APPENDIX A – GEOTECHNICAL REPORT

Desktop Geotechnical Study

Iqaluit Waste Water Treatment Plant - Upgrade/Addition Feasibility Study, Iqaluit, Nunavut



Prepared for: City of Iqaluit

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1.0 INTRODUCTION

Nunami Stantec Limited (Stantec) has prepared this Desktop Geotechnical Study to support the preliminary design of the upgrade/addition of the existing waste water treatment plant located in Igaluit, Nunavut.

This report has been prepared specifically and solely for the project described herein. This report presents a summary of available information and geotechnical comments specific to the assessed site. A geotechnical investigation with boreholes will need to be completed during the detailed design stage of the project.

2.0 SITE LOCATION AND GEOLOGY

The Iqaluit Waste Water Treatment Plant (the WWTP) is located in the City of Iqaluit. Iqaluit is located at the head of Frobisher Bay in the southern region of Baffin Island, in the Territory of Nunavut.

The proposed site is located between Akilliq Road and the shoreline of Frobisher Bay. The existing WWTP is on the south side of Akilliq Road, with an approximate footprint of 638 m². The ground surface elevation is anticipated to be approximately 6.9 m to 8.4 m; however this is to be confirmed by topographic survey. The ground surface in the area generally slopes down toward Frobisher Bay.

The site location is shown on the Key Plan in Drawing 1 and the Site Location Plan in Drawing 2 of Appendix B.

Iqaluit is located within the Canadian Shield with predominately granitic gneiss or granodiorite bedrock of the Archean Eon (Harrison et. al., 2011). Overburden soils consist of nearshore marine deposits consisting of stratified and well graded materials ranging between silty sand to gravel (Allard et al., 2012).

2.1 PROPOSED UPGRADE / ADDITION

The existing waste water treatment plant consists of one building divided into two areas. The main part of the building has dimensions of approximately 17 m by 25 m and contains the primary tanks and cells. The floor slab elevation of this building is understood to be 8.0 m. The headworks portion of the plant is approximately 9 m by 14 m with a floor slab elevation of 10.0 m.

The proposed work consists of two additions, as shown on Drawing 2, Site Location Plan. The northern addition is approximately 8 m by 15 m, with a floor slab elevation of 9.0 m and will be used to house grit removal equipment. The southern addition will be approximately 12 m by



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15 m, with a floor slab elevation of 8.0 m. The southern addition will contain the mechanical and electrical rooms.

2.2 PREVIOUS GEOTECHNICAL INVESTIGATIONS

There are two geotechnical investigation reports related to the existing WWTP that were available for review as part of this work. A geotechnical investigation was completed by AGRA Earth & Environmental Limited in 1998 to support the design of the existing waste water treatment plant. Trow Associates Inc., now exp Services Ltd., completed a geotechnical investigation in 2004 related to a proposed addition immediately south east of the main part of the existing building. This addition has not been constructed at the time of this report. It is noted that development of the site has likely changed the overburden conditions observed in the boreholes drilled by AGRA Earth & Environmental Limited and Trow Associates Inc.

2.3 BACKGROUND DOCUMENTS

1999 Construction (Main Plant)

The report prepared by AGRA recommended that footings bearing on rock would be feasible. It was noted that the surface of bedrock was variable and that some blasting may be required to achieve the desired grades. There are no recommendations specifically about the floor slabs provided in the report.

Based on the construction drawings prepared by Western Engineering, dated June 20, 1999 it is understood that the main plant was constructed on shallow foundations bearing on compacted granular pads. There was no information noted to indicate the overall thickness of the granular pad, or the elevations of the surface of rock, the floor slab, or the underside of the footings. It is also noted that there is 2" (50 mm) thick rigid insulation installed on the exterior footings and walls. The underside of footing is shown to be 1'-8" (500 mm) below the top of the floor slab however, this has not been confirmed.

2005 Construction (South East Addition)

The report prepared by Trow recommended that the building be founded on steel piles socketed in bedrock. It was noted that the surface of bedrock was variable. The floor slab for the "south east" addition was recommended to be constructed as a slab-on-grade, founded on a granular pad. The recommendations for the floor slab of the "western" addition, which has not been constructed at this time, was a structural slab supported on piles. It is noted that the proposed footprint of the new Addition is located partially on the same footprint as the "western" addition proposed to be constructed in 2005.

Based on the construction drawings prepared by Earth Tech, dated May 11, 2006 it is understood that the "south east" addition was constructed on pipe piles socketed 2 m into the bedrock. The top of the pile cap ranged between elevations of 8.3 m and 9.5 m. It is understood that there was a combination of structural slabs and slab-on-grade, constructed on a granular pad. It is unclear how thick or how variable this fill layer may be.



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3.0 SCOPE OF WORK

The scope of this Desktop Geotechnical Study included:

- A review of geological mapping of the area and available geotechnical information at the proposed site.
- Review of geotechnical reports completed for the existing WWTP.
- A summary of the anticipated subsurface conditions for the site.
- Recommendations for the preliminary design of the foundations for the building.

4.0 CLIMATE

The average daily mean temperature from the Iqaluit Airport from 1981 to 2010 is -9.3 °C (Environment Canada, 2016). The average annual precipitation is 403.7 mm with an average annual snowfall of 229.3 cm (Environment Canada, 2016). The average freezing and thawing indices between 1981 and 2010 have been 4052 C° days and 695 C° days, respectively. CSA (2010) suggests a warming trend of 0.7 °C per decade within the Eastern North region (including Iqaluit), which was adapted from a study completed by Holubec, et. al. (2009) using data from 1978 to 2008 in their model.

5.0 ANTICIPATED SUBSURFACE CONDITIONS

The following sections summarize the anticipated subsurface conditions at the site location.

5.1 ANTICIPATED SOIL CONDITIONS

Canadian Geoscience Map 64-2012 prepared by Geological Survey of Canada (Allard, et. al., 2012) indicates nearshore marine sediments overlying shallow bedrock. The overburden is described consisting of well graded sand, silty sand, gravelly sand, and gravels. The map suggests that bedrock is likely close to surface based on outcrops at surface within one hundred meters of the site.

Two geotechnical investigations have been completed on the site associated with the construction of the existing structure (AGRA Earth & Environmental Limited, 1998) and a proposed addition for the southern limits of the existing building (Trow Associates Inc., 2004), which was not constructed. The borehole records from these investigations are included in Appendix C. It is noted that development of the site has likely changed the overburden conditions observed in the boreholes drilled by AGRA Earth & Environmental Limited and Trow Associates Inc. through the placement of fill.

The report completed by AGRA (1998) described 2.0 m to 4.0 m of silty sand and silt overlying grey bedrock. Index testing to support the soil descriptions was not provided in the report. The report completed by Trow (2004) described silty sand to sandy silt, as well as fill, overlying granite



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bedrock. Gradation analysis of the fill indicates that it is approximately 25% gravel, 50% sand, and 25% silt and clay sized particles. The gradation analysis of the in-situ materials report 92% silt and clay sized particles, although based on the borehole logs, and local surficial geology mapping, it is anticipated that the gradations of the soils will be expected to vary across the site.

The bedrock sampled by Trow (2004) is described as medium to coarse grained pink and grey granite. The reported RQDs range between 0% and 100%, which corresponds to very poor to excellent quality. The uniaxial compressive strength of intact samples ranged between 113 to 166 MPa with an average of 136 MPa. It should be noted that based on the records provided by Trow (2004) the RQD does not increase with depth as what is commonly expected. It cannot be determined at this time whether the variation in rock quality may be a result of drilling techniques or if it is naturally occurring.

Depth to bedrock is reported to range between 1.9 m and 5.8 m across the site. The information presented in the two reports suggests that the depth to rock increases toward the coastline. Table 5.1 summarizes the depth to bedrock reported by others at the site.

Table 5.1: Summary of Depth to Bedrock Recorded by Others

Borehole	Depth to Bedrock Measured from Ground Surface (m)*	Approximate Geodetic Elevation of Bedrock (m)
BH1 (Trow)	5.8	1.2
BH2 (Trow)	5.7	0.7
BH3 (Trow)	2.0	5.2
BH4 (Trow)	2.9	4.8
BH573-1 (AGRA)	3.9	-
BH573-2 (AGRA)	2.1	-
BH573-3 (AGRA)	1.9	-
BH573-4 (AGRA)	3.4	-
BH573-5 (AGRA)	3.3	-
BH573-6 (AGRA)	3.6	-
BH573-7 (AGRA)	3.9	-
* The depth to bedrock may have	changed due to site grading work completed	since completion of drilling.

5.2 ANTICIPATED PERMAFROST CONDITIONS

Canada Permafrost mapping from the National Atlas of Canada shows Iqaluit is located within the continuous permafrost region (Natural Resources Canada, 1995). The Mean Annual Ground Temperature (MAGT) ranges between -5.6 °C to -7.9 °C (Smith, et. al., 2013). Frozen soil was encountered at an approximate depth of 1.5 m during a geotechnical investigation completed during the month of October (AGRA, 1998). Investigations completed at the Iqaluit International Airport, within 500 m to 1000 m of the WWTP, indicate that the active layer may be up to 2.5 m thick (Leblanc, et. al. 2012).

The pore water salinity is reported to vary between 0.1 ppt and 24 ppt in the City of Iqaluit (Hivon and Sego, 1993). The pore water salinity will affect the freezing point of the soil. As salinity



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increases the freezing point is depressed. A salinity of 32 ppt (3.2%) will depress the freezing point from 0°C to -2°C. The result of the depressed freezing point is a reduction in frozen soil strength and increased creep related movements at a given temperature (Andersland and Ladanyi, 1994).

5.3 ANTICIPATED GROUNDWATER CONDITIONS

The groundwater table was not encountered within the depths of the previous geotechnical investigations on site.

Groundwater will be limited to within the seasonal active layer, which will vary in thickness throughout the thaw season. The moisture contents of soils within the active zone have been reported to range from 48% to 74% near surface, and decreasing to as low as 7% with depth (Trow, 2004). AGRA (1998) described the soils overlying the frozen soils as saturated however did not include water contents.

Groundwater is anticipated to rise during periods of high precipitation and will also be strongly influenced by local topography.

6.0 DISCUSSION

Near the footprint of the proposed northern addition (Grit Removal and Primary Filters building) bedrock was encountered at 2.1 m and 3.9 m below grade (BH573-1 and BH573-2). Near the footprint of the proposed southern addition (Mechanical and Electrical Room building) bedrock was encountered at 2.0 m to 4.0 m below grade. Bedrock elevations are likely to be variable across the site and could range in depth more or less than what has been previously reported. In addition, the quality of the bedrock is likely to be variable. The upper bedrock may be weathered and frost-fractured. Although not previously reported in Iqaluit is it possible that ice lenses within the fissures and fractures of the upper zone of bedrock may be present.

For the purposes of conceptual design and preliminary costing we suggest using a rock socketed pile supported foundation design. Depending the finish floor slab elevation of the addition and elevation of the bedrock surface, shallow footings bearing on rock may be possible. A Geotechnical Investigation should be completed during detailed design to confirm the depth and quality of bedrock, and to determine design parameters.

Based on our present understanding of the project, and the anticipated subsurface conditions, preliminary recommendations for foundations are presented below.

6.1 SHALLOW FOOTINGS ON ROCK

The depth to bedrock at the site varied between 2.0 m to 5.7 m below ground surface at the time of the respective geotechnical investigations. The initial geotechnical report (AGRA, 1998) recommended that the WWTP be constructed on shallow footings bearing on rock. Construction drawings indicate that the footings were to be constructed on granular fill pads, however asbuilt drawings or reports are not available to confirm this. The depth to rock for the northern



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proposed addition is anticipated to be approximately 2.1 m to 3.9 m below grade, and the depth to bedrock at the southern addition has been observed to be 2.0 m to 4.0 m below the ground surface however, it is likely to be closer to 4.0 m below the ground surface within the majority of the building footprint.

Shallow footings bearing on rock may be feasible for the foundation of the northern addition. Given the anticipated depth to bedrock at the proposed southern addition shallow footings on rock are not recommended for this location. A geotechnical investigation to confirm the depth and quality of the bedrock is recommended.

Bearing capacity on fractured rock was calculated based on the method described in "Foundations on Rock", D.C. Wyllie (1999). Rock Mass Rating (RMR) value of 45 was assessed based on the Trow rock core description and uniaxial compressive strength of intact rock samples test by Trow (113 to 166 MPa with an average of about 136 MPa). The Geotechnical Bearing Resistance at Ultimate Limit State (ULS) was calculated as 4,000 kPa. It should be noted that the factored geotechnical bearing resistance at ULS incorporates a resistance factor of 0.5. Table 5.1Table 6.1 summarizes the rock mass parameters used in calculating the geotechnical bearing resistance at ULS.

Table 6.1: Summary of Rock Mass Parameters

RMR	Unconfined Compressive Strength (MPa)	s	m	Geotechnical Bearing Resistance at ULS (kPa)
45	113 (lowest value)	0.0001	0.492	4,000

It is noted that excavation of overburden for the construction of shallow footings will be difficult to complete while the active zone is still frozen. If the excavation of overburden soils within the permafrost is required below the active zone methods such as drilling and blasting, ripping, or steam injection may be required. If construction takes place after the active zone has thawed, a dewatering plan would have to be implemented to deal with surface water seeping from the thawed active zone adjacent to the excavation

The bearing surface of the bedrock should be thoroughly cleaned of all loose and weathered non-competent materials prior to placement of the footings.

6.2 ROCK SOCKETED PILES

It is anticipated that the soil and bedrock conditions on site are suitable for pipe piles socketed into bedrock, particularly for the southern addition where the bedrock is likely 3.0 m to 4.0 m below ground surface over the majority of the footprint. A geotechnical investigation to confirm the elevation and quality of the bedrock within the footprint of both additions is recommended.

The Trow borehole records described the bedrock as fractured with a very poor to excellent rock quality. The top 2 m of bedrock should be excluded in the estimation of the geotechnical resistance of the piles. This limitation could possibly be reduced if future investigations demonstrate the bedrock is less fractured.



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The geotechnical resistance of the piles at Ultimate Limit State (ULS) should be estimated based on an ultimate grout to steel bond of 600 kPa; the ultimate grout to steel bond value assumes an unconfined compressive strength of at least 20 MPa for the grout. The grout to bedrock bond strength is greater than the grout to steel bond, therefore the design will be controlled by the grout to steel bond strength provided above. A resistance factor of 0.4 and 0.3 should be applied for estimating the axial resistance of the pile in compression and tension, respectively. If slotted piles are used it may be possible to increase the resistance factor. The grout should be specifically designed for cold weather applications. Piles groups should be spaced a minimum of three pile diameters apart from center to center, closer pile spacing will require reduction to the geotechnical resistance.

A factored end-bearing geotechnical resistance of 4 MPa applied over the base area of the steel pipe pile should be used to estimate the end bearing resistance at ULS. The geotechnical resistance assumes the pile is set on sound bedrock and includes a resistance factor of 0.5. A higher end bearing resistance may be possible if the discontinuity spacing of the bedrock is observed to be >300 mm as per the Canadian Foundation Engineering Manual (Canadian Geotechnical Society, 2006).

The lateral resistance of the pile should be estimated based on the resistance developed from the rock socket portion of the pile; the resistance of the overburden should be neglected.

Although the proposed building additions will be heated, all piles should be designed to resist frost jacking heaving which could develop during construction or at the leading edge piles. Piles should be designed with a minimum bonded rock socket length of 2.5 m; the upper 2 m of fractured bedrock should be ignored which means a minimum embedment depth of 4.5 m below the top of bedrock. Frost heave forces should be included in the estimation of the loading of the piles in tension. The frost heave forces should be estimated based on 150 kPa applied over the surface of the pile within the active layer (3 m).

6.2.1 Pile Installation

Geotechnical review of the design drawings and inspection of the installation of the foundation is an integral part of the overall design process. Full time monitoring of the pile installation should be carried out by a geotechnical engineer or a technician under the supervision of a geotechnical engineer.

It is recommended that pile installations be carried out in spring while the active layer is still frozen and air temperatures are moderate during the day. The pre-drilled hole should be at least 50 mm larger in diameter than the outer diameter of the pile. The drilled socket should be cleaned and free of loose material and groundwater prior to placement of the grout and pile. If groundwater and/or cave-in of soil are encountered in the socket the hole should be cased during drilling. The pile capacity will be reduced if the hole is not free of groundwater and loose material during grout placement.

The grout should consist of a cold weather use, high early strength, non-shrink grout with a minimum unconfined compressive strength of 20 MPa such as Sika Arctic 100. The grout should be mixed and placed as per the manufacturer's specifications; the temperature of the wet



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grout, mixing water, and ground surface within the socket should be monitored to ensure the temperature is within the recommended limits. It is recommended that a potable water source be used for mixing with the grout. Surface melt water should not be used for mixing with the grout. The unconfined compressive strength of the grout should be tested for at least 10% of the piles to confirm the minimum design strength of the grout is achieved.

Immediately after placement of the grout the open ended pile should be placed in the socket. Any deleterious material (i.e. snow, soil, grease, rust or scale, etc.) should be removed from the piles prior to installation. The pile should be vibrated with the drill to set the tip in rock and to ensure contact between the pile and the grout. The pile should be temporarily supported to ensure it is plumb and centered within the drilled hole. For inclined piles downhole spacers will be required to center the pile in the socket. The annulus space around the pile should be back filled with sand slurry. The sand should have a maximum particle size of about 5 mm and contain less than 10 percent silt sized particles (fines). The sand slurry should have a pore water salinity of less than 5 ppt and be of a consistency similar to that of plastic concrete or flowing grout paste. The temperature of the sand slurry should not exceed 10°C during placement. The drill cuttings may be used to fill the inside of the piles above the rock socketed (grouted) portion of the pile. However, drill cuttings should not be used to fill annulus space between the piles and the bedrock.

Loads may not be applied to the piles for a minimum of 72 hours after grout placement.

The site soils are fine-grained and frost-susceptible, therefore it is recommended that the upper 2.5 m of each pile, located within the anticipated active layer, be smeared with arctic grade grease and wrapped in multiple layers of construction grade plastic to reduce the development of frost heave forces in the piles.

6.2.2 Seismic Considerations

The 2015 National Building Code of Canada Seismic Hazard Calculation Sheet is provided in Appendix D.

As outlined in the 2015 National Building Code of Canada, buildings and their foundations must be designed to resist a minimum earthquake force. In accordance with Table 4.1.8.4.A of the 2015 National Building Code of Canada the seismic site response for the site can be considered Site Class B – rock. The site class assumes the foundations will be placed directly on bedrock.

6.3 FLOOR SLAB

The construction of slab-on-grade floor slabs would require sub-excavation of the in-situ native soil and placement of a thaw stable gravel pad beneath the floor slabs. The construction of the gravel pad is likely cost prohibitive and could potentially impact the stability of the foundations for the existing structures. A structural floor slab supported on piles is the preferred design. If spread footings are proposed to support the building additions, geotechnical recommendation for the design and construction of gravel pad and associated slab-on-grade will be required during detailed design.



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The site grades around the building should be sloped away from the building a minimum grade of 2%. The water should be directed toward ditches that drain water away from the buildings.

6.4 THAW RELATED SETTLEMENT

The ambient temperature in the building additions will be maintained above freezing, therefore heat loss from the building will cause thawing of the soils and bedrock around and beneath the building. Thawing of the soils and eventual development of a thaw bulb may cause settlement if the soils are thaw sensitive; both vertical and horizontal movements could develop. The movements could impact the performance of infrastructure in the area such as pipes, roads, and hard surfaces. Seasonal maintenance of the impacted infrastructure and ground surface should be expected.

Provided that the building addition floor slabs are structurally supported on pile foundations, thaw related settlement will not impact the performance of the building.

6.5 CLIMATE CHANGE CONCERNS

Global climate modelling reported by CSA (2010) provides projected annual temperature increases for various regions within northern Canada. Within the Iqaluit region (E1) the projected temperature change between 2011 and 2040 is anticipated to be 1.1°C in the case of moderate green-house gases and 1.2°C in the case of a high green-house gas scenario.

The 2010 CSA Technical Guide titled "Infrastructure in Permafrost: A Guideline for Climate Change Adaption" provides guidance on assessing the potential impacts of climate change on infrastructure. The sensitivity of the site to climate change was assessed as "medium" and the consequence of permafrost degradation is assessed to be "minor" assuming the foundations are set on sound bedrock. The assessed site sensitivity and consequence suggests a risk level of "C", which suggests a qualification review should be completed. The performance of the existing WWTP building foundation and floor slabs should be reviewed.

6.6 FUTURE GEOTECHNICAL INVESTIGATIONS

It is recommended to complete a Geotechnical Investigation to support the detailed design. Boreholes should be drilled into bedrock to confirm the soil stratigraphy and the depth to competent bedrock. We recommend the following field investigation program:

- Drill five boreholes across the site to about 7 m to 8 m below ground surface.
- Collect bedrock core samples to estimate the Rock Quality Designation of the bedrock.
- Collect soil samples within the boreholes for sieve analysis testing, soil water salinity testing, and natural moisture content testing.
- Survey the borehole locations with respect to a geodetic benchmark to establish the elevation of the bedrock surface within the footprint of the building addition.
- Conduct geothermal analysis to assess the impact of the proposed buildings.



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7.0 CLOSURE

Use of this report is subject to the Statement of General Conditions provided in Appendix A. It is the responsibility of the City of Iqaluit who is identified as "the Client" within the Statement of General Conditions, and its agents to review the conditions and to notify Stantec Consulting Ltd. should any of these not be satisfied. The Statement of General Conditions addresses the following:

- Use of the report
- Basis of the report
- Standard of care
- Interpretation of site conditions
- Varying or unexpected site conditions
- Planning, design or construction

Respectfully submitted.

STANTEC CONSULTING LTD.

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APPENDIX A

Statement of General Conditions



STATEMENT OF GENERAL CONDITIONS

<u>USE OF THIS REPORT</u>: This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Stantec Consulting Ltd. and the Client. Any use which a third party makes of this report is the responsibility of such third party.

<u>BASIS OF THE REPORT</u>: The information, opinions, and/or recommendations made in this report are in accordance with Stantec Consulting Ltd.'s present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Stantec Consulting Ltd. is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

<u>STANDARD OF CARE</u>: Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

<u>INTERPRETATION OF SITE CONDITIONS</u>: Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Stantec Consulting Ltd. at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

<u>VARYING OR UNEXPECTED CONDITIONS</u>: Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Stantec Consulting Ltd. must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Stantec Consulting Ltd. will not be responsible to any party for damages incurred as a result of failing to notify Stantec Consulting Ltd. that differing site or subsurface conditions are present upon becoming aware of such conditions.

<u>PLANNING, DESIGN, OR CONSTRUCTION</u>: Development or design plans and specifications should be reviewed by Stantec Consulting Ltd., sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc.), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Stantec Consulting Ltd. cannot be responsible for site work carried out without being present.



APPENDIX B

Drawing No. 1 - Key Plan

Drawing No. 2 - Site Location Plan







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NOTES

BASEPLAN FROM GOOGLE EARTH PRO.

SEPTEMBER 2016

1:8000 Project No. 110126045

Client/Project
CITY OF IQALUIT
IQALUIT WASTE WATER TREATMENT PLANT
EXPANSION/UPGRADE
CITY OF IQALUIT, NUNAVUT

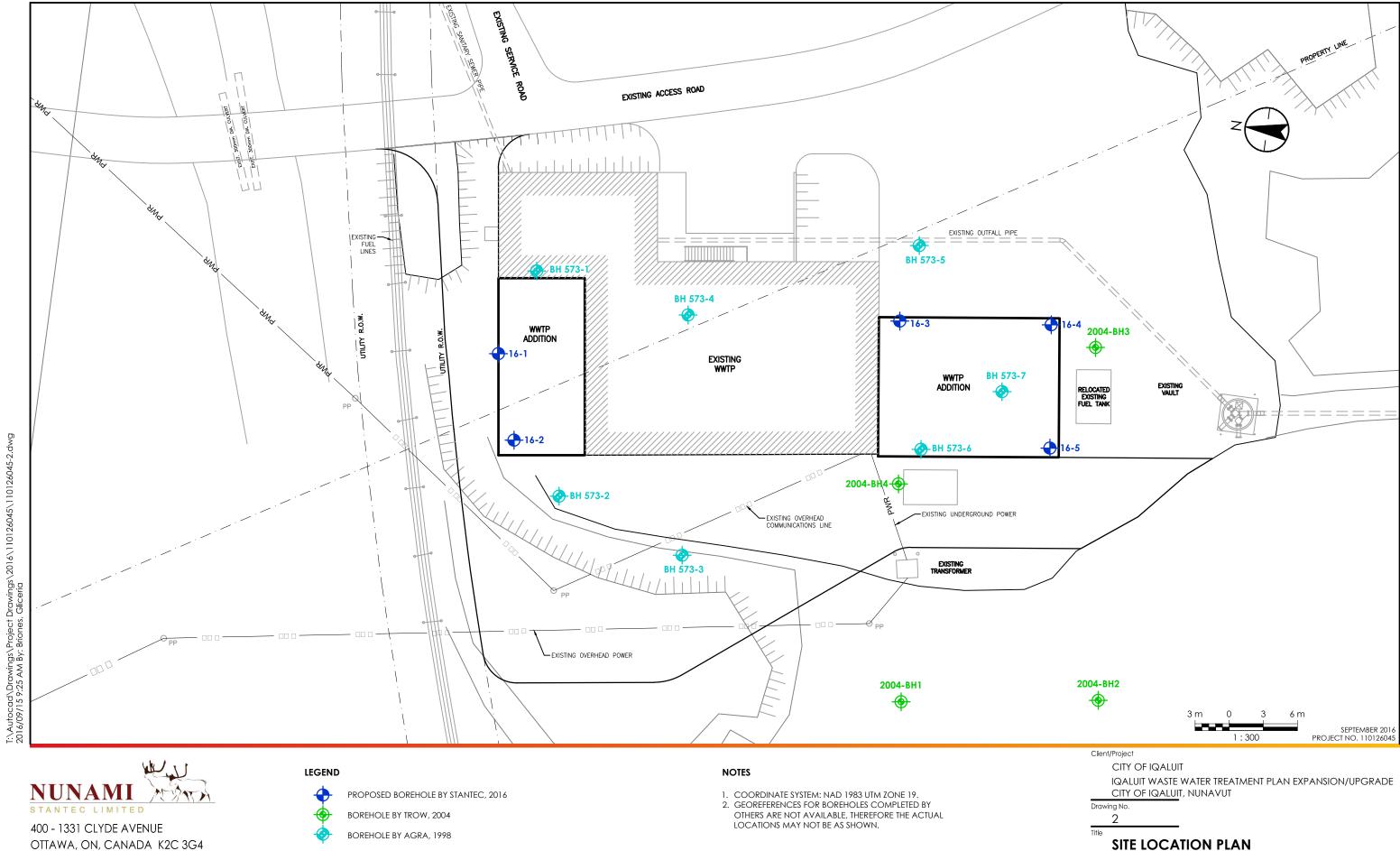
Drawing No.

1

Title

KEY PLAN

80 m 160 m



OTTAWA, ON, CANADA K2C 3G4 www.stantec.com

APPENDIX C

Borehole Records by Others
- AGRA 1998 Borehole Records
- Trow 2004 Borehole Records



	Hill M	urray & A	ssociates (nc		Contractor: Canadrill Limited		BOREHOLE NO: BH573-1
	Waste	Water Tr	eatment Pl	ant		Equipment: Air Track Drill		PROJECT NO: YX00573
1			ocation Pla	ın				ELEVATION:
	SAMP	LE TYPE	Disturb	ed	Ø	No Recovery SPT Test (N) Gral	b Sample [[]]	Split-Pen Core
	DEPTH (m)	⊠ S [*]	TANDARD PEN 40 60	(N) E 08	SYMBOL	SOIL	SAMPLE TYPE	OTHER TESTS (E) ELG
	DEP	PLASTIC 	M.C. 20 30	LIQUID 	SOIL	DESCRIPTION	SAMPLE T	COMMENTS
	- 0.0	10	20 30	40		SAND, fine to medium grained, brown, tra organics, wet.	ce	- 0.0
***************************************	1.0					SAND and SILT, fine grained, low to non plastic, grey.		1.0
	- - 2.0					FROZEN		
1	- 3.0						1	
							•	3.0
	4.0					BEDROCK, grey.	2	4.0
	5.0							5.0
	6.0					End of Borehole 1 at 5.9 m. Borehole backfilled on completion.		- - - - - - -
	7.0							7.0
	- 8.0 · · · · · · · · · · · · · · · · · ·							— 8.0 - - - -
	9.0							- 9.0 - - -
	10.0 AC	SRA E	Earth 8	& Envi	ror	nmental Limited LOGGED BY: K		COMPLETION DEPTH: 5.9 m
						et Territories REVIEWED BY:	JMO	COMPLETE: 10/08/98
ļ	98/11/18 11:4			,		St Territories Fig. No:		Page 1 of 1

	urray & A						Contractor: Canadril	Limited			BOREHOLE NO: BH573-2)
	Water Tr						Equipment: Air Trac	< Drill			PROJECT NO: YX00573	
	ion: See I										ELEVATION:	
SAMP	LE TYPE	Dist	urbed		\square	No Recovery	SPT Test (N)	Grab Sam	ple		òplit-Pen 🔲 Core	
DEPTH (m)	20	TANDARD P 40 M.C.		O DIUDI	SYMBOL		SOII		ы г түрг	SAMPLE NO	OTHER TESTS	DЕРТН (m)
님	10		30 40	-	SOIL		DESCRIP	HUN	SAMPIF	SAN	COMMENTS	DEP
0.0		20 ,	50 4 0	,		SAND, fine	e to medium graine	i, brown, trace				- 0.0
						organia	cs, wet to saturated.					
- 1.0 - - -						SAND and grey. FROZEN	SILT, fine grained,	non plastic,		3.		1.0
- 2.0						BEDROCK,	grey.	N. C.				2.0
3.0												3.0
4.0							rehole 2 al 4,1 m. ackfilled on comple	lion.		4		4.0
5.0 - -												5.0
6.0												6.0
7.0												7.0
8.0												- 8.0
9.0										-		9.0
10.0												10.0
AC	AGRA Earth & Environmenta						al Limited	LOGGED BY: KGB REVIEWED BY: JMO			COMPLETION DEPTH: 4.1 m	
	Ye	llowkn	ife, N	lorth	we	st Territo	2000	Fig. No:		*****	COMPLETE: 10/08/98 Page 1	of 1
8/11/18 11-	(TAL /										ruye r	ULI

Hill M	lurray & Asso	ociates In	С			Contractor: Canadi	ill Limited	- · · · · · · · · · · · · · · · · · · ·	***************************************		BOREHOLE NO: BH573-3	3
	Water Treat					Equipment: Air Tra	ck Drill				PROJECT NO: YX00573	
	ion: See Loco										ELEVATION:	
SAMP	LE TYPE	Disturbe	d	\square	No Recovery	SPT Test (N) Grat	b Sample	[<u> </u>	plit-Pen 📗 Core	
DEPTH (m)	20 4	DARD PEN (1 0 60	80	SYMBOL		SOI			E TYPE	LE NO	OTHER TESTS	DEPTH (m)
DEP.	PLASTIC 10 2	M.C.	LIQUID 	SOIL		DESCRII	PTION		SAMPLE	SAMPLE	COMMENTS	DEPT
0.0	10 2	0 30	40			e to medium grain non plastic, brown						0.0
- 1.0 -					saturat	ed.					Au	1.0
2.0					become BEDROCK,	es fine grained, gragned, gragned, gragned	ey, FROZEN				Nbn	2.0
- - - - -									36	5		-
- 3.0 -												3.0
- 4.0						rehole 3 at 4.0 m. ackfilled on compl	etion.			6		4.0
5.0												5.0
6.0												6.0
7.0										-		7.0
8.0												8.0
9.0 ···												9.0
10.0	2DA Ea	orth 0	Envi			Il Limited	LOGGED BY: K	CR			COMPLETION DEPTH: 4.0 m	10,0
710					imenta st Territo		REVIEWED BY:				COMPLETE: 10/08/98	
98/11/18 I I:							Fig. No:				Page 1	ot 1

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	lurray & Assoc		•		Contractor: Canadrill I	imited			BOREHOLE NO: BH573-	4
	Water Treatm				Equipment: Air Track	Drill			PROJECT NO: YX00573	
	ion: See Locati			7					ELEVATION:	
SAMP	LE TYPE	Disturbed		No Recovery	SPT Test (N)	Grab Sample		∭s	plit-Pen Core	
ОЕРТН (m)		RD PEN (N) = 60 80	I GUID T		SOIL DESCRIPT	'ION	SAMPLE TYPE	SAMPLE NO	OTHER TESTS COMMENTS	DEPTH (m)
0.0	10 20	30 40		_			S			
				SAND, fin organi	e to medium grained, cs, wet to saturated.	brown, trace				- 0.0
1.0	,			ED07E	ı			7		1.0
- 2.0				SAND and	SILT, fine grained, lo	v to non		٠	Nbn	2.0
3.0				BEDROCK,	GF0V					3.0
- 4.0				DEDROCK,	Grey.					4.0
- 5.0							20270	8		5.0
- 6.0					rehole 4 at 5.4 m. ackfilled on completio	n.				6.0
- 7.0 ···										7.0
- 8.0										- 8.0
- 9.0										9.0
10.0										<u> </u>
AC				nmenta est Territo	RE	GGED BY: KGB VIEWED BY: JMO			COMPLETION DEPTH: 5.4 m COMPLETE: 10/08/98	10.0
11/18 11:4	TOTOVV	mine, M	J1 (11VV	or remit	JUG9 FIG	ı. No:			Page 1	of 1

Hill M	lurray & A	ssociates Inc				Contractor: Canadrill Limited			BOREHOLE NO: BH573-5		
		eatment Plan	t						PROJECT NO: YX00573		
		ocation Plan								ELEVATION:	
SAMF	LE TYPE	Disturbed			No Recovery	SPT Test (N)) 🔲 Grab Sam	ple		iplit—Pen 📗 Core	
DEPTH (m)	20 PLASTIC	M.C. 20 30) 22 80 LIQUID ————(40	SOIL SYMBOL		SOII DESCRIF		CAMPI E TYPE	SAMPLE NO	OTHER TESTS COMMENTS	(27)
- 0.0			10		SAND, fine	e to medium graine	d, trace		-		_ 0
- 1.0						brown.	-,				1
2.0						SILT, fine grained, grey, FROZEN.	low to non		g		- 2
3.0					BEDROCK,	grey.					3.
4.0									10		4.
6.0						ehole 5 at 5.3 m. ackfilled on comple	ition.				- 5.
7.0											7.0
8.0									-		- 8.c
9.0											9.0
	GRAI	Farth &	Fnvi	ro	nment	al Limited	LOGGED BY: KGB			COMPLETION DEPTH: 5.	
'`							REVIEWED BY: JMO			COMPLETE: 10/08/98	- III
00 /41 /40 /7	Υe	llowknife	, North	1WE	est Lerrit	ories	Fig. No:				age 1 of 1

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Hill Murray & Associates Inc BOREHOLE NO: BH573-6 Contractor: Canadrill Limited Waste Water Treatment Plant Equipment: Air Track Drill PROJECT NO: YX00573 Location: See Location Plan **ELEVATION:** SAMPLE TYPE Disturbed No Recovery SPT Test (N) Grab Sample Split-Pen Core STANDARD PEN (N) M SYMBOL 9 SOIL OTHER TESTS SAMPLE DEPTH SAMPLE **DESCRIPTION** PLASTIC M.C. LIQUID SOIL COMMENTS 10 30 40 0.0 SAND, fine to medium grained, trace gravel, rusty brown. - 1.0 1.0 ... FROZEN 2.0 - 2.0 3.0 - 3.0 BEDROCK, grey. 4.0 4.0 11 5.0 5.0 End of Borehole 6 at 5.6 m. Borehole backfilled on completion. 6.0 6.0 - 7.0 7.0 8.0 -9.0- 9.0 LOGGED BY: KGB COMPLETION DEPTH: 5.6 m AGRA Earth & Environmental Limited REVIEWED BY: JMO COMPLETE: 10/08/98 Yellowknife, Northwest Territories Fig. No: Page 1 of 1 98/11/18 11:47AM

Hill M	urray & A	ssociates	Inc		Contractor: Canadrill Limited					BOREHOLE NO: BH573-7	7
Waste	Water Tr	eatment (Plant			Equipment: Air Trac	k Drill		•	PROJECT NO: YX00573	
	ion: See L		lan							ELEVATION:	
SAMP	LE TYPE	Distu	rbed		No Recovery	SPT Test (N)	Grab Sample		∭s	plit-Pen 📗 Core	
ОЕРТН (m)	20		0 80	SYMBOL		SOII		LE TYPE	SAMPLE NO	OTHER TESTS	DEPTH (m)
自当	PLASTIC 10	M.C. 20 3	LIQUID 	SOIL		DESCRIP	'TION	SAMPLE	SAM	COMMENTS	DEP
0.0			V 7V			e to medium graine brown.	d, trace				- 0.0
1.0					gravoi,	Biomii.					1.0
2.0					become	es grey to brown, Ff	ROZEN.				2.0
- 3.0 - - -							·				3.0
- - 4.0 -					BEDROCK,	grey.					4.0
5.0 											5.0
6.0						rehole 7 al 5.6 m. ackfilled on comple	tion.				6.0
7.0											7.0
8.0							,				8.0
9.0											9.0
10.0											10.0
Α	GRA	Earth	& Env	viro	nment	al Limited	LOGGED BY: KGB			COMPLETION DEPTH: 5.6 m	
					est Territ		REVIEWED BY: JMO			COMPLETE: 10/08/98	
			,				Fig. No:			Page 1	ot 1

And the same Assessment

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	lurray & Associates Inc		Contractor: Canadrill Limited				BOREHOLE NO: BH573-8	
<u> </u>	Water Treatment Plant		Equipment: Air Track Drill				PROJECT NO: YX00573	
ļ	ion: See Location Plan						ELEVATION:	
SAMP	PLE TYPE Disturbed	No Recover	y SPT Test (N)	Grab Sample	[∭ s	plit-Pen Core	
DEPTH (m)	■ STANDARD PEN (N) ■ 20 40 60 80 PLASTIC M.C. LIQUID 10 20 30 40	SOIL SYMBOL	SOIL DESCRIPT	ION	SAMPLE TYPE	SAMPLE NO.	OTHER TESTS COMMENTS	DEPTH (m)
0.0		SAND an	d GRAVEL(FILL), brown.					0.0
- - - 1.0								1.0
2.0				·				2.0
3.0		GRAVEL,	some sand, grey.			12		3.0
- 4.0 						4.7		4.0
5.0			orehole 8 at 5.0 m. backfilled on completion	n.		13		5.0
6.0								6.0
7.0								7.0
8.0				,				8.0
9.0								9.0
10.0								-
	GRA Earth & Envi Yellowknife, North		RE	GGED BY: KGB VIEWED BY: JMO J. No:			COMPLETION DEPTH: 5.0 m COMPLETE: 10/08/98	10.0

Hill	Murray & Associates Inc		Contractor: Canadrill Li	nited			BOREHOLE NO: BH573-9	
	te Water Treatment Plant		Equipment: Air Track Di	ill			PROJECT NO: YX00573	
	ation: See Location Plan						ELEVATION:	
SAM	PLE TYPE Disturbed	No Recovery	/ SPT Test (N)	Grab Sample	[∭ s	plit-Pen 🔲 Core	
DEPTH (m)	\ \frac{1}{2}	SOIL SYMBOL	SOIL DESCRIPTI	ON	SAMPLE TYPE	SAMPLE NO	OTHER TESTS COMMENTS	DEPTH (m)
- 0.0	10 20 30 40	SAND an	d GRAVEL(FILL), brown, o	Irv to	+			_ 0.0
1.0		moist.				To the second se		1.0
2.0								2.0
- 3.0		GRAVEL,	some sand, grey.			14.		3.0
4.0								4.0
- 5.0 			orehole 9 at 5.0 m. backfilled on completion					5.0
- 6.0 - 6.0								6.0
7.0							-	7.0
8.0				i				
9.0								9.0
10.0			-11:10 1 100	פרט מע. צמפ			TOOLOU TION DESTINATION OF THE	10.0
A(GRA Earth & Envir Yellowknife, North		REV	GED BY: KGB IEWED BY: JMO No:			COMPLETION DEPTH: 5.0 m COMPLETE: 10/08/98 Page 1	of 1

	lurray & Associates Inc		Contractor: Canadrill				BOREHOLE NO: BH573-10	0
	Water Treatment Plant		Equipment: Air Track	Drill			PROJECT NO: YX00573	
	ion: See Location Plan	T7	<u> </u>				ELEVATION:	
SAMP	PLE TYPE Disturbed	No Recover	y SPT Test (N)	Grab Sample		∭ St	plit-Pen Core	1
DEPTH (m)	■ STANDARD PEN (N) ■ 20 40 60 80	SYMBOL	SOIL		E TYPE	E NO	OTHER TESTS	(m)
DEPTI	PLASTIC M.C. LIQUID 10 20 30 40	SOILS	DESCRIP'	TION	SAMPLE	SAMPLE	COMMENTS	DEPTH (m)
0.0	10 20 30 40	SAND ar moist	nd GRAVEL(FILL), brown	, dry to				0.0
1.0								1.0
2.0								2.0
- 3.0 -		GRAVEL,	some sand, grey.					3.0
4.0						15		4.0
- 5.0 - - - - - -								- 5.0 - - -
								6.0
- 7.0		1	orehole 10 at 7.0 m. backfilled on completi	on.				- - - - - - -
8.0								- - - - - - - 8.0
9.0								9.0
10.0		<u> </u>	4-11 insits at 1	OGGED BY: KGB			COMPLETION DEPTH: 7.0 m	10.0
A	GRA Earth & Env Yellowknife, Nort		ritarias	REVIEWED BY: JMO			COMPLETE: 10/08/98 Page 1	of 1
98/11/18 11			l'	<u> </u>			1 uye 1	UI I

Trow Borehole Log 1

Froject No.	<u> </u>	_						Dr.	awing N	lo	2		T.	# ******
Project:	Addition to Waste Water Treatment Pl	ant						– .	Sheet N	۱o.	2 1 of	1		W
Location:	Iqaluit, Nunavut									_				
				Spill Spoo	n Samp	ile	×		Combus	lible Va	pour Read	ing		
Date Drilled:	May 31st, 2004			Auger Sar	-		00				олюпt			X
				SPT (N) V Dynamic (yst-			Atterberg Undraine	_		ł		Ð
Drill Type:	Manual			Shelby Tu		~`	WA		% Strain	al Fallı	nce			⊕
Datum:	Geodetic		-	Shear Stre Vane Tes	ength by	1	ţ		Shear Si Penetror					A
		T				neiration	Tasi Ni	/alua	Cambia	stible V	annur Rea	dian (ac	451	
(%) PO (%)	SOIL DESCRIPTION	Elevation	Dune	20				90	No.	50 Ural Ma	apour Rear 500 7: Istura Cont ilts (% Dry 20 3	50 1001 %	X Y	Natural Unit
g g	SOIL DESCRIPTION	6.90	ļΗ	Shear S	trength	(_{ਇਸ} 76 ਸ _ੀ		kPa 100	Attent	erg Lin n	ilts (% Ciry 20	Weight n) <u> </u>	Weight kN/m
ELL XX	The state of the s		°	5 6 6 7 9 6	1.77.	: O:	3343		12:12				44	
	DY SILT TO SITLY SAND Fine to -	6.5		777177			·		3000				H	
med	ium gravel, some organics and organic ars in upper levels, some roots,			10 (+1+2+	1.366	6100	-3 (-)				х		Ш	
	sional silty clay seams, grey to black,	-	1	33131	1-2-1-				1 1 1 1	. 1 . 1 . 1 . 1	×	2 1 2	71	
mois	it to wet.]		-> 4-1-5-	1 3 3 4 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	\$133	45.00		01110	. <u> </u>		2 (П	
				2012	1321	3133							Ή	
	_		2	-> 0-1->	- E - D - C+ E+ - E - D - G+ E+	01:25	-> ** **	- (-) d-1	4110	13-2-14	1 01 3	4444	H	
				3313			333		3000			3313		
	-			2011	1221	0100		: 1:14:	4.1.1.5	. } . ! ! . !	4.1.2.2	-9-2-1-9	Н	
	_		3	2222	1.2.2.2.	2130	3663	100000	×	×		15 51 51	1	
		Ì		2012						- 1 - 2 E - 1		21111	Н	
	_			2012			:::::::					177 71 7 1]]	
	· _		ا	33,13										
			ľ										11	
	_	-		11111		11111				13.33	· X	******		Ì
				00101	1.54.4.	4135	320					3333		
	_		5	.2 (-1.2)	1.12.11	6100	3353	1.55					11	
	_	1.2		\$ 4-1-3 ·		4-1-5-5			3.1.14		1000	3240	\mathbf{H}	
	NITE BEDROCK Fine to medium	1.2		33.3	1.00.	3133	.,	4. 6-2 6.		- : - : - :			H	
-grain with	ned, striated, pink to grey, fractured — mineralization along fractures, (very		G	:::::::::::::::::::::::::::::::::::::::	1-6-1-1-	11:12	3.2.7.5		3.1.1.2.			2012	11	
poor	to good quality).			12.2.1.2.1		2000	->->->		200	-7-1-1-1	10120	77:17		
					1441	h	5516		0600		**************************************	0.0010	11	
	-		7	2222	1-2-2-1-	01:20	-2-2-2-2		00000	. 2 (2 (2)	*****	200	Ħ	
				· · · · · ·	1-201	01120	200		2502	13/25/	12122	9010	Н	
For (Core Drilling Record please refer to et 2 of 2 of Drawing 2.			3113	1.201	555			3333			500		
			В					<u> </u>	13.2.1.3	11.1.1.			-[.]	
				2212		3133			\$ (115)			3513	H	
	-			00000	1-2-3-1-	. 11 13 13 13 - 12 13 14 14	13 (2.2.3)		4446	33.55 344	12122	3.51.73 4.44.44	П	
			٥	33131		3(33)	3203		303	3311		300	Н	
H-FX	Borehole terminated at 9.2 m	-2.3	-		;;;;;	1111	1111					30.10	1 1	
	<u> </u>				<u> </u>			::::	;::::					
NOTES:		\/\&TE		EVEL RE	CUBL)S			רטו	SE DE	ILLING F	ECOE	מא	
1.Borenole data r Trow before us	equires interpretation assistance from	ed		Weter		Hole Ope		Run	Dep	th]	% Re			3D %
	d standpipe and thermisters at regular Tim Installed in Borehola Compl		L	evel (m) 7.6	+	To (m) 9.2 m		No	(m)					
	rvised by a Trow representative sample descriptions.									ļ				
1	be read with Trow Associates Inc. 017181A													
report OTGE00	UTITA AF61717U		_	,						1				***:



Dwg No. 2 Sheet 2 of 2

Core Drilling Record

BH 1

Run No.	Depth (m)	% Recovered	RQD %
1	5.77 to 6.96	26	0
2	6.96 to 7.04	67	0
3	7.04 to 7.32	86	0
4	7.32 to 7.47	75	0
5	7.47 to 7.8	81	41
6	7.8 to 8.08	64	0
7	8.08 to 8.23	100	0
8	8.23 to 8.36	80 _	0
9	8.36 to 8.46	100	0
10	8.46 to 8.54	67	0
11	8.54 to 8.92	90	0
12	8.92 to 9.17	100	85

Project No. OTGE00017181A

Trow Borehole Log 2

Borehole terminated at 7.6 m	Project:	Addition to Waste Water Treatmen	t Plant	_						iwiiig i	_	1 of 1		row
Date Drilled: Jung and, 2004 Drill Type: Manual Datum: Geodelic Solid Description Sol	Location:	Igaluit, Nunavut								71 IGGC 11	··· –		•	
SOIL DESCRIPTION SANDY SILT TO SILT SAND Occasional roots, some organics, organic odours in upper levels, grey to black, (moist). Description of the proper	Drill Type:	Manual		-	Auger Samp SPT (N) Veil Dynamic Co Shelby Tube	e 8 1e Test	_	00		Natural M Atterberg Undraîne % Strain Shear St	Moister Limits ed Tria) at Faik trength	e Content dai at ure by	 	× ⊕
SANDY SILT TO SILT SAND Occasional roots, some organics, organic odours in upper levels, grey to black, (moist). GRANITE BEDROOK Medium to fine grained pink, some feddaps and quartz, some amphibioles, (very poor to excellent quality). For Core Drilling Record please refer to Sheet 2 of 2 of Drawing 3. For Core Drilling Record please refer to Sheet 2 of 2 of Drawing 3. Borrehole terminated at 7.6 m WATER LEVEL RECORDS Water Make To Core Drilling Record please refer to Sheet 2 of 2 of Drawing 3. Some setting and the misters at regular increase was establed in tenchicle. A 13 man sibled at almosphe and thermisters at regular increase was restated in tenchicle. A 13 man sibled at almosphe and thermisters at regular increase was restated in tenchicle. Some amphibioles, (very poor to excellent quality). WATER LEVEL RECORDS For Core Drilling Record please refer to Sheet 2 of 2 of Drawing 3. Some restated in the restate of the resta	G M W R	\$QIL DESCRIPTION		P	Standa 20	rd Penet			o l	25	30	500 750	-19	Unit Welght
NOTES: 1. Borehold data requires interpretation assistance from Trow before use by others 2. A 13 mm slotted standpipe and thermisters at regular intervals were installed in Borehole 3. Fleid work supervised by a Trow representative 4. See notes on sample descriptions.	roots – uppe	, some organics, organic odours in r levels, grey to black, (moist). NITE BEDROCK Medium to fine ed pink, some feldspar and quartz, earnphiboles, (very poor to excellenty). Core Drilling Record please refer to it 2 of 2 of Drawing 3.		о т ż з 4 5		Fig.	130 min					**************************************	74 X X X X X X X X X X X X X X X X X X X	
1. Borehold data ricquires interpretation assistance from Trow before use by others 2. A 13 mm slotted standpipe and thermisters at regular intervals were installed in Barehole 3. Field work supervised by a Trow representative 4. See notes on sample descriptions.	BRITCH, OF TRUTY OF TRUTY, OLD													Additional to the second secon
2.A 13 mm slotted standpipe and thermisters at regular intervals were installed in Borehole 3.Fleid work supervised by a Trow representative 4. See notes on sample descriptions.	NOTES:	courses interpretation assistance from	WATER	R L	EVEL REC	ORD\$				COL	RE DF	RILLING RECO)RD	
To finite the state of the stat	-	·	lapsed		Waler	Hole Te	o (m)					% Rec.	R	QD %
4. See notes on sample descriptions.	intervals were i	installed in Borehole Co												
	šl .	· '												
report OTG=00017181A	31	· · · · · · · · · · · · · · · · · · ·												
	report OTGE 000	17181A				-				······································		!	<u> </u>	



Dwg No. 3 Sheet 2 of 2

Core Drilling Record

BH 2

Run No.	Depth (m)	% Recovered	RQD %
1	5.66 to 5.74	100	0
2	5.74 to 6.23	66	53
3	6.23 to 6.38	100	100
4	6.38 to 6.86	96	96
5	6.86 to 7.34	86	63
6	7.34 to 7.62	77	77

Trow Borehole Log 3

OTGE00017181A			Drawing No4	Trov
Addition to Waste Water Treatment Plant			Sheet No. 1 of 1	ITU
Igaluit, Nunavut				
	Split Spoon Sample	⊠	Combustible Vapour Reading	□ X
May 31st, 2004	SPT (N) Value	O (M	Atterberg Limits	 ₽
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Geodetic	Shear Strength by Vanc Test	+ \$	Shear Strength by Ponetrometer Test	A
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NOTES: 1. Borehole data requires interpretation assistance from Trow before use by others

2.A 13 mm slotted standpipe and thermisters at regular intervals were installed in Borehole

- 3.Field work supervised by a Trow reprosentative
- 4. See notes on sample descriptions.
- 5.This Drawing to be read with Trow Associates Inc. report OTGE00017181A

WAT	ER LEVEL REC	DRDS
Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	0.0	4.† m

	CORE DRILLING RECORD										
Run No	Depth (m)	Depth % Rec.									



Dwg No. 4 Sheet 2 of 2

Core Drilling Record

BH 3

Run No.	Depth (m)	% Recovered	RQD %
1	2.03 to 2.11	100	0
2	2.11 to 2.39	100	0
3	2.39 to 2.59	94	0
4	2.59 to 2.79	100	0
5	2.79 to 2.84	75	0
6	2.84 to 3.02	100	0
7	3.02 to 3.33	90	<u>54</u>
8	3.33 to 3.47	86	Q.
9	3.47 to 3.63	85	0
10	3.63 to 3.76	80	0
11	3.76 to 3.99	79	0
12	3.99 to 4.14	75	0

Trow	Bore	hole	Log	4
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Project No.	OTGE00017181A						_	De	awing N	do	5		
Project.	Addition to Waste Water Treatment	Plant									1 of	1	Trow
Location:	Igaluit, Nunavut								zueer r	NO	<u>. </u>		
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	Y SAND AND GRAVEL	5.0 4.8	3.3. 3.3. 3.0.	·!·} ·!·}	1:3:4:1: 1:3:4:1:	****** ******	-7 **** -3 **** -3 ****	* (*) * (* * (*) * (*) * (*) * (*)	01000	X	**************************************	9949 9449 3613	Ħ
-GRAI grain	NITE BEDROCK Medium to coarse ed, pink to grey, fractured with		3 (2.0)		::::::::::::::::::::::::::::::::::::::		1200	1 1 1 2 2 2 1)	2012	Ħ
excel	alization along fractures, (very poof to lent quality).	-	7.0				-3.0						
For C	ore Drilling Record please refer to t 2 of 2 of Drawing 5.	-	4										
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NOTES: 1.Borehole data re Trow before use	Borehole terminated at 4.8 m												
NOTES: 1.Borehole data re	quires interpretation assistance from by others	WATER									LING R		
2.A 13 mm slotted intervals were in	standpipe and thermisters at regular	psed me pletion	Wat Level 0.0	(m)_	F	lole Öp To (m) 4.8 m		Run No.	Dept (m)	h	% Rec	ì. ————————————————————————————————————	ROD %
	vised by a Trow representative		VA	•		114 111							
5.This Drawing to i	be read with Trow Associates Inc. 17181A										···		



Dwg No. 5 Sheet 2 of 2

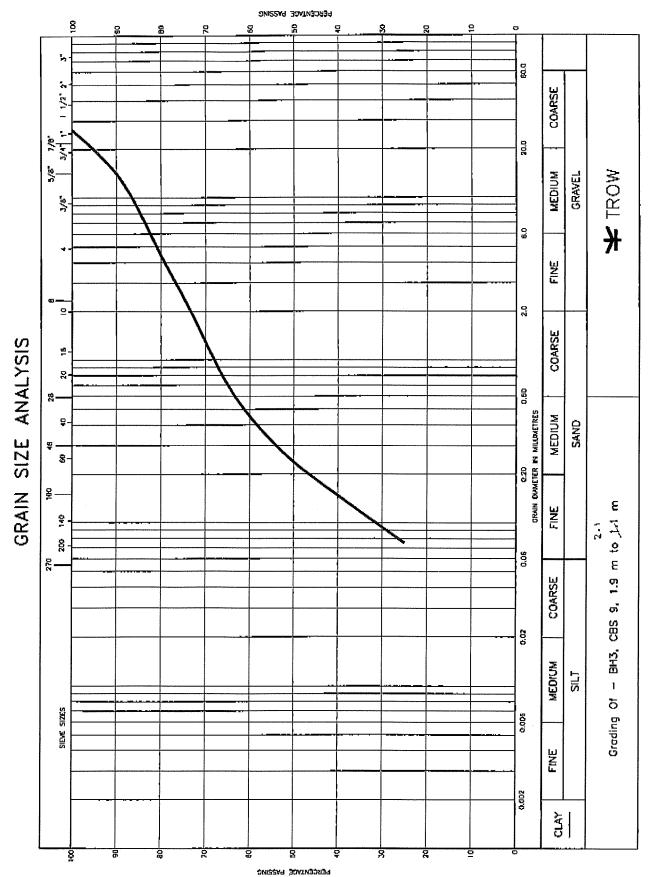
Core Drilling Record

BH 4

Run No.	Depth (m)	% Recovered	RQD %
1	2.87 to 2.97	100	100
2	2.97 to 3.15	93	82
3	3,15 to 3.53	100	80
4	3.53 to 3.98	100	100
5	3.98 to 4.24	90	81
6	4.24 to 4.29	88	0
7	4.29 to 4.60	94	54
8	4.60 to 4.75	92	0
9	4.75 to 4.80	100	0

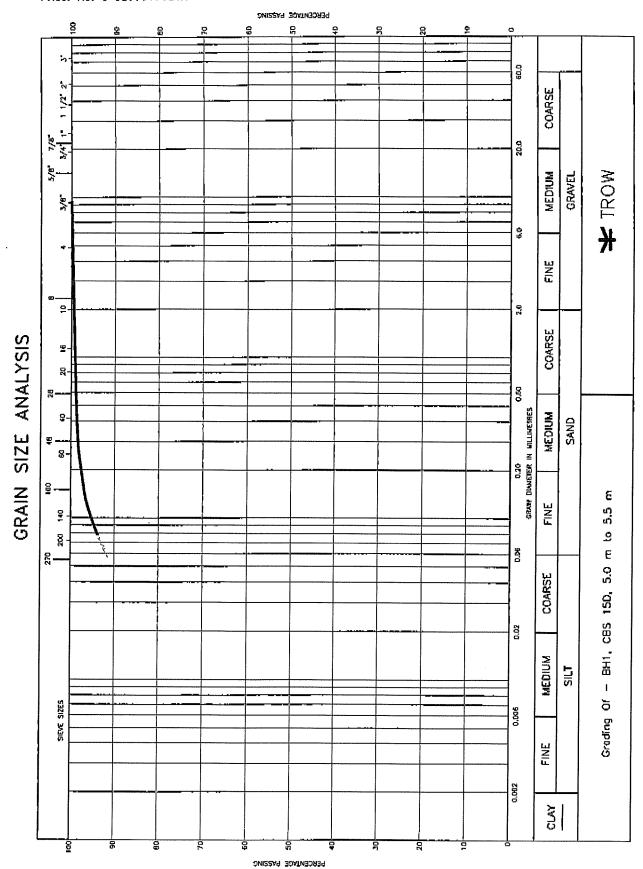
PROJ. No. OTGE00017181A

DWG. No. 6



PROJ. No. OTGEO0017181A





APPENDIX D

2015 NBC Seismic Hazard Calculation Sheet



2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836 Western Canada English (250) 363-6500 Facsimile (250) 363-6565

September 12, 2016

Site: 63.7459 N, 68.5391 W User File Reference: Iqaluit Waste Water Treatment Plant Requested by: Sylvia Dooley, Stantec Consulting Ltd.

National Building Code ground motions: 2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.05) Sa(0.1) Sa(0.2) Sa(0.3) Sa(0.5) Sa(1.0) Sa(2.0) Sa(5.0) Sa(10.0) PGA (g) PGV (m/s) 0.065 0.089 0.086 0.075 0.084 0.042 0.023 0.0056 0.0026 0.051 0.054

Notes. Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s²). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC 2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are specified in **bold** font. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. **These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.**

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.05)	0.0088	0.024	0.038
Sa(0.1)	0.015	0.036	0.054
Sa(0.2)	0.017	0.040	0.056
Sa(0.3)	0.016	0.037	0.051
Sa(0.5)	0.014	0.033	0.045
Sa(1.0)	0.0079	0.021	0.030
Sa(2.0)	0.0036	0.011	0.016
Sa(5.0)	0.0008	0.0024	0.0037
Sa(10.0)	0.0005	0.0011	0.0016
PGA	0.0082	0.021	0.031
PGV	0.0086	0.024	0.035

References

National Building Code of Canada 2015 NRCC no. 56190;

Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

User's Guide - NBC 2015, Structural Commentaries NRCC no. xxxxxx (in preparation)

Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites www.EarthquakesCanada.ca and www.nationalcodes.ca for more information

Aussi disponible en français



