Qikiqtaaluk environmental

CONTAMINATED SOIL MANAGEMENT
LONG TERM MONITORING PLAN

Prepared for:

IQALUIT INTERNATIONAL AIRPORT IMPROVEMENT PROJECT "IIAIP"
BOUYGUES-SINTRA JOINT VENTURE

June, 2015

Rev 3.4

O/Ref.: QE14-214-11

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Prepared and reviewed by:

Karl Côté, M. Eng., P. Eng.
Project Manager – Northern Projects

Approved by:

Greg Johnson, M. Sc. A, P. Eng.
Project Director – Northern Projects

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LIST OF ABBREVIATIONS

AANDC:	Aboriginal Affairs and Northern Development Canada
BTEX:	Benzene, toluene, ethylbenzene and xylenes
CCME:	Canadian Council of Ministers of the Environment
DEW Line:	Distant Early Warning Line
PH F1:	Petroleum hydrocarbon Fraction 1 (C_6 to C_{10})
PH F2:	Petroleum hydrocarbon Fraction 2 (> C_{10} to C_{16})
PH F3:	Petroleum hydrocarbon Fraction 3 (> C_{16} to C_{34})
PH F4:	Petroleum hydrocarbon Fraction 4 (> C_{34} and +)
pH:	Measure of acidity or basicity
PHC:	Petroleum hydrocarbons

1. INTRODUCTION

The purpose of this monitoring plan is to assess, during the planned life span of 10 years, the performance of the containment system to ensure that contamination is not leaching out to the environment. In 2018 the plan is to convert the containment cell into a landfarm and treat the PHC contaminated soils. The monitoring program will continue over the planned life span of the landfarm portion of the work until all of the soils have been treated. The 2 components of the monitoring plan include visual monitoring and active layer groundwater monitoring.

The arsenic contaminated soils will be sampled to determine the level of contamination, and all soils over the guideline limit of 100 mg/kg will be placed in a containment cell on site. At the choice of the project client, these soils could also be packaged and transported to the south for disposal prior to the start of landfarm operations.

2. VISUAL MONITORING

The physical integrity of the containment cell, constructed as per the *Remediation Work Plan, Iqaluit Airport Hydrocarbon Contaminated Soils* from the *TC Landfarms and Arsenic Contaminated Soils* (QE14-214-8, August 25, 2014, Version 1.1), will be inspected and reported at the same frequency as the groundwater monitoring events as described below. Documented observations will include:

- Condition of the top cover geomembrane (ripping, puncturing, cracking, stretch marks, discoloration, bulging from water or soil pressure, etc.);
- Evidence of burrowing animals in the berms or around the perimeter of the containment cell;
- Soil stains on the berms or around the perimeter of the containment cell; and
- Water resurgence or ponding on the berms or around the perimeter of the containment cell.

Visual geotechnical monitoring and reporting will be carried out by an engineer registered to practice in Nunavut. This work is planned to be carried out by Qikiqtaaluk Environmental (QE).

3. GROUNDWATER MONITORING

Groundwater samples will be retrieved from monitoring wells installed around the containment cell. One monitoring well will be installed up-gradient and 3 wells will be installed down-gradient of the cell. A total of 4 groundwater samples (4 wells) and 1 duplicate will be retrieved for analysis at every monitoring event.

The proposed location of the monitoring wells is presented in Figure 1. Typical monitoring well construction specifications and drawings (Figures 2 and 3) are presented in Appendix A.

The monitoring wells will be installed by Canadrill, a drilling contractor form Iqaluit. Well installation will be carried under the supervision of QE technical personnel.

Prior to collection of samples from a monitoring well, the well will be purged and allowed to reach equilibrium. Physical measurements shall be collected prior to and after purging and shall be referenced to the top of the monitoring well pipe. Parameters include:

- Water elevation;
- Total depth of water; and
- Presence of hydrocarbons (and layer thickness if appropriate).

Following withdrawal of a water sample, other physical measurements to be recorded include: colour, odour, pH, conductivity, and temperature.

The water sample will be filtered, as required for metal analyses, and transferred into appropriate containers, provided by the laboratory, for transport to a CAEAL accredited laboratory for analyses. Parameters for analyses include:

- PHC Fractions F1-F4 and BTEX;
- Arsenic.

Should additional soils be added to the containment cell that have new contaminants of concern, then the monitoring program will be restarted at Year 1 and these new parameters will be added to the monitoring program.

Water elevation data from a minimum of 3 wells will serve to assess groundwater hydraulic gradient and flow velocity. Review of analytical data from groundwater samples collected from wells up and down gradient allows evaluation of potential impacts associated with the containment cell. Groundwater measurements and sampling will be carried out by a technician from QE, while data interpretation and reporting will be conducted by a QE professional (engineer or geologist).

4. MONITORING FREQUENCY

The containment cell monitoring program consists of 3 phases. Each of the monitoring wells will be sampled at the end of the summer season (during the month of August) when active layer groundwater flow is at its peak.

Phase I - Years 1, 2, 3, 4 and 5

Monitoring will take place on an annual basis for a period of 5 years. The five-year term was selected on the basis that ground-temperature thermal regimes at northern sites require 3 to 5 years to reach equilibrium.

Groundwater monitoring data will be evaluated every year and compared to applicable quality criteria (Nunavut, CCME). A statistical evaluation of all Phase I data will be carried out at the end of 5 years to confirm that chemical equilibrium has been achieved, and that no stability issues have been identified. The Phase I monitoring program may be extended, if required, to provide sufficient data to establish equilibrium conditions.

Phase II - Years 7, 9

The monitoring frequency in Phase II will be downgraded from Phase I, and is anticipated to be carried out according to the following schedule: Year 7, Year 9, and every 2 years thereafter until all of the PHC soils have been treated.

Phase IV – End of Life Cycle

Once all of the soils have been treated and removed from the containment cell, which could potentially be converted into a landfarm, it will be dismantled and sampled as discussed in section of this document.

5. INTERPRETATION OF MONITORING RESULTS

To effectively assess follow-up action requirements, it is necessary that monitoring results (chemical and visual) be interpreted in concert with one another. An increase in chemical concentrations, for instance, from one year to the next does not necessarily trigger action if there is no other evidence of physical instability.

Should potential problems be identified during the monitoring program, the frequency and scope of the monitoring program will be increased. Following verification of the cause and extent of the problem, the scope of any remedial action will be reviewed, and implemented, as appropriate.

If visual monitoring results indicate a deficiency or problem required actions could include:

- Evaluate causes of distress or failure (i.e., design versus construction);
- Repair or replace the covering geomembrane; and
- Inspection by a geotechnical engineer or geomembrane supplier/installation contractor.

If groundwater monitoring results indicate increasing levels of contamination due to an unforeseen event, then it may be necessary to implement one or all of the following:

- Increase the frequency of the monitoring program;
- Carry out a review and evaluation of the nature and extent of the contamination, including the incorporation of the results of the visual monitoring program. The objective of this evaluation will be to determine the cause of the contaminant migration problem. This evaluation may require intrusive investigation into and around the cell;
- Depending on the results of the above, it may be necessary to remove and replace liner material, reconstruct containment berms, etc.;
- Assess the requirement to excavate and dispose of the contaminated soil; delineation of the vertical and horizontal extent of contamination; and
- Excavate and dispose of contaminated soil, as required.

The requirement for the specific scope and extent of remediation, as outlined above, should also incorporate an evaluation of the potential environmental impacts of the contamination.

6. DATA REPORTING

A monitoring report will be submitted after every monitoring event. The report will provide the following:

- Visual observations and photographs;
- Groundwater field measurements;
- Analytical results of samples compared to quality criteria;
- QA/QC results;
- Interpretation of monitoring data in relation to data from previous years;
- Statistical data analysis (once sufficient data is obtained); and
- Recommendations on follow up.

The report will be sent to AANDC and will be part of an annual report that will be sent-out to the NWB.

7. END OF LIFE CYCLE

Once all of the contaminated soils have been treated, the soils will be removed and used as fill at a location approved by AANDC. The geomembrane liner and geotextiles will be removed and sent to the City of Iqaluit Landfill or will be shipped to the south for disposal into a licensed landfill or waste disposal site. The soils in the berms and under the geomembrane will be sampled, and any contaminated soils found will be sent to a treatment facility in Iqaluit. Once all contaminated soils have been removed, the area will be reshaped. Monitoring wells will be decommissioned, by cutting the pipe at 0.5 m below ground surface and filling the remaining pipe with bentonite.

8. QE EXPERIENCE IN LONG TERM MONITORING

QE has been actively involved, since 1997, as a member of the Environmental Working Group (EWG) for DEW Line sites in Nunavut, responsible for:

- Developing (1998) and updating (2013) the landfill monitoring program (visual, soil, groundwater and thermal components);
- Reviewing post-construction landfill monitoring data for 99 landfills located on 15 DEW Line sites across Nunavut, from 1999 to 2015.

Mr. Karl Côté, M.Eng., P.Eng., Project Manager for QE, has been working with the EWG since 2001.

APPENDIX A

METHODOLOGY FOR THE INSTALLATION OF GROUNDWATER MONITORING WELLS

Methodology for the Installation of Groundwater Monitoring Wells

1.1 All material and supplies required (well screens, SS 304 sch 10, 1.5"D, 0.50 mm openings, threaded -1 m length sections, well tubes, SS 304 sch 10, 1.5"D, threaded -1 m length sections, watertight bottom caps and top caps, SS threaded, wells protector, 6" diam x 4' length, SCH 40 carbon steel, with 7" diam circular flange welded at mid-length, with hinged locking cap, bentonite 3/8" pellets bags, inorganic free Silica Sand bags, Arctic Sika grout bags) will be purchased in sufficient amounts prior to sealift departure, and placed in 1 of the ISO steel barge containers.

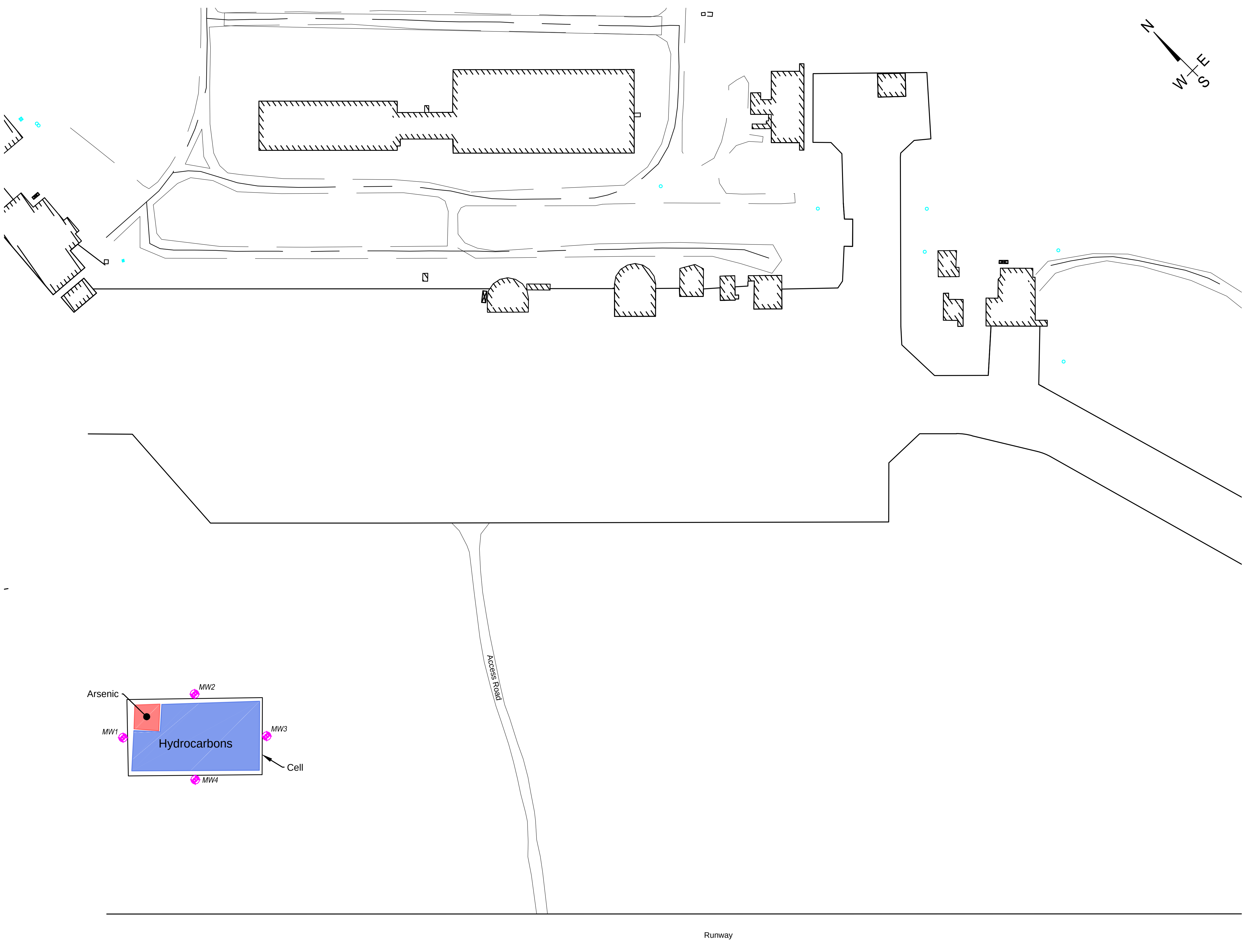
1.2 After review of the drawings and specifications, the air track drill (Canadrill) will be used to drill boreholes of 150 mm in diameter to a depth that will vary depending at which depth bedrock is found.

1.3 For MW installation where bedrock depth is found at less than 0.7 m from the surface, a borehole of approximately 3.4 m from the surface will be drilled. Three sections of perforated tube of 1 m and 1 section of non-perforated 1 m will be screwed together. The watertight end cap will also be screwed on the perforated end of the 4 m tubing. The filter sock will then be fitted around the perforated section up to 3.2 m from the end cap and be taped to remain in place during the completion of the installation. The tubing will then be inserted inside the boreholes and Silica Sand will then be poured inside the borehole up to 0.2 m from the surface. Then, the well casing is inserted for the flange to be at ground level. The soil from about 0.2 m from the surface outside of the well casing is then shovelled manually and then backfilled with bentonite pellets to ground level. Bentonite pellets are also poured around the well inside the casing to the ground level. Finally, 0.2 m of Type 5 fill is placed inside the casing on top of the bentonite seal. A mound of soil is then placed outside the casing to promote drainage.

The installation shall be adjusted as needed to ensure that groundwater in the overburden material (on top of the bedrock) is intercepted by the slotted section of pipe. If necessary, the slotted section of the pipe can be brought closer to the ground surface. Caution shall be used to ensure that the bentonite plug does not obstruct the slotted pipe. At the same time, care must be taken to ensure that surface water does not short circuit the plug and enter directly into the monitoring well.

1.4 For MW installation where bedrock is found deeper than 0.7 m, the boreholes will be drilled to about 4.5 m. Five sections of 1 m will be screwed together, with 2 non-perforated sections at both ends. Similarly to Section 1.5, the watertight cap will be screwed at one end. The filter sock will be slotted around the 3 m perforated section extending 0.2m on both ends and maintained in place using tape. The 5 m tubing will be inserted inside the borehole, end cap in the bottom. Arctic Sika grout will be mixed with water and prepared according to the recipe and then rapidly poured inside the borehole to fill about 0.8 m around the well in the bottom, taking the necessary precautions to avoid contact withthe upper portion of the well. Otherwise, the same procedure as per the above Section 1.5 will be followed with the only exception being that the bentonite seal inside the casing and bentonite chips to be placed outside the casing will be to a depth of 0.3 m instead of 0.2 m.

1.5 The casing, cap and marker post will finally be painted with fluorescent orange spray paint and the monitoring well locations will be surveyed with references to the existing benchmark coordinates in UTM Zone 20N, NAD83 (CSRS) with elevations referenced to mean sea level relative to the GEOID model Canadian HT2_0.



This document shall not be used for construction, building or installation purposes.

Legend

MW1 Monitoring Well

Source :

• QE; Excavation limit is based on field measurements; September 2014;

CONFIDENTIAL

Figure 1

Site Plan

CHARACTERIZATION OF SOIL LAYDOWN AREA NEXT TO APRON

Presented to:

sintra INC.

Property located at:

Iqaluit Airport, Nunavut

Scale: Not to scale	Design date: 2014-09-16		Revision date: 2015-03-13	
Drawn by: J. Bergeron	Verified by: G. Johnson		Approved by: S. Laberge	
Project no.: QE14-214-11	Drawing no.: QE14-214-11-01	Layout: A	Geodetic reference: MTM/NAD83	Zone 19

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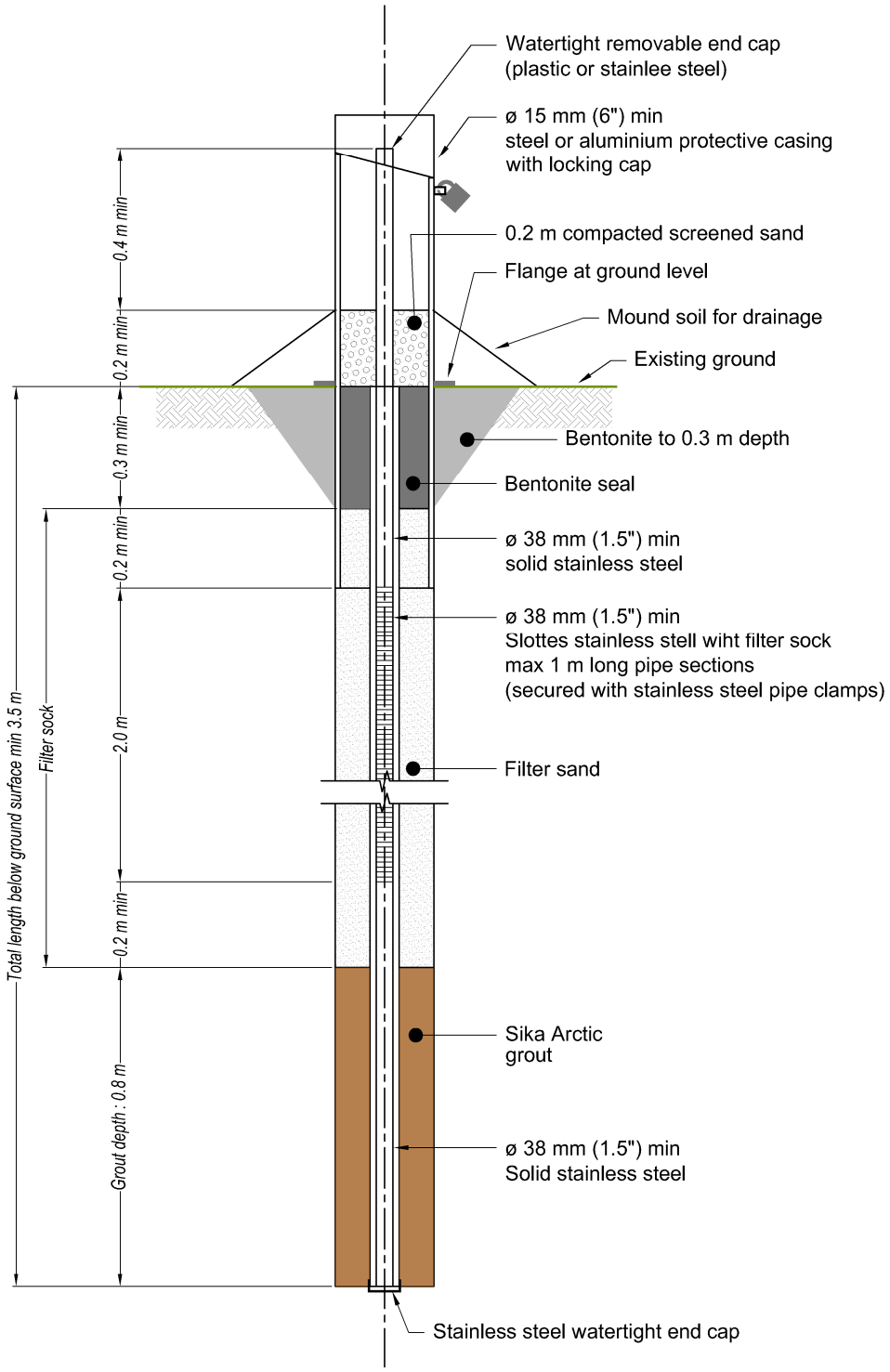

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Figure 2

Monitoring well for bedrock > 0.7 m

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Not to scale	2015-05-05	2015-05-05
Drawn by:	Verified by:	Approved by:
H. Longval	G. Johnson	S. Laberge
Project no.:	Drawing no.: / Layout:	Geodetic reference:
QE14-214-11	QE14-214-1-03 / A	None / None

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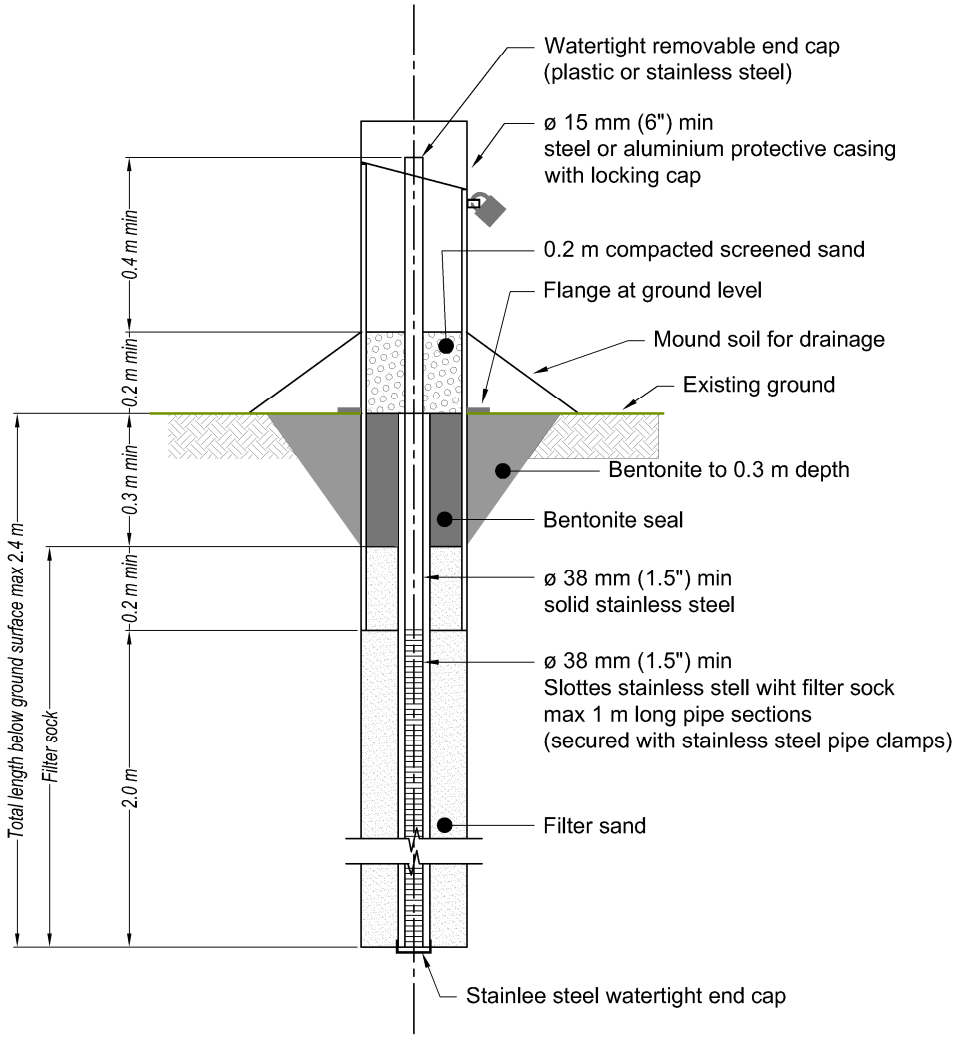

Presented to:

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Property located at:

Iqaluit Airport, Nunavut

Figure 3

Monitoring well for bedrock < 0.7 m

IQALUIT INTERNATIONAL AIRPORT
IMPROVEMENT PROJECT

Scale:	Design date:	Revision date:
Not to scale	2015-05-05	2015-05-05
Drawn by:	Verified by:	Approved by:
H. Longval	G. Johnson	S. Laberge
Project no.:	Drawing no.: / Layout:	Geodetic reference:
QE14-214-11	QE14-214-1-03 / B	None / None

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