☒ Strong, gusts

Temperature : -17 to -23 °C

Comments :

Appendix : ☐ Yes ☐ No Pictures ☒ Yes ☐ No Inspection report or other :

Picture in the folder :

ACTIVITIES PERFORMED BY SNC-LAVALIN (indicate if test forms were used)

-Completed SOP training from 7am to 9am
-Blizzard like conditions, no casing drilling in the morning.
-Drilling started in the afternoon. Visited the site borehole locations staked with expected bedrock elevation and maximum casing length.
-Four casings installed last night (T545.5 to P536.5)
-Review casing installation report, few locations has about 1 m casing embedment length, talk to Pier-Eric, there was confusion in the start and driller was trying to install casing in competent rock but after clarification they start casing instaltion properly as per Bedrock elevation provided by SNC or higher if encountered.
-Partial KGC grouting crew arrived on site and rest of the crew will come on Monday.
-Crew waiting for centerlizer for inclinometers (Expected on Monday), Casing inclination will be chedked prior to start grouting to plug casing.
-No Vicat apparatus and apparatus for Pressure filtration coeffiecient (Expected Monday)
AEM asked for borehole coordinates for exclusion zone, checked with Abdellah will be available on Tuesday

Note:
Will check with KGC tomorrow about:
-trial grout testing
-methodology for casing plug grouting
-head loss calculation for type B and other high density grouts

SITE GUIDELINES (guidelines, memos, modification proposals, etc.)

No	Subject	Given to

SPECIFIC ELEMENTS VERIFIED

Elements	Location, batch or other	Scope and comments

SAFE AND SAFETY REMARKS

-Blizzard like conditions, very high wind

-Dress up properly for extreme cold conditions

Issued by : *Muhammad Saleem* — Signature — **09-11-2019** — Date

Verified by : *Yohan Jalbert* — Signature — **09-11-2019** — Date

Borehole staked with expected bedrock depth and casing length

Casing installation in progress

SNC·LAVALIN

SITE REPORT
(Detailed)

20191110
Document number

Date	Time (Start/End)	Project No.	Prepared by
10-11-2019	6:30 am 6 :30 pm	669034	Muhammad Saleem

Project	Client
Whale Tail Dike Remedial Drilling and Grouting Works	Agnico Eagle

Consultant	Contractor
SNC-Lavalin	TCG

Weather : ☒Sunny ☒Cloudy ☐Rain ☐Storm ☐Snow ☐Glaze

Wind : ☐None ☐Light ☒Moderate ☐Strong, gusts

Temperature : -22 to -27 °C

Comments :

Appendix : ☐Yes ☐No Pictures ☒Yes ☐No Inspection report or other :

Picture in the folder :

ACTIVITIES PERFORMED BY SNC-LAVALIN (indicate if test forms were used)

- Attended daily meeting at KGC trailer.
- Yesterday Dayshift crew installed 3 casings and night shift crew installed 5 casings. Night shift crew installed casing in the competent rock which is not as required. Talk to SANA and QC to make sure that everyone understand that the casing should be socketed 300 mm into rock wheather its weak or strong.
- KGC informed that they will be ready for trial mix on Tuesday
- Contractor informed that they will use inclino meter without centerlizer as they did last winter but AEM will look if they can findout centerlizer for 4.6” casing.
- Contractor started inclination check without centerlizer
- At T521.5 something very hard at about 2’ bit could not go through, drill move to next hole
- At P524.5 again some thing very hard at about 6” but able to go through. Bit stuck at about 6 m depth and shoe brocken and left in the hole. Hole will be moved about 0.3 m either east or west direction.
- Check the water flowing in the ditch north side (up-stream) of the dike and no turbidity observed in the ditch, water was clear.

SITE GUIDELINES (guidelines, memos, modification proposals, etc.)

No	Subject	Given to

SPECIFIC ELEMENTS VERIFIED

Elements	Location, batch or other	Scope and comments

SAFE AND SAFETY REMARKS

-Dress up properly for extreme cold conditions

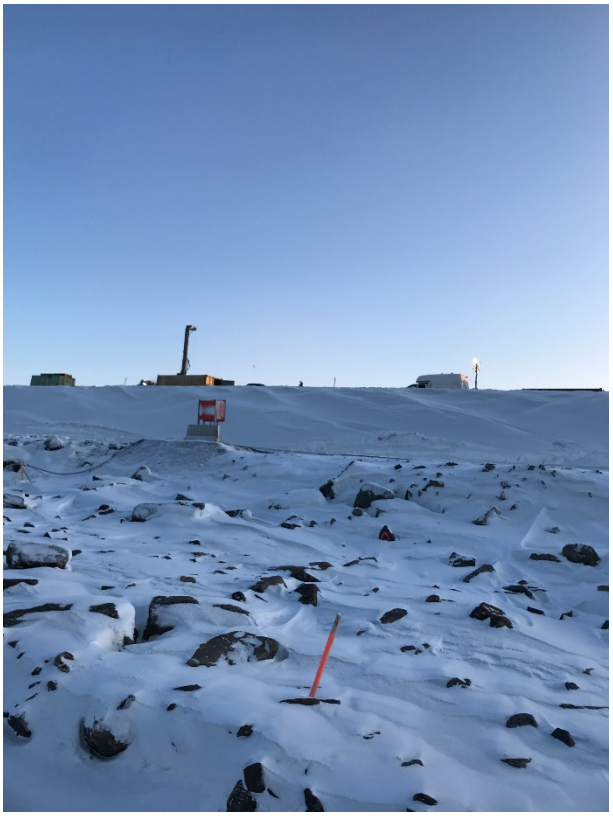
Issued by : *Muhammad Saleem* — Signature — **10-11-2019** — Date

Verified by : *Yohan Jalbert* — Signature — **10-11-2019** — Date

Checking Inclination

Checking casing alignment during installation

No turbidity observed in the ditch U/S of dike



Looking up from ditch U/S of the dike

SNC·LAVALIN

SITE REPORT
(Detailed)

20191111
Document number

Date	Time (Start/End)	Project No.	Prepared by
11-11-2019	6:30 am 6 :30 pm	669034	Muhammad Saleem

Project	Client
Whale Tail Dike Remedial Drilling and Grouting Works	Agnico Eagle

Consultant	Contractor
SNC-Lavalin	TCG

Weather : ☐Sunny ☒Cloudy ☐Rain ☐Storm ☐ Snow ☐Glaze

Wind : ☐None ☐Light ☐Moderate ☒Strong, gusts

Temperature : -21 to -27 °C

Comments :

Appendix : ☐Yes ☐No Pictures ☒Yes ☐No Inspection report or other :

Picture in the folder :

ACTIVITIES PERFORMED BY SNC-LAVALIN (indicate if test forms were used)

- Attended daily meeting at KGC trailer.
- Yesterday Dayshift crew installed 2 casings and night shift crew installed 4 casings.
- KGC informed that they will be ready for trial mix tomorrow
- Continue inclination check for installed casings (without centerlizer)
- At T533.5 drilling shoe brocken at about 5m depth. Hole moved about 0.4 m towards east but again shoe brocken. Hole drilled between the two unsuccessful holes. A big boulder encountered at about 5 m depth very hrad to keep the casing vertical. Almost hole day spent at this location.
- Visit the GHD lab, still waiting for Vicat and infiltration apparatus expected today.

SITE GUIDELINES (guidelines, memos, modification proposals, etc.)

No	Subject	Given to

SPECIFIC ELEMENTS VERIFIED

Elements	Location, batch or other	Scope and comments

SAFE AND SAFETY REMARKS

- Very windy and blowing snow
- Extra caution while driving due to low visibility
- Dress up properly for extreme cold conditions

Issued by : *Muhammad Saleem* — Signature — **11-11-2019** — Date

Verified by : *Yohan Jalbert* — Signature — **11-11-2019** — Date

Casing relocated due to shoe brocken at T521.5

Casing relocated due to shoe brocken at Q524.5

Casing shoe brocken two time at T533.5 and casing installed in middle

SNC·LAVALIN

SITE REPORT
(Detailed)

20191112
Document number

Date	Time (Start/End)	Project No.	Prepared by
12-11-2019	6:30 am 6 :30 pm	669034	Muhammad Saleem / Tom Xue

Project	Client
Whale Tail Dike Remedial Drilling and Grouting Works	Agnico Eagle

Consultant	Contractor
SNC-Lavalin	TCG

Weather : ☐Sunny ☒Cloudy ☐Rain ☐Storm ☐Snow ☐Glaze

Wind : ☐None ☐Light ☒Moderate ☐Strong, gusts

Temperature : -17 to -22 °C

Comments :

Appendix : ☐Yes ☐No Pictures ☒Yes ☐No Inspection report or other :

Picture in the folder :

ACTIVITIES PERFORMED BY SNC-LAVALIN (indicate if test forms were used)

- Attended daily meeting at Contractor trailer. AEM reminded for the pending coordinates in the exclusion zone.
- Yesterday Dayshift, no hole completed and night shift crew installed 5 casings and completed T533.5 which was started during day shift.
- Yesterday in the field discussion with QC my understanding was T533 casing shoe brocken at about 5 m depth but today checked with driller one casing brocken at about 2 m and other at about 8 m depth.
- At P488.5 casing brocken at near the bottom of the hole and casing installed at about 0.3 m east of the original location.
- Drilling crew was reminded that all the casing holes wheater brocken or good should be covered after completion.
- KGC informed during morning meeting that they will be ready for trial mix tomorrow but didn't observe any preparation for warming cement and transefering cement to 20 kg bucket. Have a doubt that they can do trial mix tomorrow.
- Visited injection unit, looks ready.
- QC continue inclination check for installed casings (without centerlizer)
- Talked to GHD QC, he received filtration test equipment but still waiting for Vicat apparatus.

SITE GUIDELINES (guidelines, memos, modification proposals, etc.)

No	Subject	Given to

SPECIFIC ELEMENTS VERIFIED

Elements	Location, batch or other	Scope and comments

SAFE AND SAFETY REMARKS

- Dress up properly for extreme cold conditions

Issued by :	*Muhammad Saleem / Tom Xue*	**12-11-2019**
	Signature	Date
Verified by :	*Yohan Jalbert*	**12-11-2019**
	Signature	Date

Casing relocated due to shoe brocken at P488.5

SNC·LAVALIN

SITE REPORT
(Detailed)

20191113
Document number

Date	Time (Start/End)	Project No.	Prepared by
13-11-2019	6:30 am 6 :30 pm	669034	Muhammad Saleem / Tom Xue

Project	Client
Whale Tail Dike Remedial Drilling and Grouting Works	Agnico Eagle

Consultant	Contractor
SNC-Lavalin	TCG

Weather : ☒Sunny ☒Cloudy ☐Rain ☐Storm ☐Snow ☐Glaze

Wind : ☐None ☐Light ☒Moderate ☐Strong, gusts

Temperature : -21 to -24 °C

Comments :

Appendix : ☐Yes ☐No Pictures ☒Yes ☐No Inspection report or other :

Picture in the folder :

ACTIVITIES PERFORMED BY SNC-LAVALIN (indicate if test forms were used)

- Attended daily meeting at Contractor trailer. AEM was informed that pending coordinates in the exclusion zone are expected this morning.
- 9 casings installed yesterday during day and night shift.
- Drilling contractor informed that they reduced pressure to avoid hammer breakdown inside the casing and will observe if this solve the problem.
- Discussed the discrepancy between the field discussion and the reporting values. Driller informed yesterday that at T533.5 two failure attempts and casing brocken at 8 m and 2 m depth but on the GHD report dated 11-11-2019, encountered block at 4.5 m and casing lost 8.6 m and at 2nd location also encountered block at 4.5 m.
- Contractor was advised to include the location of alternate hole with respect to the original hole.
- QC continue inclination check for installed casings (without centerlizer)
- KGC start moving cement from 1000 kg bag to 20 kg pails. Cement pails placed in the heated C-can.
- KGC informed they will be ready for trial mix tomorrow.

SITE GUIDELINES (guidelines, memos, modification proposals, etc.)

No	Subject	Given to

SPECIFIC ELEMENTS VERIFIED

Elements	Location, batch or other	Scope and comments

SAFE AND SAFETY REMARKS

- Dress up properly for extreme cold conditions

Issued by : *Muhammad Saleem / Tom Xue* — Signature — **13-11-2019** — Date

Verified by : *Yohan Jalbert* — Signature — **13-11-2019** — Date

Transfering cement from big bags to 20 kg pails

20 kg pails placed in the heated C-can

SNC·LAVALIN

SITE REPORT
(Detailed)

20191114
Document number

Date	Time (Start/End)	Project No.	Prepared by
14-11-2019	6:30 am 6 :30 pm	669034	Muhammad Saleem / Tom Xue

Project	Client
Whale Tail Dike Remedial Drilling and Grouting Works	Agnico Eagle

Consultant	Contractor
SNC-Lavalin	TCG

Weather : ☐Sunny ☒Cloudy ☐Rain ☐Storm ☐Snow ☐Glaze

Wind : ☐None ☐Light ☐Moderate ☒Strong, gusts

Temperature : -26 to -28 °C

Comments :

Appendix : ☐Yes ☐No Pictures ☒Yes ☐No Inspection report or other :

Picture in the folder :

ACTIVITIES PERFORMED BY SNC-LAVALIN (indicate if test forms were used)

- Attend meeting with AEM and KGC to discuss the the strategy and pathforward for trial grout testing, casing plug and blanket grouting. AEM requested to provide simplified step by step procedure for Casing plug, rock drilling and blanket grouting ASAP.
- Attended daily meeting at Contractor trailer.
- 8 casings installed and one casing in progress yesterday during day and night shift.

Grout Trial Test

- KGC conducted trial mix but they don't have super on site, mix A was tested without Super plasticizer.

- MIX A prepared with 120 KG cement, 2.4 kg Calcium Chloride (2% by weight), 84 liters water and tested for
  Marsh Time = 30-34 sec
  Specific Gravity = 1.62
  Temperature = 18C
  Bleed = not available yet.

- MIX B prepared with 120 KG cement, 2.4 kg Calcium Chloride (2% by weight), 72 liters water and tested for
  Marsh Time = 41 sec
  Specific Gravity = 1.73
  Temperature = 20 C
  Bleed = not available yet.

- MIX C prepared with 120 KG cement, 2.4 kg Calcium Chloride (2% by weight), 240 g Celbex(0.2% by weight) 60 liters water and tested for

Marsh Time = 77 sec
Specific Gravity = 1.8
Temperature =
Bleed = not available yet.

- Grout cubes were casted for strength test
- KGC didn't have vicat apparatus on site so no test was done for initial and final set time.
- They have apparatus for filtration test but technician wasn't prepared to perform filtration test.

Head Loss test

Head loss inside the 1" flexible pipe due to resistance between the grout and pipe wall was tested for Mix C. Head loss was estimated about 120 kpa over the 10 m long flexible hose. 100 Kpa pressure will be added to the effective pressure to read gauge pressure.
The pressure loss will be closely observed during the actual grouting operation and wil be adjusted in the field as needed.

SITE GUIDELINES (guidelines, memos, modification proposals, etc.)

No	Subject	Given to

SPECIFIC ELEMENTS VERIFIED

Elements	Location, batch or other	Scope and comments
Trial grout testing	Injection unit	Checked Marsh time, spectfic gravity, bleed and temperature

SAFE AND SAFETY REMARKS

- Blizzard like conditions, extra care while driving
- Dress up properly for extreme cold conditions

Issued by : *Muhammad Saleem / Tom Xue* (Signature) **14-11-2019** (Date)

Verified by : *Yohan Jalbert* (Signature) **14-11-2019** (Date)

Calibrating Marsh funnel with water

Checking marsh funnel time for grout

20 kg cement pails

SNC·LAVALIN

SITE REPORT
(Detailed)

20191115
Document number

Date	Time (Start/End)	Project No.	Prepared by
15-11-2019	6:30 am 6 :30 pm	669034	Muhammad Saleem / Tom Xue

Project	Client
Whale Tail Dike Remedial Drilling and Grouting Works	Agnico Eagle

Consultant	Contractor
SNC-Lavalin	TCG

Weather : ☐Sunny ☒Cloudy ☐Rain ☐Storm ☐Snow ☐Glaze

Wind : ☐None ☐Light ☒Moderate ☐Strong, gusts

Temperature : -17 to -21 °C

Comments :

Appendix : ☐Yes ☐No Pictures ☒Yes ☐No Inspection report or other :

Picture in the folder :

ACTIVITIES PERFORMED BY SNC-LAVALIN (indicate if test forms were used)

- Attended daily meeting at Contractor trailer.
- 7 casings installed and one casing in progress (this casing has been installed since yesterday during day and night shift).
- KGC informed that they will start casing plug tomorrow from East to West..
- KGC is modifying their injection unit to reach some of the holes close to the instrumentation zone.
- Checked with KGC about the bleeding results from yesterday trial grout and following bleed values are:
  MIX A Bleed = 5%
  Mix B Bleed = 1%
  Mix C Bleed = 0%

- Dixcussed with KGC tech for the calculation of pressure chart for casing plug.
- Checked the water collection ditch downstream side of the dike water observed clear.

While reviewing casing installation reports found that at S-686 and T689 (drilled on November 4, 2019) water encountered at about 5 m below platform.

Note: we don't have dedicated vehicle on site, hard to move around on site

SITE GUIDELINES (guidelines, memos, modification proposals, etc.)

No	Subject	Given to

SPECIFIC ELEMENTS VERIFIED

Elements	Location, batch or other	Scope and comments

SAFE AND SAFETY REMARKS

- Dress up properly for extreme cold conditions

Issued by :	*Muhammad Saleem / Tom Xue*	**15-11-2019**
	Signature	Date
Verified by :	*Nina Zuan*	**15-11-2019**
	Signature	Date

Water flowing in the ditch downstream side of the Dike

Casing installation in progress

SNC·LAVALIN

SITE REPORT
(Detailed)

20191116
Document number

Date	Time (Start/End)	Project No.	Prepared by
16-11-2019	6:30 am 6 :30 pm	669034	Muhammad Saleem / Tom Xue

Project	Client
Whale Tail Dike Remedial Drilling and Grouting Works	Agnico Eagle

Consultant	Contractor
SNC-Lavalin	TCG

Weather : ☐ Sunny ☒ Cloudy ☐ Rain ☐ Storm ☐ Snow ☐ Glaze

Wind : ☐ None ☐ Light ☒ Moderate ☐ Strong, gusts

Temperature : -17 to -22 °C

Comments :

Appendix : ☐ Yes ☐ No Pictures ☐ Yes ☒ No Inspection report or other :

Picture in the folder :

ACTIVITIES PERFORMED BY SNC-LAVALIN (indicate if test forms were used)

- Attended daily meeting at Contractor trailer.
- 6 casings installed and one casing in progress (this casing has been installed since yesterday during day and night shift).
- Drilling rig was down from just before the end of the day shift yesterday and resume drilling 2am during the night shift.
- KGC was asked to check the water level in the casing after installation completed and also monitor the water level in S686.5 and T689.5 where water level was reported at 4.5 m and 5 m depth respectively during drilling.
- KGC informed that they are working on a shack for admixture storage and therefore grouting for casing plug will not be ready to start today.
- During site visit observe that QC was trying to measure the water level with inclinometer attached with string. This is not a right way to measure the water level, proper water meter should be used to accurately measure the water level in the hole.
- Checked admixture storage area, Celbex 653, Rheomac 450 and Masterset FP20 stored in the heated C-can.

QC didn't have water meter on site to measure the water level inside the casing after installation. Will ask KCG during the morning meeting to arrange water meter.

SITE GUIDELINES (guidelines, memos, modification proposals, etc.)

No	Subject	Given to

SPECIFIC ELEMENTS VERIFIED

Elements	Location, batch or other	Scope and comments

SAFE AND SAFETY REMARKS

- Dress up properly for extreme cold conditions

Issued by :	*Muhammad Saleem / Tom Xue*	**16-11-2019**
	Signature	Date
Verified by :	*Nina Zuan*	**16-11-2019**
	Signature	Date

SNC·LAVALIN

SITE REPORT
(Detailed)

20191117
Document number

Date	Time (Start/End)	Project No.	Prepared by
17-11-2019	6:30 am 6 :30 pm	669034	Muhammad Saleem / Tom Xue

Project	Client
Whale Tail Dike Remedial Drilling and Grouting Works	Agnico Eagle

Consultant	Contractor
SNC-Lavalin	TCG

Weather : ☐Sunny ☒Cloudy ☐Rain ☐Storm ☐Snow ☐Glaze

Wind : ☐None ☐Light ☒Moderate ☐Strong, gusts

Temperature : -20 to -24 °C

Comments :

Appendix : ☐Yes ☐No Pictures ☒Yes ☐No Inspection report or other :

Picture in the folder :

ACTIVITIES PERFORMED BY SNC-LAVALIN (indicate if test forms were used)

- Attended daily meeting at Contractor trailer.
- 15 casings installed and one casing in progress (this casing has been installed since yesterday during day and night shift). These casings were installed from S-266.5 to P-308.5.
- KGC was informed to check water level with water meter inside the casing after installation completed and verify water level in the previously installed casings.

Grout Trial Test

KGC conducted another round of grout trial mix.

- MIX A+ prepared with 120 KG cement, 2.4 kg Calcium Chloride, 480ml Glenium 3030, 84 liters water and tested for
  Marsh Time = 30 sec
  Specific Gravity = 1.62
  Temperature = 20C
  Bleed = 1%
  Filtration Test (coefficient of filtration) = 0.02 min-½ < 0.06 min -½

- MIX B+ prepared with 120 KG cement, 2.4 kg Calcium Chloride, 480ml Glenium 3030 72 liters water and tested for
  Marsh Time = 32 sec
  Specific Gravity = 1.67
  Bleed = 4%

- MIX D prepared with 120 KG cement, 1.2 kg Calcium Chloride, 500ml Rheomac 450 60 liters water and tested for
  Marsh Time = 154 sec
  Specific Gravity = 1.75

- MIX E prepared with 120 KG cement, 2.4 kg Calcium Chloride, 250ml of Rheomac 450 60 liters water and tested for
  Marsh Time = 163 sec
  Specific Gravity = 1.75

  Mix D was tested first with 2.4 kg of calcium chloride and 500 ml of Rheomac 450 but the mix was too thick and TCG thought due to reaction of Rheomac 450, Calcium Chloride and Cement, it look like flash set and may clog the system so is not workable. Therefore Mix D and E were developed with different proporation of calcium chloride and Rheomac 450.

Pressure filtration test was performed on Mix A+, Mix B+ and Mix E but only the result from Mix A+ looks reliable because after completed test for Mix A+, equipment may not cleaned and dry properly and shows unexpected behaviour. Will perform this test again on other mixes during production.

Crew still not received Vicat apparatus so intitial and final set time of the grout not tested.

SITE GUIDELINES (guidelines, memos, modification proposals, etc.)

No	Subject	Given to

SPECIFIC ELEMENTS VERIFIED

Elements	Location, batch or other	Scope and comments
Grout testing	Injection unit	Specific gravity, Marsh Time, Bleed and Filtration test

SAFE AND SAFETY REMARKS

- Dress up properly for extreme cold conditions

Issued by :	*Muhammad Saleem / Tom Xue*	**17-11-2019**
	Signature	Date
Verified by :	*Nina Zuan*	**17-11-2019**
	Signature	Date

Checking Specific gravity of grout

Performing Filtration Test

SNC·LAVALIN

DAILY FIELD REPORT
(Detailed)

20191118
Document number

Date	Time (Start/End)	Project No.	Prepared by
18-11-2019	6:30 am 6:30 pm	669034	Muhammad Saleem

Project	Client
Whale Tail Dike Remedial Drilling and Grouting Works	Agnico Eagle

Consultant	Contractor
SNC-Lavalin	TCG

Weather : ☐ Sunny ☒ Cloudy ☐ Rain ☐ Storm ☐ Snow ☐ Glaze

Wind : ☐ None ☐ Light ☒ Moderate ☐ Strong, gusts

Temperature : -16 to -22 °C

Comments :

Appendix : ☐ Yes ☐ No Pictures ☒ Yes ☐ No Inspection report or other :

Picture in the folder :

ACTIVITIES PERFORMED BY SNC-LAVALIN (indicate if test forms were used)

- Attended daily meeting at Contractor trailer.
- 10 casings installed and one casing in progress (this casing has been installed since yesterday during day and night shift). These casings were installed from S-236.5 to P-308.5.
- During night shift the drill rig was down for 5 hours.
- KGC checked water level depth from S-722.5 to T-749.5. water level in the holes was measured on average at about 6.5 m below ground except T-749.5 where water level was measured at about 8.9 m below ground.
- The driller and QC reports are not consistence, KGC was advised to check and correct reports prior to distribute.
- KGC continue checking inclination without using centralizer for inclinometer. Talked to the KGC tech they check some casings for inclination but the data was lost and now start from East to West.

Grout Mixes

As per site meeting held on November 14, 2019 between SNC, AEM and KGC MIX C for casing plug was developed inline with the grouting committee recommendation with water cement ratio 0.5, 2% calcium chloride and 0.2% Celbex. Two other HMG were also tested to have incase we need in future. Because the Super Plasticizer and Rheomac 450 was not ready at the time of initial trial test, On November 17, 2019 four more mixes were tested to see the properties of the admixtures with different proportions under the present site and weather conditions and have reday if need in the future for next stage of the work.

Casing Plug

- No grouting for the casing plug started today

- Injection unit moved to the WTD at about 4 pm and set at T749.5
- Few casing stick up were found high, they have to cut about 100 to 150 mm of casing from top to adjust injection unit.
- Injection unit will be ready to start casing plug tomorrow from T749.5 using Mix C with water / cement ratio of 0.5, 2% of calcium chloride and 0.2% of celbex

SITE GUIDELINES (guidelines, memos, modification proposals, etc.)

No	Subject	Given to

SPECIFIC ELEMENTS VERIFIED

Elements	Location, batch or other	Scope and comments

SAFE AND SAFETY REMARKS

- Dress up properly for extreme cold conditions

Issued by : *Muhammad Saleem* — Signature — **18-11-2019** — Date

Verified by : *Nina Zuan* — Signature — **18-11-2019** — Date

Casing instalation near west end of WTD

Injection unit set up at T-749.5

SNC·LAVALIN

DAILY FIELD REPORT
(Detailed)

20191119
Document number

Date	Time (Start/End)	Project No.	Prepared by
19-11-2019	6:30 am 6:30 pm	669034	Muhammad Saleem

Project	Client
Whale Tail Dike Remedial Drilling and Grouting Works	Agnico Eagle

Consultant	Contractor
SNC-Lavalin	TCG

Weather : ☐Sunny ☒Cloudy ☐Rain ☐Storm ☐Snow ☐Glaze

Wind : ☐None ☐Light ☒Moderate ☐Strong, gusts

Temperature : -16 to -22 °C

Comments :

Appendix : ☐Yes ☐No Pictures ☒Yes ☐No Inspection report or other :

Picture in the folder :

ACTIVITIES PERFORMED BY SNC-LAVALIN (indicate if test forms were used)

- Attended daily meeting at Contractor trailer.
- 7 casings installed and one casing in progress (this casing has been installed since yesterday during day and night shift) between S-218 to P-236. All casings reached bedrock and have 0.3 m embedment in the rock except S218.5 where embedment depth is 0.75 m due issue with drilling bit.
- No night shift drilling last night due to driller was sick.
- KGC informed that a total of 130 casings has been installed.
- KGC reminded during the meeting to bring consistency between the QC and driller reports.
- KGC requested to provide the Casing Inclination report and casing as built report. SNC haven't received casing as built report so far.

Casing Plug

Started grouting for casing plug today using Mix C based on the trial test and inline with grouting committee recommendations.

Grout Test 1 Marsh Value = 57 sec. Specific gravity = 1.82 Bleed = <2% Temperature = 23.5C
Grout Test 2 Marsh Value = 62 sec. Specific gravity = 1.8 Bleed = <2% Temperature = 23.9C

T749.5 injected 12.6 liters grout @ 1.41 bar
S746.5 injected 32.0 liters grout @ 1.69 bar
T743.5 injected 18.4 liters grout @ 2.17 bar
P740.5 injected 62.8 liters grout @ 1.68 bar
T737.5 injected 31.1 liters grout @ 1.83 bar
S734.5 injected 28.6 liters grout @ 1.55 bar
T731.5 injected 3.6 liters grout @ 3 bar

P728.5 injected 4.6 liters grout @ 3 bar
T725.5 injected 3.0 liters grout @ 3 bar
S722.5 injected 154 liters grout @ 0.6 bar (reached max volume)

10 casings plugged today. T749.5 to S734.5 we reached maximum pressure and maintain pressure for 5 minutes and flow was 0l/min when stopped.
AT T731.5, P728.5 and T725.5 we hit the maximum pressure quickly with only about 3 liters of grout. There was mud in the casing about 0.3 to 1 m and Ken (KGC) told that he tried to clean with rig but when stopped mud came back and they could not clean the hole. He thought that casing filled with mud from socket of cut off wall and could not clean.
At S722.5 we rached maximum volume without reaching Pmax.

We need to watch those holes that could not be cleaned. Either have to drill further down to the competent rock or any other action.

SITE GUIDELINES (guidelines, memos, modification proposals, etc.)

No	Subject	Given to

SPECIFIC ELEMENTS VERIFIED

Elements	Location, batch or other	Scope and comments
Grout	Injrction unit	Marsh value, Bleed, Specific gravity and temperature

SAFE AND SAFETY REMARKS

- Dress up properly for extreme cold conditions

Issued by :	*Muhammad Saleem*	**19-11-2019**
	Signature	Date
Verified by :	*Nina Zuan*	**19-11-2019**
	Signature	Date