

Geotechnical Investigation

Iqaluit Daycare Facility
Iqaluit, Nunavut

Prepared for:
Public Works & Government
Services Canada

Prepared by:
Stantec Consulting Ltd.
400 – 1331 Clyde Avenue
Ottawa, ON K2C 3G4

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1.0 INTRODUCTION

Stantec Consulting Ltd. (Stantec) has prepared this Geotechnical Investigation report to support the design and construction of the proposed Daycare facility located in Iqaluit, 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 site.

2.0 SITE LOCATION AND GEOLOGY

2.1 SITE LOCATION

The proposed daycare facility 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 on the INAC owned double lot property (building #474) along with one other lot shown on the Borehole Location Plan, Drawing No. 2 in Appendix B. The lots are located on the southeast corner of Niaqungusiariaq & Paunna Road. The proposed building will be a single storey structure with an approximate footprint of 670 m².

2.2 GEOLOGY

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).

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 several meters of the site.

With the exception of the rock outcrop located southeast of the site, 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.

2.3 PROPOSED FACILITY

The proposed daycare facility consists of one single storey building with parking and an exterior play yard. The proposed building will have an approximate footprint of 670 m² and will be located approximately 5 m east of the existing two storey residential unit.

2.4 SITE RECONNAISSANCE – EXISTING STRUCTURE

The site has an existing two storey residential structure (building #474) shown on the Borehole Location Plan, Drawing No. 2 in Appendix B. The existing building is founded on concrete piles set on bedrock.

A bedrock outcrop is visible in the northeast and southeast quadrant of the site.

3.0 SCOPE OF WORK

The scope of this Geotechnical Investigation included:

- Field investigation to characterize the soil, bedrock and groundwater conditions at six boreholes drilled throughout the site.
- Laboratory tests including moisture content, grain size analysis, Atterberg Limits, salinity, pH and sulphate testing on select soil samples.
- Preparation of a Geotechnical Investigation Report that summarizes the results of the field investigation, laboratory results and provides geotechnical recommendations for the design and construction of the new Daycare Facility.

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 degree-days below 0°C and 695 degree-days above 0°C, respectively. The rate of change in mean air temperature for northern Canada in the Eastern North region from 1978 to 2008 is 0.7°C/decade (CSA, 2010). For the period of 2011-2040 the average change in mean annual temperature was calculated to be 1.1°C for a moderate green-house gas scenario and 1.2°C for a high green-house gas scenario, based on the average mean seasonal temperature for the period of 1971 to 2000 (CSA, 2010).

5.0 FIELD CONDITIONS

Borehole drilling was completed in October 2016 and consisted of drilling six boreholes using a Gardner Denver air-track drill model ATD3700 supplied and operated by Canadrill Ltd. The approximate borehole locations are shown on the attached Drawing No. 2, Borehole Location Plan.

The boreholes were drilled until solid bedrock was encountered; once bedrock was encountered the drilling was advanced an additional 3 m. The boreholes were advanced by the percussion rotary air blast drilling method, with a 4.5-inch (114 mm) outside diameter drill bit. Drill cuttings were ejected out of the borehole by compressed air forced out at the drill bit face.

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Due to the drilling method employed for this investigation, collected soil samples are disturbed and as a result there is an inherent uncertainty of identifying soils in terms of soil classification. The boreholes were backfilled with high-strength cementitious grout (sika grout) in the bedrock portion of the borehole and drill cuttings for the remaining portion of the borehole.

The field work was conducted under the supervision of geotechnical personnel who observed and recorded the various soil strata conditions encountered during the investigation. The soils were classified in general accordance with the procedures outlined in the attached explanatory key: Symbol and Terms Used on Borehole and Test Pit Records. Disturbed soil samples were obtained from the boreholes during the investigation. All soil samples were stored in moisture proof containers and taken to our laboratory in Ottawa, ON for further classification and testing. Selected samples were chosen for testing of soil gradation, Atterberg limits, moisture content and pore water salinity.

The approximate borehole locations and the ground surface elevations were established in the field by our Stantec field representative. Borehole locations were measured in the field using a Trimble GPS receiver with decimeter accuracy. Accuracy may have been affected by satellite coverage at the time of survey. The approximate geodetic elevations at the borehole locations are shown in the Borehole Records in Appendix C.

6.0 SUBSURFACE CONDITIONS

In general, the subsurface conditions encountered within the boreholes comprised a sand layer with varying amounts of silt and gravel followed by a layer of weathered bedrock or cobbles and boulders over intact bedrock. Within the boreholes at the time of drilling, frozen ground was encountered generally at 1 metre depth and continued to the bottom of each borehole.

Subsurface conditions observed in the boreholes are summarized in the subsections below and described in detail on the attached Borehole Records.

6.1 SOIL CONDITIONS

Surface Conditions

The surface soils comprised brown sand with some gravel. Minimal vegetation was observed at the site.

Subsurface Conditions

The subsurface soils at the site comprised of brown-grey sand with varying amounts of silt and gravel. Cobbles and boulders were observed during drilling, typically within the 2 to 3 m above the bedrock.

Due to the method employed in advancing the borehole and the presence of permafrost/frozen soil conditions, a determination of the relative soil densities/consistencies was not possible.

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A summary of laboratory grain size analyses performed on selected soil samples recovered from the boreholes are provided in the following Table 6.1

Table 6.1: Laboratory Testing Results

BH No.	Sa No.	Depth (m)	Grain Size			Unified Soil Classification
			Gravel (%)	Sand (%)	Silty/Clay (%)	
BH16-1	2	3 - 6	5	70	25	Silty SAND (SM)
BH16-2	1	0 - 3	21	69	10	Poorly graded SAND with silt and gravel (SP-SM)
BH16-3	1	0 - 4.3	31	61	8	Well graded SAND with silt and gravel (SW-SM)
BH16-4	1	0 - 2.1	30	62	8	Poorly graded SAND with silt and gravel (SP-SM)
BH16-5	1	0 - 1.5	21	75	4	Poorly graded SAND with gravel (SP)
BH16-6	1	0 - 2.4	22	69	9	Poorly graded SAND with silt and gravel (SP-SM)

Moisture contents conducted on all the recovered soil samples ranged from 2% to 13%.

6.2 BEDROCK

During the drilling investigation bedrock was inferred in all boreholes. Bedrock was identified as granitic gneiss. A weathered layer of bedrock or possibly a layer of boulders/cobbles was inferred in boreholes BH16-1, 2 and 3 above intact bedrock. A summary of the depth to bedrock is provided in Table 6.2.

Table 6.2: Summary of Bedrock Depth

BH No.	Ground Surface Elevation (m)	Depth to Inferred Boulders/Cobbles or Weathered Bedrock (m)	Depth to Intact Bedrock (m)	Intact Bedrock Elevation (m)
BH16-1	67.27	6.0	7.6	59.7
BH16-2	66.61	3.0	5.5	61.1
BH16-3	66.18	4.3	7.3	58.9
BH16-4	67.03	-	5.5	61.5
BH16-5	66.39	-	1.5	64.9
BH16-6	63.72	-	2.4	61.3

6.3 PERMAFROST

Permafrost was encountered at all borehole locations. Based on field observations of frozen soil recoveries during advancement of the boreholes, the permafrost was generally encountered at a depth of about 1.0 m below the existing ground surface.

6.4 PERMAFROST CONDITIONS AND SALINITY

Canada Permafrost mapping from the National Atlas of Canada shows Iqaluit is located within a 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 soils are inferred to be at a depth of 1.5 m at the site during the time of drilling. Investigations completed at the Iqaluit International Airport, indicate that the active layer may be up to 2.5 m thick (Leblanc, et. al. 2012).

Soil pore water salinity measurements were obtained for several samples and ranged from 0.08 to 0.11 ppt. A multiplication factor of 17 was applied to convert the salinity meter reading to soil salinity for the sand sample (NSW Government, 2000). The results are summarized in the following Table 6.3.

Table 6.3: Soil Pore Water Salinity Measurements

Sample No.	Sample Depth, m	Soil Salinity, ppt
BH16-1	0 – 3	1.36
BH16-1	0 – 3	1.53
BH16-1	0 – 3	1.87

6.5 GROUNDWATER CONDITIONS

The groundwater table was not observed within the depths of the geotechnical investigation on site however fluctuations in groundwater level due to seasonal variations or precipitation events should be anticipated. Groundwater will likely be encountered at or near the permafrost table and within the active layer during periods of thaw.

7.0 DISCUSSION

The ground surface at the site generally slopes down toward the southwest. The maximum difference between the ground surface elevation measured at borehole locations BH16-1 and BH16-6 was about 3.6 m.

Intact bedrock was observed in the boreholes at depths ranging from 1.5 m to 7.6 m below ground surface, a layer of inferred weathered bedrock or boulders was observed overlying intact bedrock in boreholes BH16-1, 2 and 3. The depth to bedrock generally increases from the northeast corner of the site toward the southwest corner of the site.

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Due to the presence of shallow bedrock and the sloping ground surface, we recommend using rock socketed piles to support the foundations for the building. A foundation set directly on bedrock is also consistent with the foundations used for the construction of the existing two storey residential structure located to the west of the site.

The following sections provide geotechnical recommendations for the design and construction of the building foundations.

7.1 SHALLOW FOOTINGS ON ROCK

The inferred bedrock at the site varied from 1.5 m to 7.6 m below ground surface, four of the boreholes encountered bedrock deeper than 5 m below ground surface. Given the depth to bedrock at the proposed building location, shallow footings on rock are not recommended for this site.

7.2 SURFACE PAD FOUNDATIONS

Surface pad foundations are not considered feasible for this site due to the large elevation differential across the site. Construction of surface pads would likely require fills extending into the footprint of adjacent properties.

7.3 ROCK SOCKETED PILES

The soil and bedrock conditions on site are suitable for pipe piles socketed into bedrock. The use of rock socketed piles comprising of open-ended steel pipe piles placed in an over-sized borehole and grouted into the bedrock is recommended. Typical pipe pile sizes for projects in northern communities are in the order of 114 mm to 141 mm outside diameter. Cobbles and boulders and weathered bedrock were inferred above the solid bedrock. The top 2 m of bedrock should be excluded in the estimation of the geotechnical resistance of the piles.

The geotechnical resistance of the piles at Ultimate Limit State (ULS) should be estimated based on a ultimate grout to steel bond of 600 kPa; the ultimate grout to steel bond value assumes the an unconfined compressive strength of at least 20 MPa for the grout. The grout to steel bond is smaller than the grout to bedrock bond and therefore should be used for design purposes. 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 to 0.5 and 0.4, respectively. The grout should be specifically designed for cold weather applications. The grout should be a high early strength, non-shrink grout with a minimum unconfined compressive strength of 20 MPa such as Sika Arctic 100, or equivalent. 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 10 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. The ULS geotechnical resistance for the piles should be the greater of that calculated using the grout

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to steel bond approach described above and the end-bearing approach described in this paragraph.

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 will be heated, all piles should be designed to resist frost jacking forces 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, (ultimate, unfactored) applied over the surface of the pile within the active layer (3 m).

7.3.1 Pile Installation

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 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 pushed to the bottom of 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. Above the grouted portion, 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 flowing paste. The temperature of the sand slurry should not exceed 10 °C during placement.

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The drill cuttings may be used to fill the inside of the piles, 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.

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 minimize the development of frost heave forces in the piles.

7.3.2 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 C which corresponds to a very dense soil and soft rock ground profile. The site class assumes the foundations will be placed within bedrock.

7.4 FLOOR SLAB

The design of rock-socketed piles would include a structural floor slab supported on piles.

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.

7.5 THAW RELATED SETTLEMENT

The ambient temperature in the building will be maintained above freezing, therefore heat loss from the building could cause thawing of the overburden soils around and beneath the building. Thawing of the overburden soils and eventual development of a thaw bulb may cause settlement of the overburden; both vertical and horizontal movements could develop within the overburden. 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 carried out. The incorporation of a ventilated air space beneath the building will help mitigate the potential movements.

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

7.6 CLIMATE CHANGE CONCERNS

Temperature trends indicate a warming trend of 0.7 °C per decade (CSA, 2010) which corresponds to about 1.4 °C increase over a 20 year design life. A warming climate could cause a change in depth of the active soil layer, which causes an increase in frost jacking. Frost jacking of piles, especially the leading edge piles, could cause movements that would damage

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the building foundations. For this reason it is recommended to design with an increased active layer depth of 2.5 m.

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 "low" 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 qualitative review should be completed. Assuming the building is designed with a structural floor slab supported on pile foundations socketed into intact bedrock, negligible movement of the structure is anticipated.

7.7 CEMENT TYPE AND CORROSION POTENTIAL

Two representative soil samples were submitted to Paracel Laboratories Limited in Ottawa, Ontario for resistivity, pH, sulphate and chloride testing. The results of the testing are summarized in Table 7.1

Table 7.1: Results of Chemical Analysis

Borehole	Sample	Depth (m)	pH	Sulphate (µg/g)	Chloride (µg/g)	Resistivity (Ohm•m)
BH16-1	BS-1	0 – 3.0	7.75	508	190	12.4
BH6-4	BS-1	0 – 2.1	7.47	154	20	34.5

The testing was completed to determine the potential for degradation of concrete in the presence of soluble sulphate and the potential for corrosion of exposed steel used in buried infrastructure.

The pH, resistivity and chloride concentration provide an indication of the degree of corrosiveness of the subsurface environment. The soil pH ranged from 7.47 to 7.75 which are within what is considered the normal range for soil pH of 5.5 to 9.0. The results are provided to aid in the selection of coatings and corrosion protection systems for buried steel objects.

The concentration of soluble sulphate provides an indication of the degree of sulphate attack that is expected for concrete in contact with soil and groundwater at the site. Soluble sulphate concentrations less than 1000 µg/g generally indicate that a low degree of sulphate attack is expected for concrete in contact with soil and groundwater. Type GU (General Use) Portland Cement should therefore be suitable for use in concrete.

8.0 CLOSURE

Use of this report is subject to the Statement of General Conditions provided in Appendix A. It is the responsibility of the Public Works and Government Services Canada 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,

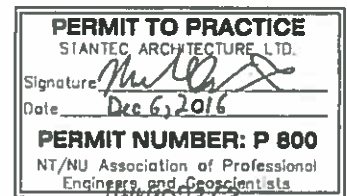
STANTEC CONSULTING LTD.



Katurah Firdaws, B.Eng.
Geotechnical Engineer



Chris McGrath, P.Eng.
Associate, Geotechnical Engineering



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9.0 REFERENCES

- Allard, M., Doyon, J., Mathon-Dufour, V., LeBlanc, A.-M., L'Hérault, E., Mate, D., Oldenborger, G.A., and Sladen, W.E. 2012. Surficial geology, Iqaluit, Nunavut. Geological Survey of Canada, Canadian Geoscience Map 64 (preliminary version), scale 1:15 000. doi:10.4095/289503
- Andersland, O.B., and Ladanyi, B. 1994. An Introduction to Frozen Ground Engineering. Chapman & Hall Inc., New York, NY, USA.
- Canadian Geotechnical Society. 2006. Canadian Foundation Engineering Manual 4th Edition. BiTech Publishers Ltd. Richmond, BC, Canada
- Canadian Standards Association (CSA). 2010. Technical Guide Infrastructure in permafrost: A guideline for climate change adaptation. Canadian Standards Association, Mississauga, ON, Canada.
- Environment Canada. (2016, September 1) *Canadian Climate Normals 1981–2010*. Retrieved from http://climate.weather.gc.ca/climate_normals
- Environment Canada. Warming Trends °C/Decade, Based on homogenized temperature data – the most recent 30 yr record (1981 – 2010); Environment Canada.
- Leblanc, A.-M., Mathon-Dufour, V., Allard, M., Oldenborger, G.A., Short, N., L'Hérault, E., and Sladen, W.E. 2013: Permafrost characterization at the Iqaluit International Airport, Nunavut, in support of decision-making and planning; *in* Summary of Activities 2012, Canada-Nunavut Geoscience Office, p. 131-142.
- National Research Council of Canada. 2015. National Building Code of Canada 2015. Ottawa, ON, Canada.
- Natural Resources Canada. 1995: Canada Permafrost; The National Atlas of Canada 5th Edition, scale 1:7 500 000.
- NSW Government. *Salinity Notes October 2000*. Retrieved from <http://dpi.nsw.gov.au>
- Harrison, J.C., St-Onge, M.R., Petrov, O.V., Strelnikov, S.I., Lopatin, B.G., Wilson, F.H., Tella, S., Paul, D., Lynds, T., Shokalsky, S.P., Hults, C.K., Bergman, S., Jepson, H.F., and Solli, A. 2011. Geological map of the Arctic, Geological Survey of Canada, Map 2159A, scale 1:5 000 000.
- S.L. Smith, D.W. Riseborough, M. Ednie and J. Chartrand. 2013. A map and summary database of permafrost temperatures in Nunavut, Canada. *Geological Survey of Canada Open File 7393*. doi: 10.4095/292615
- Wyllie, D.C. 1999. Foundations on Rock. E & FN SPON. New York, NY, USA.

APPENDIX A

Statement of General Conditions

STATEMENT OF GENERAL CONDITIONS

USE OF THIS REPORT: 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.

BASIS OF THE REPORT: 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.

STANDARD OF CARE: 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.

INTERPRETATION OF SITE CONDITIONS: 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.

VARYING OR UNEXPECTED CONDITIONS: 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.

PLANNING, DESIGN, OR CONSTRUCTION: 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 – Borehole Location Plan

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200 0 200 m 400 m
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REFERENCE:

GOOGLE EARTH PRO SCREEN SHOT.

Client/Project

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IQALUIT DAYCARE, IQALUIT, NU

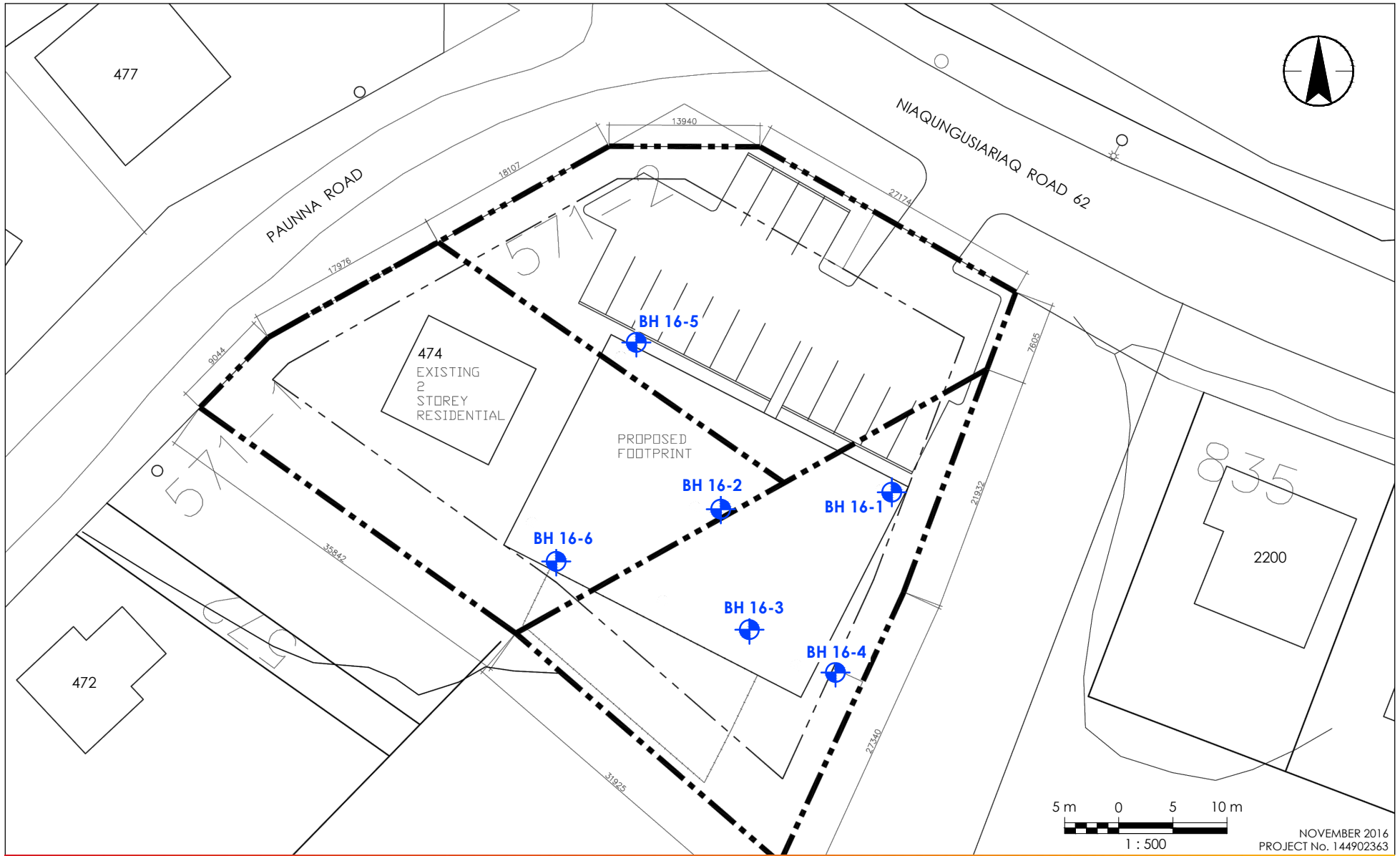
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1

Title

KEY PLAN

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LEGEND



APPROXIMATE BOREHOLE LOCATION

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 19.
2. BASE PLAN FROM A PDF COPY PROVIDED BY PWGSC.

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PWGSC
GEOTECHNICAL INVESTIGATION
IQALUIT DAYCARE, IQALUIT, NU

Drawing No.

2

Title

BOREHOLE LOCATION PLAN

APPENDIX C

Symbols and Terms Used on Borehole Records

Borehole Records

Site Photographs

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

<i>Rootmat</i>	- vegetation, roots and moss with organic matter and topsoil typically forming a mattress at the ground surface
<i>Topsoil</i>	- mixture of soil and humus capable of supporting vegetative growth
<i>Peat</i>	- mixture of visible and invisible fragments of decayed organic matter
<i>Till</i>	- unstratified glacial deposit which may range from clay to boulders
<i>Fill</i>	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

<i>Desiccated</i>	- having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
<i>Fissured</i>	- having cracks, and hence a blocky structure
<i>Varved</i>	- composed of regular alternating layers of silt and clay
<i>Stratified</i>	- composed of alternating successions of different soil types, e.g. silt and sand
<i>Layer</i>	- > 75 mm in thickness
<i>Seam</i>	- 2 mm to 75 mm in thickness
<i>Parting</i>	- < 2 mm in thickness

Terminology describing soil types:

The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488) which excludes particles larger than 75 mm. For particles larger than 75 mm, and for defining percent clay fraction in hydrometer results, definitions proposed by Canadian Foundation Engineering Manual, 4th Edition are used. The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):

Terminology describing materials outside the USCS, (e.g. particles larger than 75 mm, visible organic matter, and construction debris) is based upon the proportion of these materials present:

<i>Trace, or occasional</i>	Less than 10%
<i>Some</i>	10-20%
<i>Frequent</i>	> 20%

Terminology describing compactness of cohesionless soils:

The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test (SPT) N-Value - also known as N-Index. The SPT N-Value is described further on page 3. A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
<i>Very Loose</i>	<4
<i>Loose</i>	4-10
<i>Compact</i>	10-30
<i>Dense</i>	30-50
<i>Very Dense</i>	>50

Terminology describing consistency of cohesive soils:

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests. Consistency may be crudely estimated from SPT N-Value based on the correlation shown in the following table (Terzaghi and Peck, 1967). The correlation to SPT N-Value is used with caution as it is only very approximate.

Consistency	Undrained Shear Strength		Approximate SPT N-Value
	kips/sq.ft.	kPa	
<i>Very Soft</i>	<0.25	<12.5	<2
<i>Soft</i>	0.25 - 0.5	12.5 - 25	2-4
<i>Firm</i>	0.5 - 1.0	25 - 50	4-8
<i>Stiff</i>	1.0 - 2.0	50 - 100	8-15
<i>Very Stiff</i>	2.0 - 4.0	100 - 200	15-30
<i>Hard</i>	>4.0	>200	>30

ROCK DESCRIPTION

Except where specified below, terminology for describing rock is as defined by the International Society for Rock Mechanics (ISRM) 2007 publication "The Complete ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 1974-2006"

Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	Very Poor Quality
25-50	Poor Quality
50-75	Fair Quality
75-90	Good Quality
90-100	Excellent Quality

Alternate (Colloquial) Rock Mass Quality	
Very Severely Fractured	Crushed
Severely Fractured	Shattered or Very Blocky
Fractured	Blocky
Moderately Jointed	Sound
Intact	Very Sound

RQD (Rock Quality Designation) denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 in.) long are summed and divided by the total length of the core run. RQD is determined in accordance with ASTM D6032.

SCR (Solid Core Recovery) denotes the percentage of solid core (cylindrical) retrieved from a borehole of any orientation. All pieces of solid (cylindrical) core are summed and divided by the total length of the core run (It excludes all portions of core pieces that are not fully cylindrical as well as crushed or rubble zones).

Fracture Index (FI) is defined as the number of naturally occurring fractures within a given length of core. The Fracture Index is reported as a simple count of natural occurring fractures.

Terminology describing rock with respect to discontinuity and bedding spacing:

Spacing (mm)	Discontinuities	Bedding
>6000	Extremely Wide	-
2000-6000	Very Wide	Very Thick
600-2000	Wide	Thick
200-600	Moderate	Medium
60-200	Close	Thin
20-60	Very Close	Very Thin
<20	Extremely Close	Laminated
<6	-	Thinly Laminated

Terminology describing rock strength:

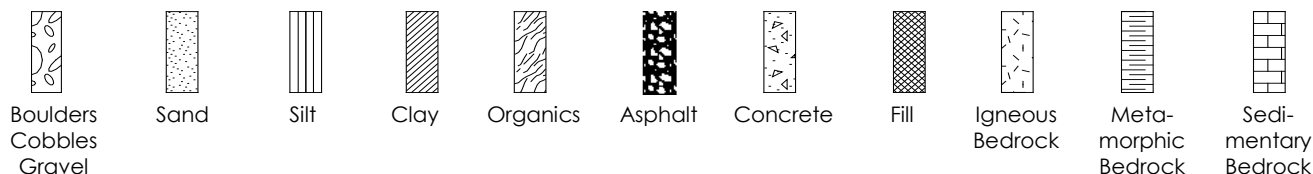
Strength Classification	Grade	Unconfined Compressive Strength (MPa)
Extremely Weak	R0	<1
Very Weak	R1	1 – 5
Weak	R2	5 – 25
Medium Strong	R3	25 – 50
Strong	R4	50 – 100
Very Strong	R5	100 – 250
Extremely Strong	R6	>250

Terminology describing rock weathering:

Term	Symbol	Description
Fresh	W1	No visible signs of rock weathering. Slight discoloration along major discontinuities
Slightly	W2	Discoloration indicates weathering of rock on discontinuity surfaces. All the rock material may be discolored.
Moderately	W3	Less than half the rock is decomposed and/or disintegrated into soil.
Highly	W4	More than half the rock is decomposed and/or disintegrated into soil.
Completely	W5	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.
Residual Soil	W6	All the rock converted to soil. Structure and fabric destroyed.

STRATA PLOT

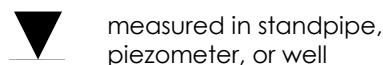
Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameter tube sampler hydraulically advanced)
PS	Piston sample
BS	Bulk sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond coring bits.

WATER LEVEL MEASUREMENT



measured in standpipe, piezometer, or well



inferred

RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (63.5 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (300 mm) into the soil. In accordance with ASTM D1586, the N-Value equals the sum of the number of blows (N) required to drive the sampler over the interval of 6 to 18 in. (150 to 450 mm). However, when a 24 in. (610 mm) sampler is used, the number of blows (N) required to drive the sampler over the interval of 12 to 24 in. (300 to 610 mm) may be reported if this value is lower. For split spoon samples where insufficient penetration was achieved and N-Values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N-values corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)





Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to 'A' size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (300 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

S	Sieve analysis
H	Hydrometer analysis
k	Laboratory permeability
γ	Unit weight
G_s	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
C	Consolidation
Q_u	Unconfined compression
I_p	Point Load Index (I_p on Borehole Record equals $I_p(50)$ in which the index is corrected to a reference diameter of 50 mm)

	Single packer permeability test; test interval from depth shown to bottom of borehole
	Double packer permeability test; test interval as indicated
	Falling head permeability test using casing
	Falling head permeability test using well point or piezometer

CLIENT Public Works and Government Services Canada BOREHOLE No. BH16-1
 LOCATION Proposed Daycare, Niaqungusiariaq & Paunna Road, Iqaluit, NU PROJECT No. 144902363
 DATES: BORING October 19, 2016 WATER LEVEL _____ DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES				UNDRAINED SHEAR STRENGTH - kPa							
					TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR QD	50	100	150	200				
0	67.27	Grey-brown silty SAND (SM) - Non-visible ice - Ground frozen at about 1 m			BS	1			WATER CONTENT & ATTERBERG LIMITS DYNAMIC PENETRATION TEST, BLOWS/0.3m STANDARD PENETRATION TEST, BLOWS/0.3m							
1																
2																
3	64.3	Grey silty SAND (SM), rock pieces present - Non-visible ice			BS	2										
4																
5																
6	61.3	Weathered BEDROCK or boulders/cobbles														
7																
8																
9	59.7	Granitic Gneiss BEDROCK, grey														
10																

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa



▲ Pocket Penetrometer Test, kPa




App'd _____

Date _____





CLIENT Public Works and Government Services Canada BOREHOLE No. BH16-1
 LOCATION Proposed Daycare, Niaqungusiariaq & Paunna Road, Iqaluit, NU PROJECT No. 144902363
 DATES: BORING October 19, 2016 WATER LEVEL _____ DATUM Geodetic



DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES				UNDRAINED SHEAR STRENGTH - kPa	
					TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR QD	50	100
									WATER CONTENT & ATTERBERG LIMITS DYNAMIC PENETRATION TEST, BLOWS/0.3m STANDARD PENETRATION TEST, BLOWS/0.3m	
									10 20 30 40 50 60 70 80 90 W _p W W _L	
10	56.7	End of Borehole at 10.6 m								
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										




 Inferred Groundwater Level
 Groundwater Level Measured in Standpipe

 Field Vane Test, kPa
 Remoulded Vane Test, kPa App'd _____
 Pocket Penetrometer Test, kPa Date _____

CLIENT Public Works and Government Services Canada BOREHOLE No. BH16-2
 LOCATION Proposed Daycare, Niaqungusiariaq & Paunna Road, Iqaluit, NU PROJECT No. 144902363
 DATES: BORING October 19, 2016 WATER LEVEL _____ DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES				UNDRAINED SHEAR STRENGTH - kPa							
					TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR QD	50	100	150	200				
0	66.61	Grey poorly-graded SAND with silt and gravel (SP-SM) - Non-visible ice - Ground frozen at about 1 m			BS	1			WATER CONTENT & ATTERBERG LIMITS DYNAMIC PENETRATION TEST, BLOWS/0.3m STANDARD PENETRATION TEST, BLOWS/0.3m							
1																
2																
3	63.6	Weathered BEDROCK or boulders/cobbles														
4																
5																
6	61.1	Granitic Gneiss BEDROCK, grey														
7																
8																
8	58.4	End of Borehole at 8.2 m														
9																
10																

 Inferred Groundwater Level
 Groundwater Level Measured in Standpipe

 Field Vane Test, kPa
 Remoulded Vane Test, kPa
 Pocket Penetrometer Test, kPa

App'd _____
 Date _____

CLIENT Public Works and Government Services Canada BOREHOLE No. BH16-3
 LOCATION Proposed Daycare, Niaqungusiariaq & Paunna Road, Iqaluit, NU PROJECT No. 144902363
 DATES: BORING October 19, 2016 WATER LEVEL _____ DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES				UNDRAINED SHEAR STRENGTH - kPa					
					TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR QD	50	100	150	200		
0	66.18	Brown well-graded SAND with silt and gravel (SW-SM) - Non-visible ice - Ground frozen at about 1 m			BS	1			WATER CONTENT & ATTERBERG LIMITS DYNAMIC PENETRATION TEST, BLOWS/0.3m STANDARD PENETRATION TEST, BLOWS/0.3m 10 20 30 40 50 60 70 80 90					
1														
2														
3														
4	61.9	Weathered BEDROCK or boulders/cobbles							W _p W W _L					
5														
6														
7														
8	58.9	Granitic Gneiss BEDROCK, grey							*					
9														
10														

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa App'd _____

△ Pocket Penetrometer Test, kPa Date _____

CLIENT Public Works and Government Services Canada BOREHOLE No. BH16-3
 LOCATION Proposed Daycare, Niaqungusiariaq & Paunna Road, Iqaluit, NU PROJECT No. 144902363
 DATES: BORING October 19, 2016 WATER LEVEL _____ DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES				UNDRAINED SHEAR STRENGTH - kPa	
					TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR QD	50	100
	55.8	End of Borehole at 10.3 m							WATER CONTENT & ATTERBERG LIMITS DYNAMIC PENETRATION TEST, BLOWS/0.3m STANDARD PENETRATION TEST, BLOWS/0.3m <div style="display: flex; align-items: center;"> <div style="flex: 1;"> <div style="text-align: center;"> 10 20 30 40 50 60 70 80 90 </div> <div style="text-align: center;"> * ● </div> </div> <div style="margin-left: 10px;"> W_p W W_L </div> </div>	
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										



☐ Inferred Groundwater Level
☐ Groundwater Level Measured in Standpipe




☐ Field Vane Test, kPa
☐ Remoulded Vane Test, kPa
☐ Pocket Penetrometer Test, kPa

App'd _____
 Date _____

CLIENT Public Works and Government Services Canada BOREHOLE No. BH16-4
 LOCATION Proposed Daycare, Niaqungusiariaq & Paunna Road, Iqaluit, NU PROJECT No. 144902363
 DATES: BORING October 19, 2016 WATER LEVEL _____ DATUM Geodetic

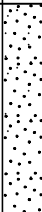

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES				UNDRAINED SHEAR STRENGTH - kPa	
					TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR QD	50	100
0	67.03								WATER CONTENT & ATTERBERG LIMITS DYNAMIC PENETRATION TEST, BLOWS/0.3m STANDARD PENETRATION TEST, BLOWS/0.3m	
1		Brown poorly-graded SAND with silt and gravel (SP-SM) - Non-visible ice - Ground frozen at about 1 m			BS	1				
2	64.9									
	64.6	Boulders								
3		Brown poorly-graded SAND with silt and gravel (SP-SM) - Frequent cobbles and boulders - Non-visible ice								
4										
5										
	61.5									
6		Granitic Gneiss BEDROCK, grey								
7										
8										
	58.8									
		End of Borehole at 8.2 m								
9										
10										



 Inferred Groundwater Level
 Groundwater Level Measured in Standpipe




 Field Vane Test, kPa
 Remoulded Vane Test, kPa
 Pocket Penetrometer Test, kPa

App'd _____
 Date _____

CLIENT Public Works and Government Services Canada BOREHOLE No. BH16-5
 LOCATION Proposed Daycare, Niaqungusiariaq & Paunna Road, Iqaluit, NU PROJECT No. 144902363
 DATES: BORING October 19, 2016 WATER LEVEL _____ DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES				UNDRAINED SHEAR STRENGTH - kPa	
					TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR QD	50	100
0	66.39	Brown poorly-graded SAND with gravel (SP) - Non-visible ice - Ground frozen at about 1 m			BS	1			WATER CONTENT & ATTERBERG LIMITS DYNAMIC PENETRATION TEST, BLOWS/0.3m STANDARD PENETRATION TEST, BLOWS/0.3m	
1	64.9								10	20
2		Granitic Gneiss BEDROCK, grey								
3										
4	61.8	End of Borehole at 4.5 m								
5										
6										
7										
8										
9										
10										

 Inferred Groundwater Level
 Groundwater Level Measured in Standpipe

 Field Vane Test, kPa
 Remoulded Vane Test, kPa App'd _____
 Pocket Penetrometer Test, kPa Date _____

CLIENT Public Works and Government Services Canada BOREHOLE No. BH16-6
 LOCATION Proposed Daycare, Niaqungusiariaq & Paunna Road, Iqaluit, NU PROJECT No. 144902363
 DATES: BORING October 19, 2016 WATER LEVEL _____ DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES				UNDRAINED SHEAR STRENGTH - kPa							
					TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR QD	50	100	150	200				
0	63.72	Brown poorly-graded SAND with silt and gravel (SP-SM) - Non-visible ice - Ground frozen at about 1 m			BS	1			WATER CONTENT & ATTERBERG LIMITS DYNAMIC PENETRATION TEST, BLOWS/0.3m STANDARD PENETRATION TEST, BLOWS/0.3m							
1																
2	61.3															
3		Granitic Gneiss BEDROCK, grey														
4																
5	58.5															
6		End of Borehole at 5.2 m														
7																
8																
9																
10																

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd _____

Date _____



Photo No. 1: Proposed Daycare Site looking south-west



Photo No. 2: Proposed Daycare Site looking north-west



Photo No. 3: Proposed Daycare Site looking south



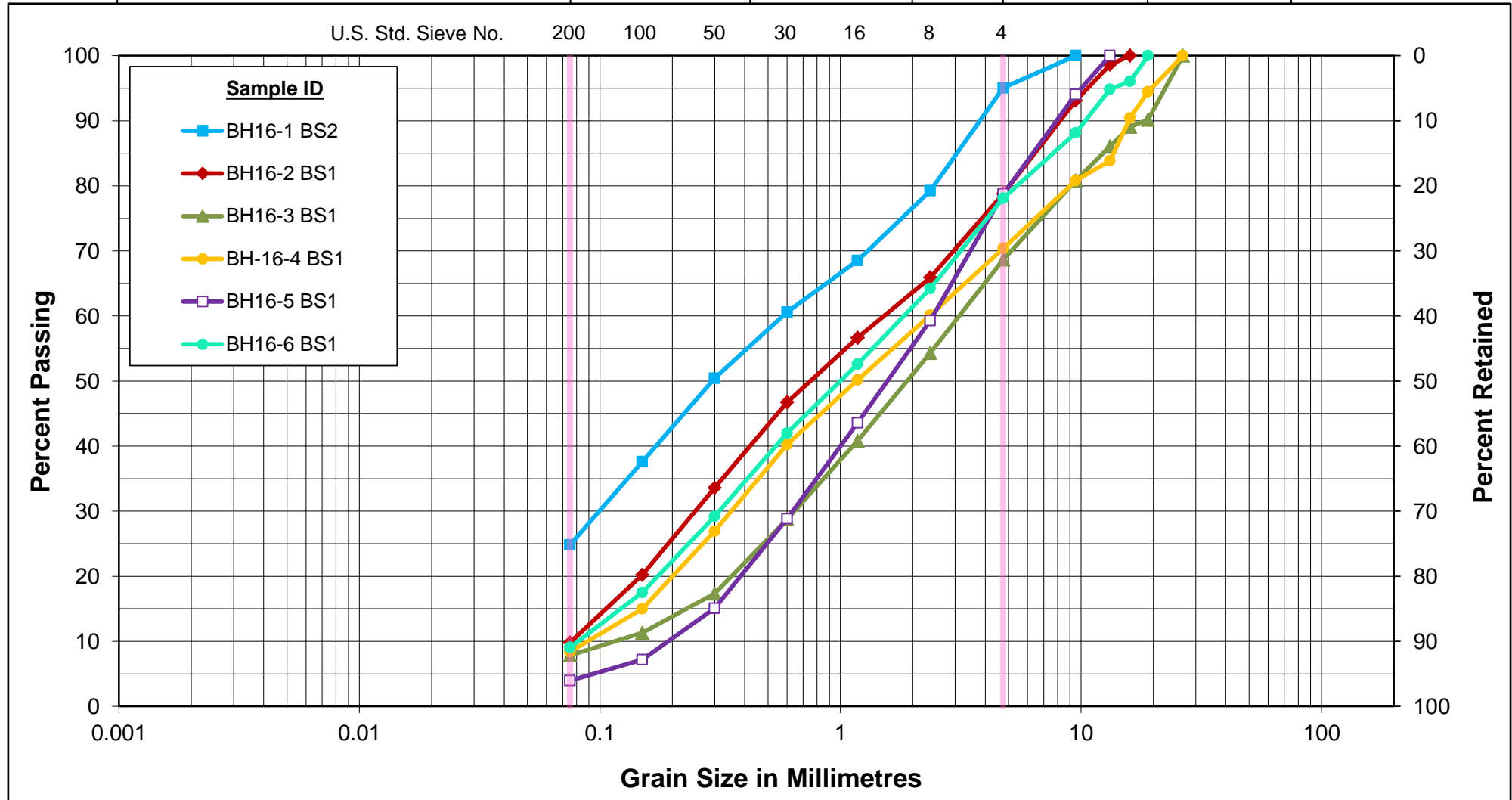
Photo No. 4: Proposed Daycare Site looking north

APPENDIX D

Laboratory Test Results

Unified Soil Classification System

CLAY & SILT	SAND			Gravel	
	Fine	Medium	Coarse	Fine	Coarse



GRAIN SIZE DISTRIBUTION

Public Works & Government Services Canada

Iqaluit Federal Daycare Centre

Figure No. 1

Project No. 144902363

APPENDIX E

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

November 15, 2015

Site: 63.7468 N, 68.498 W User File Reference: Iqaluit Daycare

Requested by: ,

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	0.064	0.042	0.023	0.0056	0.0026	0.051	0.054

Notes. Spectral ($S_a(T)$, where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). 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	0.037
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. 58190;
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.nationalbuildingcode.ca for more information

Aussi disponible en français



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