

**MTO AGREEMENT NO. 5007-E-0052
FOUNDATION INVESTIGATION
AND DESIGN REPORT 42F-21
PROPOSED SALT STORAGE FACILITY
NAGAGAMI PATROL YARD
HIGHWAY 17, NAGAGAMI, ONTARIO**

*Prepared for
MTO Northeastern Region*

February, 2009

File 03080770.08

Distribution:

4 c Client

1 c File



294 Rink Street, Suite 103
Peterborough, Ontario
Canada, K9J 2K2
Tel 705 743-6850
866 818-8366
Fax 705 743-6854

February 5, 2009

Ontario Ministry of Transportation
Pavements and Foundations Section, Foundations Group
Room 223, Central Building
1201 Wilson Avenue
Downsview, Ontario,
M3M 1J8

Attention: Mr. Ken Ahmad, P. Eng.

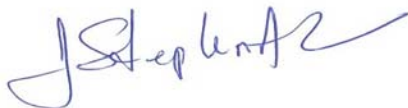
Dear Sirs:

Re: Assignment No. 5007E-0052
Foundation Investigation and Design Report
Proposed Salt Storage Facility, Nagagami Patrol Yard
File 03080770.08

We are pleased to submit our Foundation Investigation and Design Report for the proposed construction of a new salt storage facility at the MTO Nagagami patrol yard. The report is based on a borehole investigation and laboratory testing program, and addresses the Terms of Reference requirements for the assignment.

Please contact us if you have any questions about the report.

Yours truly,
JAGGER HIMS LIMITED



J. Stephen Ash, B.Sc., P.Eng.
Project Engineer – Branch Manager





TABLE OF CONTENTS

	PAGE
<i>Letter of Transmittal</i>	
1.0 INTRODUCTION.....	1
2.0 SITE DESCRIPTION	1
3.0 INVESTIGATION PROCEDURES	3
3.1 SUBSURFACE INVESTIGATION.....	3
3.2 LABORATORY TESTING.....	5
4.0 SUBSURFACE CONDITIONS	6
4.1 SOIL PROFILE SUMMARY	6
4.1.1 Asphalt and Gravelly Sand.....	6
4.1.2 Clayey Silt.....	7
4.1.3 Silt Some Clay	8
4.1.4 Sandy Silt Glacial Till	8
4.1.5 Bedrock	9
4.1.6 Groundwater.....	9
5.0 MISCELLANEOUS INFORMATION.....	9
5.1 BURIED UTILITY LOCATOR	9
5.2 DRILLING COMPANY IDENTIFICATION.....	9
5.3 LABORATORY IDENTIFICATION	10
5.4 SITE INVESTIGATORS	10
6.0 STRUCTURE FOUNDATION DESIGN	11
6.1 TYPE AND DEPTH OF FOUNDATION	11
6.2 BEARING RESISTANCE	12
6.2.1 Geotechnical Resistance at ULS.....	12
6.2.2 Geotechnical Reaction at SLS	12
6.3 LATERAL RESISTANCE	13
7.0 EARTH PRESSURE DESIGN	13
8.0 SEISMIC DESIGN	14



TABLE OF CONTENTS (Continued)

	PAGE
9.0 UNWATERING AND SUBDRAINAGE	14
10.0 FROST PENETRATION.....	14
11.0 BEDROCK EXCAVATION	15
12.0 CONSTRUCTION CONCERNS	15
12.1 SITE PREPARATION	15
12.2 FOUNDATION BACKFILL	16
12.3 PAVEMENT DESIGN.....	16
12.4 SPECIAL REQUIREMENTS.....	17
13.0 CLOSURE.....	17

APPENDIX

BOREHOLE LOGS
GRAIN SIZE ANALYSES

FIGURES

FIGURE 1	SITE PLAN.....	2
FIGURE 2	PEDOLOGICAL SKETCH	4

1.0 INTRODUCTION

This report contains the results of a foundation investigation carried out for a proposed salt storage structure at the Nagagami Patrol Yard. The work was conducted under MTO Agreement Number 5007-E-0052, and included drilling and sampling of five (5) boreholes at the proposed structure location. Site details, procedures and our findings are discussed in subsequent report sections.

2.0 SITE DESCRIPTION

The Nagagami patrol yard (site) is located on Highway 11, at the Nagagami River crossing, in McMillan Township. A site location map is included on Figure 1.

The site is currently occupied by two sand/salt storage domes, a small storage building, and a 4-bay maintenance garage/office. The site area around the existing buildings is asphalt paved; other areas are gravel surfaced. The patrol yard also contains a propane tank, a fuel tank, and an in-ground oil/water separator. The site is serviced with a private septic system and water well. Existing site vegetation includes perimeter trees with some large grassed areas. A site plan is included on Figure 1.

The site topography is flat, with a relatively steep slope toward Highway 11 located at the northeastern limit of the property. Based on topographic mapping information, the ground elevation at the site is approximately 225 m above sea level. Drainage ditches exist on the north and south sides of the two existing storage domes, and the ditches drain to the west, towards a small marsh area west of the site. The Nagagami River is to the east of the site. No bedrock outcrops exist on the site. However, an outcrop was observed to the east of the site near the river, across Highway 11. The site is relatively remote and adjacent properties are mainly vacant and/or forested.

Insert Figure 1

The proposed location for the new salt storage facility is immediately east of the existing storage domes, as indicated on Figure 1. It is understood that the new structure will have dimensions of approximately 18 m by 24 m, by 11 m high, with an approximate capacity of 2,309 tonnes. The interior area of the structure, and the exterior perimeter apron within 10 m of the structure, is to be paved with asphalt. A field pedological sketch indicating features in the immediate area around the proposed structure location is included as Figure 2.

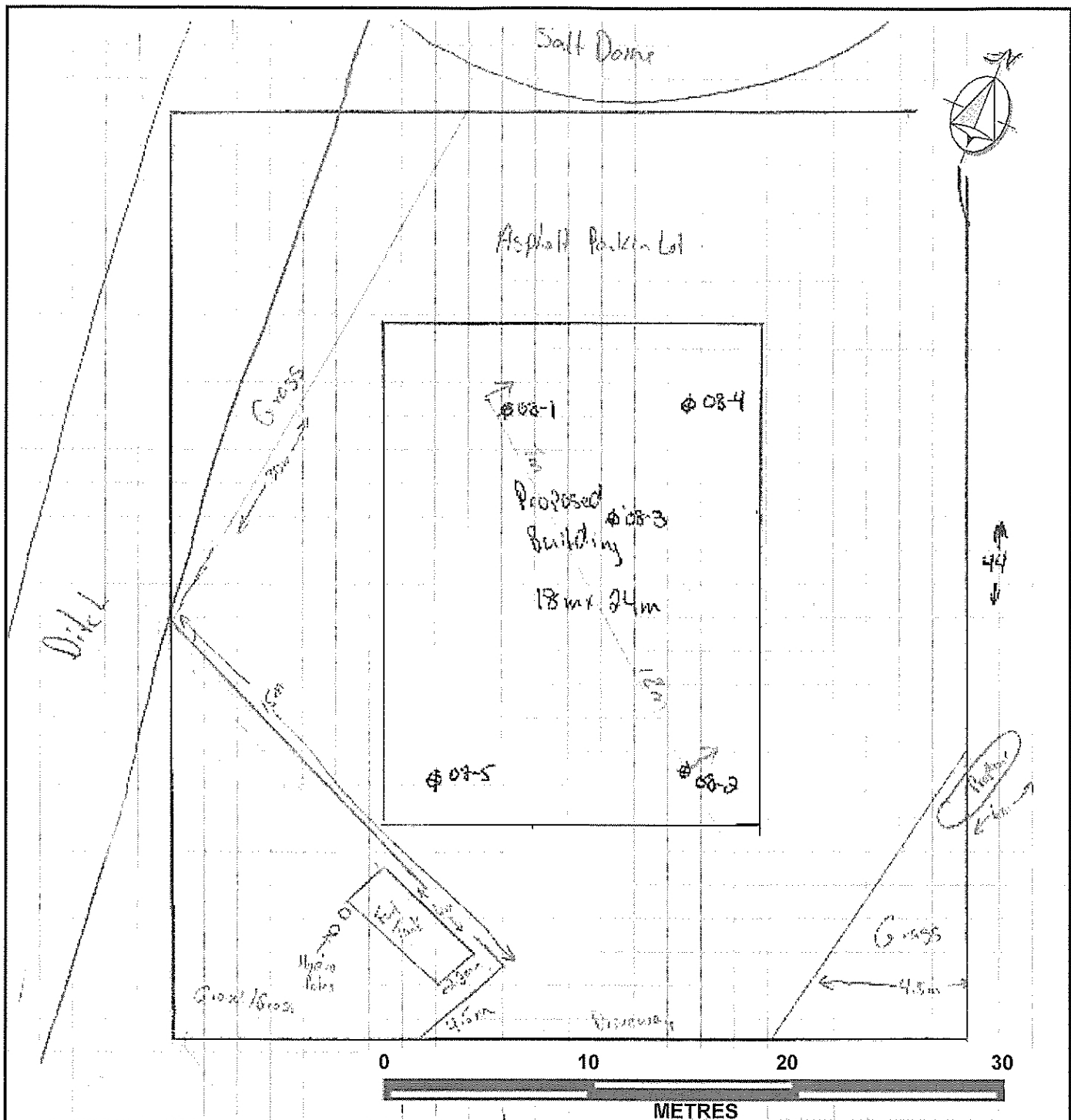
3.0 INVESTIGATION PROCEDURES

3.1 SUBSURFACE INVESTIGATION

Subsurface conditions at the proposed structure location were investigated between May 8 and May 10, 2008. Five (5) boreholes, designated as BH1 through BH5, were drilled with a truck-mounted rig equipped with hollow-stem augers and split-spoon samplers, and various other soil testing/sampling apparatus including field vane, dynamic cone penetrometer, and thin wall tube samplers. The rig also had capability for NQ size (48 mm diameter) rock coring, if necessary. All drilling and sampling was conducted under the supervision of a soils technologist. Borehole locations within the proposed building area are plotted on Figure 1.

The boreholes were located using a hand held GPS unit with WGS 84 coordinates, and the borehole elevations were surveyed to a site benchmark; the top of the onsite well was assigned a temporary elevation of 100 m. Borehole coordinates and elevations are indicated on the borehole logs.

Prior to undertaking the borehole investigation, existing buried utilities on the site were cleared with a private locator and Ontario One-Call services. MTO site supervisors accompanied field staff on the initial site inspection to stake out borehole locations and clear buried service conflicts.



LEGEND

PEDOLOGICAL FIELD SKETCH

GEOTECHNICAL INVESTIGATION
NAGAGAMI PATROL YARD
Nagagami, Ontario
For: Ministry of Transportation

DATE: DECEMBER, 2008

SCALE: 1:500

PROJECT: 03080770.08

REF. NO.: 0308077008PEDOF5

JAGGER HIMS
LIMITED

Environmental Consulting Engineers

FIGURE

2

MTO's minimum requirements for the borehole investigation included the following.

- Five boreholes in the area of the structure, unless justification for additional boreholes was authorized by the MTO Project Manager.
- Boreholes advanced to a minimum of 3 m below refusal depth, as defined by material for which Standard Penetration Test (SPT) N values exceed 100 blows per 0.3 m.
- A maximum drilling depth of 15 m, unless refusal was encountered at shallower depth or justification for deeper drilling was authorized by the MTO Project Manager.
- When bedrock exists in foundation element locations, obtain a minimum 3 m core sample from below the bedrock surface. Determine the bedrock/soil interface by geological definition.
- Semi-continuous soil sampling at 0.75 m intervals within critical foundation zones and a maximum sampling interval of 1.5 m within the investigated depth.
- Backfilling of boreholes with bentonite sealant, and repair of holes in asphalt in accordance with abandonment procedures and regulations. Artesian groundwater pressure, if encountered, to be sealed at the source.

Soil samples were taken mainly using split spoon/standard penetration test (SPT) procedures (ASTM D1586). Soil samples collected during drilling operations were inspected and logged, and then placed in labeled bags for transport and storage. Jars with tight-sealing Teflon-lined lids were used for laboratory moisture content specimens.

3.2 LABORATORY TESTING

Soil samples from the borehole investigation were reviewed by the project geotechnical engineer, to confirm field descriptions and assess laboratory testing requirements.

The following routine laboratory testing was conducted on selected soil samples:

- Natural Moisture Content (LS-701): 14
- Particle Size Distribution Analysis (LS-602, LS-702): 14

No complex level soil or rock testing was completed for this site.

4.0 SUBSURFACE CONDITIONS

4.1 SOIL PROFILE SUMMARY

The subsurface profile in the investigated areas generally consists of sand to gravelly sand, presumed to be fill material, overlying layers of clayey silt, silt with some clay, and silty sand glacial till. The boreholes were terminated within the till unit at depths below ground level ranging from 8.2 m to 15.8 m. None of the boreholes encountered bedrock. Significant groundwater seepage was absent in most of the boreholes. Individual soil units and details are described in the following subsections, and the subsurface profile is shown on Figure 1.

4.1.1 Asphalt and Gravelly Sand

Boreholes BH1 through BH4 penetrated approximately 50 mm to 65 mm of existing asphalt; BH5 was drilled just beyond the existing pavement edge. Brown sand to gravelly sand, presumed to be fill, was encountered below the asphalt (and from the surface at BH5), extending to depths ranging from 0.6 m to 0.7 m. The presumed fill material contains trace to some silt (silty at BH3), is moist to saturated, and is loose to compact based on SPT N values of 5 to 19 blows per 305 mm (uncorrected for depth). The fill has a natural moisture content of approximately 8 % to 9 % based on laboratory tests.

Results of laboratory particle size distribution analyses for samples taken at BH2 and BH4 are included in the Appendix and indicate the following distribution (2 samples):

- 21 % to 31 % gravel (>4.75 mm),
- 59 % to 71 % sand (0.075 mm to 4.75 mm),
- 5 % to 10 % silt (0.002 mm to 0.075 mm), and
- 0 % to 3 % clay (<0.002 mm).

It is noted that layers of saturated wood fragments and loose sand with wood fragments was penetrated at BH4, from a depth of 0.7 m to 2.2 m below ground level.

4.1.2 Clayey Silt

Layers of brown to grey clayey silt were encountered at BH1 and BH3, extending from below the presumed fill to an approximate depth of 2.2 m below ground level. The clayey silt contains trace to some sand and a trace of gravel, and some samples taken within this layer contained occasional layers of organic silt up to 130 mm thick. Results of laboratory particle size distribution analyses of selected samples indicate the following distribution (2 samples):

- 0 % to 3 % gravel (>4.75 mm)
- 9 % to 15 % sand (0.075 mm to 4.75 mm),
- 56 % to 63 % silt (0.002 mm to 0.075 mm), and
- 26 % to 28 % clay (<0.002 mm).

The material has stiff to very stiff consistency based on uncorrected SPT N values of 14 to 17 blows per 305 mm, and is inferred to be over-consolidated. Based on laboratory tests the natural moisture content of the clayey silt ranges from approximately 24 % to 35 %, and the soil is described as wetter than plastic limit (WTPL) based on the sample inspections.

4.1.3 Silt Some Clay

A layer of silt with some clay was penetrated at BH2 from a depth of 0.7 m to 1.4 m below ground level. The material contains some sand size particles, and has the following particle size distribution (1 sample):

- 0 % gravel (>4.75 mm),
- 18 % sand (0.075 mm to 4.75 mm),
- 62 % silt (0.002 mm to 0.075 mm), and
- 20 % clay (<0.002 mm).

The silt some clay has stiff consistency based on an uncorrected SPT N value of 9 blows per 305 mm, and is inferred to be over-consolidated. Laboratory tests indicate that the natural moisture content of the soil is approximately 20 %, and it is described as being about plastic limit (APL) to wetter than plastic limit (WTPL) based on the sample inspections.

4.1.4 Sandy Silt Glacial Till

All of the boreholes penetrated into, and were terminated in, a relatively thick deposit of sandy silt to silty sand glacial till soil. The upper surface of the till unit occurs at 0.7 m to 2.2 m depth; it is inferred that the top surface has been disturbed at several locations due to prior site development activities. The till has the following particle size distribution based on laboratory tests (9 samples):

- 2 % to 14 % gravel (>4.75 mm),
- 23 % to 40 % sand (0.075 mm to 4.75 mm),
- 34 % to 63 % silt (0.002 mm to 0.075 mm), and
- 12 % to 18 % clay (<0.002 mm).

The till deposit is loose to very dense, generally being compact to dense, based on uncorrected SPT N values ranging from 5 to over 100 blows per 305 mm. The natural moisture content of the soil ranges from 7 % to 15 % based on laboratory tests.

4.1.5 Bedrock

None of the boreholes encountered bedrock.

4.1.6 Groundwater

Groundwater levels of 1.60 m and 9.60 m below ground level were measured in BH1 and BH4, respectively. It is suspected that this water was perched within the upper fill/subgrade materials, overlying soils with lower hydraulic conductivity at depth. Groundwater seepage was not observed in the other boreholes. Borehole BH3 caved at approximately 5.3 m depth. No significant artesian groundwater pressures were encountered.

5.0 MISCELLANEOUS INFORMATION

5.1 BURIED UTILITY LOCATOR

Buried utility clearances were performed by Cable Master of Newmarket, Ontario (ph: 905-715-7305).

5.2 DRILLING COMPANY IDENTIFICATION

The drilling company used on the assignment was Abraflex of Lively, Ontario (ph: 705-222-2272).

5.3 LABORATORY IDENTIFICATION

Medium complexity laboratory tests were conducted by Golder Associates of Mississauga, Ontario (ph: 905-567-4444), under a subcontract with Jagger Hims Limited.

5.4 SITE INVESTIGATORS

Mr. David Lembke of Jagger Hims Limited supervised the field drilling program. Mr. Stephen Ash, P. Eng. and Mr. Ben McWade, EIT, of Jagger Hims Limited, completed the geotechnical assessments and prepared the reports. Mr. Ash was the project manager and lead contact for the assignment.

6.0 **STRUCTURE FOUNDATION DESIGN**

6.1 **TYPE AND DEPTH OF FOUNDATION**

Based on the subsurface soil profile determined by the borehole investigation, the site location is suitable for a shallow foundation design, and it is recommended that the subject storage structure be supported on reinforced concrete strip footings at least 0.6 m wide.

Foundation loadings should be transferred to the following elevations, relative to the assumed site benchmark described previously:

Borehole No. (existing ground elevation) ¹	Depth to Suitable Bearing Material ²	Elevation of Suitable Bearing Material ¹
BH1 (99.0)	0.8	98.2
BH2 (99.2)	1.4	97.7
BH3 (99.1)	1.0	98.1
BH4 (99.1)	2.2	96.9
BH5 (99.0)	0.8	98.2

Notes:

1. metres above site datum (the top of the onsite well was assigned an elevation of 100.0 m for the investigation).
2. metres below existing ground level

It is recommended that the deleterious materials above the recommended bearing level be subexcavated and replaced with engineered granular fill. The engineered fill should be installed from the base of the subexcavation up to 0.6 m below final exterior grade (i.e. elevation 98.4 masd). As such, an estimated 0.2 m to 1.6 m of engineered granular fill will be required. High density Styrofoam insulation is recommended to protect the foundation subgrade, footings and foundation walls from frost effects, as discussed in Section 10.0.

Footings constructed below the frost penetration depth of 2.4 m could also be considered for this site, alleviating the need for insulation. However, excavation requirements, site disturbance factors and foundation costs are expected to be more substantial for this option.

6.2 BEARING RESISTANCE

In accordance with the MTO Terms of Reference, foundation design for the proposed salt storage facility is based on the procedure stated in Section 6 of the Canadian Highway Bridge Design Code (CHBDC), published by the Canadian Standards Association (CSA/CAN-S6-00). It is understood that shallow depth foundations are preferred, if possible, to minimize the amount of excavation/site disturbance, should shallower subgrade soils be appropriate for structural loadings.

6.2.1 Geotechnical Resistance at ULS

The unfactored bearing resistance at Ultimate Limit State (ULS) for a 0.6 m wide by 18 m long strip footing, installed at a depth of 0.6 m on engineered granular fill placed over an approved clayey silt or sandy silt glacial till subgrade, is 400 kPa. Based on Table 6.6.2.1 of the CHBDC, the factored ULS bearing resistance is 200 kPa.

6.2.2 Geotechnical Reaction at SLS

The geotechnical reaction at Serviceability Limit State (SLS) considers factors outlined in Section 6.6.3 of the CHBDC.

Footing settlement will occur mainly from the live and dead loads applied by the structure. We understand that salt stored within the proposed structure will not be placed against or within 1 m of the foundation wall, so induced stresses below the footings from the material stockpile will be negligible relative to the design structural loadings.

An analysis of the soil profile conditions indicates that clayey silt and glacial till materials are over-consolidated, and the proposed structure is not expected to affect existing subsurface drainage and groundwater levels to a significant degree.

Based on inferred recompression indices for the bearing materials, estimated settlement at the factored ULS loading of 200 kPa will be 25 mm, or less. However, it is recommended that the SLS design loading be limited to 150 kPa to account for soil variability and to limit differential settlement potential to less than 15 mm. Combinations of dead loadings and short-term live loadings (e.g. from equipment traffic, wind) up to the factored ULS bearing resistance could be considered, as permitted by the applicable building codes.

6.3 LATERAL RESISTANCE

The factored geotechnical horizontal soil resistance for a 0.6 m wide by 18 m long strip footing constructed at the recommended design depth is calculated as 648 kN. Passive soil resistance is not included in this value.

7.0 EARTH PRESSURE DESIGN

No shoring or earth retaining systems are anticipated for the project, so lateral earth pressure design requirements are minimal.

The following active (K_a) and passive (K_p) earth pressure coefficients are recommended, using a resistance factor of 0.5 applied to an estimated 35° internal friction angle for assumed granular foundation backfill:

- $K_a = 0.5$
- $K_p = 1.9$

Compaction pressures should be added to lateral pressure computations in accordance with Section 6.9.3 of CHBDC, if appropriate.

8.0 SEISMIC DESIGN

Seismic surveys were beyond the scope of the assignment. However, based on Table 4.1.8.4.A of the Ontario Building Code and the inferred compact to very dense soil conditions encountered during the investigation, it is recommended that Site Class C be used for seismic design (if required). Acceleration and velocity based site coefficients can be obtained from Tables 4.1.8.4.B and 4.1.8.4.C.

9.0 UNWATERING AND SUBDRAINAGE

With the exception of removing accumulated precipitation and runoff from the foundation excavations, no groundwater unwatering is required for construction.

The foundation grade is above the groundwater table, so no subdrains are recommended.

10.0 FROST PENETRATION

Based on the MTC report RR225 “Aspects of Prolonged Exposure of Pavements to Sub-Zero Temperatures,” the depth of frost penetration for the Nagagami Patrol Yard is 2.4 m. Based on sample inspections and laboratory tests, site materials within that depth include clayey silt, silt with some clay and sandy silt glacial till soil. The silty materials contain up to approximately 46 percent particles in the 0.005 to 0.075 mm size range, and therefore are considered to have medium susceptibility to frost heaving (MSFH). The site soils are well drained, and groundwater is not a factor within the frost penetration depth.

To provide sufficient foundation protection against frost heave and frost adhesion, we recommend that footings and foundation walls be insulated with high density Styrofoam board with the following minimum specifications:

- compressive strength of 215 kPa
- thermal resistance of 0.87 m²°C/W
- water absorption less than 0.7 % by volume

The Styrofoam insulation board should be at least 75 mm thick, placed at the top of footing grade (approximately 0.55 m below ground level), and should extend horizontally at least 1.8 m from both faces of the foundation wall. The insulation board should also be placed on both vertical sides of the footing or grade beam, extending from the ground surface to the top of footing grade. The horizontal insulation board should abut the vertical board to form a tightly sealed joint.

11.0 BEDROCK EXCAVATION

No bedrock excavation is required for shallow foundation construction at this site.

12.0 CONSTRUCTION CONCERNS

12.1 SITE PREPARATION

Site preparation will involve stripping loose surficial materials, subexcavation of deleterious materials below footings, and placement of granular engineered fill to design elevations. Trenching will be required for the foundation excavation and should be conducted in accordance with OPSS 206 and the Occupational Health and Safety Act (OHSA). Type 3 soil materials should be assumed, and the sides of trenches should be sloped at 1:1, maximum. Engineered fill to replace subexcavated material below foundation footings shall consist of Granular A, per SP 110S13 amending OPSS 1010, compacted to

100 percent of standard Proctor maximum dry density (ASTM D698), in accordance with OPSS 206, 501 and 514 as applicable.

Site preparation is expected to involve leveling and grading of the building area to the design subgrade elevations. A finished floor/exterior grade elevation of 99 masd has been suggested in this report, which is consistent with existing onsite structures and areas. Fill below the pavement structure (including the building floor) areas should consist of Granular B (Type I or II), per SP 110S13 amending OPSS 1010, and fill should be placed and compacted in accordance with OPSS 206, 501 and 514, as applicable.

12.2 FOUNDATION BACKFILL

Foundation backfill must be free-draining, non-frost susceptible granular material such as Granular B (Type I or II), or an approved equivalent. Backfill must be placed and compacted in accordance with OPSS 501.

12.3 PAVEMENT DESIGN

The following pavement structure has been recommended for the interior of the proposed structure.

Material	GBE Factor	GBE (mm)
40 mm Superpave 12.5 surface course	2.0	80
50 mm Superpave 12.5 binder course	2.0	100
150 mm Granular A base	1.0	150
Total = 240 mm		Total GBE= 330 mm

The following pavement structure is recommended for the 10 m apron surrounding the structure.

Material	GBE Factor	GBE (mm)
50 mm Superpave 12.5 surface course	2.0	100
150 mm Granular A base	1.0	150
<i>Total = 200 mm</i>		<i>Total GBE = 250 mm</i>

Pavement design details are provided in our memorandum dated December 15, 2008.

12.4 SPECIAL REQUIREMENTS

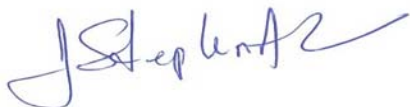
Should perched groundwater be encountered during the excavation process, precautions must be taken during construction to limit subgrade soil disturbance, and maintain dry and stable conditions.

The insulated foundation design will require a foundation trench at least 4 m wide, not including setbacks for side slopes.

13.0 CLOSURE

This concludes the foundation investigation and design report for the proposed structure. Please direct any questions to the undersigned.

JAGGER HIMS LIMITED



J. Stephen Ash, P. Eng.
Branch Manager



Andrew G. Hims, P.Eng.
Consulting Engineer

APPENDIX

BOREHOLE LOGS GRAIN SIZE ANALYSES

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. NAGAGAMI PATROL YARD LOCATION NORTHEASTERN REGION ORIGINATED BY DCL
 DIST ALGOMA HWY 11 BOREHOLE TYPE 110 mm I.D HSA / 51 mm O.D SPLIT SPOON COMPILED BY BPM
 DATUM RELATIVE / m BELOW GROUND DATE 2008 05 08 - 2008 05 08 CHECKED BY JSA

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
99.0	ASPHALT (64 mm)												
0.0	GRAVELLY SAND; BROWN GRAVELLY SAND, SATURATED, LOOSE	1	SS	5									
98.3													
0.7	CLAYEY SILT; BROWN CLAYEY SILT, TRACE SAND, WTPL, STIFF -DARK BROWN ORGANIC SILT SEAM AT 0.7 m DEPTH -BROWN SAND SEAM AT 1.9 m DEPTH	2	SS	14									3 15 56 26
96.8		3	SS	16									
2.2	SANDY SILT TILL; BROWN SANDY SILT TILL, SOME TO TRACE GRAVEL, TRACE TO SOME CLAY, SATURATED, COMPACT TO DENSE	4	SS	8									14 40 34 12
		5	SS	23									
		6	SS	57									7 32 49 12
		7	SS	29									GROUNDWATER PERCHED WITHIN SILT UNIT AT 1.6 mbgl. BOREHOLE CAVED AT 1.7 mbgl
		8	SS	19									
		9	SS	16									
		10	SS	20									
		11	SS	27									
		12	SS	35									
		13	SS	24									
83.2													
15.8	BOREHOLE TERMINATED AT 15.8 m IN SANDY SILT TILL												

ONTARIO MOT MTO-3080770.08.GPJ ONTARIO MOT.GDT 2/2/09

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. NAGAGAMI PATROL YARD LOCATION NORTHEASTERN REGION ORIGINATED BY DCL
 DIST ALGOMA HWY 11 BOREHOLE TYPE 110 mm I.D HSA / 51 mm O.D SPLIT SPOON COMPILED BY BPM
 DATUM RELATIVE / m BELOW GROUND DATE 2008 05 09 - 2008 05 09 CHECKED BY JSA

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			20	40	60	80	100					
99.2	ASPHALT (64 mm)															
0.0	GRAVELLY SAND: BROWN GRAVELLY SAND, TRACE TO SOME SILT, MOIST, COMPACT	1	SS	19		99										31 59 10
0.7	SILT: BROWN SILT, SOME SAND, SOME CLAY, APL TO WTPL, STIFF	2	SS	9		98										18 62 20
97.7	SANDY SILT TILL: BROWN SANDY SILT, SOME TO TRACE GRAVEL, SOME TO TRACE CLAY, MOIST, COMPACT TO VERY DENSE	3	SS	31		97										BOREHOLE DRY AND STABLE ON COMPLETION
1.4		4	SS	19		96										
		5	SS	22		95										
		6	SS	66		94										
		7	SS	51		93										
		8	SS	42		92										
		9	SS	55		91										
		10	SS	42		90										
		11	SS	41		89										
		12	SS	39		88										
		13	SS	56		84										5 33 48 14
83.4	BOREHOLE TERMINATED AT 15.9 m IN SANDY SILT TILL															
15.8																

ONTARIO MOT. MTO-3080770.08.GPJ. ONTARIO MOT.GDT. 2/2/09

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. NAGAGAMI PATROL YARD LOCATION NORTHEASTERN REGION ORIGINATED BY DCL
 DIST ALGOMA HWY 11 BOREHOLE TYPE 110 mm I.D HSA / 51 mm O.D SPLIT SPOON COMPILED BY BPM
 DATUM RELATIVE / m BELOW GROUND DATE 2008 05 09 - 2008 05 09 CHECKED BY JSA

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			20	40	60	80	100					
99.1	ASPHALT (51 mm)															
0.0	GRAVELLY SAND: GREY GRAVELLY SAND TO SILTY SAND, SOME GRAVEL, MOIST, COMPACT CLAYEY SILT: BROWN TO GREY CLAYEY SILT, TRACE SAND, WTPL -BLACK ORGANIC SILT SEAM AT 0.8 m DEPTH (130 mm THICK)	1	SS	11		99										
98.5		2	SS	16		98										9 63 28
0.6		3	SS	17		97										
96.9	SANDY SILT TILL: BROWN TO GREY SANDY SILT TILL, SOME TO TRACE GRAVEL, SOME CLAY, MOIST, COMPACT TO VERY DENSE	4	SS	14		96										2 23 63 12
2.2		5	SS	22		95										BOREHOLE DRY, CAVED AT 5.3 mbgl AFTER AUGER REMOVED
		6	SS	81		94										
		7	SS	34		93										
		8	SS	30		92										
90.9	BOREHOLE TERMINATED AT 8.2 m IN SANDY SILT TILL					91										
8.2																

RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. NAGAGAMI PATROL YARD LOCATION NORTHEASTERN REGION ORIGINATED BY DCL
 DIST ALGOMA HWY 11 BOREHOLE TYPE 110 mm I.D HSA / 51 mm O.D SPLIT SPOON COMPILED BY BPM
 DATUM RELATIVE / m BELOW GROUND DATE 2008 05 10 - 2008 05 10 CHECKED BY JSA

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								WATER CONTENT (%)		
								○ UNCONFINED		+ FIELD VANE							● QUICK TRIAXIAL	
99.1	ASPHALT (51 mm)						20	40	60	80	100	10	20	30	GR SA SI CL			
0.0	SAND: BROWN SAND, SOME GRAVEL, TRACE SILT, TRACE CLAY, WET, COMPACT		1	SS	12	▽	99								21 71 5 3			
98.5	WOOD FRAGMENTS: PINE FRAGMENTS, NO SOIL RECOVERED, SATURATED	X X X X X X X X X	2	SS	19		98											
0.7																		
97.7	SAND: GREY SAND, WOOD FIBRES, SATURATED, LOOSE		3	SS	5		97									5 25 52 18		
1.4																		
96.9	SANDY SILT TILL: GREY SANDY SILT TILL, SOME TO TRACE GRAVEL, TRACE TO SOME CLAY, MOIST TO WET, LOOSE TO DENSE		4	SS	10		96											
2.2																		
			6	SS	57		94											
			7	SS	55		93									5 35 47 13		
			8	SS	20		92											
			9	SS	21	90												
			10	SS	19	89									GROUNDWATER AT 9.6 mbgl, BOREHOLE CAVED AT 9.7 mbgl			
			11	SS	37	87												
			12	SS	6	86												
														</				

RECORD OF BOREHOLE No 5

1 OF 1

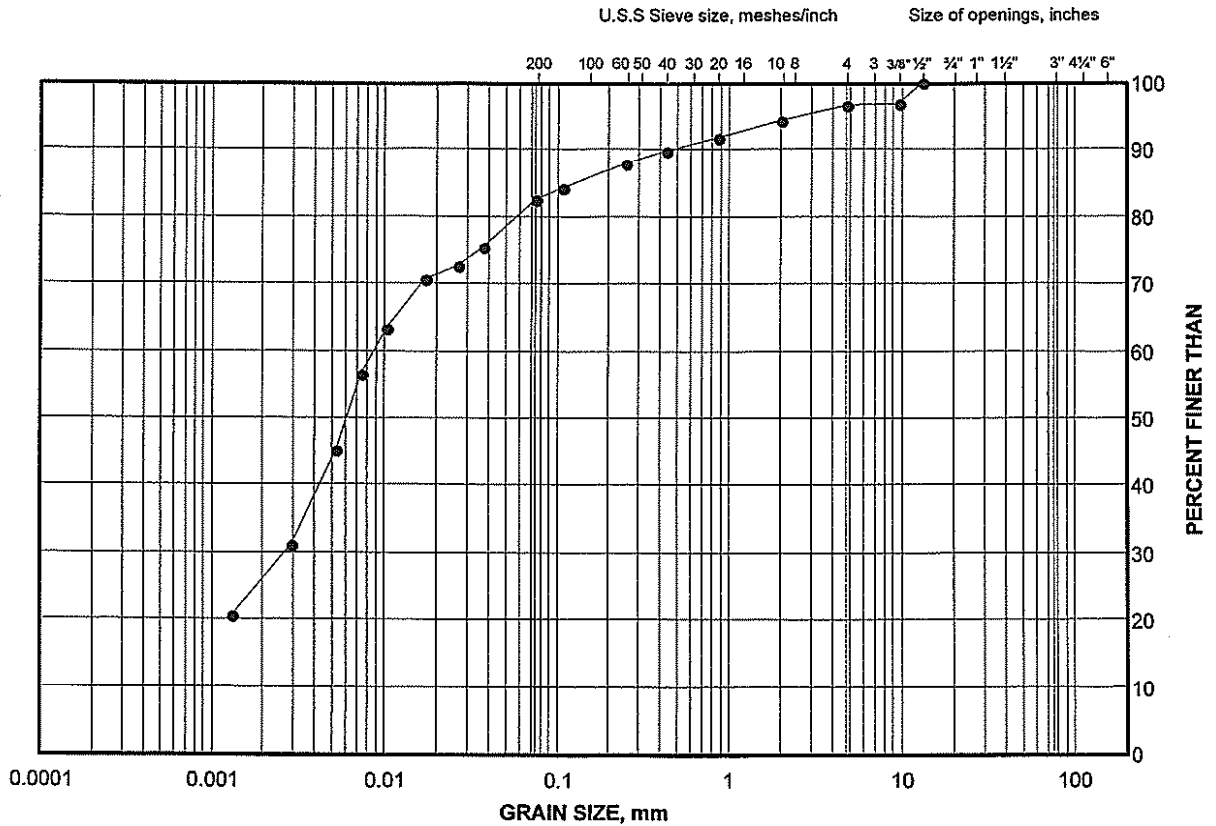
METRIC

W.P. NAGAGAMI PATROL YARD LOCATION NORTHEASTERN REGION ORIGINATED BY DCL
 DIST ALGOMA HWY 11 BOREHOLE TYPE 110 mm I.D HSA / 51 mm O.D SPLIT SPOON COMPILED BY BPM
 DATUM RELATIVE / m BELOW GROUND DATE 2008 05 10 - 2008 05 10 CHECKED BY JSA

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80	100	W _p	W		
99.0																
0.0	SAND: BROWN SAND, SATURATED		1	AS												
98.3																
0.7	SAND AND SILT: BROWN SAND AND SILT, SOME GRAVEL, SOME CLAY, MOIST, LOOSE TO VERY DENSE		2	SS	9											12 38 36 14
			3	SS	6											10 34 42 14
			4	SS	20											
			5	SS	18											4 28 52 16
			6	SS	109											BOREHOLE DRY AND STABLE ON COMPLETION
			7	SS	85											
			8	SS	51											
90.8																
8.2	BOREHOLE TERMINATED AT 8.2 m IN SANDY SILT															

GRAIN SIZE DISTRIBUTION

FIGURE




SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
•	08-1	2	0.80 - 1.40

REMARKS
3080770.08

Project Number: 08-1116-0020

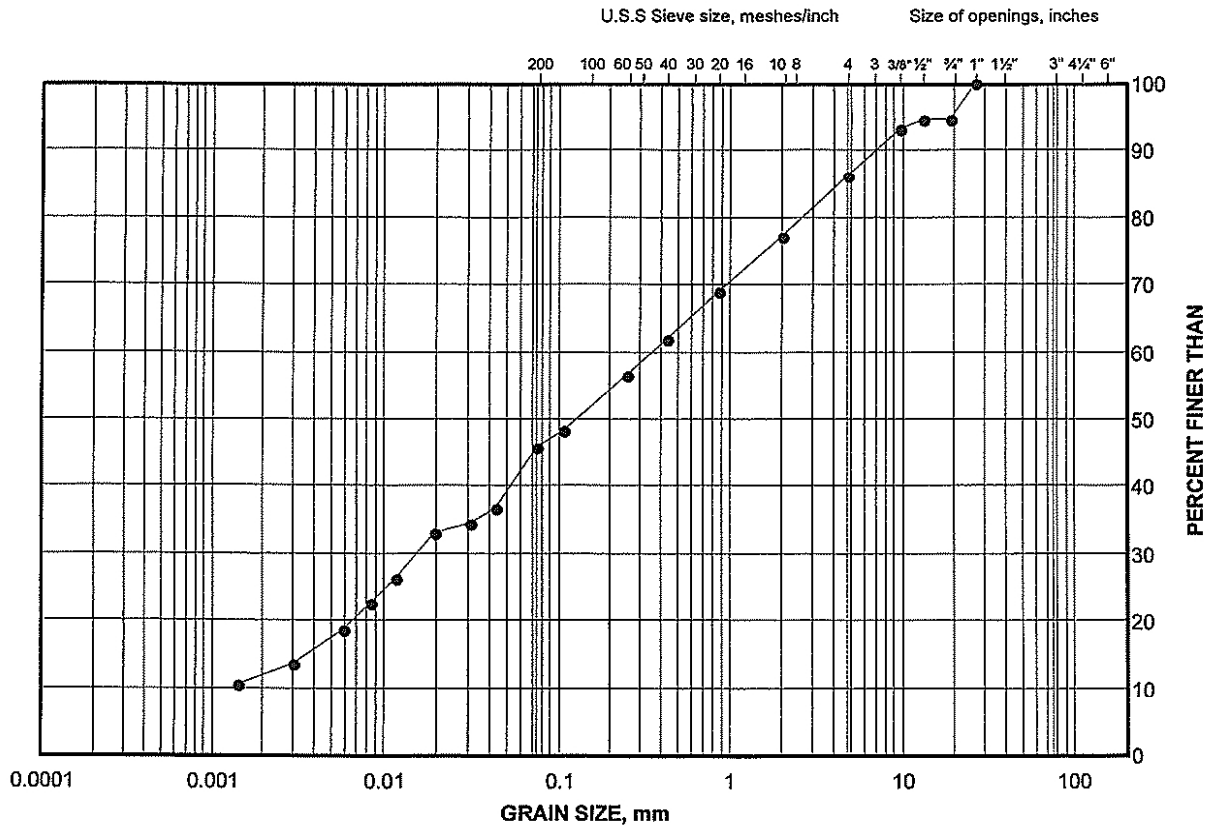
Checked By: 

Golder Associates

Date: 30-Jul-08

GRAIN SIZE DISTRIBUTION

FIGURE



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
•	08-1	4	2.30 - 2.90

REMARKS
3080770.08

Project Number: 08-1116-0020

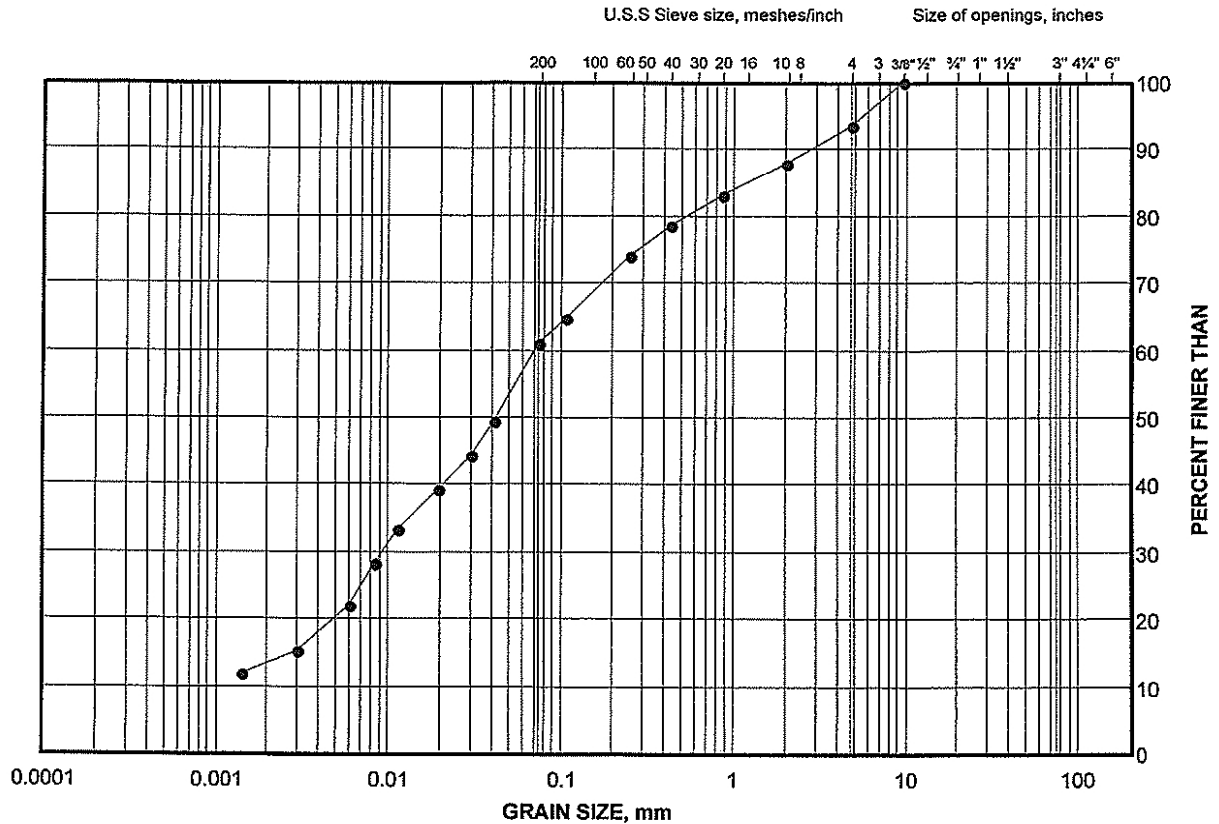
Checked By: *[Signature]*

Golder Associates

Date: 31-Jul-08

GRAIN SIZE DISTRIBUTION

FIGURE



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
•	08-1	6	4.60 - 5.20

REMARKS
3080770.08

Project Number: 08-1116-0020

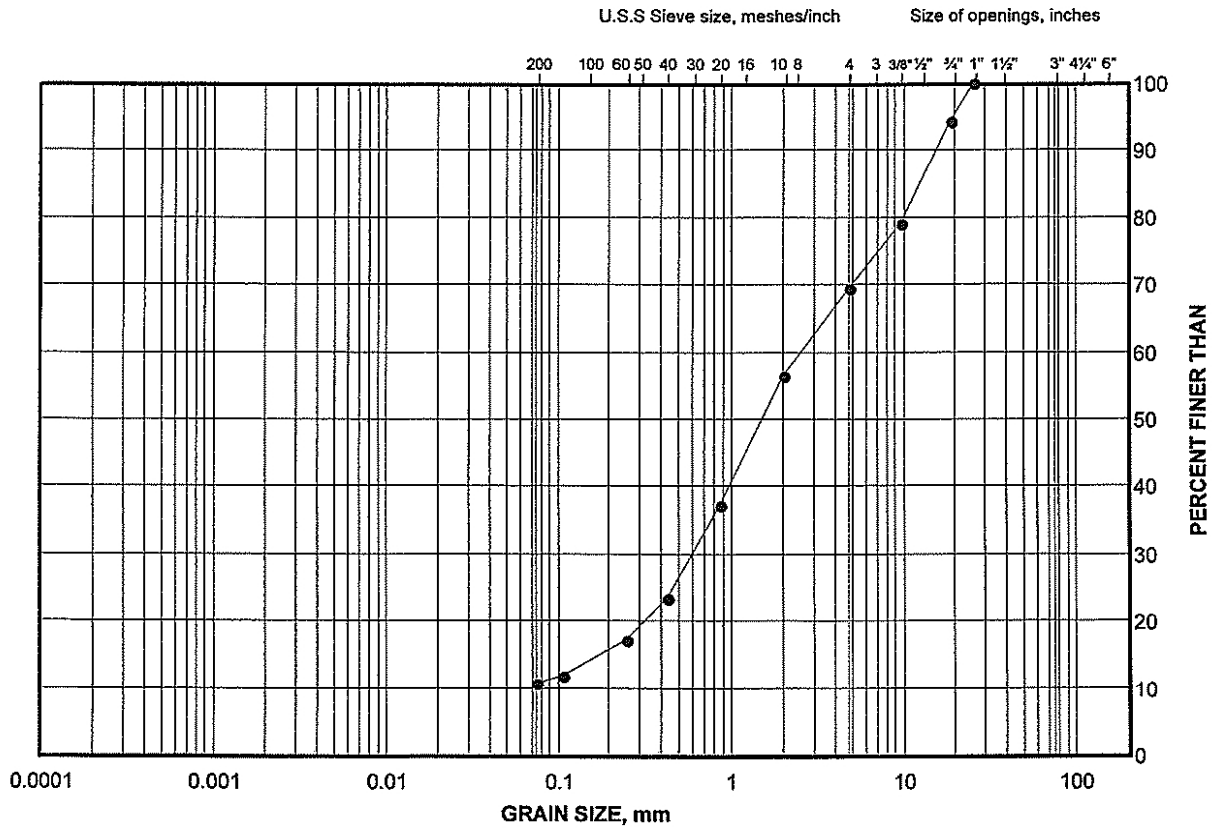
Checked By: *[Signature]*

Golder Associates

Date: 31-Jul-08

GRAIN SIZE DISTRIBUTION

FIGURE



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
•	08-2	1	0.00 - 0.60

REMARKS
3080770.08

Project Number: 08-1116-0020

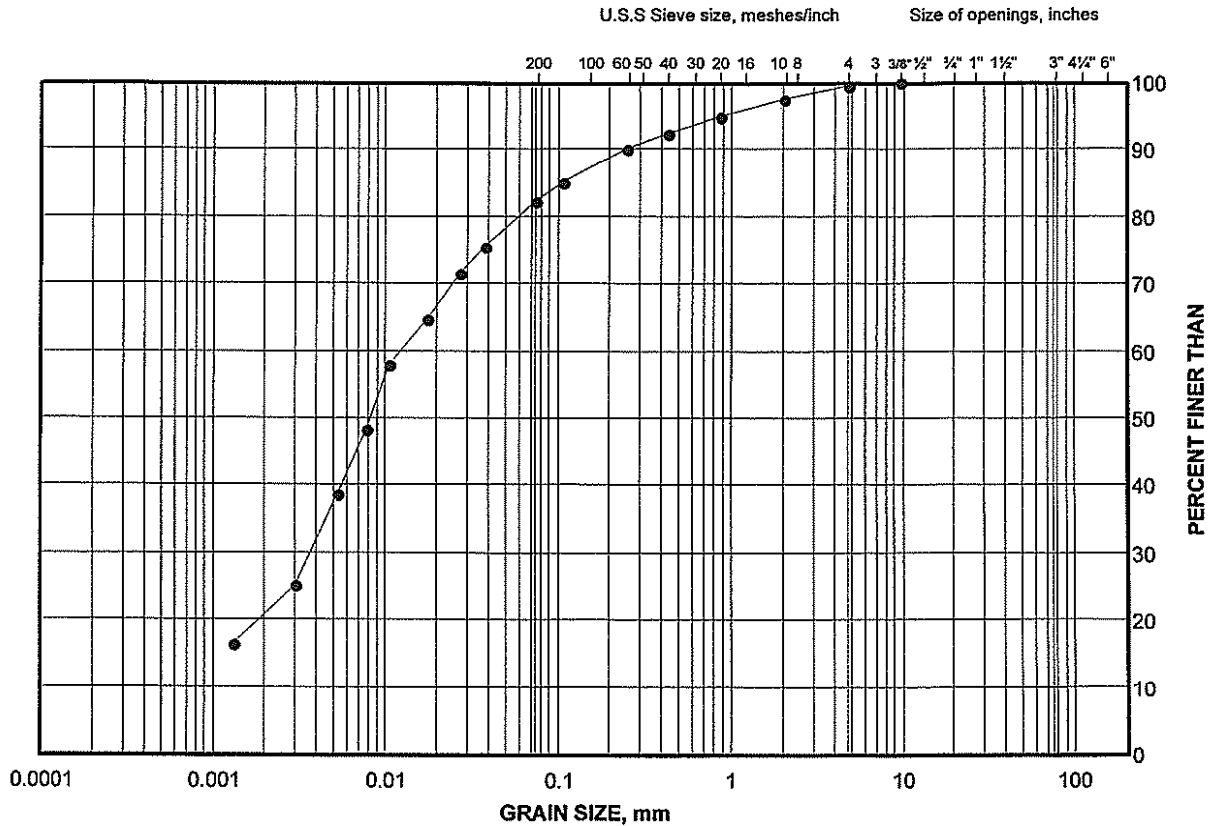
Checked By: 

Golder Associates

Date: 29-Jul-08

GRAIN SIZE DISTRIBUTION

FIGURE



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
•	08-2	2	0.80 - 1.40

REMARKS
3080770.08

Project Number: 08-1116-0020

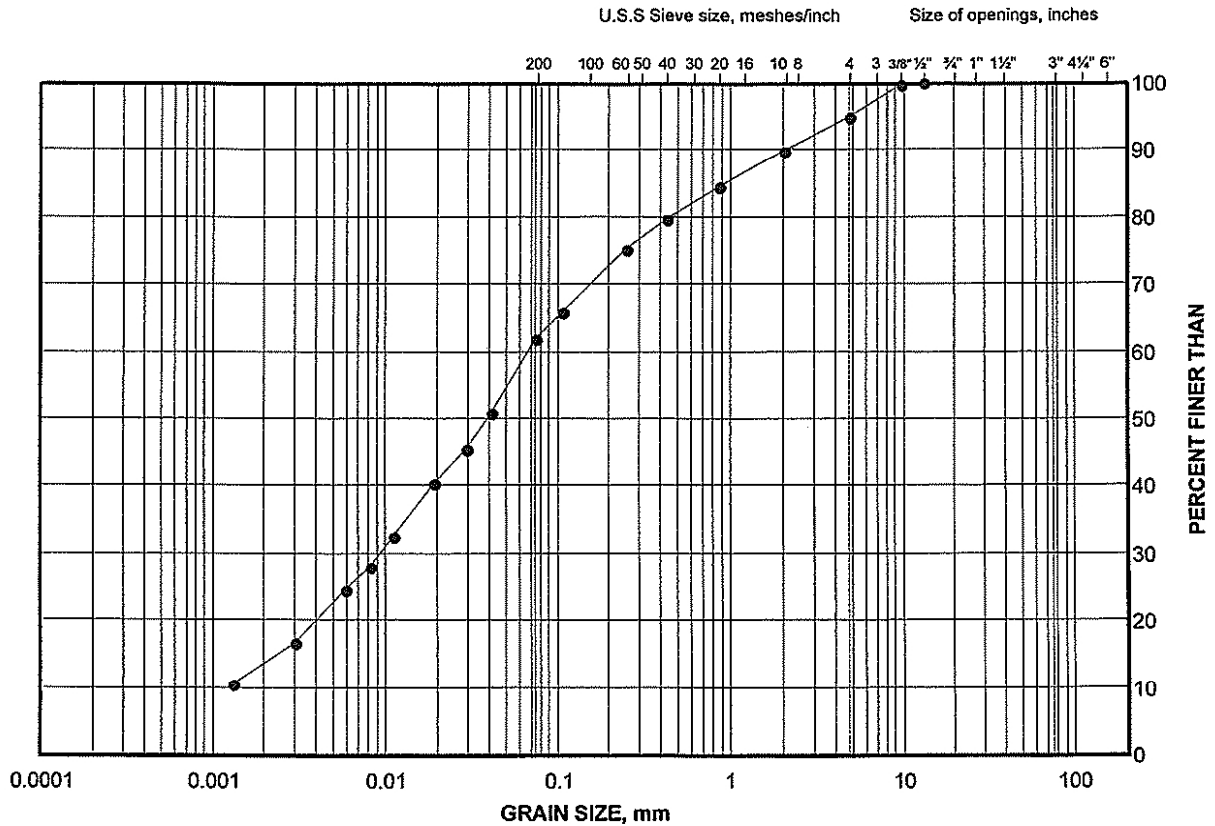
Checked By: 

Golder Associates

Date: 29-Jul-08

GRAIN SIZE DISTRIBUTION

FIGURE



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
•	08-2	8	7.60 - 8.20

REMARKS
3080770.08

Project Number: 08-1116-0020

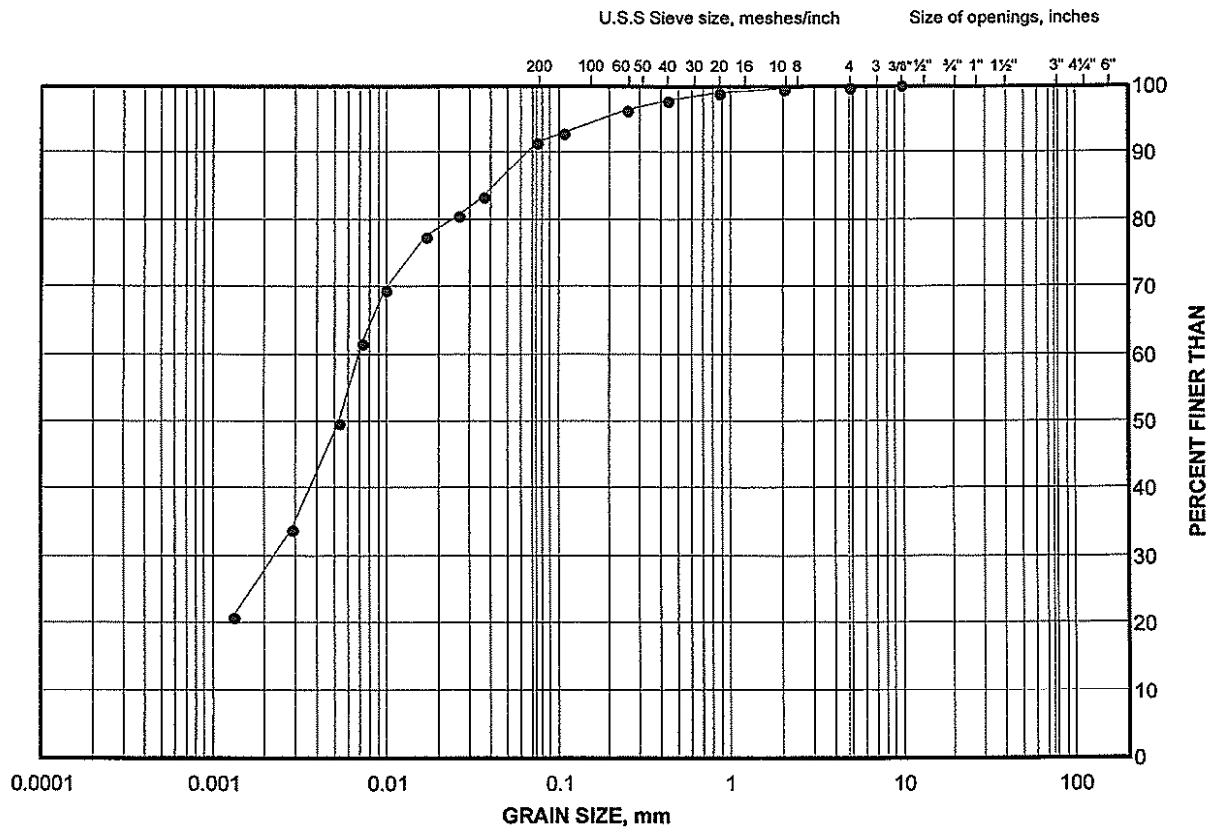
Checked By:

Golder Associates

Date: 30-Jul-08

GRAIN SIZE DISTRIBUTION

FIGURE



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
•	08-3	2	0.80 - 1.20

REMARKS
3080770.08

Project Number: 08-1116-0020

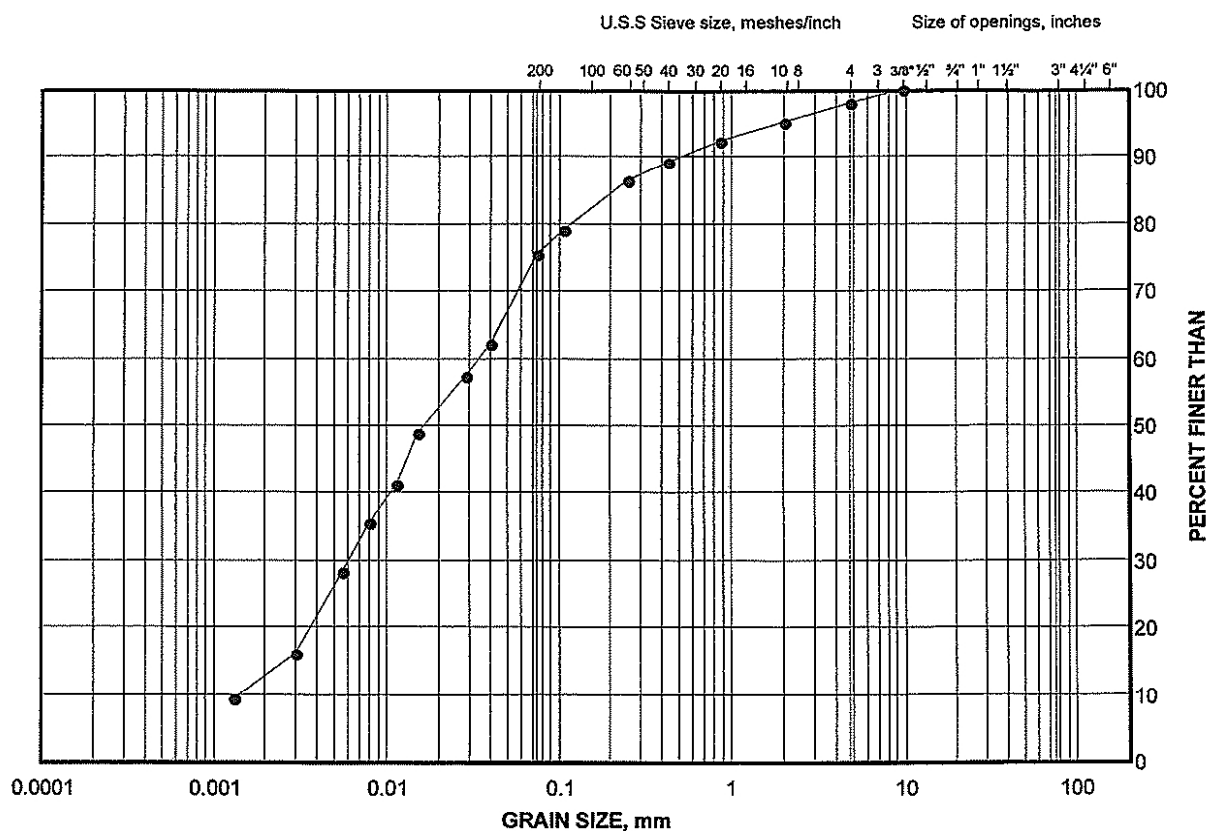
Checked By: 44

Golder Associates

Date: 30-Jul-08

GRAIN SIZE DISTRIBUTION

FIGURE



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
•	08-3	4	2.30 - 2.90

REMARKS
3080770.08

Project Number: 08-1116-0020

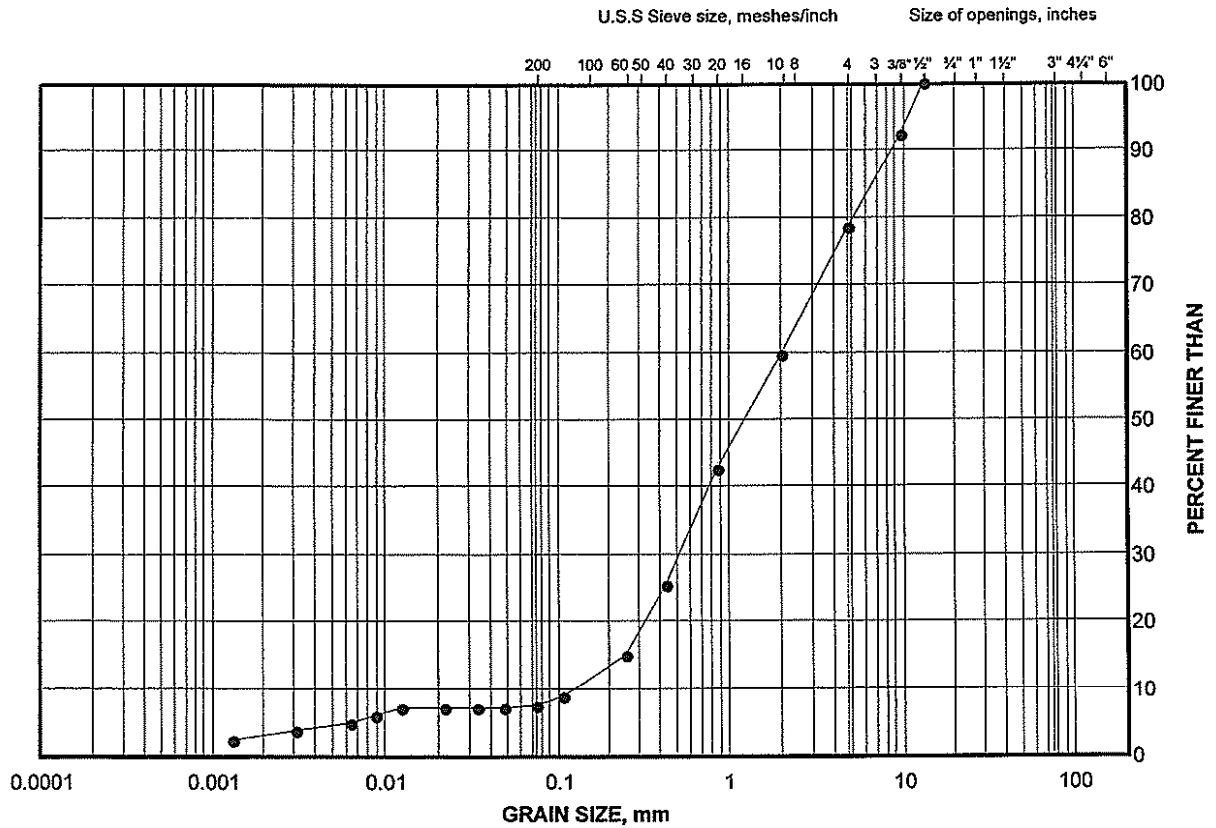
Checked By: *[Signature]*

Golder Associates

Date: 29-Jul-08

GRAIN SIZE DISTRIBUTION

FIGURE



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
•	08-4	1	0.00 - 0.60

REMARKS
3080770.08

Project Number: 08-1116-0020

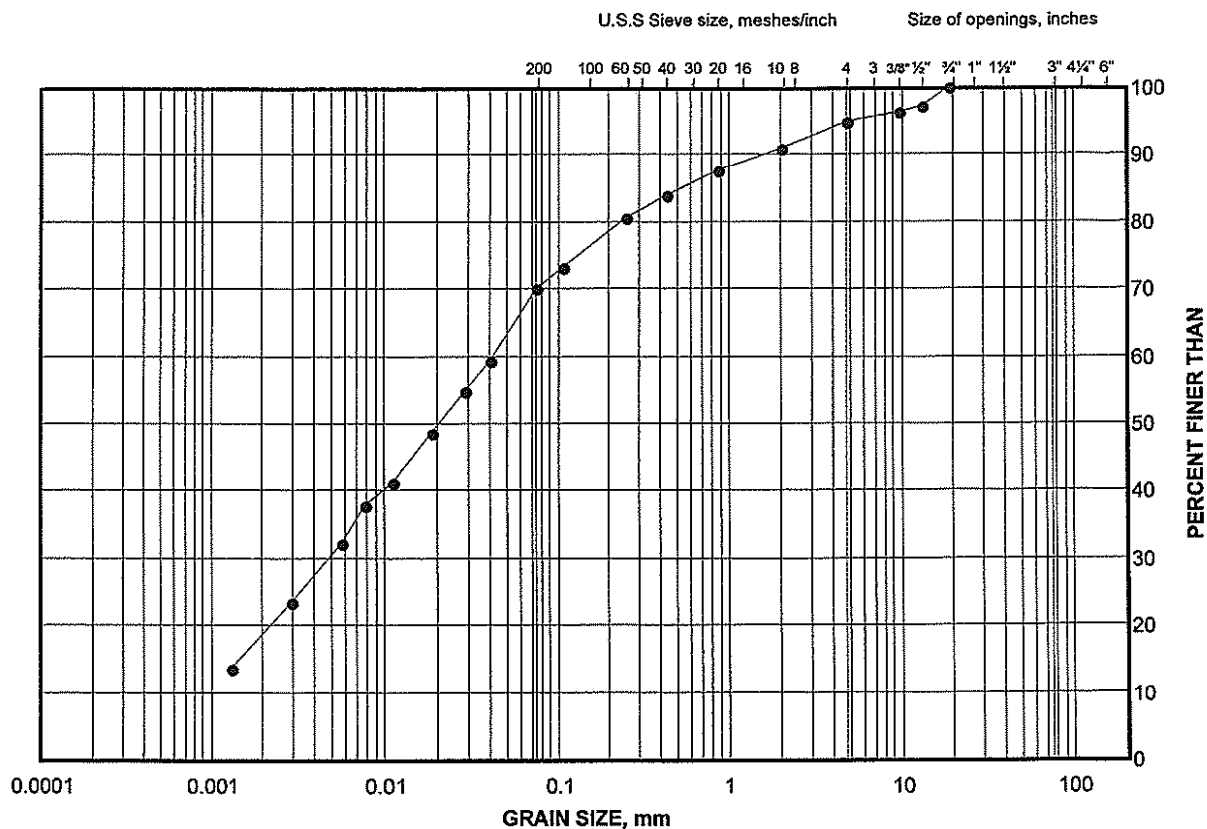
Checked By: 

Golder Associates

Date: 30-Jul-08

GRAIN SIZE DISTRIBUTION

FIGURE



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
•	08-4	4	2.30 - 2.90

REMARKS
3080770.08

Project Number: 08-1116-0020

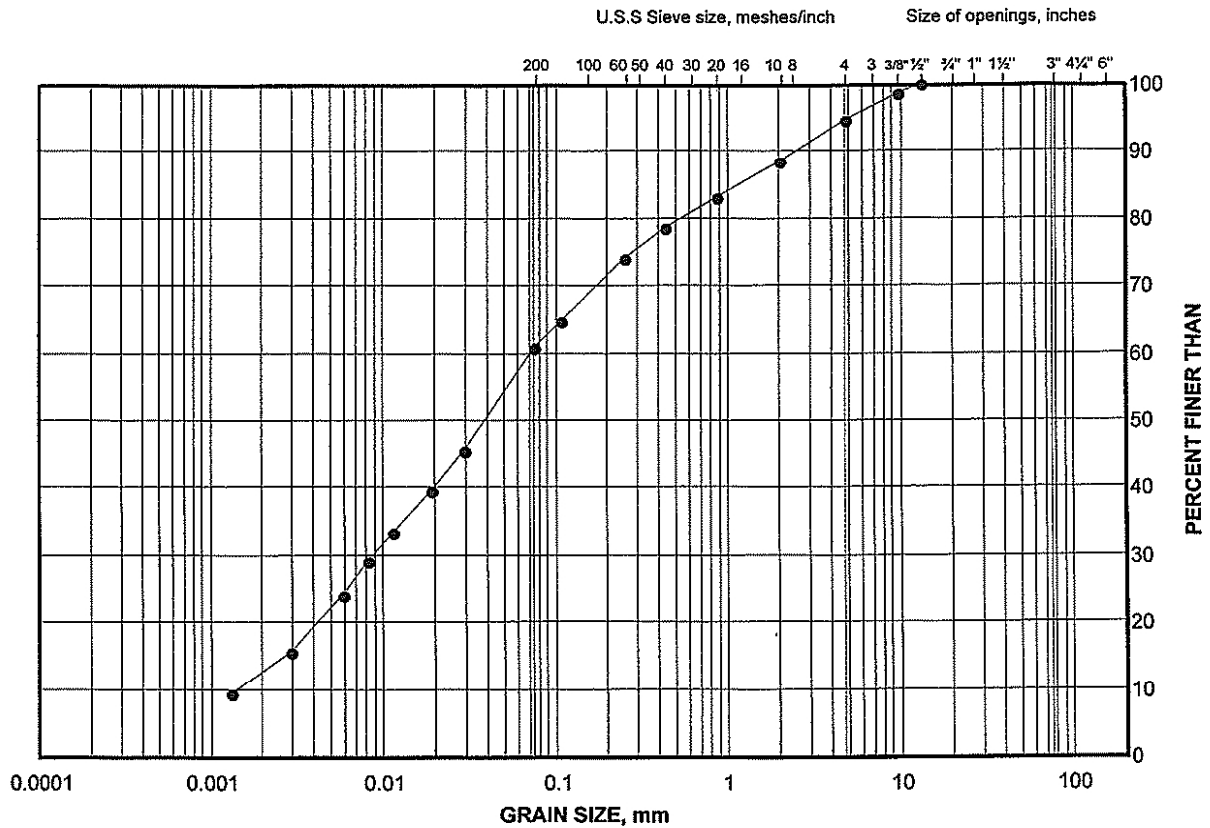
Checked By: _____

Golder Associates

Date: 30-Jul-08

GRAIN SIZE DISTRIBUTION

FIGURE



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
•	08-4	7	6.10 - 6.70

REMARKS
3080770.08

Project Number: 08-1116-0020

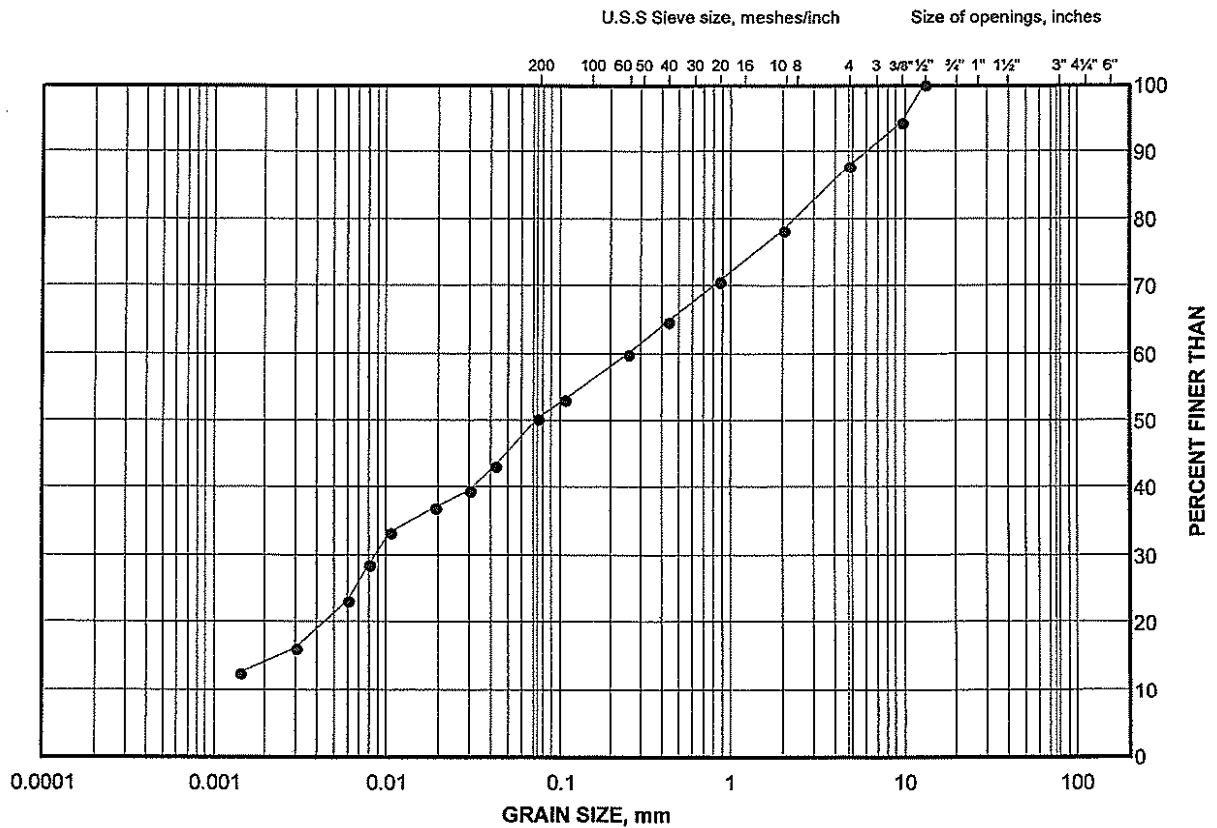
Checked By:

Golder Associates

Date: 30-Jul-08

GRAIN SIZE DISTRIBUTION

FIGURE



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
•	08-5	2	0.80 - 1.40

REMARKS
3080770.08

Project Number: 08-1116-0020

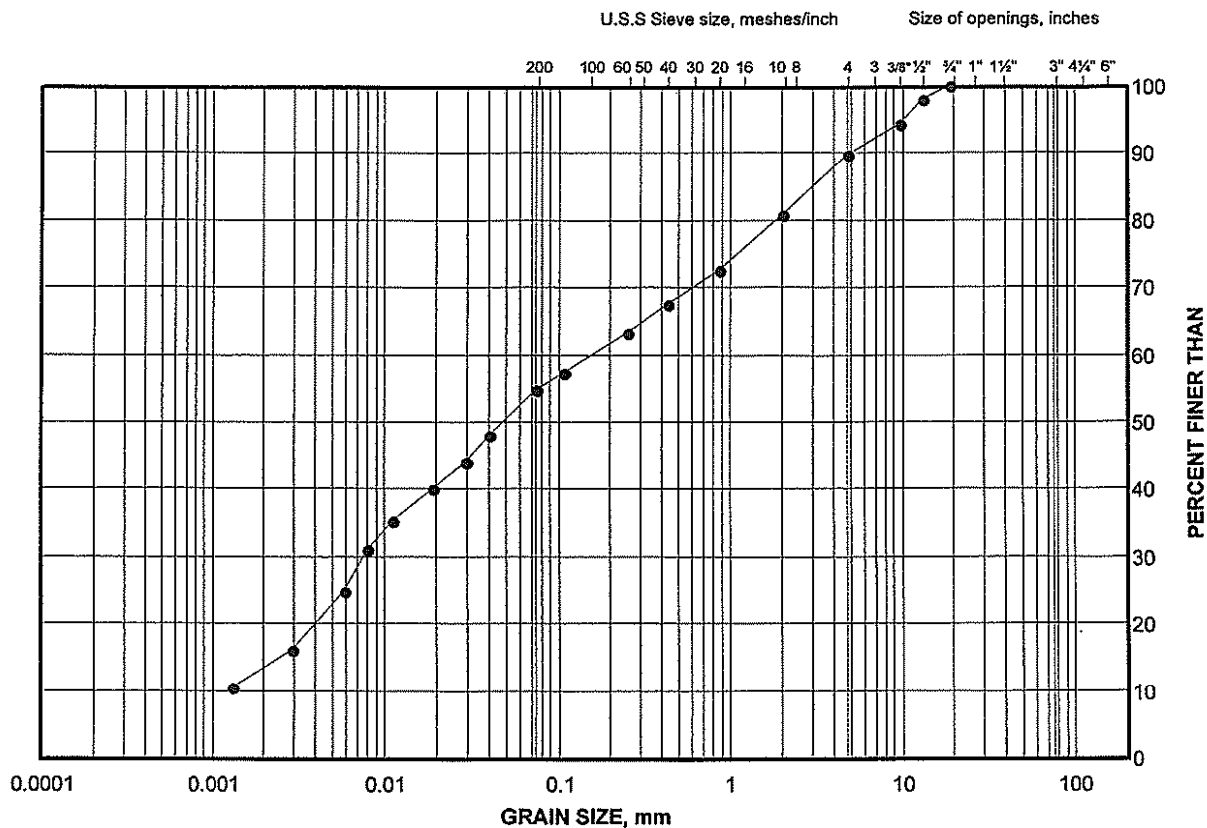
Checked By: 

Golder Associates

Date: 31-Jul-08

GRAIN SIZE DISTRIBUTION

FIGURE



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
•	08-5	3	1.50 - 2.10

REMARKS
3080770.08

Project Number: 08-1116-0020

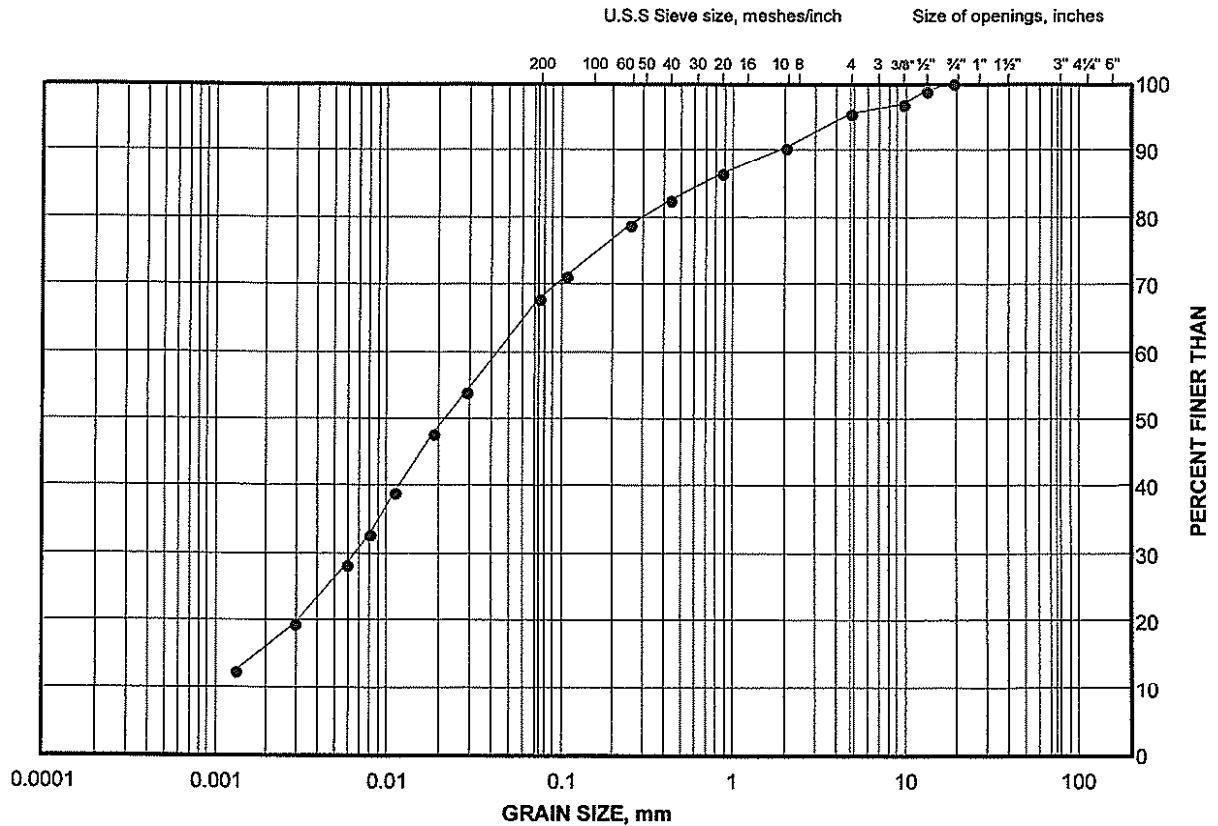
Checked By: *[Signature]*

Golder Associates

Date: 30-Jul-08

GRAIN SIZE DISTRIBUTION

FIGURE



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
•	08-5	5	3.10 - 3.70

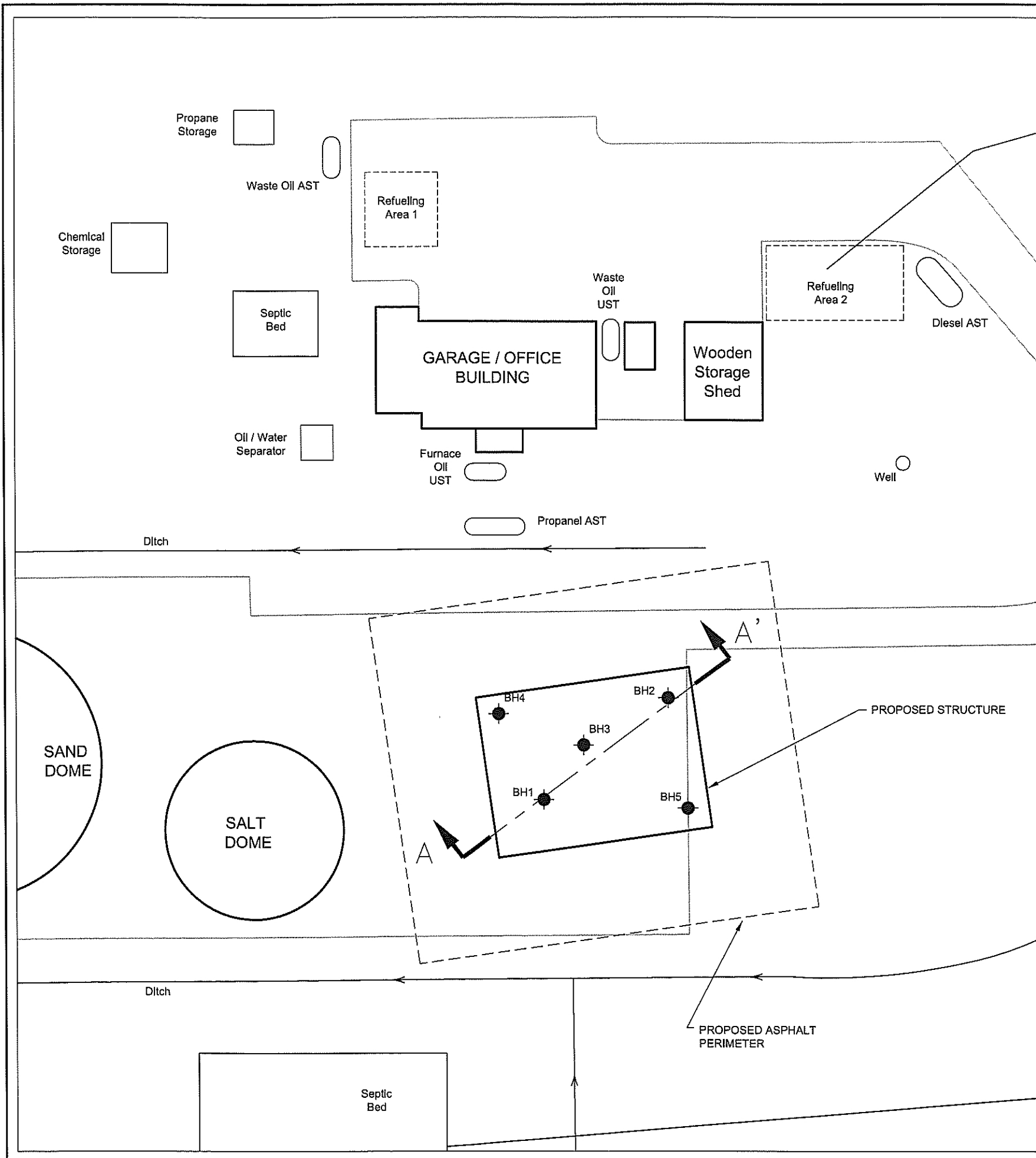
REMARKS
3080770.08

Project Number: 08-1116-0020

Checked By:

Golder Associates

Date: 30-Jul-08

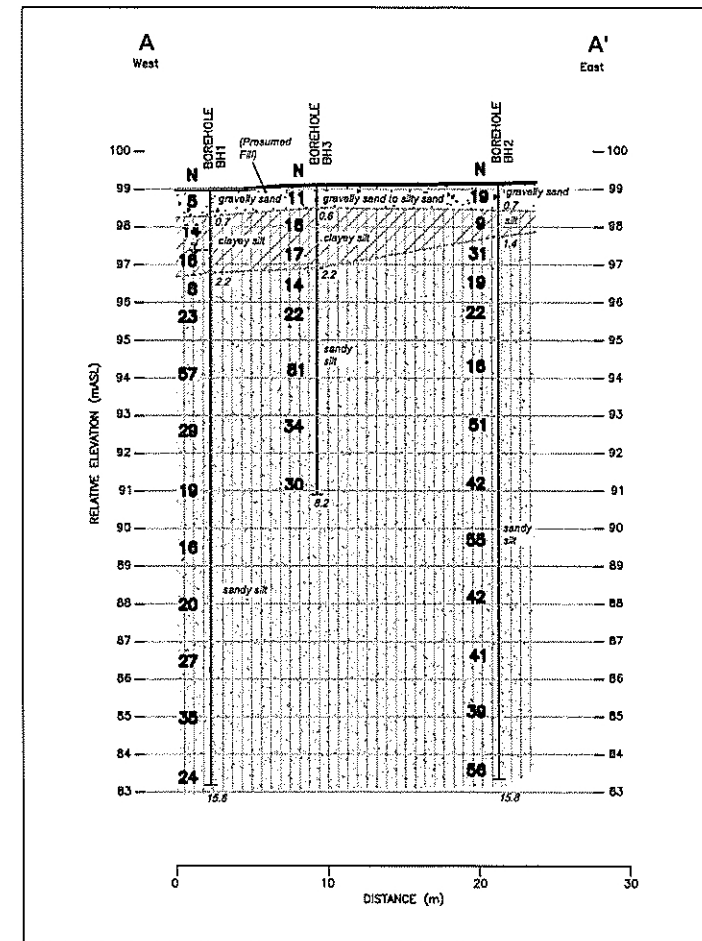


METRIC

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

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 THE TOP OF THE WELL CASING (ASSUMED 100 m).

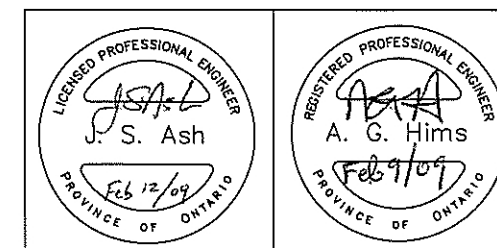


CROSS SECTION A-A'

PLAN VIEW

SCALE 1:500
0 5 10 m

JAGGER HIMS LIMITED
Environmental Consulting Engineers



REF. NO.:
JAGGER HIMS LIMITED DRAWING: 3-08077008F1-SP Nagagami.dwg,
DATED DECEMBER, 2008.

Agreement No.: 5007-E-0052

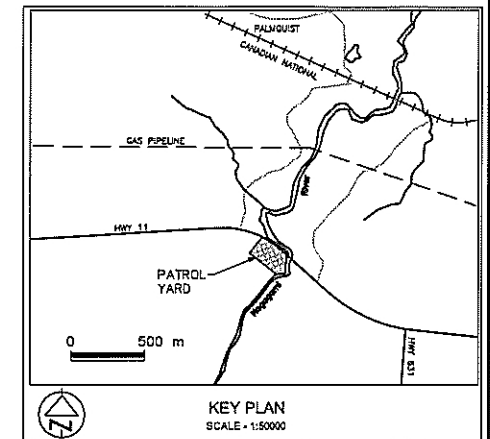


PATROL FACILITY SITE PLAN

NAGAGAMI PATROL YARD
KING'S HIGHWAY 11

FIGURE

1



KEY PLAN
SCALE = 1:50000

LEGEND

- Borehole
- N Blows/0.3m (Std. Pen Test, 475 J / blow)
- Water Level At Time Of Investigation

BH No	RELATIVE ELEVATION (m)	COORDINATES (WGS84)	
		LATITUDE	LONGITUDE
1	98.984	49° 46' 19.4"	84° 32' 23.2"
2	99.152	49° 46' 19.6"	84° 32' 22.3"
3	99.104	49° 46' 19.4"	84° 32' 22.8"
4	99.144	49° 46' 19.6"	84° 32' 23.2"
5	99.025	49° 46' 19.1"	84° 32' 22.4"

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.

DATE	BY	DESCRIPTION

HWY. No. 11	CHECKED JSH	DATE DEC 2008	SITE
SUBM'D	CHECKED	APPROVED	DWG