• Government of Nunavut

Geotechnical Investigation

Type of Document
FACTUAL REPORT

Project Name
Proposed and Existing Sewage Lagoon
Hamlet of Whale Cove, Nunavut

Project Number
OTT-00201369-A0

Prepared By:

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Ottawa, Ontario K2B 8H6
Canada

Date Submitted
November 14, 2011

Government of Nunavut

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Date Submitted:
November 14, 2011

Legal Notification

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Executive Summary

A geotechnical investigation was undertaken at the site of the existing sewage lagoon for the Hamlet of Whale Cove and at a potential location for a new sewage lagoon. This work was authorized by Government of Nunavut.

It is understood that design/rehabilitation plans have not been finalized to date. Therefore, a factual report is required at this stage. Design recommendations from a geotechnical perspective will follow once the rehabilitation/reconstruction plans have been finalized.

The existing sewage lagoon was constructed in low lying area of a valley, by building berms across it. The area is reported to be on old pond. The potential site of a new lagoon is located in an active quarry approximately 2 kms north of the Hamlet.

The geotechnical investigation comprised of drilling four boreholes at the existing sewage lagoon site (Boreholes 1 to 4 inclusive) and one borehole (Borehole 5) at the proposed location of the new lagoon. The investigation revealed that fill extends to 1.2 m to 1.5 m in Borehole 1 and 2 which were drilled on the crest of the berms. The fill is underlain by sand and gravel, sandy silt, sandy gravel and silty sand to 7.2 m (Elevation 13.9 m) to 5.7 m (Elevation 16.2 m). In Boreholes 3 and 4, a surficial veneer of sand and gravel 0.4 m to 0.9 m thick is underlain by bedrock. The bedrock was identified as dolomite of good to excellent quality. Depth to permafrost was established in Boreholes 1 and 2 at 5.7 m. It is considered that the permafrost had degraded over the years since the area used to be a pond prior to its conversion into sewage lagoon.

Borehole 5 drilled at the potential location of new sewage lagoon encountered 1.5 m of surficial sand which was underlain by sandy gravel to the entire depth investigated i.e. 3.7 m depth, Elevation 12.5 m. Permafrost was not encountered in this borehole to the depth investigated.

A detailed description of the subsoil conditions encountered at the two sites is given in the accompanying report.

The above and other related considerations are discussed in greater detail in the attached report.

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List of Figures

Chapter 1 – Introduction

1 Introduction

A geotechnical investigation was undertaken at the site of the existing sewage lagoon and at a potential site for construction of a new sewage lagoon in the Hamlet of Whale Cove, Nunavut. This work was authorized by the Government of Nunavut.

The existing lagoon was constructed in a valley by berming low areas. It is understood that the berms of the existing lagoon are not sufficiently high to maintain a free board of 1 m. In addition, the lagoon is leaking.

The purpose of the geotechnical was to:

(a) Establish the geotechnical conditions at the site of the existing sewage lagoon;

(b) Suggest remedial measures which will enable achieving a free board of 1 m and make the lagoon less pervious; and

(c) Comment on the feasibility of constructing a new lagoon at an alternative site.

The purpose of this report is to report the geotechnical conditions. Engineering recommendations will be provided at a later stage once the design aspects have been finalized.

Chapter 2 – Procedure

2 Procedure

2.1 Drilling and Soil Sampling

The fieldwork for the geotechnical investigation was undertaken between September 16 and September 19, 2011 with a Hilti drill rig. The fieldwork was supervised by a representative of **exp** Services Inc. (**exp**) on a full time basis.

The fieldwork consisted of drilling 5 boreholes to depths varying between 2.4 m and 9.5 m. The locations of the boreholes are shown on Site Plan, Figure 1.

The boreholes were initially advanced by performing continuous standard penetration tests and retrieving the soil samples. However, the boreholes could only be advanced by this method in overburden until refusal was met on cobbles and boulders. The boreholes were then cased and advanced by core drilling techniques with the Hilti drill rig. Most of the boreholes were drilled by dry coring. Water was used in cases where the core barrel could not be advanced by dry coring. During core drilling, a careful record of colour of wash water, wash water return and any sudden drops of the drill rods was kept.

Water level observations were made in the boreholes during the course of the fieldwork. All the soil samples were visually examined in the field for textural classification, preserved in plastic bags and identified. A portion of each soil samples was placed in Tupperware containers and weighed on-site for determination of moisture content. The boreholes were logged. Similarly, the rock core was placed in the core boxes, identified and logged. On completion of drilling all the soil samples and rock core were transported to the **exp** laboratory in the City of Ottawa.

The locations and elevations of the boreholes were established by representative of **exp** Services Inc. The elevation of the borehole refer to the Geodetic datum.

All the soil samples and rock core were visually examined in the laboratory by a geotechnical engineer and borehole logs prepared. The engineer also assigned the laboratory testing. The laboratory testing consisted of performing natural moisture content on all the samples and grain size analysis, on selected soil samples.

Chapter 3 –
Site and Soil Description

3 Site and Soil Description

The Hamlet of Whale Cove is located 72 kms south of Rankin Inlet and 161 kms north of Arviat in Kivalliq Region, Nunavut, Canada on the western shore of Hudson Bay. The terrain is arctic tundra, consisting mostly of rocks, mosses and lichens. The population of Whale Cove is 353 according to 2006 census.

The layout of the community is shown on Figure 1. The existing sewage lagoon and existing wetland are located approximately south and southwest of the Hamlet of Whale Cove. A potential alternative location for a new lagoon was also investigated and is shown on Figure 1. It is located approximately 2 kms north of the Hamlet of Whale Cove.

A total of 4 boreholes (Boreholes 1 to 4) were drilled at the site of the existing sewage lagoon. The locations of the boreholes are shown on Site Plan, Figure 2. One borehole (Borehole 5) was drilled at the site of the potential new lagoon. The location of this borehole is shown on Figure 3.

A detailed description of the geotechnical conditions encountered in the five (5) boreholes (Boreholes 1 to 5 inclusive) is given on the borehole logs, Figure Nos. 4 to 8 inclusive. The borehole logs and related information depict subsurface conditions only at the specific locations and times indicated. Subsurface conditions and water levels at other locations may differ from conditions at the locations where sampling was conducted. The passage of time also may result in changes in the conditions interpreted to exist at the locations where sampling was conducted. Boreholes were drilled to provide representation of subsurface conditions as part of a geotechnical exploration program and are not intended to provide evidence of potential environmental conditions.

The sewage lagoon is located in a low lying area approximately 600 metres south of the Hamlet of Whale Cove. It is understood that the area was a natural pond. In order to increase its capacity, berms were constructed in the low lying areas to bridge across the higher ground. A total of two berms were constructed in the northeast and southwest part of the lagoon.

The area in the immediate vicinity of the lagoon is shown on Figure 2. A review of this figure indicates that the crest of the southwest berms is at Elevation 21.1 m whereas the crest of the northeast berm is at Elevation 21.9 m. These berms have been constructed with a crest width of 3 m approximately and upstream and downstream slopes of 3H:1V. The effluent level in the lagoon was at Elevation 20.5 m at the time of the investigation. The base of the lagoon slopes towards the centre with the lowest level being at Elevation 18.25 m.

Boreholes 3 and 4 were drilled on original ground close to the periphery of the lagoon. In Borehole 3, 330 mm of topsoil was encountered. From the existing ground surface in Borehole 4 and beneath the topsoil in Borehole 3, sand and gravel extends to 0.4 m to 0.9 m depth (Elevation 20.2 m to 20.7 m).

The sand and gravel stratum in both the boreholes was underlain by Dolomite bedrock. The dolomite contains some calcite veins. It has some vertical and inclined joints. A Total Core Recovery and Rock Quality Designation of 100 percent and 85 to 100 percent respectively was obtained when core drilling the bedrock. On this basis, the bedrock quality may be described as very good to excellent.

Chapter 4 –
Geotechnical Conditions at Existing Lagoon Site

4 Geotechnical Conditions at Existing Lagoon Site

The following soil stratigraphy was encountered at the site of the existing sewage lagoon in descending order:

4.1 Topsoil

Approximately 330 m of topsoil was encountered in Borehole 3.

4.2 Fill

Boreholes 1 and 2 were drilled on top of the existing berms and encountered fill to 1.2 m and 1.5 m depth respectively (Elevation 19.9 m and 20.4 m). The fill consists of sand and gravel with some cobbles and silt. It has a moisture content of 6 to 14 percent.

The fill comprises of 2 percent clay, 3 percent silt, 47 percent sand and 48 percent gravel (Figure 9).

4.3 Silt

The fill in Borehole 1 is underlain by a 200 mm thick layer of silt with some organics. This is possibly the original topsoil.

4.4 Sand to Sand and Gravel

The silt in Borehole 1 is underlain by sand which extends to 4.2 m depth (Elevation 16.9 m) and sandy silt which extends to 5.4 m (Elevation 15.7 m). The sand stratum contains some shells and occasional cobbles and boulders. Its moisture content varies from 14 to 22 percent. The sand stratum comprises of 2 percent clay, 11 percent silt, 68 percent sand and 19 percent gravel (Figure 10).

The sandy silt has a moisture content of 20 to 24 percent. Typically, it contains 15 percent clay, 48 percent silt, 25 percent sand and 12 percent gravel (Figure 11).

Beneath the fill in Borehole 2 and from the existing ground surface in Boreholes 3 and 4, sand and gravel was encountered and extends to 0.4 m to 4.5 m (Elevation 17.3 m to 20.7 m). The natural moisture content of this stratum varies from 9 to 20 percent.

The sandy silt in Borehole 1 and the sand and gravel in Borehole 2 are underlain by sandy gravel which extends to the entire depth investigated in Borehole 1 (i.e. 7.2 m depth, Elevation 13.9 m) and to 5.7 m depth (Elevation 16.2 m) in Borehole 2. It has a moisture content of 10 to 15 percent. This stratum contains 2 percent clay, 13 percent silt, 27 percent sand and 58 percent gravel (Figure 12).

The sandy gravel in Borehole 2 is underlain by silt and sand stratum which extends to the entire depth investigated i.e. 9.5 m, Elevation 12.4 m. This stratum contains some clayey silt layers. Its moisture content varies from 11 to 30 percent. It comprises of 12 percent clay, 40 percent silt and 48 percent sand (Figure 13).

4.5 Bedrock

The sand and gravel in Borehole Nos. 3 and 4 is underlain by Dolomite bedrock which extends to the maximum depth investigated in the boreholes. The bedrock was of good to excellent quality based on the Rock Quality Designation results which ranged between 98 and 100 percent.

4.6 Ground Temperature Records

It is noted that permafrost was encountered at 5.7 m depth in Boreholes 1 and 2. It is considered that the permafrost has degraded over the years since the site was an old pond.

A thermister was installed to 8.8 m depth in Borehole 2 on October 26, 2011, subsequent to completion of drilling. Readings were taken immediately after installation of the thermister and on October 27, 2011. The observations made have been tabulated on Table 1.

Table 1 – Ground Temperature Readings

Borehole #	Depth Below Ground Surface (m)	Measured Temperature, °C
		October 27, 2011
2	0.8	0.4
	1.8	1.8
	2.8	3.0
	3.8	1.8
	4.8	1.9
	5.8	-1.8
	6.8	-2.3
	7.8	-2.7
	8.8	-3.0

A review of Table 1 indicates that permafrost is likely present below 5.8 m depth although the readings were taken over a short time interval. This information correlates well with the depth of permafrost (5.8 m) observed in this borehole at the time of drilling.

Chapter 5 –
Proposed Lagoon Location (Borehole 5)

5 Proposed Lagoon Location (Borehole 5)

As indicated previously, Borehole 5 was drilled at the proposed location of the new lagoon approximately 2 kms north of the Hamlet of Whale Cove. This area has been quarried for sand and gravel. The borehole was drilled from the quarry floor. The surficial soil in this area is silty sand which extends to 1.5 m depth (Elevation 14.7 m). This stratum contains some organics and gravel. Its moisture content varies from 9 to 13 percent. It comprises of 5 percent clay, 10 percent silt, 68 percent sand and 17 percent gravel (Figure 14).

The silty sand is underlain by sandy gravel till which extends to the entire depth investigated i.e. 3.7 m (Elevation 12.5 m). The natural moisture content of this stratum is 10 to 11 percent. It comprises of 1 percent clay, 6 percent silt, 16 percent sand and 77 percent gravel (Figure 15).

Permafrost was not encountered at this location to the entire depth investigated.

Chapter 6 – General Comments

6 General Comments

The comments and recommendations provided in this report are intended only for the guidance of design engineers. The number of boreholes required for design purposes to determine the localized underground conditions between test pits affecting construction costs, techniques, sequencing, equipment scheduling, etc. would be more extensive than those carried out under this study. Contractors bidding on or undertaking the works should, in this light, complete more detailed investigations, as well, as their own interpretations of the actual test pit results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

The information contained in this report is not intended to reflect on environmental aspects of the soils. Should specific information be required, including for example, the presence of pollutants, contaminants or other hazards in the soil, additional testing may be required.

We trust that the information contained in this report will be satisfactory for your purposes. Should you have any questions, please do not hesitate to contact this office.

Figures

HUDSON BAY

ALTERNATE SITE LOCATION

WHALE COVE

MUN. LANDFILL

EXISTING WETLANDS

EXISTING LAGOON

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scale 1:10,000	CLIENT: GOVERNMENT OF NUNAVUT	project no. 201369
date OCT. 2011	TITLE: SITE LOCATION PLAN	FIG–1
drawn by BERRIGAN		

Filename: p:\projects\civil engineering services\201000\ott-00201369-a0 - sewage lagoon wetland upgrade - whale cove - gn\dwgs\geotech\201369 - location plan-fig-1 & fig-3.dwg
Last Saved: 11/1/2011 2:26:57 PM
Last Plotted:11/1/2011 2:28:16 PM Plotted by: abozarada
Pen Table:: trow-dme-march2008.ctb

EXISTING TRUCK DISCHARGE

EXISTING BERM

21.86
BH 2

EXISTING LAGOON

21.07
BH 4

EXISTING BERM

21.10
BH 1

21.12
BH 3

22.00
21.00
20.00
19.00

LEGEND

21.07 BH 4 — BOREHOLE LOCATION AND NUMBER

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scale: 1:1000	CLIENT: GOVERNMENT OF NUNAVUT	project no.: OTT-00201369-A0
date: SEPT 2011	TITLE: BOREHOLE LOCATION PLAN	FIG-2
drawn by: BERRIGAN		

Filename: p:\projects\civil engineering services\201000\ott-00201369-a0 - sewage lagoon wetland upgrade - whale cove - gn\dwgs\geotech\201369 bh plan - fig-2ex.dwg
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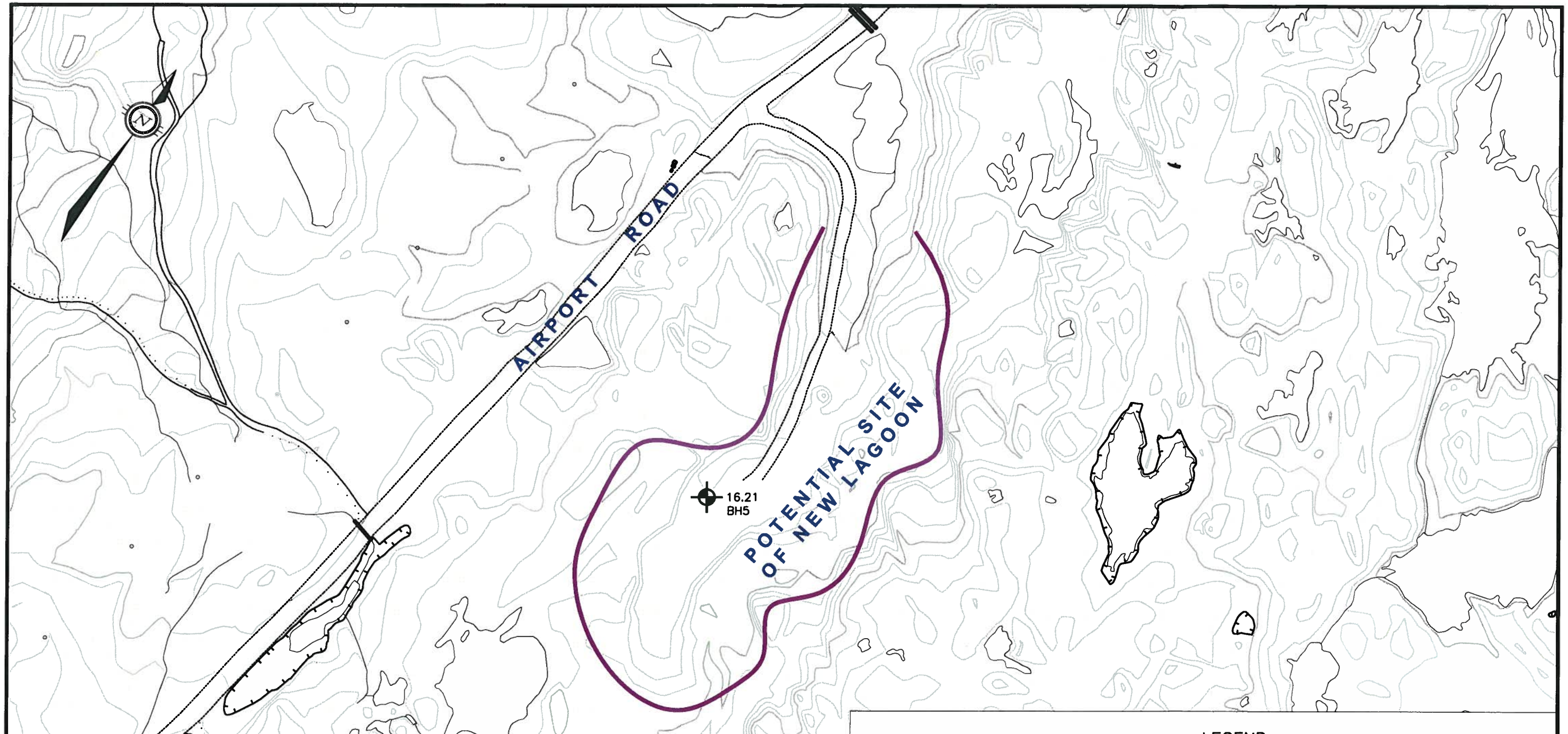

LEGEND

21.07 BH 4 — BOREHOLE LOCATION AND NUMBER

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scale 1:2000	CLIENT: GOVERNMENT OF NUNAVUT	project no. 201369
date NOV. 2011	TITLE: ALTERNATE SITE LOCATION	FIG–3
drawn by BERRIGAN		

Filename: p:\projects\civil engineering services\201000\cot-00201369-a0 - sewage lagoon wetland upgrade - whale cove - gn\dwg\geotech\201369 - location plan-fig-1 & fig-3 2011.11.08.dwg
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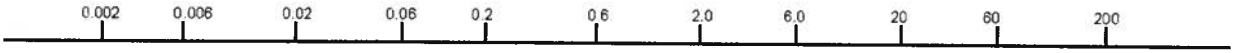
Pen Table:: trow standard, july 01, 2004.ctb

Notes On Sample Descriptions

1. All sample descriptions included in this report follow the Canadian Foundations Engineering Manual soil classification system. This system follows the standard proposed by the International Society for Soil Mechanics and Foundation Engineering. Laboratory grain size analyses provided by **exp** Services Inc. also follow the same system. Different classification systems may be used by others; one such system is the Unified Soil Classification. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.

ISSMFE SOIL CLASSIFICATION

CLAY	SILT			SAND			GRAVEL			COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE		



EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

CLAY (PLASTIC) TO	FINE	MEDIUM	CRS.	FINE	COARSE
SILT (NONPLASTIC)	SAND			GRAVEL	

UNIFIED SOIL CLASSIFICATION

2. Fill: Where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc., none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional geotechnical site investigation.

3. Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

Log of Borehole 1

Project No: OTT-00201369-A0

Project: Geotechnical Investigation - Proposed Existing Sewage Lagoon

Location: Hamlet of Whale Cove, Nunavut

Date Drilled: September 17, 2011

Drill Type:

Datum: Geodetic

Logged by: Checked by:

Figure No. 4

Page. 1 of 1

Split Spoon Sample	⊠	Combustible Vapour Reading	□
Auger Sample	▯	Natural Moisture Content	×
SPT (N) Value	○	Atterberg Limits	⊢○
Dynamic Cone Test	——	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth
		FILL Sand and gravel, fine to coarse, some cobbles, black organics, brown, moist	21.1	0
			19.9	1
		SILT Some organics, black, wet	19.7	
		SAND Some gravel, occasional cobbles and boulders, some shells, brown, moist to wet		2
			16.9	3
		SANDY SILT Slightly cohesive, some shells, some fine to medium gravel, grey, moist to very wet		4
			15.7	5
		SANDY GRAVEL Fine to coarse, frequent cobbles and boulders, grey, wet **PERMAFROST** @ 5.7 M		6
			13.9	7
		Borehole Terminated at 7.2 m depth		

Standard Penetration Test N Value: 20 40 60 80

Shear Strength kPa: 50 100 150 200

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60

SAMPLES

Natural Unit Wt. kN/m³

10

34

92

NOTES:
1. Borehole/Test Pit data requires Interpretation by exp. before use by others
2. Borehole backfilled upon completion.
3. Field work was supervised by an exp representative.
4. See Notes on Sample Descriptions
5. This Figure is to read with exp. Services Inc. report OTT-00201369-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
On Completion	No water	No Cave

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE BOREHOLE LOGS 201369 WHALE COVE.GPJ TROW OTTAWA.GDT 11/9/11

Log of Borehole 2

Project No: OTT-00201369-A0

Project: Geotechnical Investigation - Proposed Existing Sewage Lagoon

Location: Hamlet of Whale Cove, Nunavut

Date Drilled: 'September 16, 2011

Drill Type:

Datum: Geodetic

Logged by: _____ Checked by: _____

Figure No. 5

Page. 1 of 1

Split Spoon Sample | Auger Sample | SPT (N) Value | Dynamic Cone Test | Shelby Tube | Shear Strength by Vane Test (S)

Combustible Vapour Reading | Natural Moisture Content | Atterberg Limits | Undrained Triaxial at % Strain at Failure | Shear Strength by Penetrometer Test

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth
		FILL Fine to coarse sand and gravel, some cobbles and boulders, some silt, brown, moist	21.9	0
		SAND AND GRAVEL Fine to coarse, some cobbles and boulders, sandy to clayey silt layers, brown to grey, moist to wet	20.4	1
		SANDY GRAVEL Fine to coarse, grey	17.3	3
		SILT AND SAND Clayey silt layer, some shells, some gravel, organic smell, grey, frozen **PERMAFROST** @ 5.7 M	16.3	5
		Borehole Terminated at 9.5 m depth	12.4	9

Standard Penetration Test N Value: 20 40 60 80

Shear Strength: 50 100 150 200 kPa

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % / Atterberg Limits (% Dry Weight): 20 40 60

SAMPLES

Natural Unit Wt. kN/m³

32 43 93 100 124

NOTES:
1. Borehole/Test Pit data requires Interpretation by exp. before use by others
2. A thermister was installed to 8.8 m in a 25 mm PVC rigid pipe.
3. Field work was supervised by an exp representative.
4. See Notes on Sample Descriptions
5. This Figure is to read with exp. Services Inc. report OTT-00201369-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
On Completion	No water	No Cave

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE BOREHOLE LOGS 201369 WHALE COVE.GPJ TROW OTTAWA.GDT 11/9/11

Log of Borehole 3

Project No: OTT-00201369-A0

Project: Geotechnical Investigation - Proposed Existing Sewage Lagoon

Location: Hamlet of Whale Cove, Nunavut

Date Drilled: 'September 18, 2011

Drill Type:

Datum: Geodetic

Logged by: _____ Checked by: _____

Figure No. 6

Page. 1 of 1

Split Spoon Sample	⊠	Combustible Vapour Reading	□
Auger Sample	▯	Natural Moisture Content	×
SPT (N) Value	○	Atterberg Limits	⊢○
Dynamic Cone Test	——	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth
		TOPSOIL ~330 mm Sand and gravel, some cobbles and boulders, black to grey	21.1	0
		BEDROCK Dolomite, calcite partings, occasional vertical joints, grey (very good to excellent quality)	20.2	1
				2
		Borehole Terminated at 2.9 m depth	18.2	

Standard Penetration Test N Value: 20 40 60 80

Shear Strength kPa: 50 100 150 200

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60

SAMPLES

Natural Unit Wt. kN/m³

NOTES:
1. Borehole/Test Pit data requires Interpretation by exp. before use by others
2. Borehole backfilled upon completion.
3. Field work was supervised by an exp representative.
4. See Notes on Sample Descriptions
5. This Figure is to read with exp. Services Inc. report OTT-00201369-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
On Completion	No water	No Cave

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	0.94 - 1.45	100	85
2	1.45 - 2.23	100	100
3	2.23 - 2.92	100	100

LOG OF BOREHOLE BOREHOLE LOGS 201369 WHALE COVE.GPJ TROW OTTAWA.GDT 11/9/11

Log of Borehole 4

Project No: OTT-00201369-A0

Project: Geotechnical Investigation - Proposed Existing Sewage Lagoon

Location: Hamlet of Whale Cove, Nunavut

Figure No. 7

Page. 1 of 1

Date Drilled: 'September 19, 2011

Drill Type:

Datum: Geodetic

Logged by: _____ Checked by: _____

Split Spoon Sample ⊠
Auger Sample ▯
SPT (N) Value o
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test + S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits |—o—|
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth
		SAND AND GRAVEL	21.1	0
		Organics, some cobbles	20.7	
		BEDROCK		
		Dolomite, calcite partings, occasional vertical joints, grey (excellent quality)		1
				2
			18.7	
		Borehole Terminated at 2.4 m depth		

Standard Penetration Test N Value: 20 40 60 80
Shear Strength kPa: 50 100 150 200
Combustible Vapour Reading (ppm): 250 500 750
Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60
SAMPLES
Natural Unit Wt. kN/m³

LOG OF BOREHOLE BOREHOLE LOGS 201369 WHALE COVE.GPJ TROW OTTAWA.GDT 11/9/11

NOTES:
1. Borehole/Test Pit data requires Interpretation by exp. before use by others
2. Borehole backfilled upon completion.
3. Field work was supervised by an exp representative.
4. See Notes on Sample Descriptions
5. This Figure is to read with exp. Services Inc. report OTT-00201369-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
On Completion	No water	No Cave

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	0.38 - 1.17	100	100
2	1.17 - 2.36	100	100

Log of Borehole 5

Project No: OTT-00201369-A0

Project: Geotechnical Investigation - Proposed Existing Sewage Lagoon

Location: Hamlet of Whale Cove, Nunavut

Date Drilled: 'September 19, 2011

Drill Type:

Datum: Geodetic

Logged by: _____ Checked by: _____

Figure No. 8

Page. 1 of 1

Split Spoon Sample	⊠	Combustible Vapour Reading	□
Auger Sample	▯	Natural Moisture Content	×
SPT (N) Value	o	Atterberg Limits	⊢—⊖
Dynamic Cone Test	——	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth
		SILTY SAND Some gravel, shells, black organic staining, grey, very moist to wet	16.2	0
		SANDY GRAVEL TILL Fine to coarse, slightly cohesive, grey, wet	14.7	1
				2
			12.5	3
		Borehole Terminated at 3.7 m depth		

Standard Penetration Test N Value: 20 40 60 80

Shear Strength kPa: 50 100 150 200

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60

SAMPLES

Natural Unit Wt. kN/m³

9 23 33 47

NOTES:
1. Borehole/Test Pit data requires Interpretation by exp. before use by others
2. Borehole backfilled upon completion.
3. Field work was supervised by an exp representative.
4. See Notes on Sample Descriptions
5. This Figure is to read with exp. Services Inc. report OTT-00201369-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
On Completion	No water	Cave at 2.13 m

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE BOREHOLE LOGS 201369 WHALE COVE.GPJ TROW OTTAWA.GDT 11/9/11

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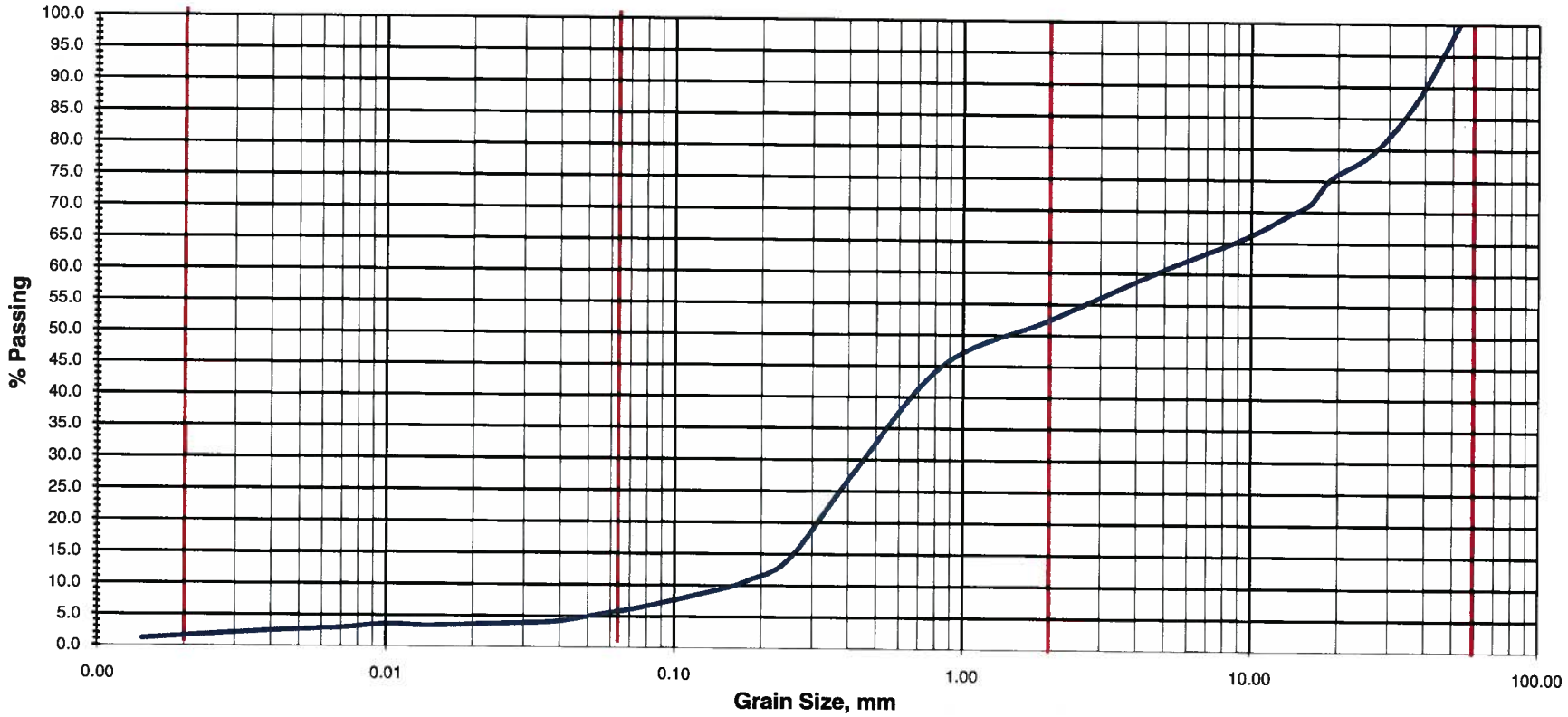
Method of Test for Particle Size Analysis of Soil

MTO Test Method LS - 702, Rev. No. 19

Grain Size Distribution Curve



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
	SILT			SAND			GRAVEL			
Modified M.I.T. Classification										

Trow Project No.:	OTT-000201369-A0	Project Name :	Geotechnical Investigation - Proposed Water Reservoir		
Client :	Government of Nunavut	Project Location :	Whale Cove - Government of Nunavut		
Date Sampled :	September 19, 2011	Bore Hole No.:	1	Sample No.: SS2	Depth (m) : 0.6 to 1.2
Sample Description :	Sand and Gravel				Figure : 9

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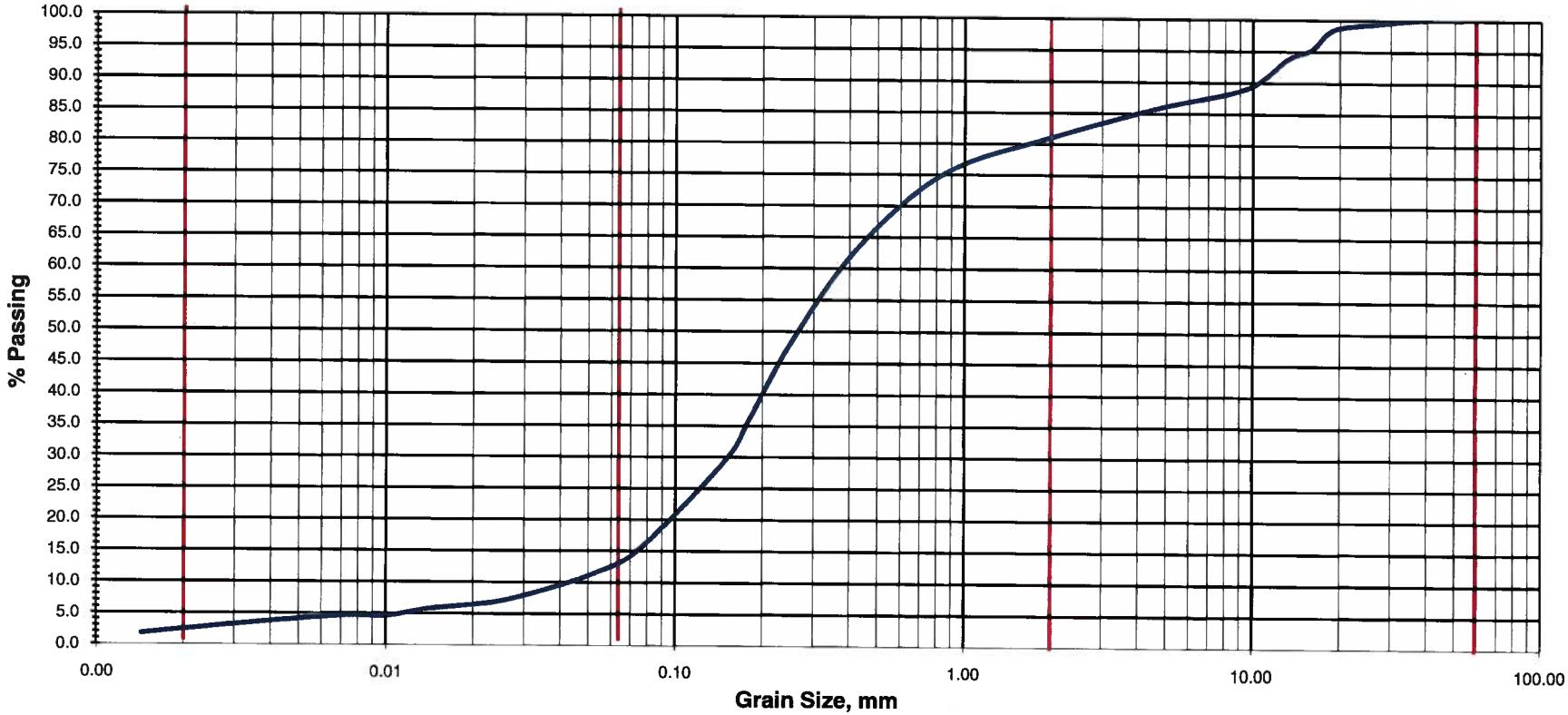
Method of Test for Particle Size Analysis of Soil

MTO Test Method LS - 702, Rev. No. 19

Grain Size Distribution Curve



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
	SILT			SAND			GRAVEL			
Modified M.I.T. Classification										

Trow Project No.:	**OTT-000201369-A0**	**Project Name :**	**Geotechnical Investigation - Proposed Water Reservoir**		
Client :	**Government of Nunavut**	**Project Location :**	**Whale Cove - Government of Nunavut**		
Date Sampled :	**September 18, 2011**	**Bore Hole No.:**	**1**	**Sample No.:** **SS8**	**Depth (m) :** **2.7 to 3.1**
Sample Description :	**Sand - Some Gravel and Silt**				**Figure :** **10**

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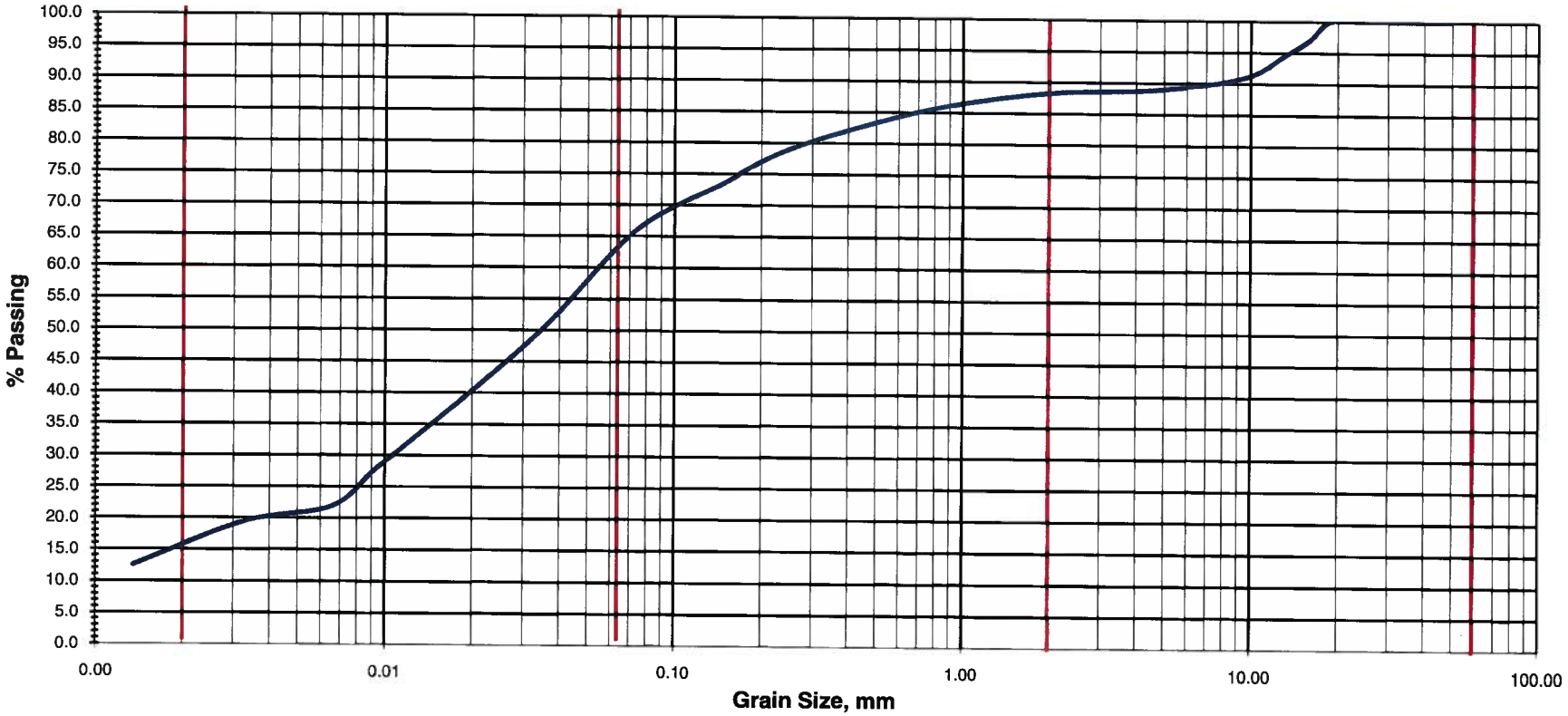
Method of Test for Particle Size Analysis of Soil

MTO Test Method LS - 702, Rev. No. 19

Grain Size Distribution Curve



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
	SILT			SAND			GRAVEL			
Modified M.I.T. Classification										

Trow Project No.:	**OTT-000201369-A0**	**Project Name :**	**Geotechnical Investigation - Proposed Water Reservoir**		
Client :	**Government of Nunavut**	**Project Location :**	**Whale Cove - Government of Nunavut**		
Date Sampled :	**September 16, 2011**	**Bore Hole No.:**	**1**	**Sample No.:** **Core 12**	**Depth (m) :** **4.6 to 5.2**
Sample Description :	**Sandy Silt , Some Clay**				**Figure :** **11**

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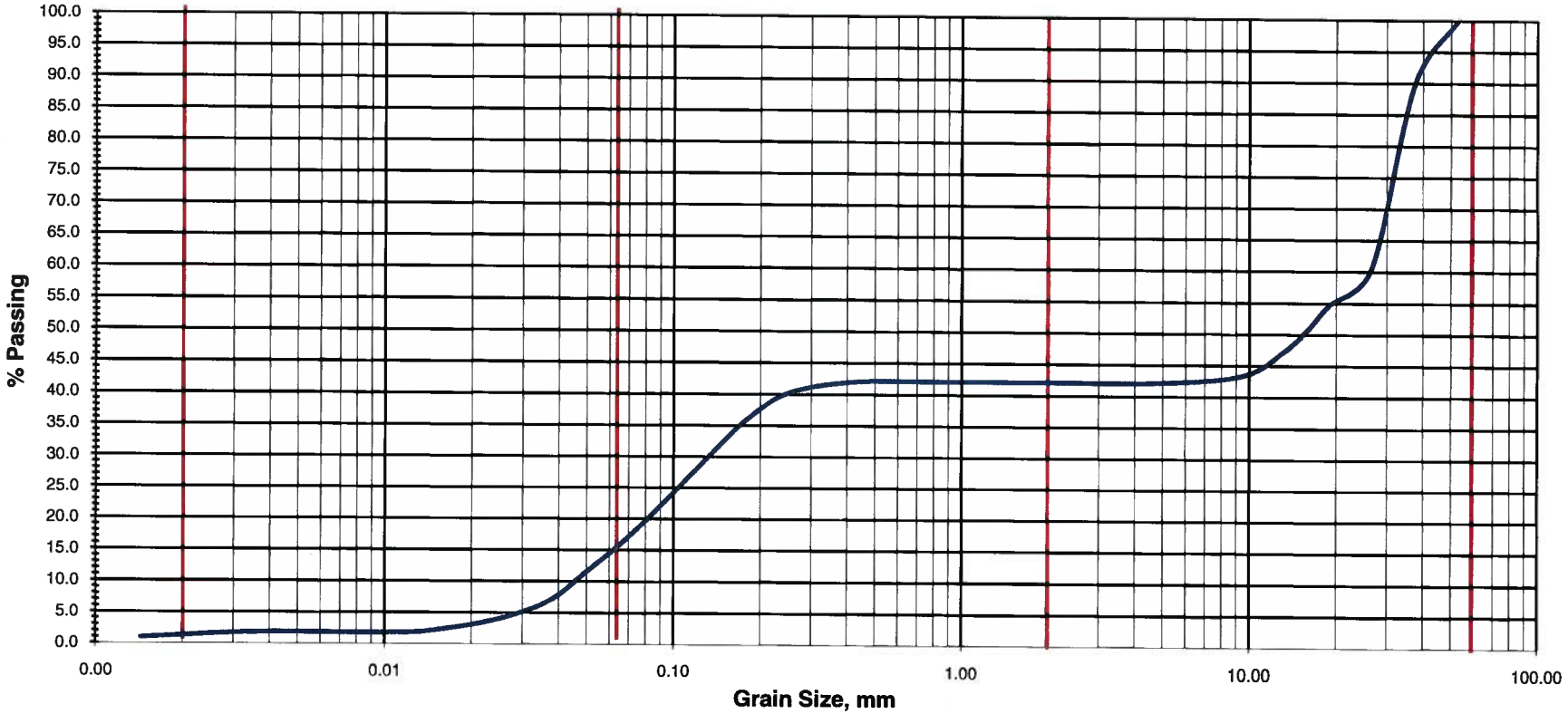
Method of Test for Particle Size Analysis of Soil

MTO Test Method LS - 702, Rev. No. 19

Grain Size Distribution Curve



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
	SILT			SAND			GRAVEL			
Modified M.I.T. Classification										

Trow Project No.:	OTT-000201369-A0	Project Name :	Geotechnical Investigation - Proposed Water Reservoir		
Client :	Government of Nunavut	Project Location :	Whale Cove - Government of Nunavut		
Date Sampled :	September 18, 2011	Bore Hole No.:	1	Sample No.: SS15	Depth (m) : 6.1 to 6.7
Sample Description :	Sandy Gravel, Some Silt				Figure : 12

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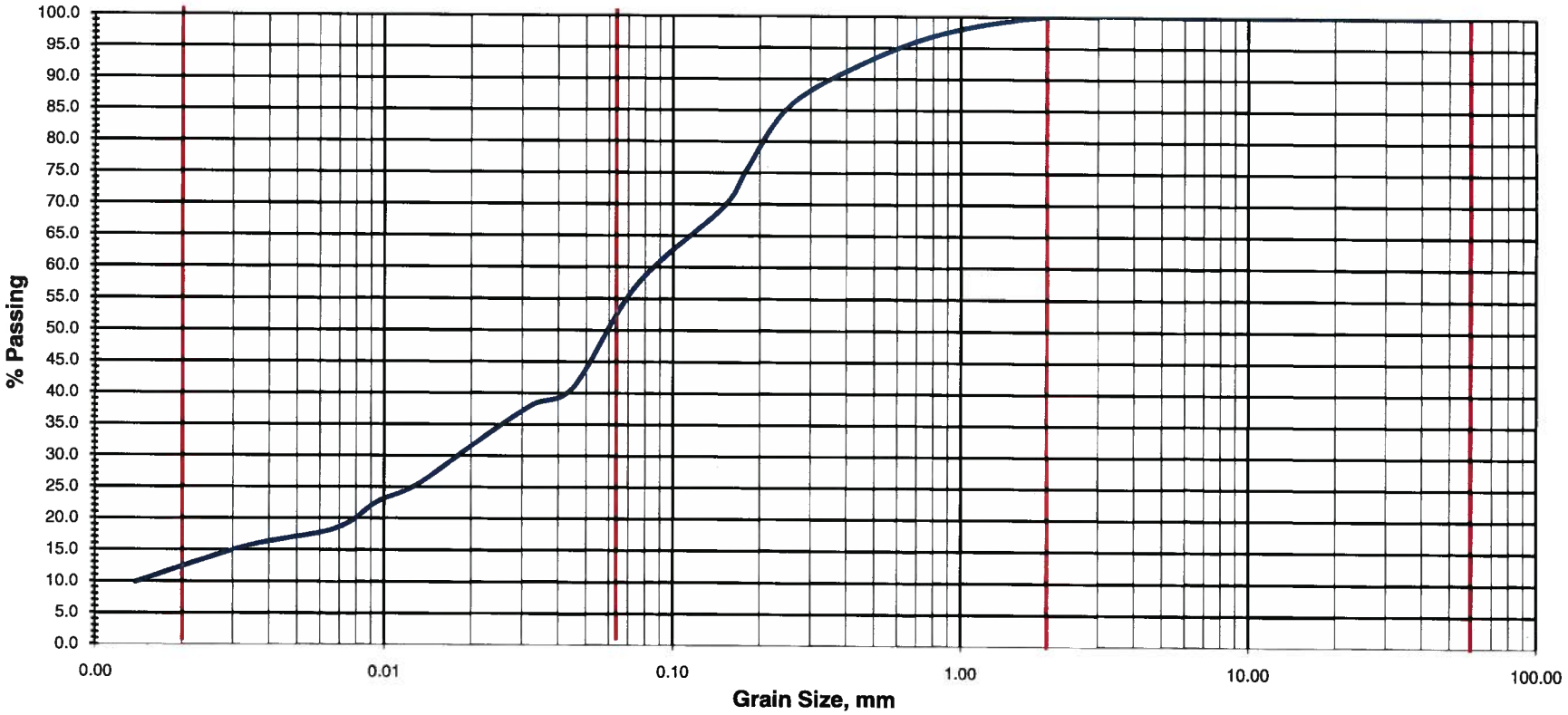
Method of Test for Particle Size Analysis of Soil

MTO Test Method LS - 702, Rev. No. 19

Grain Size Distribution Curve



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
	SILT			SAND			GRAVEL			
Modified M.I.T. Classification										

Trow Project No.:	OTT-000201369-A0	Project Name :	Geotechnical Investigation - Proposed Water Reservoir		
Client :	Government of Nunavut	Project Location :	Whale Cove - Government of Nunavut		
Date Sampled :	September 16, 2011	Bore Hole No.:	2	Sample No.: SS15	Depth (m) : 8.2 to 8.8
Sample Description :	Silt and Sand , Some Clay				Figure : 13

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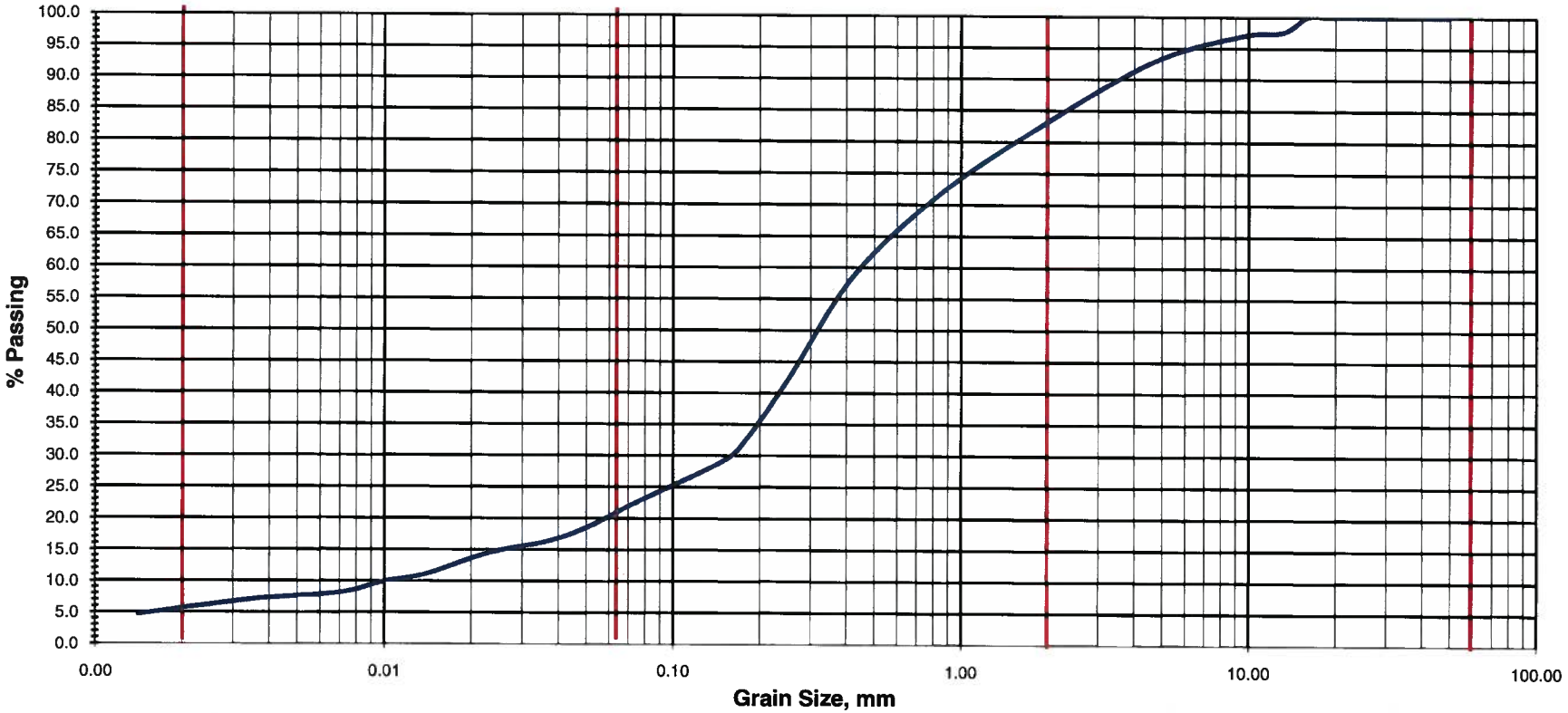
Method of Test for Particle Size Analysis of Soil

MTO Test Method LS - 702, Rev. No. 19

Grain Size Distribution Curve



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
	SILT			SAND			GRAVEL			
Modified M.I.T. Classification										

Trow Project No.:	OTT-000201369-A0	Project Name :	Geotechnical Investigation - Proposed Water Reservoir		
Client :	Government of Nunavut	Project Location :	Whale Cove - Government of Nunavut		
Date Sampled :	September 19, 2011	Bore Hole No.:	5	Sample No.: SS2	Depth (m) : 0.6 to 1.2
Sample Description :	Sand , Some Silt and Gravel				Figure : 14

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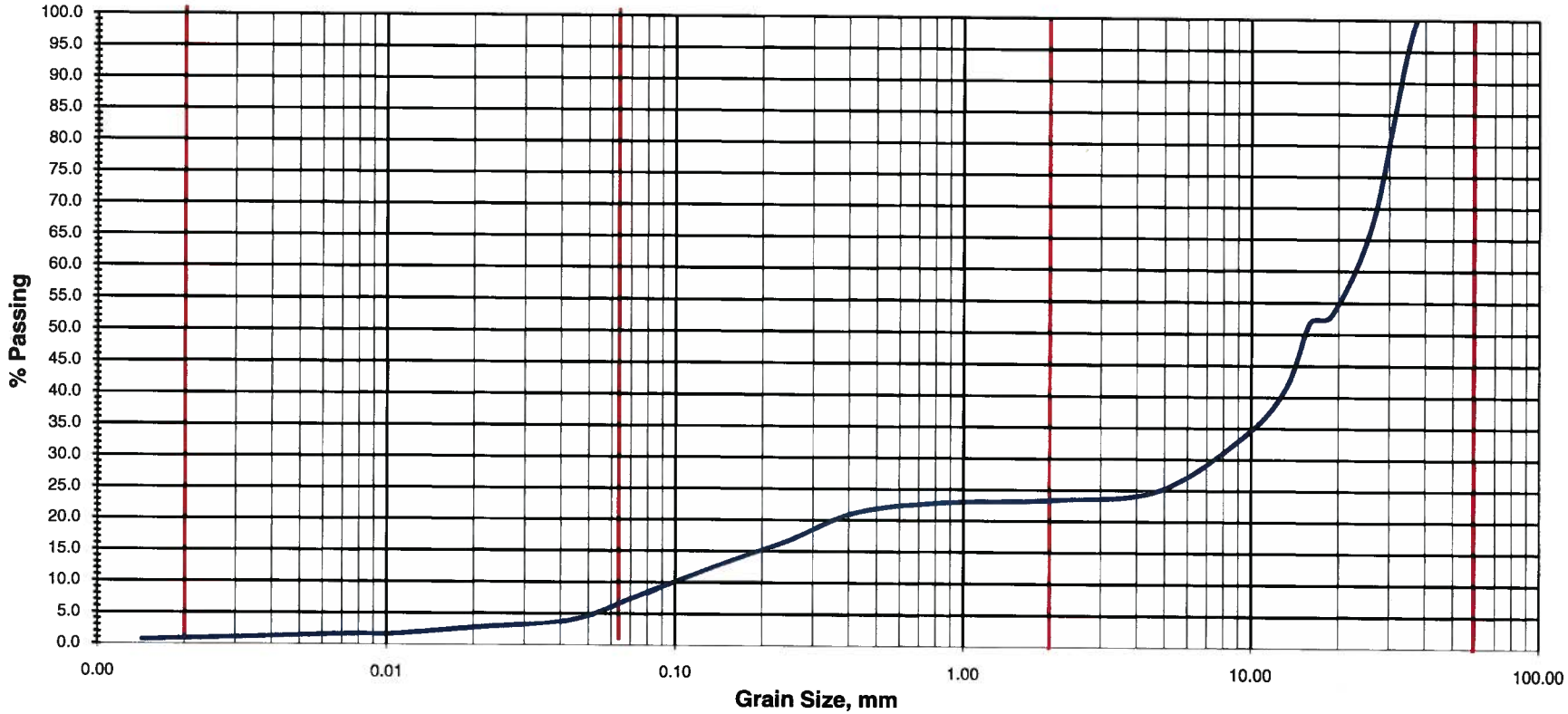
Method of Test for Particle Size Analysis of Soil

MTO Test Method LS - 702, Rev. No. 19

Grain Size Distribution Curve



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
	SILT			SAND			GRAVEL			
Modified M.I.T. Classification										

Trow Project No.:	**OTT-000201369-A0**	**Project Name :**	**Geotechnical Investigation - Proposed Water Reservoir**		
Client :	**Government of Nunavut**	**Project Location :**	**Whale Cove - Government of Nunavut**		
Date Sampled :	**September 19, 2011**	**Bore Hole No.:**	**5**	**Sample No.:** **Core 6**	**Depth (m) :** **2.6 to 3.0**
Sample Description :		**Sandy Gravel**			**Figure :** **15**

List of Distribution

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