

**MTO Agreement No. 5011-E-0010
WO No. 2011-11039
Proposed Winter Materials Storage
Facility
Whitney Patrol Yard
Supplementary Foundation
Investigation and Design Report**

Geocres No. 31E-320

July 2013

Prepared for:
Ontario Ministry of Transportation
Northeastern Region
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Project No. 121-17876-00



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July 30, 2013

Mr. Jean-Pierre Perron, P. Eng.
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Northeastern Region
447 McKeown Avenue
North Bay, Ontario P1B 9S9

**Re: MTO Agreement No. 5011-E-0010 / WO No.: 2011-11039
Proposed Winter Materials Storage Facility – Whitney Patrol Yard
Supplementary Foundation Investigation and Design Report (Geocres No. 31E-320)**

Dear Mr. Perron:

We are pleased to submit a supplementary Foundation Investigation and Design Report (FIDR) for the proposed Winter Materials Storage Facility at the Ontario Ministry of Transportation Northeastern Region (MTO) Whitney Patrol Yard in Whitney, Ontario. This report is provided in addition to our Foundation Investigation Report (Geocres No. 31E-320) submitted June 24, 2013. An additional borehole and laboratory testing program was conducted to assess soil and groundwater conditions beneath the existing parking lot area and provide recommendations for foundation design for the proposed structure.

This report presents the investigation methodology and findings, and was completed in accordance with the Terms of Reference provided in MTO Agreement #5011-E-0010.

We trust that this report meets your current requirements. Please contact us if you have any questions.

Yours truly,
GENIVAR Inc.

A handwritten signature in blue ink, appearing to read "J. Stephen Ash", with a stylized flourish at the end.

J. Stephen Ash, P. Eng., P. Geo.
Director, Environment

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1. Introduction

GENIVAR Inc. (GENIVAR) was retained by the Ontario Ministry of Transportation Northeastern Region (MTO) to undertake a supplementary foundation investigation for the proposed construction of a winter materials storage facility at the Whitney Patrol Yard, located on Highway 60, eight kilometers west/north of the Highway 60 / Highway 127 intersection in the Township of Airy, north of the Town of Whitney, Ontario. The purpose of the investigation was to assess subsurface conditions beneath the proposed building and provide recommendations for foundation design.

The geotechnical investigation was conducted in accordance with MTO Agreement #5011-E-0010. This Foundation Investigation and Design Report includes factual results of the geotechnical investigation carried out at the Whitney site, including the field and laboratory testing information, and geotechnical recommendations for foundation design and construction, including a discussion on foundation design alternatives.

2. Site Description and Regional Geology

2.1 Site Description

The Whitney Patrol Yard (site) is located on Highway 60 approximately 5.5 kilometres west of the Town of Whitney, Ontario. A Site Plan is included as Drawing 1 and colour photographs of the site are included in Appendix C.

The site is fairly level with a slight slope to the northeast and a natural ridge to the east and south. There is a drainage ditch located on the west side of the site, along Highway 60. Access to the site is from Highway 60 and the surrounding land is predominantly treed.

The site is an operational MTO Patrol Yard, and is currently occupied by a number of structures, including:

- 1 salt shed
- 1 storage shed
- 1 circular sand dome
- a 6-bay garage with office
- 1-4,000 L diesel fuel storage tank
- 1-8,000 L diesel fuel storage tank
- 3 tall cylindrical white tanks
- 1 onsite well

The perimeter of the site is generally grassed. The driving / parking area between the existing buildings and Highway 60 is paved while the area around the buildings is generally unpaved (gravel surface).

2.2 Regional Geology

Two different sources were consulted to determine the regional geology in the Whitney area: i) Map 2544 – Bedrock Geology of Ontario, Southern Sheet, published by the Ministry of Northern Development and Mines, and ii) Physiography of Southern Ontario, published by Ministry of Natural Resources, May 2011.

Based on the mapping information, the site is located in the Algonquin Highlands physiographic region, within a glacial spillway of predominantly sand and silt deposits. The soil profile is underlain by Precambrian bedrock formations that are part of the Central Gneiss Belt.

3. Report Review

3.1 Historic Report Review

A previous report for Highway 60, approximately 1.5 kilometres south of the Whitney Patrol Yard site was obtained from the MTO Geocres Library in Downsview, Ontario. The report, titled '*Foundation Investigation Report for Highway 60 over a Swamp Area*' and dated July 1966, included a geotechnical investigation to address the performance of fill material placed over a swampy section of Highway 60. (Geocres 31E-31)

Based on the report information, the terrain in the area consists of hills and valleys formed by undulating Precambrian bedrock, with the valleys being partially filled with sand and silt soils. In this specific section of Highway 60, the highway crosses a 120 m wide valley containing organic peat deposits overlying sands and silts. The geotechnical investigation consisted of sampling 11 boreholes supplemented by 6 dynamic cone penetration tests (DCPT's). An additional borehole was put down adjacent to Borehole #11 to perform field vane testing. Loose to compact sandy silt soils were encountered 4.6 m below existing ground surface at elevation 398.5 metres above sea level (mASL) to 6.1 m below existing ground surface at elevation 397.0 mASL, beneath the organic peat layer. The maximum depth of penetration into the sandy silt layer was 15 m below ground surface, to elevation 287.1 mASL, where augering was terminated on either bedrock or boulders.

3.2 Original Foundation Report Review

A borehole investigation was performed at the Whitney Patrol Yard (site) on September 5 and September 6, 2012, to provide subsurface information for the proposed replacement of the existing rectangular salt/sand sheds. The investigation consisted of advancing five (5) exploratory boreholes, designated as BH12-1 through BH12-5, commencing from the existing ground level. Borehole locations are shown on Drawing 1 and were laid out as required by the Terms of Reference for the assignment. A borehole was located at each of the four corners of the proposed storage structure, and a fifth borehole was located as close to the centre of the proposed structure as possible, given the existing utility and space constraints.

An additional borehole and laboratory testing program was conducted on December 4 and December 5, 2012, to assess soil and groundwater conditions beneath the existing sand dome area and provide recommendations for foundation design for a replacement structure. The investigation consisted of advancing two (2) exploratory boreholes, designated as BH12-6, and BH12-7, commencing from existing ground levels. Borehole locations are shown on Drawing 1.

4. Investigation Procedures

4.1 Subsurface Investigation

The subject borehole investigation for the proposed winter materials storage facility was performed at the Whitney Patrol Yard (site) on May 30, 2013, and consisted of advancing two (2) exploratory boreholes designated as BH13-8 through BH13-9, and advancing one (1) Dynamic Cone Penetration Test (DCPT) designated as BH13-10. Seven (7) boreholes were previously advanced on September 5 and September 6, 2012, and December 4 and December 5, 2012 as noted previously. Borehole locations are shown on Drawing 1 and were laid out as required by the Terms of Reference for the assignment. Boreholes were located in the northwest, southwest, and southeast corners of the proposed Winter Materials Structure. Subsurface data for the northeast corner of the proposed structure will be taken from the existing borehole BH12-1, as it is located within close proximity.

MTO minimum requirements for the borehole investigation outlined a maximum drilling depth of 10.0 m, unless refusal was encountered at shallower depth, or justification for deeper drilling was authorized by the MTO Project Manager. Augering was terminated in dense coarse sand material at elevation 389.7 metres above sea level (mASL) in borehole BH13-8. Augering was terminated on bedrock at elevation 398.2 mASL in BH13-9. Bedrock coring was completed at BH13-9 and was terminated at elevation 395.1 mASL in Granitic Gneiss. A Dynamic Cone Penetration Test (DCPT's) at BH13-10 met refusal on presumed bedrock at elevation 397.4 mASL.

The longitude and latitude of the individual borehole locations were obtained using a hand-held GPS unit in the WGS 84 reference system. These coordinates were subsequently converted to MTO standard coordinates (Northings and Eastings). Borehole elevations were surveyed to a known benchmark: the Nail Set In Root at the base of a pine tree was used and has a reported geodetic elevation of 399.873 mASL. Borehole elevations and coordinates are shown on Drawing 1, and are provided on the borehole logs included in Appendix A.

Drilling and soil sampling were completed using a truck-mounted drill rig operating under the supervision of an experienced GENIVAR soils technician. The boreholes were advanced to the sampling depths by means of continuous flight hollow stem augers. Standard Penetration Test (SPT) N values were recorded for the sampled intervals as the number of blows required to drive a split spoon sampler 305 mm into the soil, using a 63.5 kg drop hammer falling 750 mm (ASTM D1586 procedure). Refusal depth for the purposes of this investigation was generally defined in the MTO Terms of Reference as the depth at which SPT N values exceed 100 blows for 305 mm of penetration. Based on discussions with MTO Managers, some latitude in this refusal standard was given where consistently dense soil was penetrated, to prevent excessive machine damage. SPT N values are used in this report to assess consistency for cohesive soils and relative density for non-cohesive materials.

Soil samples were collected using SPT procedures at approximately 0.75 m intervals to 5.0 m depth, and at 1.5 m intervals thereafter to the final termination depth. Soil samples from discrete units were logged in the field using visual and tactile methods, and were then placed in labelled plastic bags for transport, future reference, possible laboratory testing, and storage. Soils designated for laboratory moisture content testing were placed in sealed laboratory jars for transport.

DCPT was attempted in borehole BH13-10 as noted above. In the DCPT, a 51 mm diameter, 60° Apex cone point, screw-attached to the tip of A-size rods, is driven into the ground using the same driving energy as in the SPT method. By recording the number of blows to drive the cone/rod assembly into the soil every 305 mm, a qualitative record of relative density/consistency may be obtained. Refusal of the DCPT occurred in BH13-10 at 2.1 m depth (elevation 397.4 mASL), due to presumed bedrock.

NQ-size coring equipment (47.6 mm diameter) was used to obtain one (1) bedrock core sample 3.1 m long, at BH13-9. Core recovery and rock quality index properties were determined by field inspection. Core samples were placed in labelled core boxes for transport, future reference and storage.

Groundwater conditions within the boreholes were observed during drilling, prior to backfilling. Boreholes were backfilled with drill cuttings mixed with bentonite hole plug, and the top portion of the boreholes was sealed with emulsified asphalt. The backfill material was compacted with the drill rig. As such, the boreholes are abandoned in accordance with O. Reg. 903 requirements, as amended. Table 4-1 below summarizes borehole numbers, final drilling depths, and the surveyed elevations of the three (3) supplementary boreholes/DCPT (BH13-8, BH13-9, and BH13-10), along with the original seven (7) boreholes (BH12-1 through BH12-7).

Table 4-1: Borehole Numbers, Drilling Depths and Elevations

Borehole No.	Drilling Depth Below Existing Ground Surface (m) / Elevation (mASL)	Dynamic Cone Penetration Test Depth (m)
BH12-1	5.0 / 395.1	5.0 m to 7.6 m
BH12-2	5.0 / 395.0	5.0 m to 8.8 m
BH12-3	9.6 / 390.2	9.6 m to 11.0 m
BH12-4	9.2 / 390.8	9.2 m to 10.1 m
BH12-5	3.5 / 396.8	3.5 m to 4.9 m
BH12-6	11.3 / 388.6	-
BH12-7	7.8 / 392.3	7.8 m to 7.8 m
BH13-8	9.8 / 389.7	-
BH13-9	4.5 / 395.1	-
BH13-10	2.1 / 397.4	0.0 m to 2.1 m

1. No DCPT conducted at BH12-6
2. DCPT depth at BH12-7 less than 0.1 m

4.2 Laboratory Testing

The following soil testing program, as summarized in Table 4-2, was completed on selected soil samples from boreholes BH13-8 and BH13-9 to confirm the textural classifications and provide geotechnical parameters for the encountered materials. No sampling was conducted in BH13-10.

Table 4-2: Soil Testing Program – Whitney Patrol Yard

Test	ASTM Standard	Number of Samples
Natural Moisture Content	ASTM D2216	12
Particle Size Analysis	ASTM D422	4

The minimum number of laboratory tests was set at 25 percent of the samples, according to the MTO Terms of Reference. Low complexity soil tests were completed at GENIVAR's RAQ's certified laboratory in Peterborough. Laboratory testing results are presented on the borehole logs and in Appendix B.

5. Subsurface Conditions

Subsurface conditions beneath the proposed Winter Materials Storage Facility were explored at the three (3) supplementary boreholes/DCPT locations, designated as BH13-8 to BH13-10. Borehole locations are shown on Drawing 1 and the soil strata are indicated on two cross-sections presented on Drawing 2. The soil strata indicated on the cross-sections were interpolated from the supplementary borehole information and the original seven (7) boreholes (reported on November 13, 2012, and February 26, 2013). Borehole logs of all ten (10) boreholes are provided in Appendix A, and laboratory test results with summary tables are included in Appendix B.

5.1 Soil Profile Summary

5.1.1 Asphalt Pavement

A 60 mm thick layer of asphaltic concrete (hot laid mix) was encountered at surface in BH13-10 which was overlaid with 50 mm of fine sand, the source of which is presumed to be a nearby stockpile.

5.1.2 Granular Fill

Granular fill was encountered in BH13-8, extending to 0.8 mbgs (metres below ground surface). A summary of the granular fill depths (metres below ground surface; mbgs) and elevations (geodetic) at the original and supplementary borehole locations are as follows:

Table 5-1: Granular Fill Particle Size Distribution

Reporting	Borehole No.	Depth to Bottom of Fill Layer (Elevation)
Previous Investigations	BH12-1	0.8 mbgs (399.4 mASL)
	BH12-2	0.8 mbgs (399.3 mASL)
	BH12-3	2.7 mbgs (397.2 mASL)
	BH12-4	2.9 mbgs (397.1 mASL)
	BH12-5	1.4 mbgs (398.9 mASL)
	BH12-6	3.0 mbgs (396.9 mASL)
	BH12-7	3.0 mbgs (397.0 mASL)
Supplementary Boreholes	BH13-8	0.8 mbgs (398.7 mASL)
	BH13-9	N/A
	BH13-10	N/A

Note: N/A indicates not applicable as fill not detected.

Standard Penetration Test results (N values) recorded in the fill layer 13 blows per 305 mm of penetration, indicating compact relative density.

5.1.3 Topsoil

A layer of silty organic topsoil was encountered at surface in BH13-9. The topsoil layer is 50 mm thick.

5.1.4 Sand

A sand layer with trace to some silt and trace to some gravel was encountered in boreholes BH13-8, and BH13-9. This sand layer extended to elevation 389.7 mASL in BH13-8 and 398.2 mASL in BH13-9.

Standard Penetration Test N values of 3 to 77 blows per 305 mm of penetration were recorded in the sand layer, indicating loose to very dense relative density.

5.1.5 Bedrock

Borehole BH13-9 was cored and terminated in Granitic Gneiss bedrock, and was terminated at 4.5 m depth below ground surface (Elevation 395.1 mASL). Photographs of the bedrock core are included in Appendix C.

A description of the bedrock is provided in Table 5.2. Total Core Recovery (TCR) ranged from 92 % to 100 %. Rock Quality Designation (RQD) values for the core samples in borehole BH13-9 ranged from 75 % to 63 %, which is described as fair to good.

Table 5-2: Rock Core (RC) Description, RQD, and Recovery Data

Borehole ID.	RC #	Depth (m)	TCR (%)	RQD (%)	Description
BH13-9	1	1.40 – 2.92	92	75	Felsic to Intermediate (Granitic) Gneiss, black, pink, white, phaneritic with some visible K-Feldspar phenocrysts, hard, fair to good RQD, slight to fresh weathering, banding present at 80 degrees to core axis.
	2	2.92 – 4.50	100	84	

5.1.6 Dynamic Cone Penetration Testing

Dynamic cone penetration testing (DCPT) was performed at surface at borehole BH13-10. The DCPT was terminated due to refusal after 2.1 m of penetration, on presumed bedrock.

5.2 Groundwater Conditions

Groundwater conditions were observed in the open boreholes upon completion of drilling. Results are summarized in Table 5-3.

Table 5-3: Summary of Groundwater Levels

Location	Measured Groundwater Depth mbgs (elevation mASL)	Date Measured	Soil Moisture
BH12-1	dry	5 September 2012	Moist throughout
BH12-2	dry	5 September 2012	Wet at 2.5 mbgs (397.5 mASL)
BH12-3	6.4 (393.4)	6 September 2012 (5 hours after completion)	Wet from 3.0 to 5.0 mbgs (397 to 395 mASL)
BH12-4	6.4 (393.6)	6 September 2012	Moist throughout
BH12-5	dry	6 September 2012	Moist throughout
BH12-6	7.0 (392.9)	4 December 2012	Wet from 4.6 to 10.7 mbgs (395.2 to 389.2 mASL)
BH12-7	7.8 (392.2)	5 December 2012	Wet from 3.0 to 7.8 mbgs (397.0 to 392.6 mASL)
BH13-8	3.0 (396.5)	30 May 2013	Saturated from 3.0 to 9.6 mmbgs. (396.5 to 389.7 mASL)
BH13-9	N/A	30 May 2013	Water introduced into borehole during coring
BH13-10	dry	30 May 2013	N/A

Notes: mbgs = metres below ground surface
N/A = Not applicable

Groundwater in Boreholes BH12-6 and BH12-7 was measured to be 7.0 m and 7.8 m below the surface (below elevation 393 mASL) at the time of the investigation. However, soil sample inspections indicate that shallower, possibly perched zones of groundwater may exist in the fill material at 2 m to 3 m below grade. Groundwater levels and relative soil moisture will probably fluctuate seasonally at the site, in response to climate conditions and/or heavy infiltration events.

6. Geotechnical Design Considerations

The proposed new Winter Materials Storage Facility is to be 21.3 m long by 12.2 m wide. The following design considerations are provided in addition to our Foundation Investigation and Design Report (Geocres No. 31E-320) for an adjacent structure onsite, submitted on February 26, 2013. Foundation engineering guidelines presented in this section have been developed based on the soil conditions investigated and described in Section 5, and specifically for boreholes BH13-8, BH13-9, and BH13-10 and the profile shown on Drawing 2, and in accordance with the most recent edition of the Canadian Highway Bridge Design Code (CHBDC), and the most recent edition of the Canadian Building Code in effect for MTO projects.

The three (3) supplemental boreholes designated as BH13-8, BH13-9, and BH13-10 were drilled to assess the subsurface conditions at the proposed new Winter Materials Storage Facility as shown on Drawing 1. Borehole BH13-8 encountered a compact granular fill layer, overlying loose sand, compact silty sand and dense gravelly sand to silty sand material extending to depth. Borehole BH13-9 encountered topsoil at surface, overlying dense sand extending to auger refusal on bedrock at 1.4 m depth (elevation 398.2 mASL). The bedrock was cored at BH13-9 to a final depth of 4.5 m (elevation 395.1 mASL). Borehole BH13-10 was completed using the DCPT method and met refusal at 2.1 m depth (elevation 397.4 mASL) on bedrock.

Groundwater in BH13-8 was measured to be at 3.0 m below the ground surface at the time of the investigation.

6.1 “Red Flag” Conditions and NSSP's

The proposed structure is located in an area of variable depth bedrock ranging from 1.4 m to over 9.8 m depth, based on the borehole information. Depending on the foundation design depth, the Contractor should be prepared to deal with possible shallow bedrock conditions for foundation construction.

Therefore, the following Non-standard Special Provision (NSSP) is recommended for the site:

- NSSP 1. The Contractor shall be equipped to excavate and remove bedrock, if required, to facilitate foundation construction. Bedrock removal procedures may include blasting, mechanical breaking or other hard rock removal methods. Rock removal procedures shall consider potential effects to adjacent structures and features and the Contractor shall obtain all necessary permits and approvals to complete the work. If blasting methods are required to remove rock, a licensed blasting specialist shall be used and a blasting plan with pre-blast and post-blast surveys should be submitted to MTO for verification.

6.2 Structure Foundation Design Options

Based on the results of this investigation, several foundation options are available, including shallow and deep foundations. The preferred foundation option should be determined in view of following factors:

- Existing Subsurface Conditions
- Serviceability
- Advantages\ Disadvantages
- Reliability
- Risk/ Consequences

Comments for consideration of foundation design alternatives are provided in Table 6-1.

Table 6-1: Foundation Design Alternatives

Foundation Type	Advantages/ Disadvantages	Reliability	Risks/ Consequences	Recommendations
Strip Footing on Native Sand, Silty Sand Layer	Excavation required, good foundation capacity, provides frost protection, requires greater effort to control soil disturbance (particularly if footings constructed during wet seasons).	Good, provided that good construction practices are used to minimize soil disturbance.	Risk of localized bedrock removal at BH13-9. Minor risk of perched groundwater and potential subgrade disturbance; subexcavation may be required; temporary shoring may be required. Footing construction on bedrock may be required.	Recommended excavation to at least El. 398 mASL, based on borehole information.
Strip Footing on Approved Granular Fill	Reduced but acceptable bearing capacity achievable versus footing on undisturbed native soil or bedrock, insulation may be required if footing constructed at <1.8 m depth.	Good, provided that adequate fill density is verified.	Compaction and subexcavation procedures may be required. Excavation sides may slough if not cut at proper slope or supported.	Recommended as possible second option. Confirm fill density is acceptable. Construct on approved subgrade material.
Slab-on-Grade	Medium to high cost, medium geotechnical resistance, insulation may be required to extend beyond structure, engineered fill may be required.	Good.	Removal of shallow deleterious material and/or existing fill is required. Larger excavation/disturbed area required for insulation component.	Recommended as possible third option.
Drilled and Cast-in-Place Concrete Foundation	High bearing resistance, protection of subgrade against disturbance not as critical as for shallow foundations, high cost. Possibility of encountering bedrock.	Good	Must extend to deeper competent material or bedrock. Liners may be required. Construction difficulties if boulders encountered during drilling. Additional drilling may be required to verify bedrock.	Not Recommended due to economic and constructability reasons.
Steel H Piles	High bearing resistance, protection of subgrade against disturbance not as critical as for shallow foundations, high cost. Possibility of encountering cobbles and boulders during driving.	Good	Must extend to deeper competent material or bedrock. Vibrations and/or soil disturbance may be an issue for nearby structures. Additional drilling may be required to verify bedrock.	Not Recommended due to economic and constructability reasons.

6.3 Frost Penetration Depth

The recommended design frost protection depth for the site area is 1.8 m (Source: OPSD 3090.101). Therefore, a permanent soil cover of about 1.8 m or its thermal equivalent of high density insulation foam is recommended for frost protection of foundations. In case of rockfill, only one-half of the rockfill thickness should be assumed to be effective in providing frost protection. In consideration of the depth of required soil cover for frost protection and the high groundwater conditions, it is assumed that a grade raise around the structure area is not an option.

6.4 Preferred Foundation Option

Based on an assessment of foundation design alternatives, the preferred foundation design option is to construct the foundation using shallow strip footings based on the dense sand to silty sand layer, at or below elevation 398 mASL. Subgrade density should be verified at the foundation level, and recompact if necessary using several passes of a vibratory plate (1 tonne minimum). If necessary, localized shallow bedrock may have to be removed or footings may be stepped to situate them directly upon rock. The footing design should consider additional reinforcement in the transition zone from soil to rock bearing.

The following geotechnical resistances are appropriate for strip footings with minimum 1.0 m width and 1.8 m depth, constructed on undisturbed sand to silty sand material (as at boreholes BH13-8 and BH12-1):

- Factored Geotechnical Resistance at Ultimate Limit State (ULS) = 190 kPa
- Geotechnical Resistance at Serviceability Limit State (SLS) = 285 kPa

The Geotechnical Resistance at Serviceability Limit State (SLS) value is based on maximum total and differential settlements of 25 mm and 20 mm, respectively.

The founding subsoil shall be inspected by the Geotechnical Engineer to confirm that it is suitable to support the design loads, and to confirm that all disturbed or loose soils are properly removed from below all footing areas. If necessary, the base of excavations shall be covered with a minimum 50 mm thick mud slab immediately after inspection and approval to protect the subgrade material from disturbance.

6.5 Resistance to Lateral Loads

Resistance to lateral forces/sliding between concrete footings and subsoils should be calculated in accordance with Section 6.7.5 of the CHBDC. The coefficient of friction ($\tan \delta$) may be taken as 0.40 for cast in place concrete footings constructed on undisturbed silt and sand. This represents an unfactored value; in accordance with CHBDC, a factor of 0.8 is to be applied in calculating the horizontal resistance.

Resistance to lateral loads could be increased (if necessary) by constructing a shear key at the bottom of the footing. The design of shear keys would require a specific analysis taking into consideration the magnitude of the horizontal loading, the magnitude of the vertical loading, and any variations in the bearing pressure due to overturning moments.

The above guidelines assume that the subgrade soils will not be excessively disturbed by construction activities.

6.6 Backfill and Lateral Earth Pressure

Backfill behind foundation/retaining walls should consist of non-frost susceptible, free-draining backfill materials (i.e. Granular 'A' or Granular 'B' Type I or II, with no more than 8 % passing the 0.75 mm sieve as per requirement of OPSS 1010 and its Amendment No. 110S13).

Computation of earth pressures acting against walls should be in accordance with the CHBDC. For design purposes, the properties outlined in Table 6-2 may be assumed for backfill.

Table 6-2: Backfill Properties

Property	Compacted Granular 'A' or Granular 'B' Type II	Compacted Granular 'B' Type I
Angle of Internal Friction ϕ (unfactored)	35°	32°
Unit Weight γ	22 kN/m ³	21 kN/m ³
Coefficients of Lateral Earth Pressure		
K_a	0.27	0.31
K_b	0.35	0.41
K_o	0.43	0.47
K^*	0.45	0.57

Notes:

- K_a is the coefficient of active earth pressure
- K_b is the backfill earth pressure coefficient for an unrestrained structure, including compaction effects
- K_o is the coefficient of earth pressure at rest
- K^* is the earth pressure coefficient for a soil loading a fully restrained structure and includes compaction effects

Earth pressure coefficients are based on the assumption that the backfill behind retaining structures is free-draining granular material and adequate drainage is provided.

Should temporary shoring be required to support excavations, shoring systems should be designed by a Professional Engineer experienced in this type of work. Shoring walls below grade can be designed using the following expression:

$$P = K (\gamma h + q)$$

where:

P = lateral earth pressure (kPa) acting at depth h

K = earth pressure coefficient

γ = unit weight of backfill (kN/m³)

h = depth to point of interest in metres

q = equivalent value of surcharge on the ground surface (kPa)

The above expression assumes that the perimeter drainage system prevents the build up of any hydrostatic pressure behind the wall and backfilling materials.

The coefficients of lateral earth pressure given in Table 6-3 may be used for the design of the temporary shoring systems, based on the borehole results.

Table 6-3: Recommended Unfactored Parameters for Temporary Shoring Design

Soil Type	K_a	K_o	K_p	γ (kN/m ³)
Granular Fill	0.33	0.5	3.0	20.0
Compact to dense Silt some Sand/Sand and Silt	0.31	0.48	3.1	18.5
Dense to very Dense Sand Till (if encountered)	0.29	0.45	3.4	20.0

All construction specification for temporary protection systems should follow the requirements of MTO specifications OPSS 539.

6.7 Seismic Design

The Ontario Building Code (OBC) specifies that the structure should be designed to withstand forces due to earthquakes. For the purpose of earthquake design the information relevant to the geotechnical conditions at this site is the 'Site Class'. Based on the explored soil properties and in accordance with Table 4.1.8.4.A of the Ontario Building Code (2006), it is recommended that Site Class 'D' (stiff soil) be applied for structural design at this site.

Seismic information for the Whitney site is provided in the table below. Data from the 2005 National Building Code Seismic Hazard Calculation is provided in this table to be consistent with the 2006 Ontario Building Code.

Parameter	Whitney	Source
Site Class	D	2006 Ontario Building Code Table 4.1.8.4.A
$S_a(0.2)$	0.298	2005 National Building Code Seismic Hazard Calculation
$S_a(1.0)$	0.075	2005 National Building Code Seismic Hazard Calculation
F_a	1.26	2006 Ontario Building Code Table 4.1.8.4.B
F_v	1.4	2006 Ontario Building Code Table 4.1.8.4.C

Generally, the looser the sediment, and the higher the water table, the more susceptible the soil is to liquefaction. Based on the texture and density of the subsurface soils, there is a slight possibility of liquefaction of the saturated silty sand layer at BH13-8. The underlying very dense till is not susceptible. Settlements risks due to liquefaction are relatively small, but the designer may wish to consider use of seismic bracing in the structure design, if appropriate.

6.8 Dewatering and Drainage

It is anticipated that no significant groundwater seepage will be encountered with foundation construction depths. However, soil sample inspections indicate that shallower, possibly perched zones of groundwater may exist in fill materials depending on time of year and environmental conditions. The bottom of foundation excavations may encounter temporary minor seepage, and localized pumping may be required to stabilize the soils during construction.

If encountered, groundwater and/or perched infiltration water can be removed by pumping from strategically placed filtered sumps and/or using gravity drainage. It is recommended that the Contractor be requested to submit water management plans to the MTO Project Manager for approval, prior to construction. Dewatering procedures should follow the requirements and specifications of OPSS 517.

Depending on the construction and dewatering procedures to be used, the Contractor should obtain a Permit to Take Water under Section 34 of the Ontario Water Resources Act if he believes that pumping rates will exceed 50,000 L/day. It is expected that a PTTW will not be required for construction of the winter materials storage facility.

Since the structure foundation will be backfilled with granular material, it is suggested that a 100 mm diameter geotextile wrapped subdrain be installed at exterior footing level. The subdrains should follow the footing perimeter and be connected to a frost free outlet for gravity drainage.

6.9 Excavations

Construction excavations are required for foundations and utility services. Temporary excavations must be carried out in accordance with the latest edition of Ontario Regulation (O.Reg.) 213/91 of the Occupational Health and Safety Act (OHSA) as well as MTO specifications OPSS 539 – Protection Systems and OPSS 902 – Excavations and Backfilling to Structure. The soils at the site may be classified as shown in Table 6-4, in accordance with the OHSA.

Table 6-4: Soil Classification for Excavations

Soil Type		Above Groundwater Level (Moist)	Below Groundwater Level (Wet or Saturated)
Granular Fill material		Type 3	Type 4
Sand/Silty Sand		Type 3	Type 4
Dense to very dense encountered)	Sand Till (if	Type 2	Type 3

Type 3 excavations should be cut with 1H:1V or flatter side slopes. Type 4 excavations should be cut with 3H:1V or flatter side slopes. If the appropriate side slopes cannot be achieved, the excavations must be properly supported (shored). All excavation and grading procedures should follow the requirements and specifications of OPSS 206, and management of excess material should follow the requirements of OPSS 180.

Excavations should be protected from exposure to precipitation and associated ground surface runoff and should be inspected regularly for signs of instability. If localized instability is noted during excavation, or if wet conditions are encountered, excavation side slopes should be flattened as required to maintain safe working conditions.

Since the subject site was used for many years to store road salt, and will be used in the future for the same purpose, it is expected that the new foundation will be exposed to chloride, sodium and sulfate attack. To reduce damage potential and rate of deterioration, we recommend to use high sulfate-resistant cement (Type HS as per CSA A.23) in the concrete mix design with water-cement ratio should not exceed 0.45.

7. Miscellaneous Information

The following GENIVAR personnel and subcontractors responsible for completion of this foundation investigation are summarized in Table 7-1.

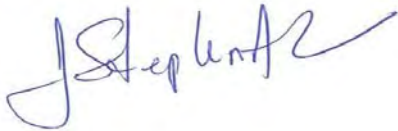
Table 7-1: Summary of Task Responsibilities and Personnel

Task	Name	Address	Phone
Buried Utility Locates	Peter Flowerday Central Cable Contractors	Wanapitae, ON	705-694-5256
Drilling	Dan Boileau Abraflex Drilling	Lively, ON	705-222-2272
Field Supervision	Dave Lembke, C.E.T., rcji GENIVAR Inc.	Peterborough, ON	705-743-6850
Project Coordinator	Dave Lembke, C.E.T., rcji GENIVAR Inc.	Peterborough, ON	705-743-6850
Laboratory Low Complexity	Kelly Whitney, C.E.T. GENIVAR Inc.	Peterborough, ON	705-743-6850
Report Preparation	Dave Lembke, C.E.T., rcji GENIVAR Inc.	Peterborough, ON	905-799-8220
Report Review	Steve Ash, P. Eng., P. Geo. GENIVAR Inc.	Peterborough, ON	705-743-6850
RAQ's Key Contact	Jason Balsdon, M.A.Sc., P. Eng. GENIVAR Inc.	Newmarket, ON	905-853-3303

8. Closure

The data presented in this foundation investigation report, and the quality thereof, is based on a scope of work authorized by the Client. While we believe the borehole information to be representative of site conditions, subsurface conditions between and beyond the test hole locations may vary. GENIVAR accepts no liability for use of or reliance on the report information by third parties, without express written consent.

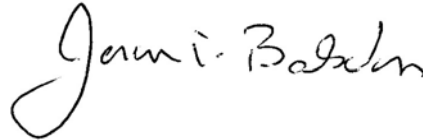
Prepared by:
GENIVAR Inc.



J. Stephen Ash, P. Eng., P. Geo.
Director, Environment



Reviewed by:



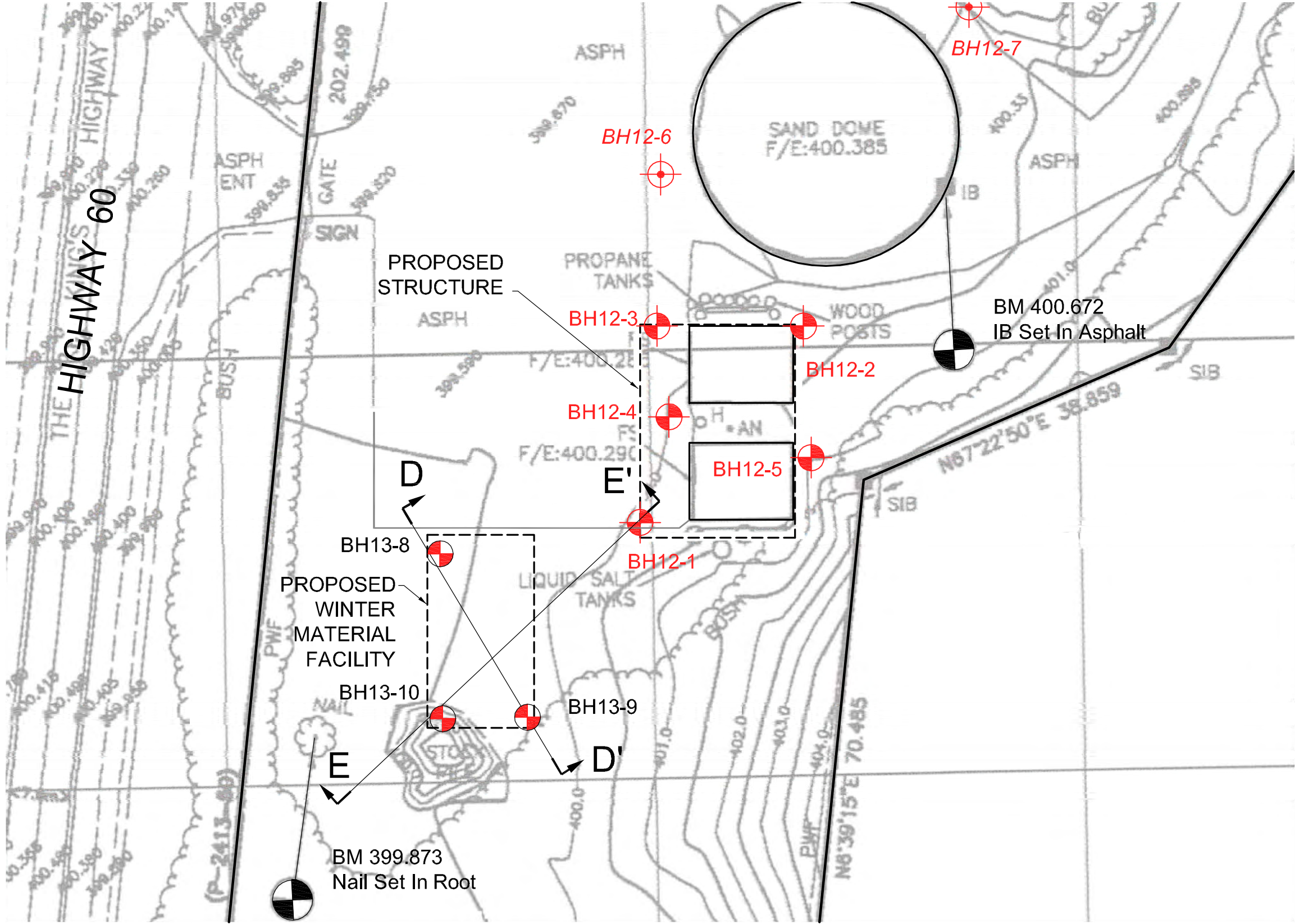
Jason Balsdon, M.A.Sc., P. Eng.
Director, Environment



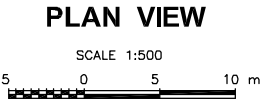
Drawings

Drawing 1 – Borehole Location Plan

Drawing 2 – Soil Strata



- NOTES:
1. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
 2. COORDINATES AT BOREHOLE LOCATIONS WERE BY HANDHELD GPS.
 3. BOREHOLE ELEVATIONS WERE SURVEYED RELATIVE TO SIB IN THE EXISTING SAND / SALT DOME FOOTING (EL. 400.672 mASL).



METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES

Agreement No.: 5011-E-0010
WO No.: 2011-11039

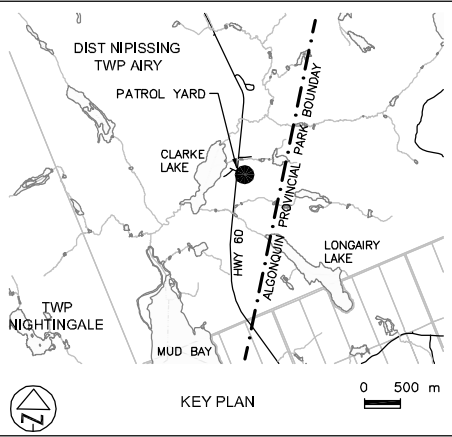


BOREHOLE LOCATION PLAN
PROPOSED SAND/SALT STORAGE
FACILITY
WHITNEY PATROL YARD
HIGHWAY 60

DRAWING

1

Client: MTO - Northeastern Region



LEGEND

- Borehole and Cone (SEPT. 2012)
- Borehole (DEC. 2012)
- Borehole and Cone (MAY 2013)
- Benchmark (mASL)
- Proposed Facility
- E -> E' Line of Cross Section (See Dwg. 2)

BH No	ELEVATION (mASL)	COORDINATES (NAD 83 Zone17)	
		NORTHING	EASTING
12-1	400.176	5045812.8	713539.8
12-2	400.071	5045835.9	713559.0
12-3	399.845	5045835.9	713541.8
12-4	399.993	5045825.3	713543.2
12-5	400.262	5045820.5	713559.9
12-6	399.851	5045853.8	713542.2
12-7	400.040	5045873.5	713578.5
13-8	399.462	5045809.1	713516.2
13-9	399.578	5045789.9	713526.5
13-10	399.604	5045789.7	713516.5

— NOTE —
THE ACTUAL SOIL STRATIFICATION HAS BEEN VERIFIED FROM DATA OBTAINED
AT THE BOREHOLE LOCATIONS ONLY. THE INFERRED CONTACTS SHOWN
ARE BASED ON GEOLOGICAL EVIDENCE AND THESE MAY VARY FROM
THOSE SHOWN BETWEEN BORINGS.

REVISIONS	DATE	BY	DESCRIPTION

GEOCREs No. 31E-320

HWY No 60	CHECKED JSA	DATE JULY 2013	SITE ---
SUBM'D ---	CHECKED ---	APPROVED ---	DWG ---
DRAWN PLB	CHECKED ---	APPROVED ---	DWG ---



PROJECT: 121-17876-00 111-12 3



SITE PLAN MAPPING REF. NO.:
MTO PLAN H-328-60-1, SURVEY SEPT. 27, 2010.



NOTES:

1. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
2. COORDINATES AT BOREHOLE LOCATIONS WERE BY HANDHELD GPS.
3. BOREHOLE ELEVATIONS WERE SURVEYED RELATIVE TO SIB IN THE EXISTING SAND / SALT DOME FOOTING (EL. 400.672 mASL).

LEGEND	
N	Blows/0.3m (Std. Pen Test, 475 J / blow)
CONE	Blow/0.3m (60° Cone, 475 J / blow)
	Water Level At Time Of Investigation

BH No	ELEVATION (mASL)	COORDINATES (NAD 83 Zone17)	
		NORTHING	EASTING
12-1	400.176	5045812.8	713539.8
12-2	400.071	5045835.9	713559.0
12-3	399.845	5045835.9	713541.8
12-4	399.993	5045825.3	713543.2
12-5	400.262	5045820.5	713559.9
12-6	399.851	5045853.8	713542.2
12-7	400.040	5045873.5	713578.5
13-8	399.462	5045809.1	713516.2
13-9	399.578	5045789.9	713526.5
13-10	399.604	5045789.7	713516.5

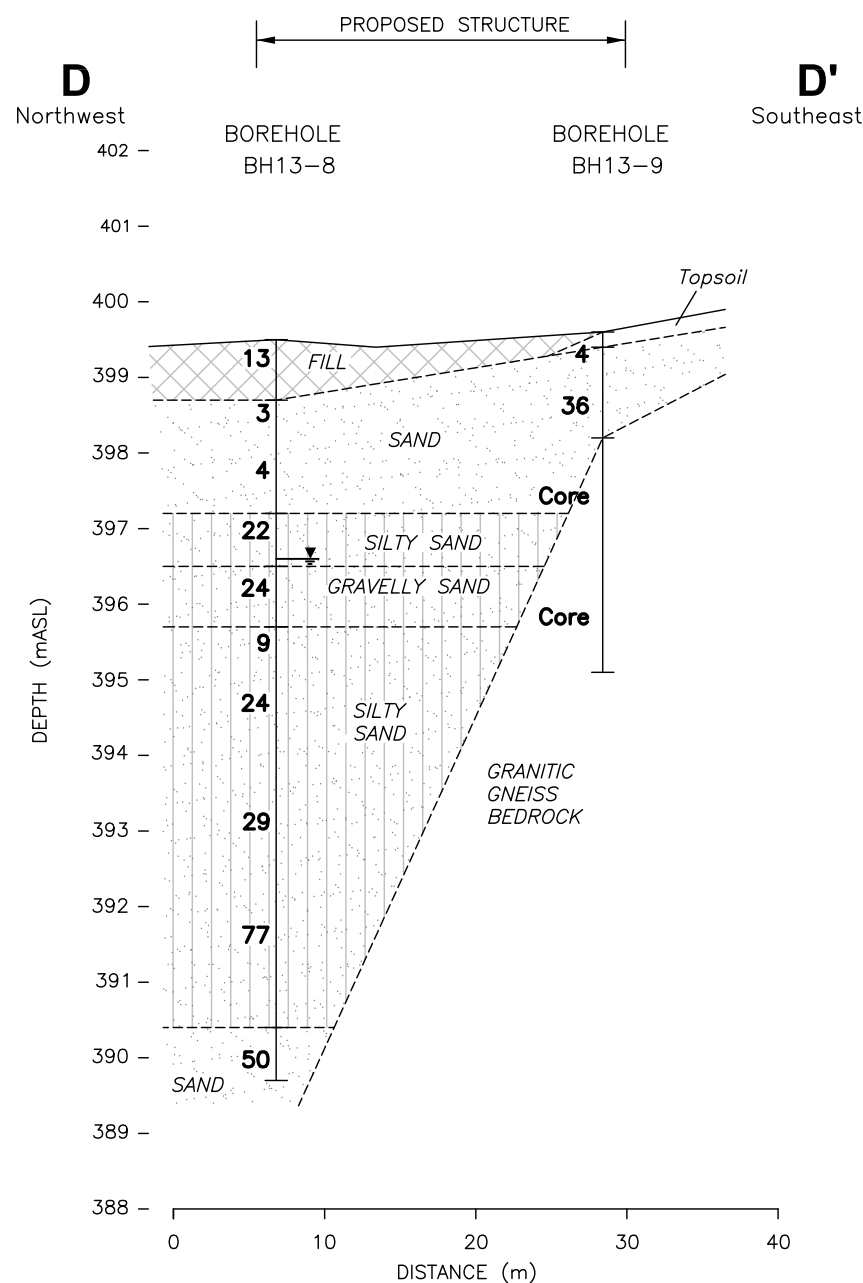
— NOTE —
THE ACTUAL SOIL STRATIFICATION HAS BEEN VERIFIED FROM DATA OBTAINED AT THE BOREHOLE LOCATIONS ONLY. THE INFERRED CONTACTS SHOWN ARE BASED ON GEOLOGICAL EVIDENCE AND THESE MAY VARY FROM THOSE SHOWN BETWEEN BORINGS.

REVISIONS	DATE	BY	DESCRIPTION

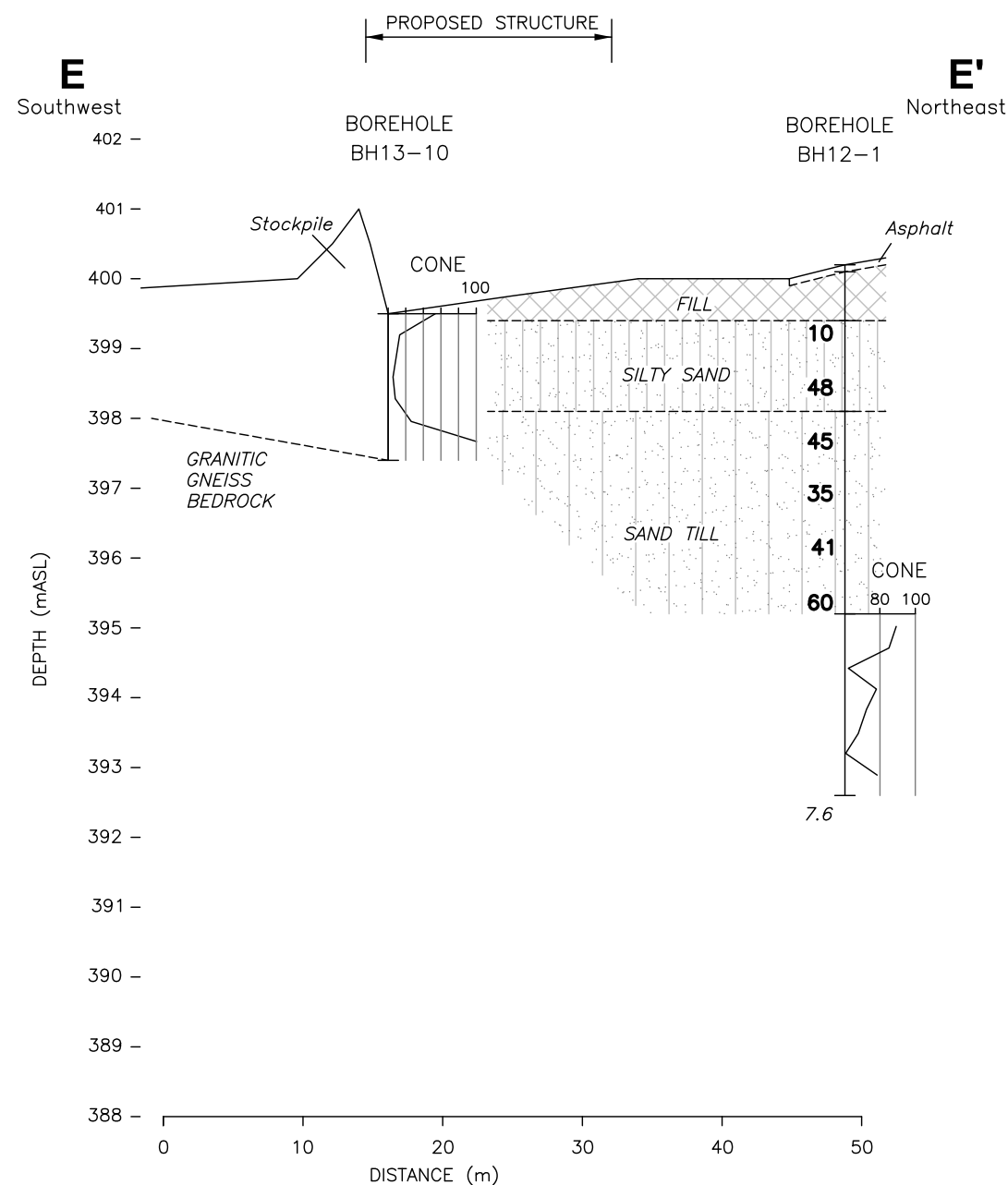
GEOCRES No. 31E-320

HWY No. 60	CHECKED JSA	DATE JULY 2013	DIST NIPissing
SUBM'D --	CHECKED --	SITE --	DWG --
DRAWN PLB	CHECKED --	APPROVED --	

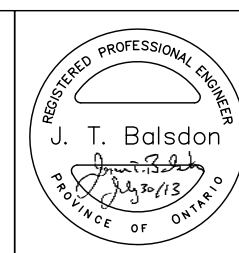
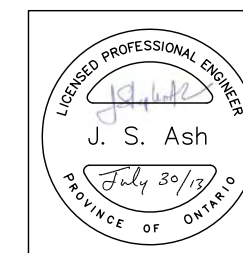
CROSS SECTION D-D'



CROSS SECTION E-E'



PROJECT: 121-17876-00 111-12 3



SITE PLAN MAPPING REF. NO.:
MTO PLAN H-328-60-1, SURVEY SEPT. 27, 2010.

Appendix A

Borehole Explanation Forms

Borehole Logs (including logs from
previous GENIVAR investigations)

BOREHOLE LOG EXPLANATION FORM

This explanatory section provides the background to assist in the use of the borehole logs. Each of the headings used on the borehole log, is briefly explained.

DEPTH

This column gives the depth of interpreted geologic contacts in metres below ground surface.

STRATIGRAPHIC DESCRIPTION

This column gives a description of the soil based on a tactile examination of the samples and/or laboratory test results. Each stratum is described according to the following classification and terminology.

<u>Soil Classification*</u>		<u>Terminology</u>	<u>Proportion</u>
Clay	<0.002 mm		
Silt	0.002 to 0.06 mm	"trace" (e.g. trace sand)	<10%
Sand	0.06 to 2 mm	"some" (e.g. some sand)	10% - 20%
Gravel	2 to 60 mm	adjective (e.g. sandy)	20% - 35%
Cobbles	60 to 200 mm	"and" (e.g. and sand)	35% - 50%
Boulders	>200 mm	noun (e.g. sand)	>50%

* Extension of MIT Classification system unless otherwise noted.

The use of the geologic term "till" implies that both disseminated coarser grained (sand, gravel, cobbles or boulders) particles and finer grained (silt and clay) particles may occur within the described matrix.

The compactness of cohesionless soils and the consistency of cohesive soils are defined by the following:

<u>COHESIONLESS SOIL</u>		<u>COHESIVE SOIL</u>		
Compactness	Standard Penetration Resistance "N", Blows / 0.3 m	Consistency	Standard Penetration Resistance "N", Blows / 0.3 m	Undrained Shear Strength (cu) (kPa)
Very Loose	0 to 4	Very Soft	0 to 2	0 to 12
Loose	4 to 10	Soft	2 to 4	12 to 25
Compact	10 to 30	Firm	4 to 8	25 to 50
Dense	30 to 50	Stiff	8 to 15	50 to 100
Very Dense	Over 50	Very Stiff	15 to 30	100 to 200
		Hard	Over 30	Over 200

The moisture conditions of cohesionless and cohesive soils are defined as follows.

COHESIONLESS SOILS

Dry
Moist
Wet
Saturated

COHESIVE SOILS











DTPL - Drier Than Plastic Limit
APL - About Plastic Limit
WTPL - Wetter Than Plastic Limit
MWTPL - Much Wetter Than Plastic Limit

STRATIGRAPHY

Symbols may be used to pictorially identify the interpreted stratigraphy of the soil and rock strata.

MONITOR DETAILS

This column shows the position and designation of standpipe and/or piezometer ground water monitors installed in the borehole. Also the water level may be shown for the date indicated.

	Standpipe		Geotextile Material / Liner		Granular Backfill
	Piezometer		Borehole Seal (Bentonite Grout)		Granular (Filter) Pack
	Screened Interval		Cement Seal		Native Soil Backfill / Cave / Slough
	Borehole Seal (Peltonite, Bentonite or Hole Plug)				

Where monitors are placed in separate boreholes, these are shown individually in the "Monitor Details" column. Otherwise, monitors are in the same borehole. For further data regarding seals, screens, etc., the reader is referred to the summary of monitor details table.

SAMPLE

These columns describe the sample type and number, the "N" value, the water content, the percentage recovery, and Rock Quality Designation (RQD), of each sample obtained from the borehole where applicable. The information is recorded at the approximate depth at which the sample was obtained. The legend for sample type is explained below.

SS = Split Spoon	GS = Grab Sample
TW = Thin Walled Shelby Tube	CS = Channel Sample
AS = Auger Flight Sample	WS = Wash Sample
CC = Continuous Core	RC = Rock Core
PH = TW Advanced Hydraulically	TCR = Total Core Recovery

$$\% \text{ Recovery} = \frac{\text{Length of Core Recovered Per Run}}{\text{Total Length of Run}} \times 100$$

Where rock drilling was carried out, the term RQD (Rock Quality Designation) is used. The RQD is an indirect measure of the number of fractures and soundness of the rock mass. It is obtained from the rock cores by summing the length of core recovered, counting only those pieces of sound core that are 100 mm or more in length. The RQD value is expressed as a percentage and is the ratio of the summed core lengths to the total length of core run. The classification based on the RQD value is given below.

RQD Classification

RQD (%)

Very poor quality	< 25
Poor quality	25 - 50
Fair quality	50 - 75
Good quality	75 - 90
Excellent quality	90 - 100

TEST DATA

The central section of the log provides graphs which are used to plot selected field and laboratory test results at the depth at which they were carried out. The plotting scales are shown at the head of the column.

Dynamic Penetration Resistance - The number of blows required to advance a 51 mm diameter, 60° steel cone fitted to the end of 45 mm OD drill rods, 0.3 m into the subsoil. The cone is driven with a 63.5 kg hammer over a fall of 750 mm.

Standard Penetration Resistance - Standard Penetration Test (SPT) "N" Value - The number of blows required to advance a 51 mm diameter standard split-spoon sampler 300 mm into the subsoil, driven by means of a 63.5 kg hammer falling freely a distance of 750 mm. In cases where the split spoon does not penetrate 300 mm, the number of blows over the distance of actual penetration in millimetres is shown as $\frac{x\text{Blows}}{\text{mm}}$

Water Content - The ratio of the mass of water to the mass of oven-dry solids in the soil expressed as a percentage.

W_P - Plastic Limit of a fine-grained soil expressed as a percentage as determined from the Atterberg Limit Test.

W_L - Liquid Limit of a fine-grained soil expressed as a percentage as determined from the Atterberg Limit Test.

REMARKS

The last column describes pertinent drilling details, field observations and/or provides an indication of other field or laboratory tests that were performed.

RECORD OF BOREHOLE No BH12-1

1 OF 1

METRIC

LOCATION WHITNEY PATROL YARD N 5045812.8 ; E 713539.8

ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGERS WITH SPT AND DCPT

COMPILED BY JW

DATUM GEODETTIC DATE 9.5.12 - 9.5.12

CHECKED BY RK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	W _p W W _L	20 40 60 80 100	10 20 30							
400.2	ASPHALT: 50 mm THICK GRANULAR FILL: GRAVELLY SAND FILL, SOME SILT DARK BROWN, MOIST SILTY SAND: FINE SAND, SOME SILT ORANGE, COMPACT, MOIST GRAVELLY SILTY SAND BROWN, DENSE, MOIST SAND TILL: FINE SAND TILL, SOME GRAVEL, SOME SILT, TRACE CLAY BROWN, DENSE TO VERY DENSE, MOIST		1	AS		400							29 60 (11)					
399.4			2	SS	10		399											
0.8			3	SS	48			398										
398.0			4	SS	45				397									
2.1			5	SS	35					396								
			6	SS	41						395							
395.1			7	SS	60							394						
5.0	DYNAMIC CONE PENETRATION TEST BELOW 5.0 m DEPTH NO SOIL SAMPLING COMPLETED																	
392.6	END OF BOREHOLE BOREHOLE CAVED AT 4.0 m DEPTH ON COMPLETION, DRY																	
7.6																		

ONTARIO MOT WHITNEY GINT GPJ ONTARIO MOT GDT 2/15/13

+³, X³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH12-2

1 OF 1

METRIC

LOCATION WHITNEY PATROL YARD N 5045835.9 E 713559.0




ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGERS WITH SPT AND DCPT

COMPILED BY JW

DATUM GEODETTIC DATE 9.5.12 - 9.5.12

CHECKED BY RK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p W W _L				
400.1								20 40 60 80 100						
0.0	FILL: SILTY SAND FILL, BROWN, MOIST		1	AS				20 40 60 80 100						
399.3														
0.8	SILTY SAND: SILTY SAND, TRACE CLAY, TRACE GRAVEL BROWN, LOOSE TO COMPACT, MOIST		2	SS	11		399							
			3	SS	4		398							1 62 33 4
			4	SS	12									
			5	SS	12		397							
396.4														
3.7	SAND TILL: GRAVELLY SILTY SAND TILL, TRACE CLAY BROWNISH GREY, DENSE TO VERY DENSE, MOIST		6	SS	48		396							28 44 25 3
			7	SS	55		395							
395.0	DYNAMIC CONE PENETRATION TEST BELOW 5.0 m DEPTH. NO SOIL SAMPLING COMPLETED.						394							
							393							
							392							
391.2														
8.8	END OF BOREHOLE BOREHOLE OPEN AND DRY ON COMPLETION													

ONTARIO MOT: WHITNEY GINT GPJ ONTARIO MOT GDT 2/15/13

RECORD OF BOREHOLE No BH12-3

1 OF 1

METRIC

LOCATION WHITNEY PATROL YARD N 5045835 9 : E 713541 8

ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGERS WITH SPT AND DCPT

COMPILED BY JW

DATUM GEODETIC DATE 9 5 12 - 9 6 12

CHECKED BY RK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL × LAB VANE						
								20 40 60 80 100						
									10 20 30					
399.8														
399.7	ASPHALT: 50 mm THICK		1	AS			399							15 74 (11)
	FILL: SAND FILL, SOME GRAVEL, SOME SILT BROWN, COMPACT, MOIST		2	SS	23									
			3	SS	19		398							
397.2			4	SS	16									
2.7	SILT: SILT TO SANDY SILT, TRACE SAND, TRACE CLAY GREY, COMPACT, MOIST TO WET						397							
			5	SS	18								0 6 90 4	
			6	SS	20		396							
			7	SS	21		395							
394.3														
5.6	SAND AND SILT: FINE SAND AND SILT, TRACE CLAY, TRACE GRAVEL BROWN, COMPACT, SATURATED		8	SS	17		394							2 54 42 2
							393							
392.8														
7.1	SAND TILL: SILTY SAND TILL, SOME GRAVEL, TRACE TO SOME SILT BROWN, DENSE TO VERY DENSE, WET TO MOIST		9	SS	43		392							
							391							
390.2			10	SS	56									
9.6	DYNAMIC CONE PENETRATION TEST BELOW 9.6 m DEPTH. NO SOIL SAMPLING COMPLETED.						390							
							389							
388.8	END OF BOREHOLE BOREHOLE CAVED AT 6.6 m DEPTH UPON COMPLETION WATER LEVEL AT 6.4 m DEPTH													
11.0														

+³, X³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH12-4

1 OF 1

METRIC

LOCATION WHITNEY PATROL YARD N 5045825.3 ; E 713543.2




ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGERS WITH SPT AND DCPT

COMPILED BY JW

DATUM GEODETTIC DATE 9.6.12 - 9.6.12

CHECKED BY RK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
400.0								20	40	60	80	100				
399.9	ASPHALT: 50 mm THICK		1	AS												
	FILL: SAND FILL, TRACE TO SOME GRAVEL, TRACE SILT BROWN, LOOSE TO COMPACT, MOIST		2	SS	5		399									
			3	SS	9		398									1 96 (3)
			4	SS	18											
397.1							397									
2.9	SILTY SAND: SILTY SAND, SOME SILT GREY, COMPACT, MOIST		5	SS	15											
			6	SS	24		396									
395.6							395									
4.4	SAND TILL: GRAVELLY SAND TILL, SOME SILT, TRACE CLAY BROWN, VERY DENSE, MOIST TO WET		7	SS	51		394									23 58 17 2
			8	SS	51		393									
			9	SS	44		392									
390.8							391									
9.2	DYNAMIC CONE PENETRATION TEST BELOW 9.2 m DEPTH. NO SOIL SAMPLING COMPLETED						390									
389.9																
10.1	END OF BOREHOLE BOREHOLE CAVED AT 7.6 m DEPTH UPON COMPLETION WATER LEVEL AT 6.4 m DEPTH.															

ONTARIO MOT WHITNEY GINT GPJ ONTARIO MOT GDT 2/15/13

RECORD OF BOREHOLE No BH12-5

1 OF 1

METRIC

LOCATION WHITNEY PATROL YARD N 5045820.5 , E 713559.9

ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGERS WITH SPT AND DCPT

COMPILED BY JW

DATUM GEODETIC DATE 9.6.12 - 9.6.12

CHECKED BY RK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
400.3								20 40 60 80 100						
0.0	FILL: FINE SAND FILL, SOME GRAVEL, TRACE SILT BROWN, VERY DENSE, MOIST		1	AS			400							
			2	SS	86									
398.9								399						
1.4	SAND TILL: GRAVELLY SILTY SAND TILL, TRACE CLAY BROWNISH GREY TO GREY, VERY DENSE, MOIST		3	SS	72									26 52 20 2
			4	SS	76			398						
			5	SS	59									
396.8							397							
3.5	DYNAMIC CONE PENETRATION TEST BELOW 3.7 m DEPTH. NO SOIL SAMPLING COMPLETED						396							
395.4	END OF BOREHOLE BOREHOLE CAVED AT 3.4 m DEPTH UPON COMPLETION, DRY													
4.9														

ONTARIO MOT WHITNEY GINT GPJ ONTARIO MOT GDT 2/15/13

RECORD OF BOREHOLE No BH12-6

1 OF 1

METRIC

LOCATION WHITNEY PATROL YARD N

ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT SOLID STEM AUGERS WITH SPT AND DCPT

COMPILED BY DCL

DATUM GEODETTIC DATE 12.4.12 - 12.4.12

CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										
								20	40	60	80	100						20
399.9	ASPHALT: 76 mm THICK FILL: SAND, SOME TO TRACE GRAVEL, SOME TO TRACE SILT, BROWN, COMPACT, MOIST		1	AS														
399.6			2	SS	23													
			3	SS	20													
			4	SS	26													
396.9	SILT: SILT, TRACE TO SOME SAND, TRACE CLAY, GREY, COMPACT TO DENSE, WET		5	SS	21													
3.0			6	SS	32													
395.3	SAND: SAND, TRACE GRAVEL, TRACE CLAY, BROWN, COMPACT, WET SILT: SILT, TRACE TO SOME SAND, TRACE CLAY, GREY, COMPACT, WET		7	SS	21													
395.6																		
4.8			8	SS	26													
392.2	SAND AND SILT: SAND AND SILT, TRACE CLAY, BROWN, DIALTENT, COMPACT TO LOOSE, SATURATED		9	SS	21													
7.6																		
			10	SS	6													
389.2	GRAVELLY SILTY SAND TILL: GRAVELLY, SILTY SAND TILL, TRACE CLAY, GREYISH BROWN, VERY DENSE, MOIST		11	SS	104													
10.7																		
388.6	END OF BOREHOLE BOREHOLE CAVED AT 10.1 m DEPTH ON COMPLETION, WATER PRESENT AT 7.0 m																	
11.3																		

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH12-7

1 OF 1

METRIC

LOCATION WHITNEY PATROL YARD

ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT SOLID STEM AUGERS WITH SPT AND DCPT

COMPILED BY DCL

DATUM GEODETTIC DATE 12.5.12 - 12.5.12

CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)				
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE											
400.0																						
400.0	ASPHALT: 76 mm THICK GRANULAR FILL: SAND, SOME SILT, SOME CLAY, SOME TO TRACE GRAVEL BROWN, COMPACT TO DENSE, MOIST		1	AS																		
			2	SS	37																	
			3	SS	12																	
			4	SS	29																	
397.0	SILT: SILT, SOME SAND, TRACE CLAY, TRACE GRAVEL GREY, COMPACT TO DENSE, DILATANT, WET TO SATURATED																					
3.0			5	SS	22																	
			6	SS	28																	
			7	SS	31																	
			8	SS	22																	
392.4	GRAVELLY FINE SAND TILL: GRAVELLY, SILTY SAND TILL, TRACE CLAY, GREYISH BROWN, VERY DENSE, SATURATED END OF BOREHOLE, AUGER AND DCPT REFUSAL AT 7.8 m DEPTH.																					
392.8			9	SS	50																	
7.8																						

+ 3, X 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH13-8

1 OF 1

METRIC

LOCATION WHITNEY PATROL YARD








ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGERS WITH SPT

COMPILED BY DCL

DATUM GEODETTIC DATE 5.30.13 - 5.30.13

CHECKED BY KZK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _P W W _L				GR	SA	SI	CL
								20 40 60 80 100					20 40 60 80 100							
399.5																				
0.0	SAND FILL SAND FILL, SOME FINE TO MEDIUM GRAVEL, TRACE SILT, BROWN, LOOSE, MOIST		1	S	13		399								○					
398.7																○				
0.8	SAND MEDIUM SAND, TRACE FINE GRAVEL, TRACE SILT, ORANGE, VERY LOOSE, MOIST		2	S	3												○			
																	○			
			3	S	4												○			
397.2																	○			
2.3	SILTY SAND FINE SAND SOME SILT, TO SILTY FINE SAND, GREY, COMPACT, DILATANT, WET TO SATURATED		4	S	22												○			
396.4																	○			
3.0	GRAVELLY SAND GRAVELLY FINE SAND, SOME SILT, GREY, COMPACT, SATURATED		5	S	24												○			
395.7																	○			
3.8	SILTY SAND FINE SILTY SAND, SOME FINE TO MEDIUM GRAVEL, GREY, LOOSE, SATURATED		6	S	9											○				
																○				
			7	S	24											○				
																○				
	- TURNS WET BELOW 6.1 m		8	S	29											○				
																○				
																○				
			9	S	77											○				
																○				
390.3																○				
9.1	SAND COARSE SAND, TRACE SILT, GREY, VERY DENSE, WET		10	S	50											○				
389.7																				
9.8	END OF BOREHOLE																			

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MOT MAY 2013 EXTRA HOLES.GPJ ONTARIO MOT.GDT 7/10/13

RECORD OF BOREHOLE No BH13-9

1 OF 1

METRIC

LOCATION WHITNEY PATROL YARD

ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGERS WITH SPT

COMPILED BY DCL

DATUM GEODETIC DATE 5.30.13 - 5.30.13

CHECKED BY KZK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
399.6								20	40	60	80	100					
399.4	TOPSOIL SILT TOPSOIL, BLACK, LOOSE, MOIST		1	S	4		399										
	SAND FINE SAND, SOME FINE TO MEDIUM GRAVEL, SOME SILT, BROWN, COMPACT, MOIST		2	S	36												17 69
398.2																	
1.4	GRANITIC GNEISS FELSIC TO INTERMEDIATE GNEISS, BLACK, PINK, WHITE, PHANERITIC WITH SOME VISIBLE K-FELDSPAR PHENOCRYSTS, HARD, FAIR TO GOOD RQD, SLIGHT TO FRESH WEATHERING. BANDING PRESENT AT 80 DEGREES TO CORE AXIS		1	CORE			398										RQD = 74%
			2	CORE			397										
							396										RQD = 85%
395.1																	
4.5	END OF BOREHOLE. TERMINATED IN BEDROCK																

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH13-10

1 OF 1

METRIC

LOCATION WHITNEY PATROL YARD

ORIGINATED BY DCL

BOREHOLE TYPE DCPT

COMPILED BY DCL

DATUM GEODETIC DATE 5.30.13 - 5.30.13

CHECKED BY KZK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES								
399.5	ASPHALT 60 mm THICK DYNAMIC CONE PENETRATION TEST CONDUCTED, NO SOIL SAMPLING COMPLETED.						20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	10 20 30					
398.4													
397.4	DCPT MET REFUSAL ON PRESUMED BEDROCK												

Appendix B

Summary of Particle Size Distribution
Results (Table B1)

Particle Size Distribution Analyses
(Figures B1 to B4)

Table B1: Summary of Grain Size Distribution and Hydrometer Tests

Borehole No.	Sample ID	Soil Description	Percentage Retained (%)			
			Gravel	Sand	Silt	Clay
BH12-1	AS1	Gravelly sand, some silt	29	60	11	
BH12-1	SS6	Sand, some gravel, some silt, trace clay	13	67	18	2
BH12-2	SS3	Silty sand, trace gravel, trace clay	1	62	33	4
BH12-2	SS6	Gravelly, silty sand, trace clay	28	44	25	3
BH12-3	SS1	Sand, some gravel, some silt	15	74	11	
BH12-3	SS5	Silt, trace sand, trace clay	0	6	90	4
BH12-3	SS8	Sand and silt, trace gravel, trace clay	2	54	42	2
BH12-4	SS3	Sand, trace gravel, trace silt	1	96	3	
BH12-4	SS7	Gravelly sand, some silt, trace clay	23	58	17	2
BH12-5	SS3	Gravelly sand, some silt, trace clay	26	52	20	2
BH12-6	SS6	Silt, trace sand, trace clay	0	8	90	2
BH12-6	SS10	Sand and silt, trace clay	0	49	49	2
BH12-6	SS11	Gravelly silty sand, trace clay	24	53	21	2
BH12-7	SS4	Sand, some silt, trace gravel	4	86	10	
BH12-7	SS8	Silt, some sand, trace clay, trace gravel	1	19	76	4
BH13-8	SS3	Sand, trace silt, trace gravel	4	88	8	
BH13-8	SS5	Gravelly sand, some silt	27	55	18	
BH13-8	SS7	Silty sand, some gravel	19	57	24	
BH13-9	SS2	Sand, some gravel, some silt	17	69	14	

Terminology	Proportion
"trace" (e.g. trace sand)	< 10%
"some" (e.g. some sand)	10% to 20%
adjective (e.g. sandy)	20% to 35%
"and" (e.g. and sand)	35% to 50%
Noun (e.g. sand)	> 50%

NOTE:

Division of Particle Sizes (USCS except clay based on MIT division)

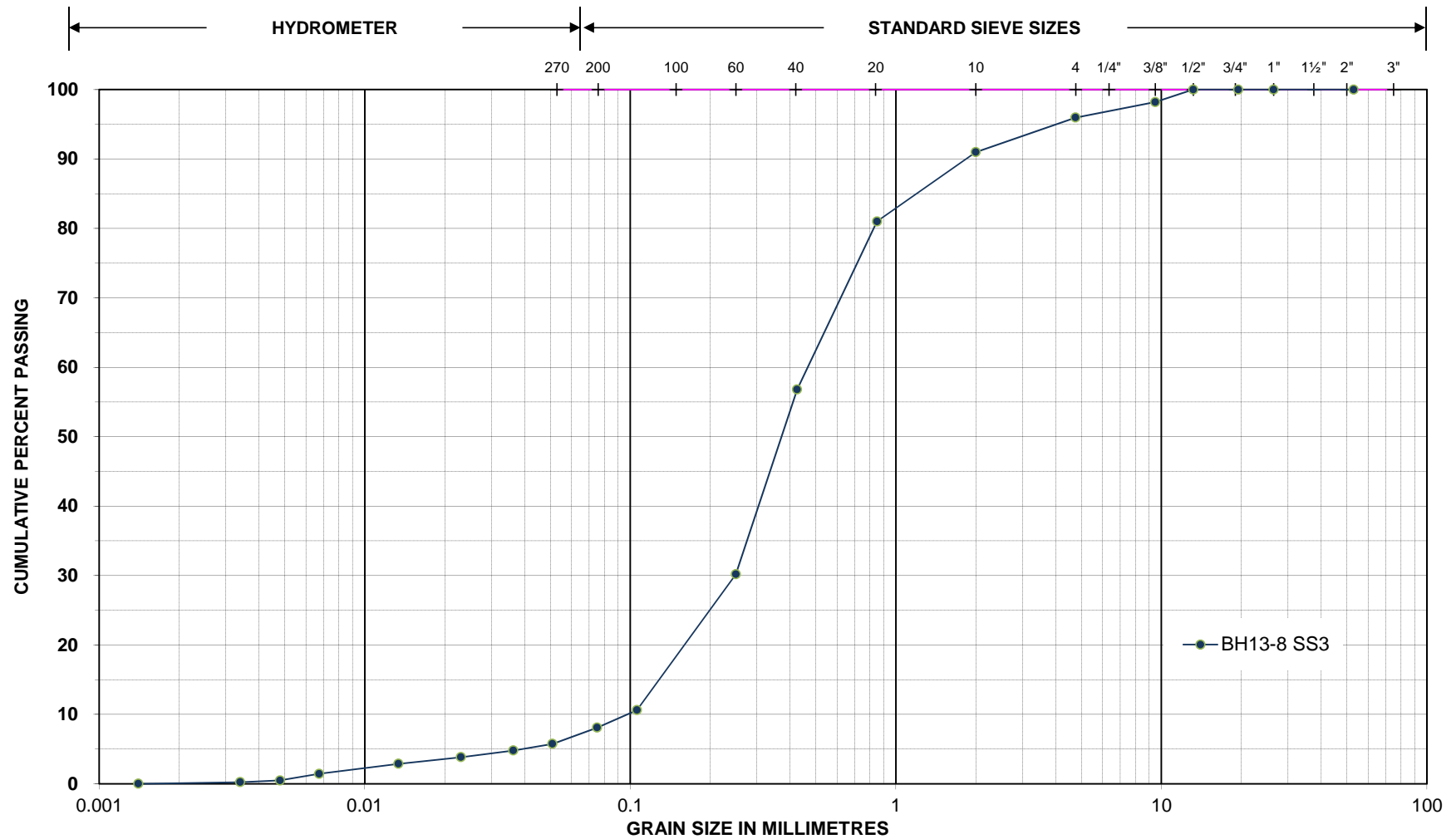
- Gravel > 4.75 mm
- Sand 0.075 mm to 4.75 mm
- Silt 0.002 mm to 0.075 mm
- Clay < 0.002 mm



GENIVAR

PARTICLE SIZE DISTRIBUTION

ASTM D422



Unified Classification System

SILT AND CLAY	SAND	GRAVEL
---------------	------	--------

Project Name: MTO Agreement # 5011-E-0010 (Whitney)

Project No.: 121-17876-00

Remarks.: Sand, trace gravel, trace silt

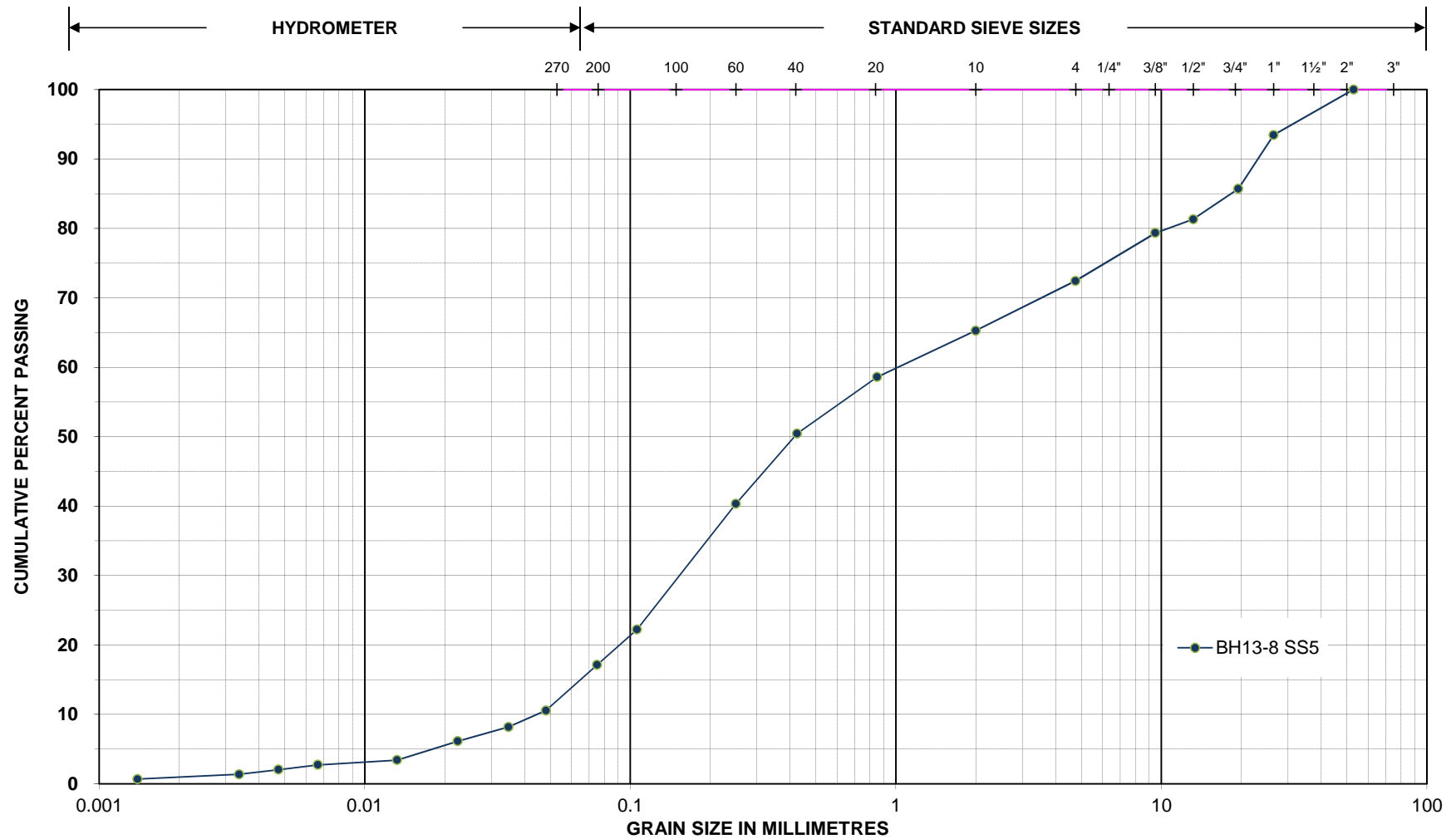
FigureNo. B1



GENIVAR

PARTICLE SIZE DISTRIBUTION

ASTM D422



Unified Classification System

SILT AND CLAY	SAND	GRAVEL
---------------	------	--------

Project Name: MTO Agreement # 5011-E-0010 (Whitney)

Project No.:

121-17876-00

Remarks: Gravelly sand, some silt

Figure No.:

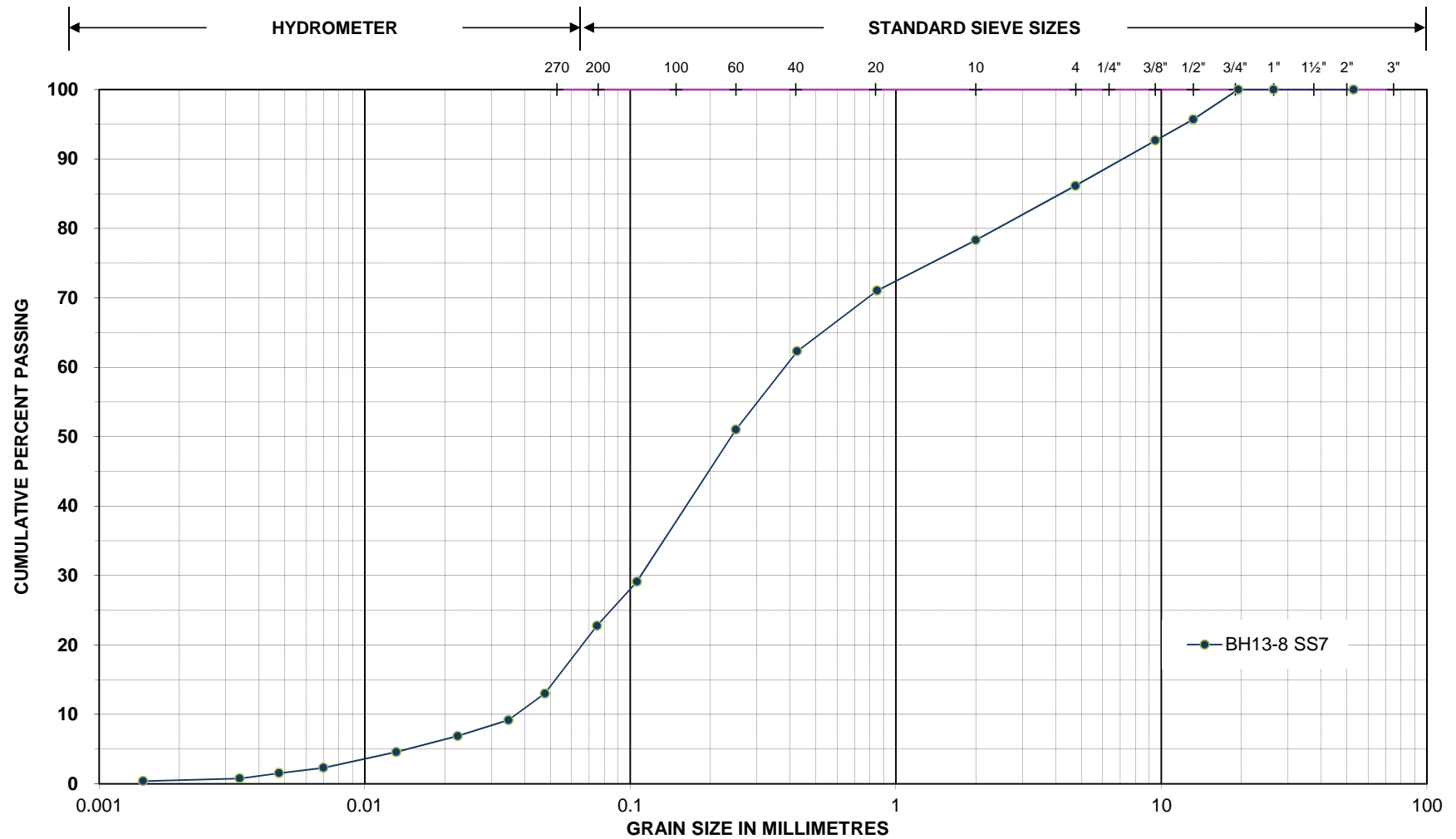
B2



GENIVAR

PARTICLE SIZE DISTRIBUTION

ASTM D422



Unified Classification System

SILT AND CLAY	SAND	GRAVEL
---------------	------	--------

Project Name: MTO Agreement # 5011-E-0010 (Whitney)

Project No.:

121-17876-00

Remarks: Silty sand, some gravel

Figure No.

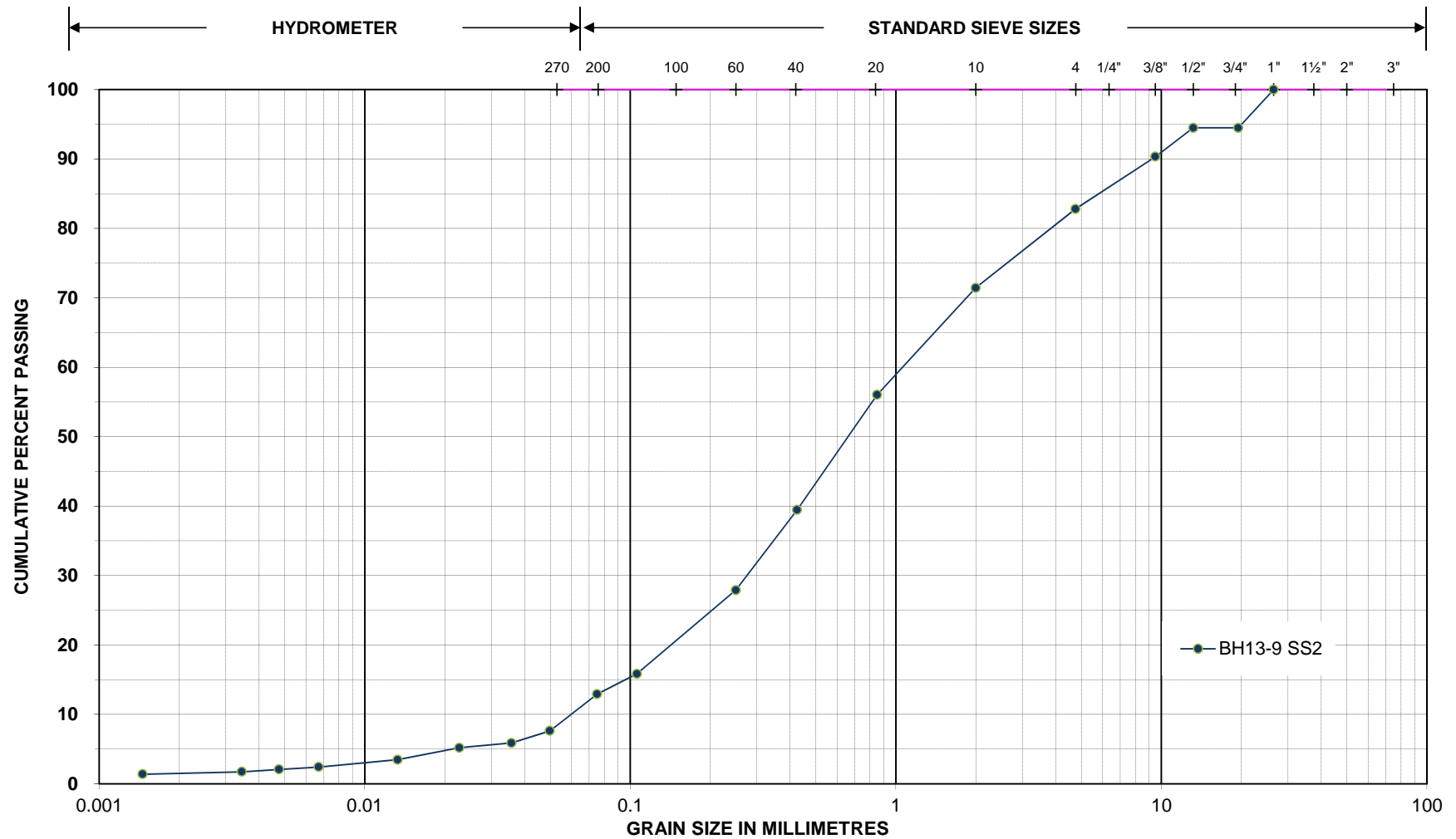
B3



GENIVAR

PARTICLE SIZE DISTRIBUTION

ASTM D422



Unified Classification System

SILT AND CLAY	SAND	GRAVEL
---------------	------	--------

Project Name:	MTO Agreement # 5011-E-0010 (Whitney)	Project No.:	121-17876-00
Remarks	Sand some gravel, some silt	Figure No.	B4

Appendix C

Site Photographs

Rock Core Photographs

**MTO AGREEMENT #5011-E-0010
WHITNEY PATROL YARD**



Photograph 1: Existing sand/salt sheds, dome, and garage. Looking north.



Photograph 2: Existing sand/salt shed. Location of proposed sand/salt shed. Looking south.

**MTO AGREEMENT #5011-E-0010
WHITNEY PATROL YARD**



Photograph 3: Borehole BH12-1. Southwest corner of proposed shed. Looking east.



Photograph 4: Borehole BH12-2. Northeast corner of proposed shed. Looking west.

**MTO AGREEMENT #5011-E-0010
WHITNEY PATROL YARD**



Photograph 5: Borehole BH12-3. Northwest corner of proposed shed. Looking east.



Photograph 6: Borehole BH12-4. Middle of proposed shed. Looking east.

**MTO AGREEMENT #5011-E-0010
WHITNEY PATROL YARD**



Photograph 7: Borehole BH12-6. West side of Sand Dome. Looking East.



Photograph 8: Borehole BH12-7. Northeast side of Sand Dome. Looking Northwest.

**MTO AGREEMENT #5011-E-0010
WHITNEY PATROL YARD**



Photograph 9: BH13-8. Northwest corner of Proposed Winter Material Structure. Facing East.



Photograph 10: BH13-9. Southeast corner of Proposed Winter Material Structure. Facing North.

**MTO AGREEMENT #5011-E-0010
WHITNEY PATROL YARD**



Photograph 11: BH13-10. Southwest corner of Proposed Winter Material Structure. Facing North.



Photograph 12: BH13-9 Rock Core. 1.4 mbg to 4.5 mbg

**MTO AGREEMENT #5011-E-0010
WHITNEY PATROL YARD**



Photograph 13: BH13-9 Rock Core. 1.4 mbg to 4.5 mbg.