Golder Associates Ltd.

309 Exeter Road, Unit #1
London, Ontario, Canada N6L 1C1
Telephone: (519) 652-0099
Fax: (519) 652-6299

FOUNDATION INVESTIGATION AND DESIGN REPORT

MTO FERRY DOCK AT PELEE ISLAND
DISTRICT #31 CHATHAM, SOUTHWESTERN REGION
WORK ORDER NUMBER 01-33-001
PURCHASE ORDER NUMBER 3005-A-000218

Submitted to:

Morrison Hershfield Limited
235 Yorkland Boulevard
Toronto, Ontario
M2J 1T1

DISTRIBUTION:

12 Copies - Morrison Hershfield Limited
2 Copies - Golder Associates Ltd.

October 20, 2005

021-4216-1-3
Geocres No. 40G15-2

TABLE OF CONTENTS

TABLE OF CONTENTS CONTINUED

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Morrison Hershfield Limited (Morrison Hershfield) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out additional preliminary foundation investigations for the MTO ferry docks at Leamington, Kingsville and Pelee Island in conjunction with Work Order Number 01-33-001. This report addresses the additional investigation at the Pelee Island dock site.

The purpose of this foundation investigation is to determine the subsurface conditions in front of the sheet pile wall and to obtain the soil parameters and lake information necessary to revise and complete stability calculations for the sheet pile walls. The work includes drilling three new boreholes at each site as well as utilizing existing borehole, lake level and scour/dredging data. The terms of reference for the scope of work are outlined in Golder's proposal for additional preliminary foundations engineering services dated August 18, 2004. The work was carried out in accordance with our Quality Control Plan dated October 30, 2002.

The report is provided as part of the planning phase of the project. Morrison Hershfield provided Golder with drawings for the existing dock and scour profiles.

The results of previous foundation investigations carried out at the site were reviewed during preparation of this report and the relevant borehole records from those reports are provided in Appendix A in their original format. The previous reports are:

- Golder Associates report number 881-3342 prepared for Public Works Canada entitled "Geotechnical Investigations, West Wharf and Scudder Wharf, Pelee Island, Ontario", dated November 7, 1988.

- Golder Associates report number 881-3342-1 prepared for Public Works Canada entitled "Supplementary Geotechnical Investigations, West Wharf and Scudder Wharf, Pelee Island, Ontario", dated January 15, 1990.

2.0 SITE DESCRIPTION

The ferry dock site is located at the West Wharf which is located adjacent to the community of West Side which is on the south end of the west side of Pelee Island. The West Wharf extends about 170 metres into Lake Erie in a westerly direction generally perpendicular to the existing beach. The ferry dock is about 130 metres long located at the end of the West Wharf and extends in a southerly direction parallel to the west shore of the island. The dock has an asphalt paved surface and is enclosed at the south and west sides by steel sheet piling with a concrete cap.

The site location is shown on Figure 1 and select site photographs taken during the investigation are provided in Appendix B.

Based on information provided by Morrison Hershfield, the existing dock surface is at elevation 176 metres (all elevations are referenced to International Great Lakes Datum, IGLD), the lake water level is at about elevation 174 metres, the dredge line is at elevation 169 metres and the design sheet pile tip is at elevation 164.5 metres.

3.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out between September 13 and 16, 2004. At that time, three boreholes were put down in front of the steel sheet pile walls about 0.4 metres from the dock using a timber platform with safety rails cantilevered over the wall. The boreholes were drilled and sampled to depths of 20.0 to 20.5 metres below the dock. The borehole locations are shown in plan on Drawing 1 together with the locations of the boreholes put down in the previous investigations.

The investigation was carried out using an all terrain vehicle mounted CME-750 drill rig supplied and operated by Lantech Drilling Services Inc. The boreholes were advanced using a combination of rotary mud drilling techniques in NW size casing and coring of the bedrock in NQ size. In the boreholes, samples of the overburden were obtained at regular intervals of depth using 50 millimetre outside diameter split-spoon samplers in accordance with the Standard Penetration Test (SPT) procedures. In situ vane shear testing were also carried out in the softer cohesive materials. In addition, thin walled tube samples were obtained from the silty clay and clayey silt till soils, where feasible, at the borehole locations. The boreholes were backfilled using Ministry of Transportation, Ontario (MTO) recommended procedures and as required by Ontario Regulation 903 (amended by Ontario Regulation 128/03).

The field work was supervised on a full-time basis by a member of our engineering staff who located the boreholes in the field, directed the drilling, sampling and in-situ testing operations, and logged the boreholes. The soil and rock samples were identified in the field, placed in labeled containers and transported to our laboratory in London, Ontario for further examination. Index and classification tests consisting of grain size analyses, Atterberg limits tests, consolidation testing and water content determinations were carried out on selected samples. The rock core and thin walled tube samples were transported to our laboratory in Mississauga, Ontario for additional examination and high complexity laboratory testing. Triaxial testing was carried out on a thin walled tube sample from borehole 101. The results of the field and laboratory testing are given on the Record of Borehole sheets and in Appendix C.

The as-drilled borehole locations and elevations were referenced to a temporary benchmark and existing dock features. The temporary vertical control bench mark is located on the top of coping for the existing dock which is understood to be at elevation 176.0 metres referenced to IGLD.

4.0 GENERAL SITE GEOLOGY AND STRATIGRAPHY

4.1 Geology

Pelee Island is about 40 square kilometers of land founded on a low dome of limestone in Lake Erie rising only 12 metres above the lake at the highest point. The island is covered with a generally level clay plain. The clay plain at Pelee Island is a bevelled till plain about 3 metres deep in the central portion of the island and extending to depths of up to 15 metres on the west side of the island.

The West Wharf has been constructed into Lake Erie about 170 metres west of the current shoreline with the ferry dock located at the end of the Wharf and running parallel to the west shore of the island. The extension of the Wharf and dock in Lake Erie has been accomplished by mass filling to raise the grade in the Lake Erie bed.

The bedrock is Devonian age dolomitic limestone of the Dundee Formation belonging to the Hamilton Group overlying Lucas Formation limestone of the Detroit River Group. The dolomitic limestone is light brown to grey and fine to medium grained.

4.2 Site Stratigraphy

The detailed subsurface water, soil and rock conditions encountered in the boreholes together with the results of the field and laboratory testing are shown on the Record of Borehole sheets following the text of this report and in Appendix C. The records of the relevant boreholes previously drilled at the site are provided in Appendix A. The stratigraphic boundaries shown on the borehole sheets are inferred from non-continuous sampling and, therefore, may represent transitions between soil types rather than exact planes of geological change. Subsoil conditions will vary between and beyond the borehole locations.

In summary, the subsoils in front of the sheet pile wall at the site generally consist of thin, intermittent silty fine sand sediments and a 1.5 to 3 metre thick deposit of silty clay extending to about elevation 166 metres. The silty clay deposit is underlain by layers of clayey silt till and sandy silt till with boulders which extend to a depth of about 17 metres where the limestone bedrock was encountered at about elevation 159 metres.

The locations and elevations of the borings, together with the interpreted stratigraphical profiles, are shown on the attached Drawings 1 and 2. A detailed description of the subsurface conditions encountered in the boreholes for this investigation is provided on the Record of Borehole sheets and a summary of the soil stratigraphy is provided in the following paragraphs.

4.2.1 Surficial Sand

Borehole 101 encountered a 0.3 metre thick surficial lake bed deposit consisting of silty fine sand beneath 5.9 metres of water. Also, borehole 301 (881-3342-1) encountered 0.8 metres of compact fine to medium sand beneath 5.0 metres of water at the time of drilling in June 1989. Shells and organics were noted in the granular lake bed deposits.

Boreholes 102, 103 and 302 (881-3342-1) did not encounter the surficial granular lake bed deposits.

4.2.2 Silty Clay

Beneath the silty fine sand in borehole 101 and below about 5.2 to 6.1 metres of water in boreholes 102 and 103, respectively, a layer of silty clay with traces of sand and gravel was encountered. The silty clay deposit was 1.5 to 3.1 metres thick at the borehole locations and extended to between elevations 166.4 and 165.8 metres. The silty clay had standard penetration test N values of 5 blows per 0.3 metres penetration in each of the boreholes. The results of in situ vane testing indicated undrained shear strengths ranging from 66 to 92 kilopascals with an average undrained shear strength of about 76 kilopascals. The in situ vane sensitivities ranged from 1.9 to 4.6. The testing indicated that the silty clay layer has a stiff consistency.

The results of consolidated, undrained triaxial laboratory testing carried out on a sample of the silty clay materials collected from borehole 101 are provided on Figures C-1 to C-4 in Appendix C. The laboratory testing indicated that the sample had an effective angle of internal friction of 32 degrees and an effective cohesion of zero.

The water contents of the silty clay samples ranged from about 12 to 25 per cent with an average water content of 20 per cent. The silty clay deposit had average plastic and liquid limits of about 12 and 30 per cent, respectively, with an average plasticity index of 18 per cent. The results are shown on the Plasticity Chart, Figure C-5 in Appendix C, which indicates a clay material of low plasticity.

4.2.3 Clayey Silt Till

Beneath the silty clay deposit, the boreholes encountered a 2.9 to 3.5 metre thick layer of clayey silt till. The clayey silt till layer extended to between elevation 162.9 and 163.5 metres. The clayey silt till was noted to contain cobbles and boulders had typical standard penetration test N values of 23 to 38 blows per 0.3 metres penetration. One test in borehole 103, in which a boulder was encountered, had an N value of 100 blows for 125 millimetres penetration. In situ vane testing attempted in the upper portion of the clayey silt till deposit indicated undrained shear strengths greater than 144 kilopascals. The testing indicated that the clayey silt till layer has a very stiff to hard consistency.

The water contents of the clayey silt till samples ranged from about 10 to 14 per cent with an average water content of 13 per cent. The clayey silt till deposit had average plastic and liquid limits of about 11 and 23 per cent, respectively, with an average plasticity index of 12 per cent. The results are shown on the Plasticity Chart, Figure C-6, in Appendix C, which indicates a clay material of low plasticity. The results of grain size analyses carried out on samples of clayey silt till from boreholes 101 and 103 are shown on Figure C-7 in Appendix C.

4.2.4 Sandy Silt Till

Beneath the clayey silt till in boreholes 101 and 102 and the boulder in borehole 103, a 3.4 to 4.7 metre thick deposit of sandy silt till was encountered and extended to the bedrock surface at about elevation 159 metres. In addition to the boulder encountered at the surface of the deposit in borehole 103, former boreholes 301 and 302 (881-3342-1) also encountered pockets of sand, sand and gravel, cobbles and boulders in the sandy silt till deposit.

The sandy silt till had standard penetration test N values of 49 blows per 0.3 metres penetration to 100 blows per 100 millimetres penetration, indicating a dense to very dense deposit. The measured water content of the sandy silt till samples were about 9 to 12 per cent. The results of a grain size analysis carried out on a sample of sandy silt till from borehole 102 are shown on Figure C-8 in Appendix C.

4.2.5 Bedrock

The bedrock surface was encountered in the boreholes some 16.7 to 17.2 metres below the dock surface, or between elevations 158.8 and 159.3 metres. The top 2.8 to 3.5 metres of the bedrock was cored in NQ size in the boreholes and it was identified to be light grey to brown, medium strong, argillaceous dolomitic limestone of the Dundee formation. The total rock core recoveries (TCR) recorded were 50 to 100 per cent, with measured solid core recoveries (SCR) of 36 to 100 per cent and rock quality designations (RQD) of 34 to 100 per cent.

4.3 Water Conditions and Lake Bed Elevations

Lake Erie water levels were noted at the three borehole locations during drilling and are reported to be about 1.8 metres below the dock, or at about elevation 174.2 metres. No artesian water levels were noted in the borehole casings. These measured water levels and lake bed elevations are shown on the attached Record of Borehole sheets and are summarized below:

BOREHOLE NUMBER	LAKE WATER ELEVATION (m)	LAKE BED ELEVATION (m)
101	174.17	168.23
102	174.17	168.08
103	174.17	168.93

Based on the profile drawings provided, it is understood that the design dredge elevation at the ferry dock is at elevation 169.0 metres with about 0.5 to 1.5 metres of scour measured in 2003. The measured lake surface and bottom levels are shown in profile and section on Drawing 2 together with the subsurface stratigraphy encountered in the boreholes. The lake bed at the docks was at elevation 168.2 metres at borehole 101 drilled at the southern end, at elevation 168.1 metres at borehole 102 drilled in the central area, and at elevation 168.9 metres at borehole 103 drilled at the north end. The lake bed at the location of borehole 101 is underlain by 0.3 metres of silty fine sand.

Lake level data collected since 1918 by the Canadian Hydrographic Service indicate that the minimum and maximum recorded water levels for Lake Erie are 173.18 and 175.04 metres, respectively. It should be noted that the lake level is subject to seasonal fluctuations and the historical mean level for the month of August is reported to be 174.94 metres.

5.0 ENGINEERING RECOMMENDATIONS

This section of the report provides our recommendations on the foundation aspects of the existing sheet pile walls for the MTO ferry dock at Pelee Island. Similar foundation investigations were undertaken for this project at the ferry docks in Leamington and Kingsville.

Our recommendations are based on our interpretation of the factual information obtained during the investigation and the results of field and laboratory testing. It should be noted that the interpretation and recommendations are intended for use only by the design engineer. Where comments are made on construction they are provided only in order to highlight those aspects which could affect the design of the project.

5.1 Existing Sheet Pile Walls

Based on information provided by Morrison Hershfield, the existing docks are at elevation 176.0 metres (all elevations are referenced to International Great Lakes Datum, IGLD) and the lake water level is at elevation 174.3 metres. Lake level data collected since 1918 by the Canadian Hydrographic Service indicate that the minimum and maximum recorded water levels for Lake Erie are 173.18 and 175.04 metres, respectively. Based on the information provided, it is understood that the design dredge elevations at the Pelee Island ferry dock is at elevation 169.0 metres. The current lake bed survey data provided indicate about 0.5 to 1.5 metres of scour below the design level being measured in 2003. The design sheet pile tips are at elevation 164.5 metres. Based on the pile lengths noted on Public Works Canada drawing number MA-004, dated February 21, 1993, the piles were to extend to elevation 164.5 metres. The boreholes encountered very stiff to hard clayey silt till with cobbles and boulders at the design sheet pile tip elevations.

It is understood that soil parameters are required to analyze the stability of the existing sheet pile walls at the dock. The subsurface conditions encountered in the three boreholes drilled in Lake Erie adjacent to the retaining wall during this investigation typically consisted of thin intermittent surficial fine grained granular deposits below some 5.2 to 6.1 metres of water. These deposits were underlain by a 1.5 to 3.1 metre thick layer of stiff silty clay. Below elevation 165.8 to 166.6 metres, the silty clay deposit is underlain by layers of very stiff to hard clayey silt till and very dense sandy silt till which extend to depths of about 17 metres where limestone bedrock was encountered at elevations between 158.8 and 159.3 metres. Cobbles and boulders are indicated in the till deposits. The stratigraphy encountered in the boreholes is detailed on the Record of Borehole sheets and Drawing 2.

5.1.1 Geotechnical Parameters

Based on the subsurface conditions encountered in the boreholes, the following parameters are recommended for the analysis and design of the sheet pile walls in accordance with the Canadian Highway Bridge Design Code (CHBDC):

Total unit weight of granular backfill: 22 kN/m^3

Total unit weight of native soils:
- Surficial granular soils 17 kN/m^3
- Silty clay 17 kN/m^3
- Till deposits 22 kN/m^3

Undrained shear strength of cohesive soils:
- Silty clay 75 kPa
- Clayey silt till 200 kPa

MATERIAL	ANGLE OF FRICTION		COEFFICIENTS OF LATERAL EARTH PRESSURE			
			No Wall Friction		With 10° Wall Friction	
	Internal	Soil/Steel	'active',K_a	'passive', K_p	K_a	K_p
Compact to dense rock fill	40°	25°	0.22	4.60	0.21	7.0
Loose surficial granular soils	28°	17°	0.36	2.77	0.34	3.7
Stiff silty clay	32°	21°	0.31	3.20	0.29	4.6
Very stiff to hard clayey silt till	34°	22°	0.25	4.00	0.23	6.0
Very dense sandy silt till	35°	22°	0.25	4.00	0.23	6.0

The inclusion of soil/wall friction in the analyses will depend upon the amount of relative movement which has or can occur or would be required to develop these forces. Further, the wall friction coefficient has been limited to 10° since larger values would necessitate substantial wall deformation, particularly to develop passive resistance.

An unbalanced water head behind the sheeting of at least 0.3 metres should be included in the structural analyses. In addition, the analyses should address the potential for future dredging, if required, for dock and ferry operations and/or the potential for additional scour.

Section B-B[1], as shown on Drawing 2 should be used for the analytical model.

5.1.2 Geotechnical Considerations

A conventional factor of safety of 1.3 should be applied to the calculated depth of embedment or, alternatively, a factor of safety of 1.5 should be applied to K_p. The degree to which forces below the soil and steel sheeting can be mobilized will be dependent upon the amount of relative movement which has or can occur.

We understand that if the stability of the sheet pile walls is found to be marginally acceptable, consideration would be given to replacing the loose surficial sands and silts in the lake bed adjacent to the docks with less erodible and heavier fill. In addition, consideration could be given to replacing the rock fill below the deck of the dock with lighter weight fill. It should be noted that expanded polystyrene fill is not considered suitable at this site due to the high water level.

In addition to these geotechnical considerations, a number of structural options could be considered such as a pile supported relieving platform constructed behind the wall or steel pipes inserted into the hard clayey silt till to effectively increase the toe resistance. The following table provides a summary of the various stabilization alternatives, their advantages, disadvantages, relative costs and risks.

ALTERNATIVE	ADVANTAGES	DISADVANTAGES	COSTS	RISKS
Relieving Platform (piles driven to bedrock for support of backfill)	Decreases active pressures	Disturbance of dock area	Expensive construction	Interference with existing services below dock
Light Weight Fill Above the Water Level	Decreases active pressures	Disturbance of dock area, installation below water level less effective	Expensive construction	Interference with existing services below dock
Drilled Pile/Grouted Toe Restraint	Increases passive pressures	Installation below water	Less expensive	Buckling of existing sheeting
Rock Anchors Connected to Waler	Increases stability	Installation from marine equipment	Moderately expensive	Some below water operations
Addition of Lake Bed Fill	Reduces scour and increases passive pressures	Requires careful placement	Less expensive	Below water operations

If the analyses indicate that the stability of the wall is not acceptable, a monitoring program should be implemented to assess the magnitude and rate of wall deformation and related effects.

GOLDER ASSOCIATES LTD.

Azmi M. Hammoud, P. Eng.

Philip R. Bedell, P. Eng.
Principal

Fintan J. Heffernan, P. Eng.
Designated MTO Contact

AMH/PRB/FJH/jk
n:\active\projects - other offices\windsor\2002\021-4200\021-4216-1 mh - ferry docks - pelee island\reports\pelee (021-4216-1-3)\oct 20 05 - fdn inv report- pelee.doc

LIST OF ABBREVIATIONS

The abbreviations commonly employed on each "Record of Borehole", on the figures and in the text of the report, are as follows:

I. SAMPLE TYPES

AS auger sample
CS chunk sample
DO drive open
DS Denison type sample
FS foil sample
RC rock core
SC soil core
ST slotted tube
TO thin-walled, open
TP thin-walled, piston
WS wash sample
SS split spoon

II. PENETRATION RESISTANCES

Dynamic Penetration Resistance:
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 0.3 m (12 in.).

Standard Penetration Resistance, N:
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 0.3 m (12 in.).

WH sampler advanced by static weight-weight, hammer

PH sampler advanced by hydraulic force

PM sampler advanced by manual force

III. SOIL DESCRIPTION

(a) *Cohesionless Soils*

Relative Density	"N" Blows/0.3 m or Blow/ft.
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) *Cohesive Soils*

Consistency	"Cu" = "Su" kPa	psf.
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1000
Stiff	50 to 100	1000 to 2000
Very stiff	100 to 200	2000 to 4000
Hard	over 200	over 4000

IV. SOIL TESTS

C consolidation test
H hydrometer analysis
M sieve analysis
MH combined analysis, sieve and hydrometer [1]
Q undrained triaxial [2]
R consolidated undrained triaxial [2]
S drained triaxial
U unconfined compression
V field vane test
Chem chemical analysis

NOTES:

1. Combined analyses when 5 to 95 per cent of the material passes the No. 200 sieve.
2. Undrained triaxial tests in which pore pressures are measured are shown as Q or R.

LIST OF SYMBOLS

I. GENERAL

$\pi = 3.1416$
e = base of natural logarithms 2.7183
$\log_e$ a or ln a, natural logarithm of a
$\log_{10}$ a or log a, logarithm of a to base 10
t time
g acceleration due to gravity
V volume
W weight
m mass
M moment
F factor of safety

II. STRESS AND STRAIN

u pore pressure
σ normal stress
σ' normal effective stress (σ is also used)
τ shear stress
ε linear strain
ε_{sy} shear strain
υ Poisson's ration (μ is also used)
E modulus of linear deformation (Young's modulus)
G modulus of shear deformation
K modulus of compressibility
η coefficient of viscosity

III. SOIL PROPERTIES

(a) *Unit weight*

γ unit weight of soil (bulk density)
γ_s unit weight of solid particles
γ_w unit weight of water
γ_d unit dry weight of soil (dry density)
γ' unit weight of submerged soil
G_s specific gravity of solid particles $G_s = \gamma_s/\gamma_w$
e void ratio
n porosity
w water content
S_r degree of saturation

(b) *Consistency*

w_L liquid limit
w_P plastic limit
I_P plasticity index
w_S shrinkage limit
I_L liquidity index = $(w - w_p)I_p$
I_C consistency index - $(w_L - w)/I_p$
e_{max} void ratio in loosest state
e_{min} void ratio in densest state
D_r relative density = $(e_{max} - e)/(e_{max} - e_{min})$

(c) *Permeability*

h hydraulic head or potential
q rate of discharge
v velocity of flow
i hydraulic gradient
κ coefficient of permeability
j seepage force per unit volume

(d) *Consolidation (one-dimensional)*

m_v coefficient of volume change = $-\Delta e/(1+e)\Delta\sigma'$
C_c compression index = $-\Delta e/\Delta\log_{10}\sigma'$
c_v coefficient of consolidation
T_F time factor = $c_v t/d^2$ (d, drainage path)
U degree of consolidation

(e) *Shear strength*

τ_f shear strength
c' effective cohesion intercept
ϕ' effective angle of shearing resistance, or friction

(in terms of effective stress: $\tau_f = c' + \sigma' \tan\phi$)

S_u apparent cohesion*
ϕ_u apparent angle of shearing resistance, or friction

(in terms of total stress: $\tau_f = cu + \sigma \tan\phi_u$)

μ coefficient of friction
S_t sensitivity

*For the case of a saturated cohesive soil, $\phi_u = 0$ and the undrained shear strength $\tau_f = S_u$ is taken as half the undrained compressive strength.

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING STATE

Fresh: no visible sign of weathering.

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.
Completely weathered: rock is wholly decomposed and in a friable condition but the rock texture and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing-
Very thickly bedded	>2 m
Thickly bedded	0.6 m to 2m
Medium bedded	0.2 m to 0.6m
Thinly bedded	60 m to 0.2 m
Very thinly- bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	< 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	> 3 m
Wide	I – 3 m
Moderately close	0.3 – I m
Close	50 – 300 mm
Very close	< 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	> 60 mm
Coarse Grained	2 – 60 mm
Medium Grained	60 microns – 2 mm
Fine Grained	2 – 60 microns
Very Fine Grained	< 2 microns

Note: *Grains >60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)
The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)
The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)
The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varies front 0% for completely broken core to 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index

A count of' the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to (W.R.T.) Core Axis

The angle of the discontinuity relative to the axis (length) of the core, In a vertical borehole a discontinuity with a 90' angle is horizontal.

Description and Notes

An abbreviated description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces

Abbreviations

B – Bedding
FO - Foliation Schistosity
CL - Cleavage
SH - Shear Plane Zone
VN - Vein
F - Fault
CO - Contact
J - Joint
FR - Fracture
M F - Mechanical Fracture
II - Parallel To
⊥ - Perpendicular To

P - Polished
S - Slickensided
SM - Smooth
R - Ridged / Rough
ST - Stepped
PL - Planar
FL - Flexured
UE - Uneven
W - Wavy
C - Curved

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 101

1 OF 2

METRIC

PROJECT 021-4216-1-3
G.W.P. WP
DIST ____ HWY N/A
DATUM I.G.L.D.
LOCATION REFER TO BOREHOLE LOCATIONS - DRAWING 1
BOREHOLE TYPE ROTARY DRILLING (NW CASING), TRI-CONE
DATE September 13, 2004 - September 14, 2004
ORIGINATED BY DJM
COMPILED BY WDF
CHECKED BY AMH

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
176.00	DOCK SURFACE										
0.00							175				
174.17						▽	174				
1.83	WATER						173				
							172				
							171				
							170				
							169				
168.23							168				
7.77 / 167.92	SILTY FINE SAND, trace organic material, Grey										
8.08	SILTY CLAY, trace sand, trace gravel, Stiff, Grey		1	SS	5						
			2	SH	PH		167				R
166.40											
9.60	CLAYEY SILT, trace sand, gravel, with sand pockets (TILL), Very stiff to hard, Grey						166	(>144 kPa)			
			3	SS	30						
			4	SS	25		165				
163.50							164				6 27 47 20
12.50	SANDY SILT, some clay, trace gravel, with cobbles (TILL) Very dense Grey		5	SS	100/100mm		163				
			6	SS	88		162				

Continued Next Page

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 101

2 OF 2 **METRIC**

PROJECT 021-4216-1-3 | G.W.P. WP | DIST | HWY N/A | DATUM I.G.L.D.

LOCATION REFER TO BOREHOLE LOCATIONS - DRAWING 1 | BOREHOLE TYPE ROTARY DRILLING (NW CASING), TRI-CONE | DATE September 13, 2004 - September 14, 2004

ORIGINATED BY DJM | COMPILED BY WDF | CHECKED BY AMH

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			7	SS	100		160	○		
			8	SS	144		159	○		
158.81										
17.19	Fresh, microcrystalline to fine grained, thinly to medium bedded, light grey to brown, faintly to moderately porous, medium strong to strong, argillaceous DOLOMITIC LIMESTONE, occasionally fossiliferous and interclustic with pitted to vuggy zones and calcite nodules (DUNDEE FORMATION)		9	SS	110/200mm			○		
			10	CORE	-		158	T.C.R. (%) 100 / S.C.R. (%) 100 / R.Q.D. (%) 100		
			11	CORE	-		157	97 / 97 / 97		
155.97							156			
20.03	END OF BOREHOLE									

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 102

1 OF 2

METRIC

PROJECT 021-4216-1-3
G.W.P. WP
DIST ____ HWY N/A
DATUM I.G.L.D.
LOCATION REFER TO BOREHOLE LOCATIONS - DRAWING 1
BOREHOLE TYPE ROTARY DRILLING (NW CASING), TRI-CONE
DATE September 14, 2004 - September 14, 2004
ORIGINATED BY DJM
COMPILED BY WDF
CHECKED BY AMH

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
176.00	DOCK SURFACE										
0.00							175				
174.17						▽	174				
1.83	WATER						173				
							172				
							171				
							170				
							169				
168.08							168				
7.92	SILTY CLAY, trace sand, trace gravel, Stiff Grey		1	SS	5						
			2	SH	PH		167				
166.55											
9.45	CLAYEY SILT, trace sand, gravel, with cobbles (TILL), Very stiff to hard, Grey		3	SH	PH			(>144 kPa)			
			4	SS	38		166				
			5	SS	29		165				
			6	SS	34		164				
163.05							163				
12.95	SANDY SILT, trace to some clay, trace gravel, with cobbles (TILL) Very dense Grey		7	SS	105/200mm						
			8	SS	110		162				44 30 16 10

Continued Next Page

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 102

2 OF 2 **METRIC**

PROJECT 021-4216-1-3 | G.W.P. WP | DIST | HWY N/A | DATUM I.G.L.D.

LOCATION REFER TO BOREHOLE LOCATIONS - DRAWING 1 | BOREHOLE TYPE ROTARY DRILLING (NW CASING), TRI-CONE | DATE September 14, 2004 - September 14, 2004

ORIGINATED BY DJM | COMPILED BY WDF | CHECKED BY AMH

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			9	SS	101		160		○ at 10		
159.08											
16.92	Fresh, microcrystalline to fine grained, thinly to medium bedded, light grey to brown, faintly to moderately porous, medium strong to strong, argillaceous DOLOMITIC LIMESTONE, occasionally fossiliferous and interclustic with pitted to vuggy zones and calcite nodules (DUNDEE FORMATION)		~~10~~	~~SS~~	~~75/0mm~~		159				
			11	CORE	-			T.C.R. (%): 86			
			12	CORE	-		158	T.C.R. (%): 97 / S.C.R. (%): 86 / R.Q.D. (%): 86			
							157	S.C.R. (%): 57 / R.Q.D. (%): 57			
			13	CORE	-			T.C.R. (%): 93 / S.C.R. (%): 93 / R.Q.D. (%): 93			
155.55							156				
20.45	END OF BOREHOLE										

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 103

1 OF 2

METRIC

PROJECT 021-4216-1-3
G.W.P. WP
DIST ____ HWY N/A
DATUM I.G.L.D.
LOCATION REFER TO BOREHOLE LOCATIONS - DRAWING 1
BOREHOLE TYPE ROTARY DRILLING (NW CASING), TRI-CONE
DATE September 15, 2004 - September 16, 2004
ORIGINATED BY DJM
COMPILED BY WDF
CHECKED BY AMH

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
176.00	DOCK SURFACE										
0.00											
174.17						▽					
1.83	WATER										
168.93											
7.07	SILTY CLAY, trace sand, trace gravel, Stiff Grey		1	SS	5						
			2	SH	PH						
			3	SS	5						
165.79											
10.21	CLAYEY SILT, trace sand, trace gravel, with cobbles and boulders (TILL), 0.1 thick sand layer at 11.64m depth Very stiff to hard, Grey		4	SS	28						
			5	SS	23						
			6	SS	38						
162.89			7	SS	100/125mm						5 25 50 20
13.11	BOULDER										
13.32	SANDY SILT, trace to some clay, trace gravel, with cobbles (TILL) Dense to Very dense Grey		8	SS	105/150mm						

Continued Next Page

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

ON_MTO 021-4216-P.GPJ ON_MOT.GDT 10/19/04

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 103

2 OF 2 **METRIC**

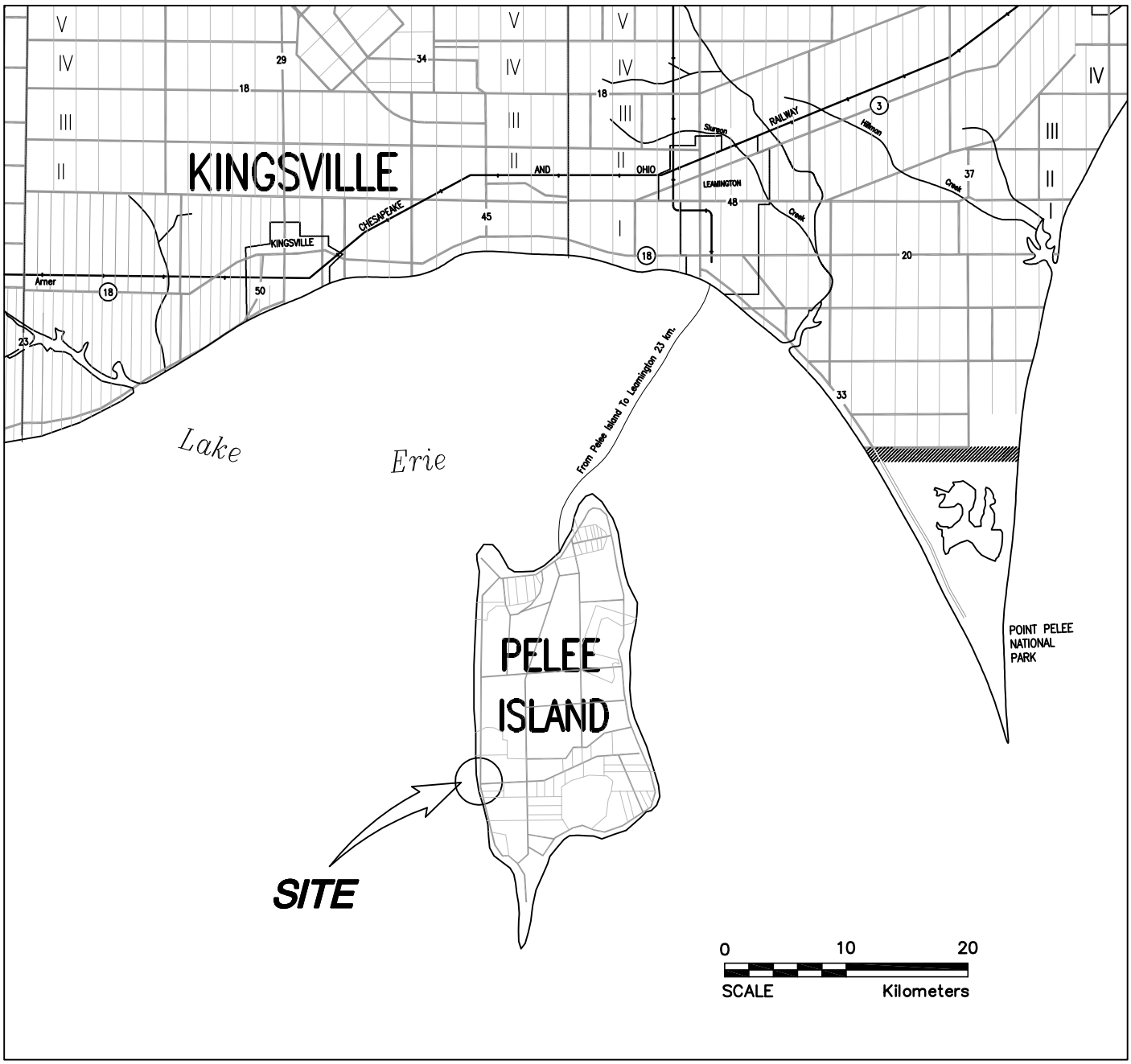
PROJECT 021-4216-1-3 | G.W.P. WP | DIST | HWY N/A | DATUM I.G.L.D.

LOCATION REFER TO BOREHOLE LOCATIONS - DRAWING 1 | BOREHOLE TYPE ROTARY DRILLING (NW CASING), TRI-CONE | DATE September 15, 2004 - September 16, 2004

ORIGINATED BY DJM | COMPILED BY WDF | CHECKED BY AMH

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			9	SS	49		160		○ at 10		
159.30			10	SS	100/100mm				○ at 10		
16.70	Fresh, microcrystalline to fine grained, thinly to medium bedded, light grey to brown, faintly to moderately porous, medium strong to strong, argillaceous DOLOMITIC LIMESTONE, occasionally fossiliferous and interclustic with pitted to vuggy zones and calcite nodules (DUNDEE FORMATION)		11	CORE	-		159	T.C.R. (%) 53; S.C.R. (%) 53; R.Q.D. (%) 53			
			12	CORE	-		158	T.C.R. (%) 100; S.C.R. (%) 100; R.Q.D. (%) 100			
			13	CORE	-		157	T.C.R. (%) 50; S.C.R. (%) n/a; R.Q.D. (%) n/a			
155.82							156				
20.18	END OF BOREHOLE										

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



PROJECT

MTO FERRY DOCK
PELEEE ISLAND, ONTARIO

TITLE

SITE LOCATION PLAN

Golder Associates
LONDON, ONTARIO

PROJECT No. 021-4216-1-3			FILE No. 0214216-1-P-000	
			SCALE AS SHOWN	REV. 0
CADD	WDF	Oct 2004	**FIGURE 1**	
CHECK	AMH	Oct 2004		

Drawing file: 0214216-1-P-000.DWG Oct 19, 2004 - 11:42am

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

DIST	31
CONT. No.	01-33-001
WP No.	3005-A-000218

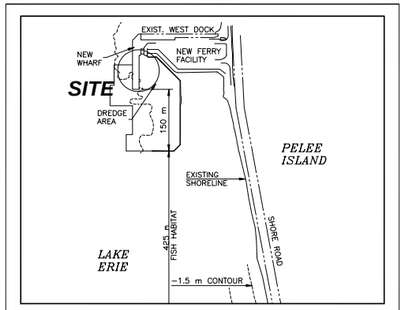
SHEET

MTO FERRY DOCK
PELEE ISLAND, ONTARIO

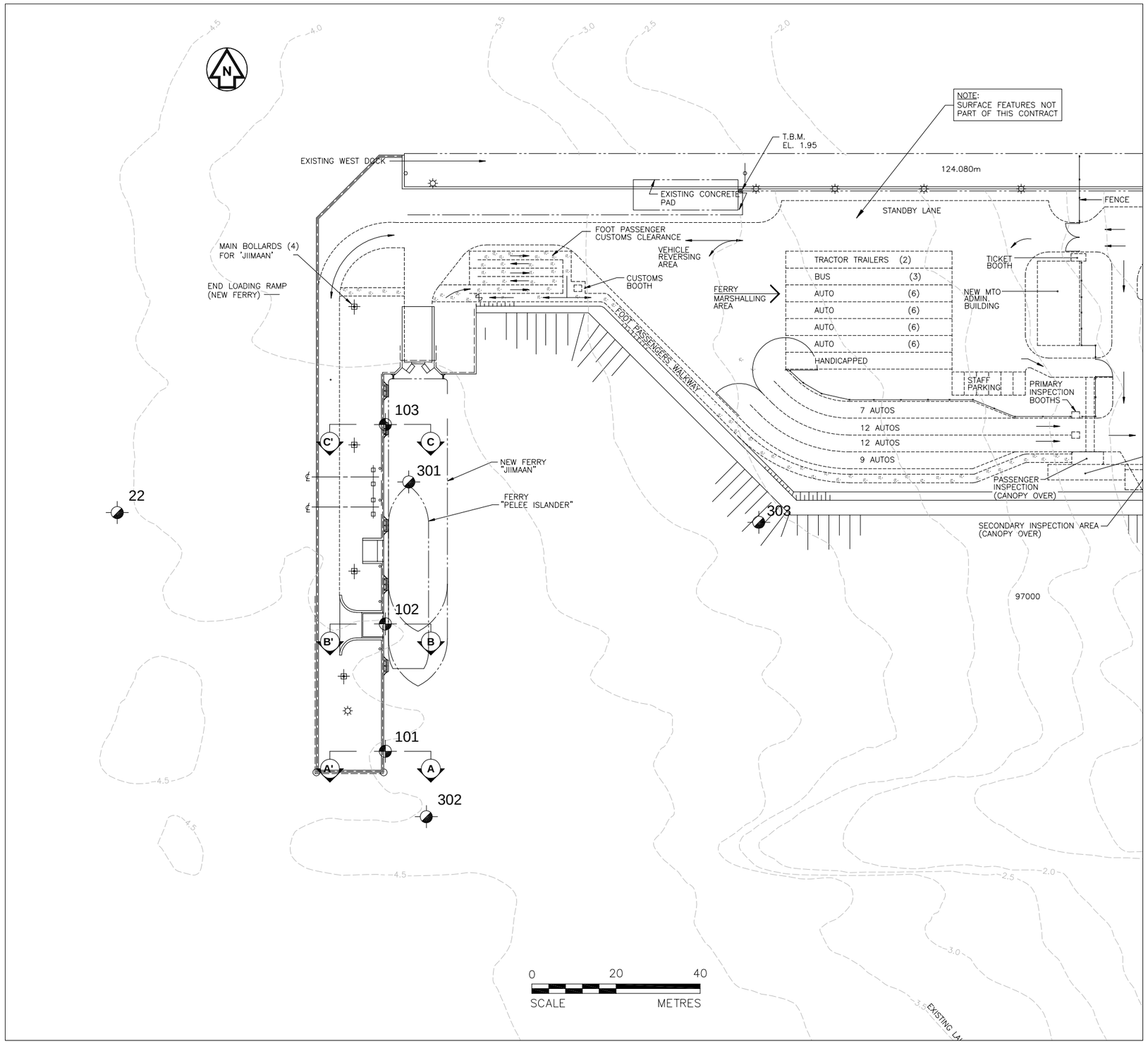
BOREHOLE LOCATIONS

Golder Associates Ltd.
LONDON, ONTARIO, CANADA

REFERENCE
DRAWING SUPPLIED BY PUBLIC WORKS CANADA
ARCHITECHURAL AND ENGINEERING SERVICES, ONTARIO REGION
GENERAL ARRANGEMENT PLAN
PELEE ISLAND FERRY WHARF
PROJECT No. 670759 DRAWING No. MA-001
DATED FEBRUARY 21, 1993



KEY PLAN



LEGEND

- Borehole Current Investigation
- Borehole Previous Investigations

No.	ELEVATION (metres)	CO-ORDINATES NORTH	CO-ORDINATES EAST
101	176.00	N/A	N/A
102	176.00	N/A	N/A
103	176.00	N/A	N/A
301	174.28	N/A	N/A
302	174.28	N/A	N/A
303	174.28	N/A	N/A
22	173.91	N/A	N/A

NOTES
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

NO.	DATE	BY	REVISION

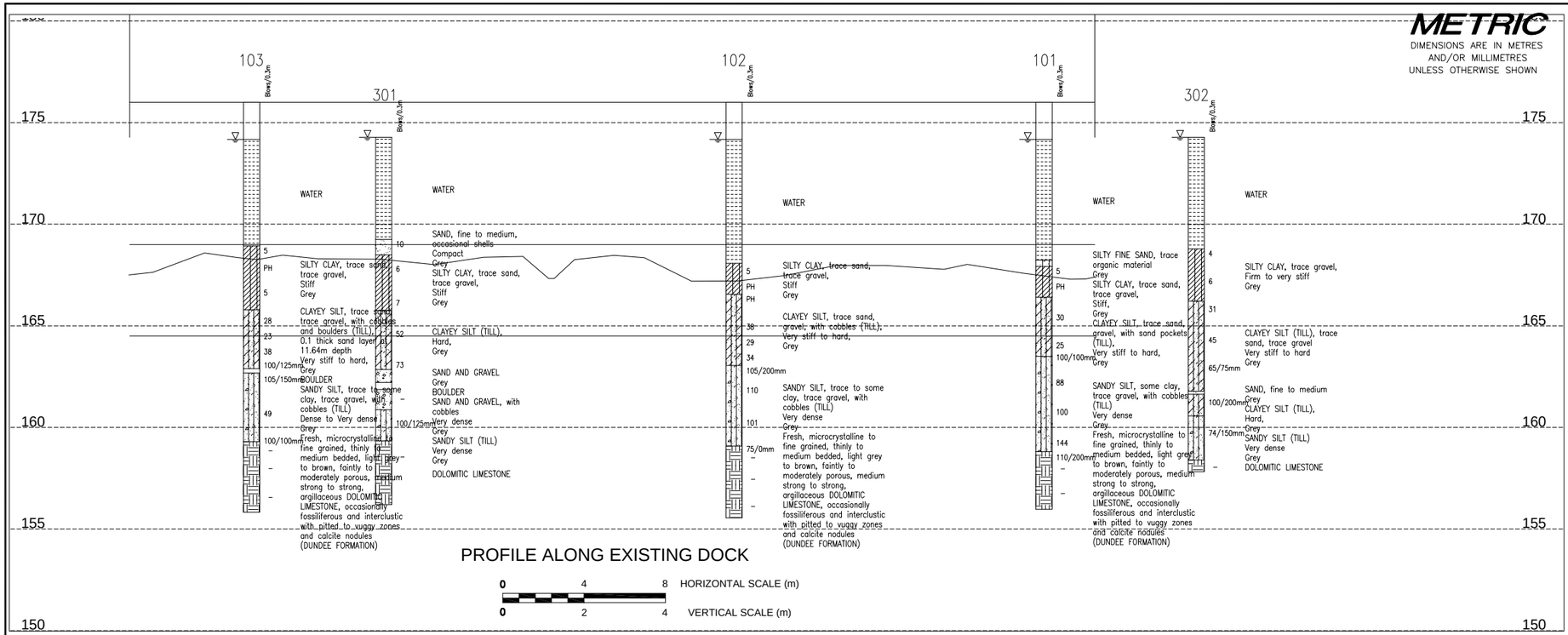
Geocres No.

HWY. No.		PROJECT NO.: 021-4216-1	
SUBM'D. –	CHKD: –	DATE: SEPT 2004	
DRAWN: WDF	CHKD.	APPD.	DWG. 1

0214216-1-P-001.DWG

1 = 1 metric D size dwg 22" x 32" 11" x 17" plot half scale

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



PROFILE ALONG EXISTING DOCK

0 4 8 HORIZONTAL SCALE (m)

0 2 4 VERTICAL SCALE (m)

DIST	31
W.O. No.	01-33-001
P.O. No.	3005-A-000218

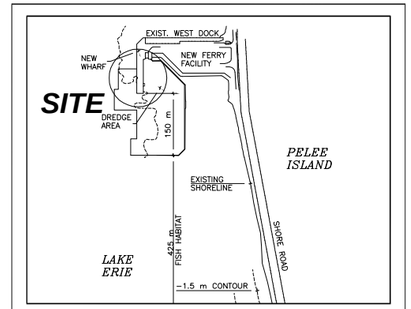
MTO FERRY DOCK
PELEE ISLAND, ONTARIO

SOIL STRATA

SHEET

Golder Associates Ltd.
LONDON, ONTARIO, CANADA

REFERENCE
DRAWING SUPPLIED BY PUBLIC WORKS CANADA
ARCHITECHURAL AND ENGINEERING SERVICES, ONTARIO REGION
KINGSVILLE, ONTARIO, FERRY WHARF
GENERAL ARRANGEMENT PLAN
PROJECT No. 670762, DRAWING No. MA002
DATED 1993 01 15



KEY PLAN

LEGEND

- Borehole Current Investigation
- Borehole Previous Investigations (Boreholes by others indicated by 1988 and 1993)
- Seal
- Piezometer
- N Blows/0.3m (Std. Pen. Test, 475 j/blow)
- WL in piezometer
- WL during drilling

No.	ELEVATION (metres)	CO-ORDINATES NORTH	CO-ORDINATES EAST
101	176.00	N/A	N/A
102	176.00	N/A	N/A
103	176.00	N/A	N/A
301	174.28	N/A	N/A
302	174.28	N/A	N/A

NOTES
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

NO.	DATE	BY	REVISION

Geocres No.

HWY. No. N/A		PROJECT NO.: 021-4216-1-3	
SUBM'D. –	CHKD: –	DATE: OCT. 2004	
DRAWN: WDF	CHKD. AMH	APPD.	DWG. 2

Drawing file: 0214216-1-P-002.DWG

APPENDIX A

RECORDS OF PREVIOUS BOREHOLES

RECORD OF BOREHOLE 22

SHEET 1

LOCATION - SEE FIGURE 1 | BORING DATE SEPT.18,1988 | DATUM LG.L.D.

SAMPLER HAMMER, 63.5kg, DROP, 760mm | PENETRATION TEST HAMMER, 63.5kg, DROP, 760mm

PROJECT 881-3342

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (M)	SAMPLES: NUMBER	TYPE	BLOWS/0.3M	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m; SHEAR STRENGTH Cu, kPa (nat.V.- + Q.- ● rem.V.- ⊕ U.- O)	HYDRAULIC CONDUCTIVITY, k, CM/SEC; WATER CONTENT, PERCENT (Wp W Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		WATER LEVEL (LAKE)		173.91							
				0.00							LAKE LEVEL AT ELEV. 173.91 DURING DRILLING
2		-WATER-									
4		Loose grey SAND occ. gravel and shell.		168.73							
				168.42	1	50 DO	4				
6	ROTARY DRILLING Nw TRI-CONE / Nw CASING 6.86	Stiff grey SILTY CLAY trace sand occ. gravel.		5.49	2	50 DO	5				
8				165.69							
				8.22	3	50 DO	12			MH	
10		Stiff to hard grey CLAYEY SILT trace sand occ. gravel, cobble (TILL).			4	50 DO	18				
					5	50 DO	19				
12					6	50 DO	54				
				160.19							
14		Very stiff grey SILTY CLAY occ. gravel occ. silt partings		13.72	7	50 DO	16				
				158.73							
		END OF BOREHOLE (PROBABLY LIMESTONE BEDROCK)		15.24							
16											
18											
20											

(Golder Report No. 881-3342)

" Note; This Drawing has been Reduced"

0 16 10 6 PERCENT AXIAL STRAIN AT FAILURE

DEPTH SCALE 1 : 100

Golder Associates

LOGGED D.J.M.

CHECKED

RECORD OF BOREHOLE 301

SHEET 1

LOCATION See Figure 4 | BORING DATE June 22,1989 | DATUM LG.L.D.

SAMPLER HAMMER, 63.5kg, DROP, 760mm | PENETRATION TEST HAMMER, 63.5kg, DROP, 760mm

PROJECT 881-3342-1

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (M)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3M	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH Cu, kPa (nat.V.- + Q.- ● rem.V.- ⊕ U.- O)	HYDRAULIC CONDUCTIVITY, k, CM/SEC / WATER CONTENT, PERCENT (Wp W Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		WATER LEVEL (LAKE)		174.28							
	WASH BORING Nx CASING	WATER		0.00							LAKE LEVEL AT ELEV. 174.28 DURING DRILLING JUNE 22, 1989.
				169.25							
		Compact grey fine to medium SAND occ. shells		5.03	1	50 DO	10				
				168.49							
6		Stiff grey SILTY CLAY trace sand occ. gravel		5.79	2	50 DO	6				
					3	50 DO	7				
				165.75							
		Hard grey CLAYEY SILT (TILL)		8.53	4	50 DO	52				
10					5	50 DO	73				
				162.85							
		Grey SAND AND GRAVEL		11.43							
12				162.21							
		BOULDER		12.07							
		Grey SAND AND GRAVEL occ. cobbles		12.41	6	NX RC	-				
				160.87							
		Very dense grey SANDY SILT (TILL)		13.41	7	50 DO	100/125mm				
14				159.34							
		Slightly to very weathered light brown to grey MICROCRYSTALINE DOLOMITIC LIMESTONE		14.94	8	Nx RC	-	T.C.R. 100% S.C.R. 98% R.Q.D. 96%			
16					9	Nx RC	-	T.C.R. 100% S.C.R. 100% R.Q.D. 100%			
18				156.21							
		END OF BOREHOLE		18.07							
20											

0 16 10 6 PERCENT AXIAL STRAIN AT FAILURE

(Golder Report No. 881-3342)

" Note; This Drawing has been Reduced"

DEPTH SCALE 1 : 100

Golder Associates

LOGGED D.J.M.

CHECKED

RECORD OF BOREHOLE 302

SHEET 1

LOCATION See Figure 4 | BORING DATE June 26,1989 | DATUM LGLD.

SAMPLER HAMMER, 63.5kg, DROP, 760mm | PENETRATION TEST HAMMER, 63.5kg, DROP, 760mm

PROJECT 881-3342-1

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (M)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3M
0		WATER LEVEL (LAKE)		174.28			
	WASH BORING Nx CASING	WATER		0.00			
				168.79			
6		Firm to very stiff grey SILTY CLAY occ. gravel		5.49	1	50 DO	4
					2	50 DO	6
8				166.21			
		Very stiff to hard grey CLAYEY SILT trace sand occ. gravel (TILL)		8.07	3	50 DO	31
10					4	50 DO	45
					5	50 DO	65/75mm
12				161.78			
		Grey fine to medium SAND		12.65	6	50 DO	100/200mm
		Hard grey CLAYEY SILT (TILL)		160.56			
14		Very dense grey SANDY SILT (TILL)		13.72	7	50 DO	74/150mm
				158.40			
16		Probably DOLOMITIC LIMESTONE		15.88 / 157.82	8	WS	-
		END OF BOREHOLE		16.46			
18							
20							

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

SHEAR STRENGTH Cu, kPa — nat.V.- + Q.- ● rem.V.- ⊕ U.- ○

25 50 75 100

HYDRAULIC CONDUCTIVITY, k, CM/SEC

WATER CONTENT, PERCENT

Wp W Wl

10 20 30 40

0 15 10 6 PERCENT AXIAL STRAIN AT FAILURE

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

LAKE LEVEL AT ELEV. 174.28 DURING DRILLING JUNE 26, 1989.

(Golder Report No. 881-3342)

" Note; This Drawing has been Reduced"

DEPTH SCALE 1 : 100

Golder Associates

LOGGED D.J.M.

CHECKED

RECORD OF BOREHOLE 303

SHEET 1

LOCATION See Figure 4 | BORING DATE June 26,1989 | DATUM I.G.L.D.

SAMPLER HAMMER, 63.5kg, DROP, 760mm | PENETRATION TEST HAMMER, 63.5kg, DROP, 760mm

PROJECT 881-3342-1

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (M)	SAMPLES: NUMBER	TYPE	BLOWS/0.3M	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	HYDRAULIC CONDUCTIVITY, k, CM/SEC	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		WATER LEVEL (LAKE)		174.28				SHEAR STRENGTH Cu, kPa; nat.V.- + Q.- ●; rem.V.- ⊕ U.- O; 25 50 75 100	WATER CONTENT, PERCENT Wp W Wl; 10 20 30 40		LAKE LEVEL AT ELEV. 174.28 DURING DRILLING JUNE 26, 1989.
				0.00							
2	WASH BORING Nx CASING	WATER									
				170.26							
4		Very loose fine to medium SAND		4.02	1	50 DO	3		O		
				4.57	2	50 DO	6	⊕ +	O		
6		Firm to very stiff grey SILTY CLAY occ. gravel			3	50 DO	7	⊕ +	O		
				166.51							
8		Hard grey CLAYEY SILT (TILL)		7.77	4	39	46		O		
				164.53	5	50 DO	41		O		
10		END OF BOREHOLE		9.75							
12											
14											
16											
18											
20											

(Golder Report No. 881-3342)

" Note; This Drawing has been Reduced"

0 / 15 ⊕ 5 / 10 PERCENT AXIAL STRAIN AT FAILURE

DEPTH SCALE 1 : 100

Golder Associates

LOGGED D.J.M.

CHECKED

APPENDIX B

SITE PHOTOGRAPHS

SITE PHOTOGRAPHS

Photo 1: General view of drilling platform at Pelee Island dock.

Photo 2: Drilling adjacent to docked ferry boat.

APPENDIX C

LABORATORY TEST DATA

CONSOLIDATED UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENTS SHEET 1 OF 4			FIGURE C-1
SPECIMEN	A	B	C
BOREHOLE NUMBER	101	101	101
SAMPLE NUMBER	2	2	2
SPECIMEN DIAMETER, cm	4.95	4.94	5.01
SPECIMEN HEIGHT, cm	10.01	10.09	10.12
WATER CONTENT BEFORE CONSOLIDATION, %	16.1	18.5	13.9
CELL PRESSURE, σ_3, kPa	290.0	375.0	475.0
BACK PRESSURE, kPa	275.0	275.0	275.0
PORE PRESSURE PARAMETER "B"	0.96	0.97	0.96
CONSOLIDATION PRESSURE, σc, kPa	15.0	100.0	200.0
VOLUMETRIC STRAIN DURING CONSOLIDATION, %	0.3	3.0	3.3
WATER CONTENT AFTER CONSOLIDATION, %	15.9	16.9	12.3
AVERAGE RATE OF STRAIN, %/hr	0.5	0.5	0.5
TIME TO FAILURE, DAYS	1	1	1
WATER CONTENT AFTER TEST, %	15.2	16.7	12.1
MAX. DEVIATOR STRESS, $(\sigma_1-\sigma_3)$, kPa	109.5	174.2	351.1
AXIAL STRAIN AT $(\sigma_1-\sigma_3)$ MAXIMUM, %	20.1	12.6	19.7
MAX EFFECTIVE PRINCIPAL STRESS RATIO, (σ_1/σ_3) MAXIMUM	5.7	3.1	3.4
DEVIATOR STRESS AT (σ_1/σ_3) MAXIMUM, kPa	31.8	152.1	267.4
AXIAL STRAIN AT (σ_1/σ_3) MAXIMUM, %	1.6	4.8	4.1
PORE PRESSURE PARAMETER, Af, AT $(\sigma_1-\sigma_3)$ MAXIMUM	-0.31	0.09	0.12
PORE PRESSURE PARAMETER, Af, AT (σ_1/σ_3) MAXIMUM	0.26	0.19	0.34
NATURAL WATER CONTENT, %	14.6	16.9	12.8
DRY DENSITY, Mg/m^3	1.97	1.88	2.01
FILTER DRAINS USED, y/n	y	y	y
TEST NOTES:			
CHANGED RATE OF STRAIN, %/hr	-	-	-
AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %	-	-	-
FAILURE PLANE NUMBER	-	-	-
ANGLE OF FAILURE, DEGREES	-	-	-

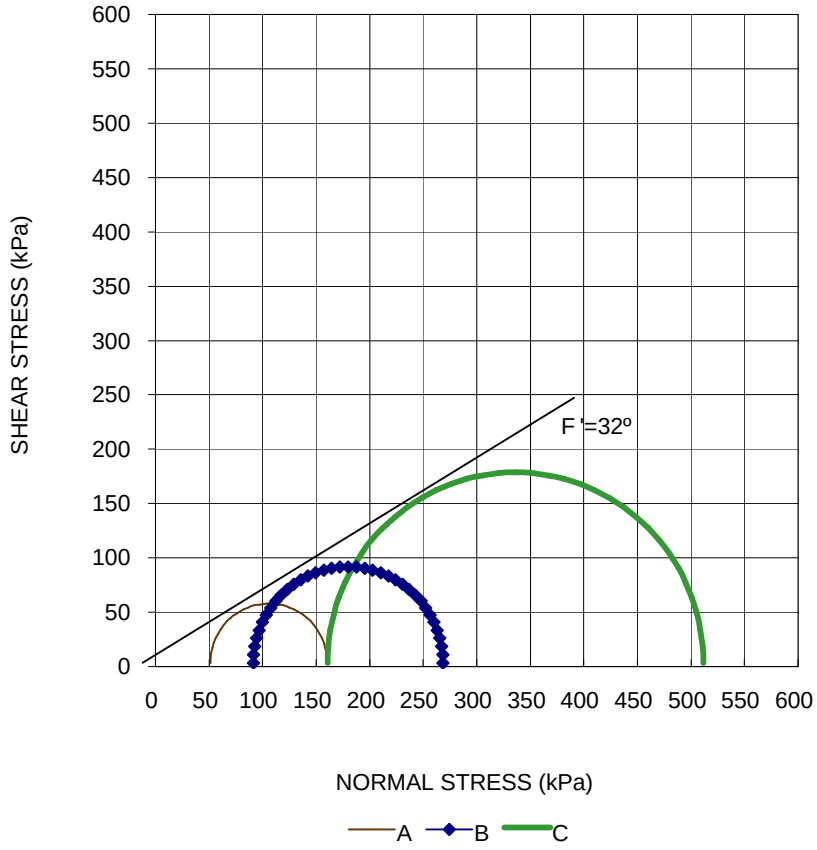
Date: October, 2004 Prepared By: LFG

Project No. 021-4216-1 **Golder Associates** Checked By: MM

CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS
SHEET 2 OF 4

FIGURE C-2

BH 101 SA 2



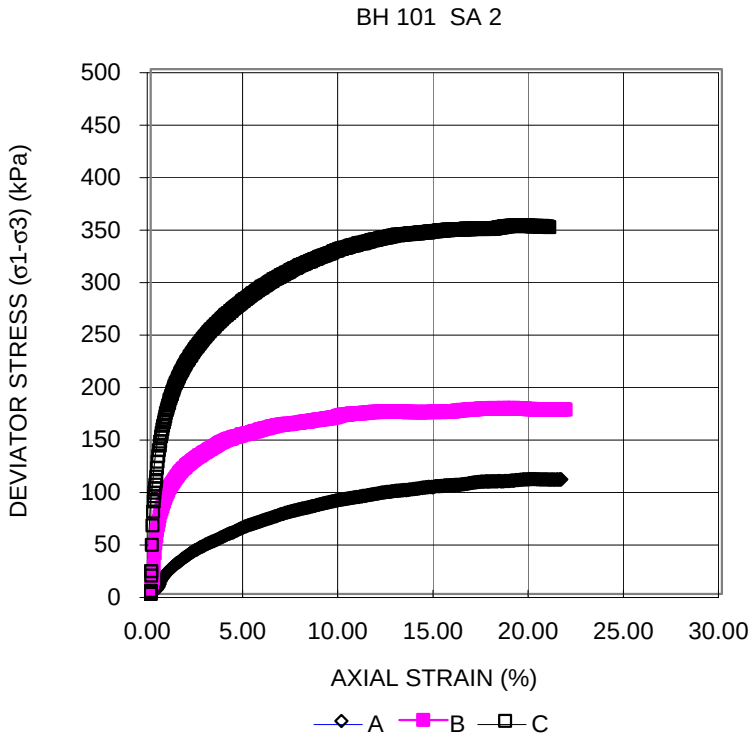
Date: October, 2004
Project No. 021-4216-1

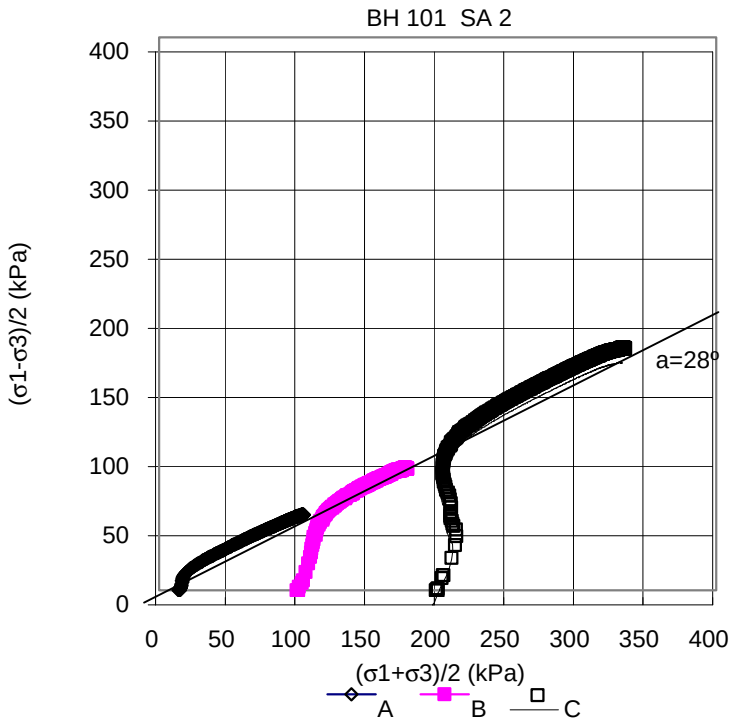
Golder Associates

Prepared By: LFG
Checked By: MM

CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS
SHEET 3 OF 4

FIGURE C-3





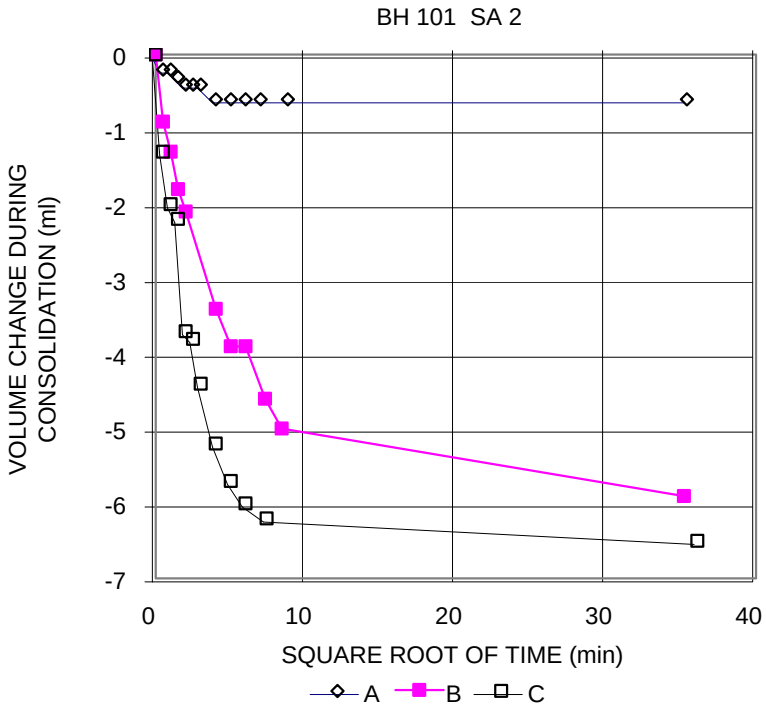
Date: October, 2004
Project No. 021-4216-1

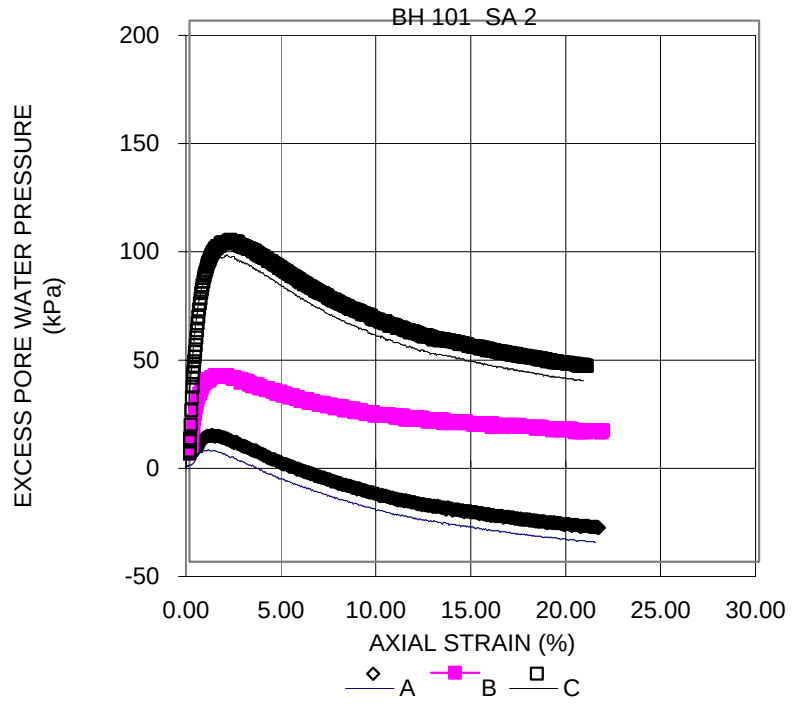
Golder Associates

Prepared By: LFG
Checked By: MM

CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS
SHEET 4 OF 4

FIGURE C-4

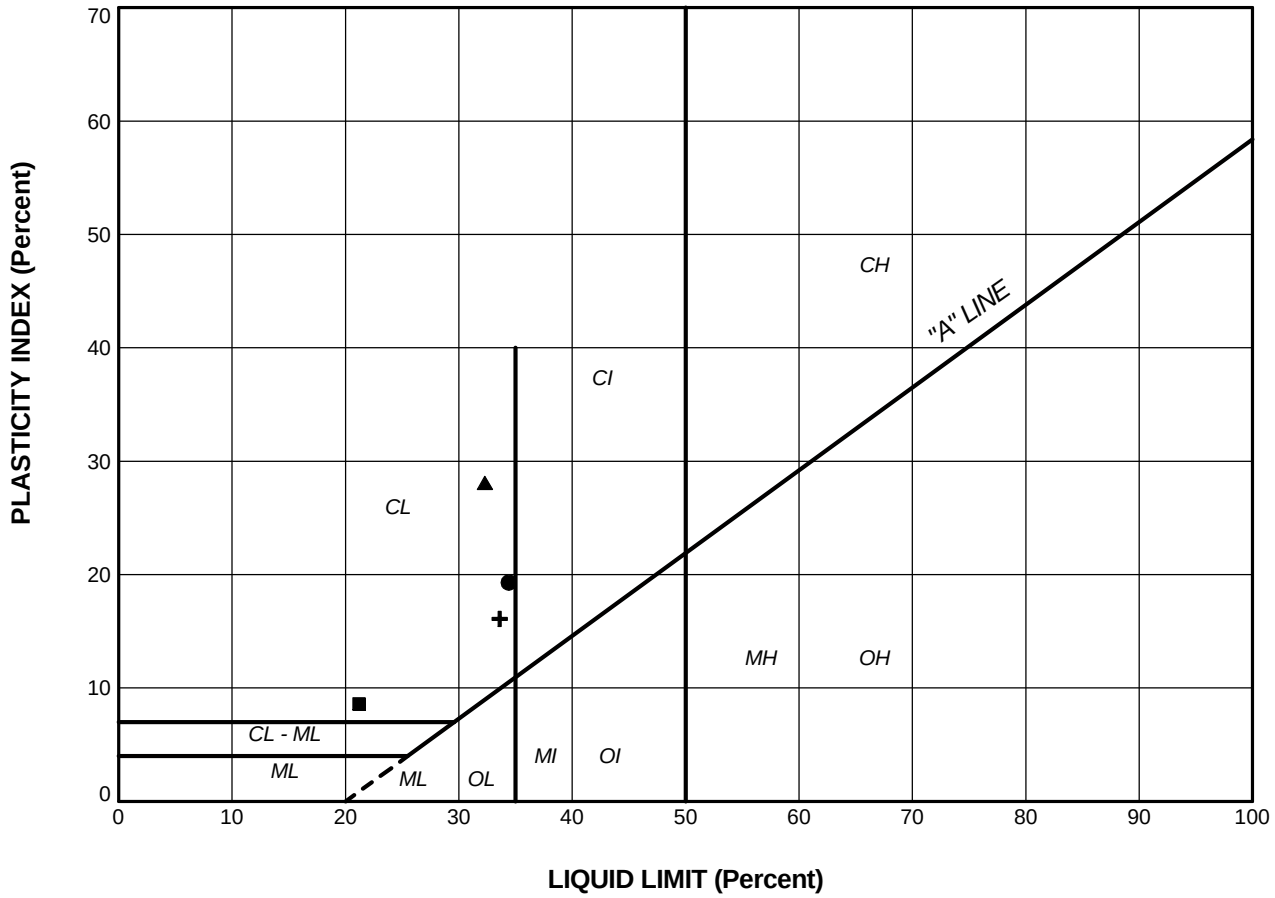




Date: October, 2004
Project No. 021-4216-1

Golder Associates

Prepared By: LFG
Checked By: MM



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)	LL(%)	PL(%)	PI
●	101	1	167.9	34.4	15.1	19.3
■	101	2	167.2	21.2	12.6	8.6
▲	102	1	167.9	32.3	4.2	28.1
✚	103	3	166.9	33.6	17.5	16.1

PROJECT

MTO FERRY DOCK
PELEE ISLAND, ONTARIO

TITLE

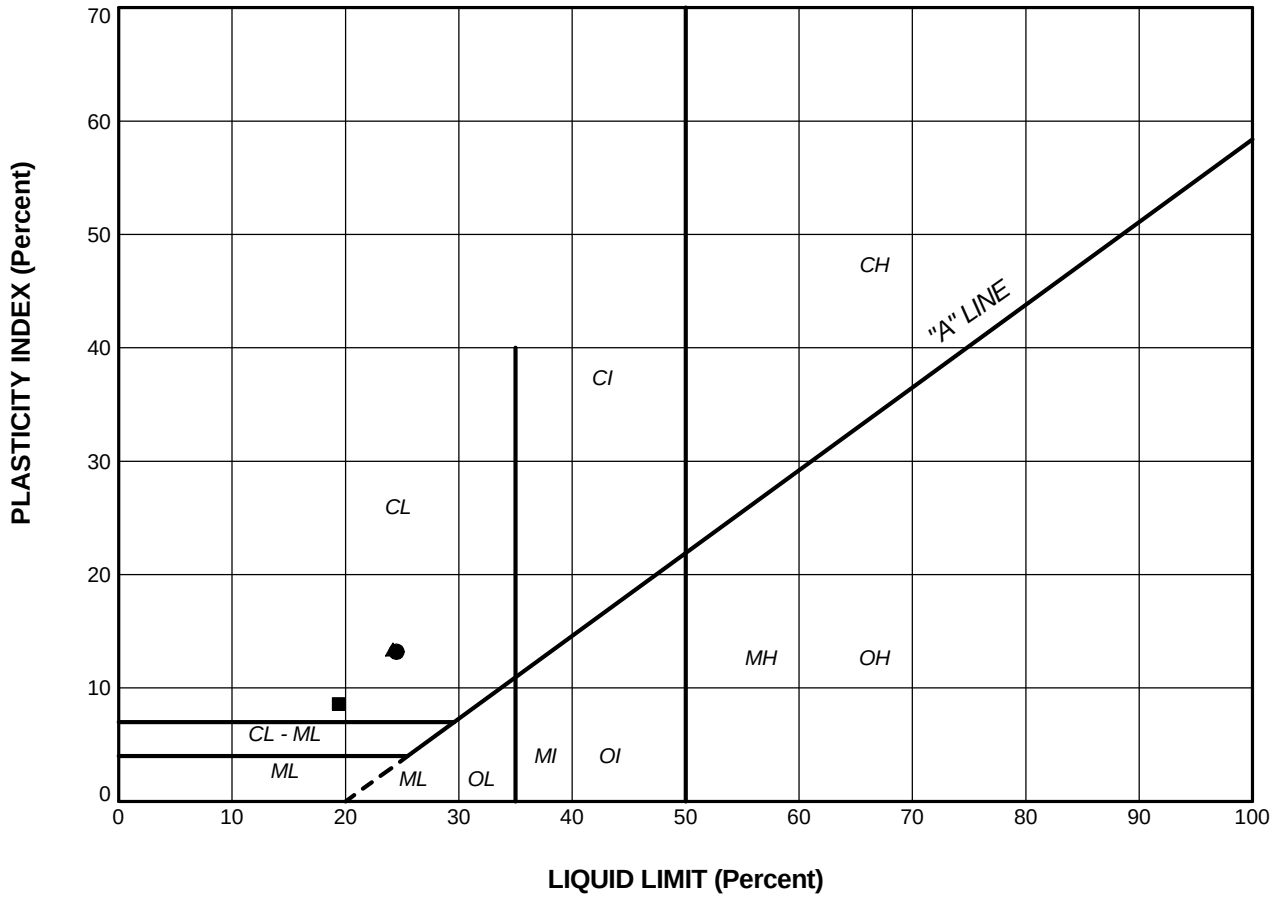
PLASTICITY CHART

(SILTY CLAY)

Golder Associates
LONDON, ONTARIO

PROJECT No.		021-4216-1-3	FILE No.	021-4216-P.GPJ
			SCALE	N/A REV.
DRAWN	WDF	Oct 18/04		
CHECK	AMH	Oct 18/04		**FIGURE C-5**

MTO_PI GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)	LL(%)	PL(%)	PI
●	101	3	165.6	24.5	11.3	13.2
■	102	3	166.6	19.4	10.8	8.6
▲	103	5	164.7	24.2	10.8	13.4

PROJECT

MTO FERRY DOCK
PELEE ISLAND, ONTARIO

TITLE

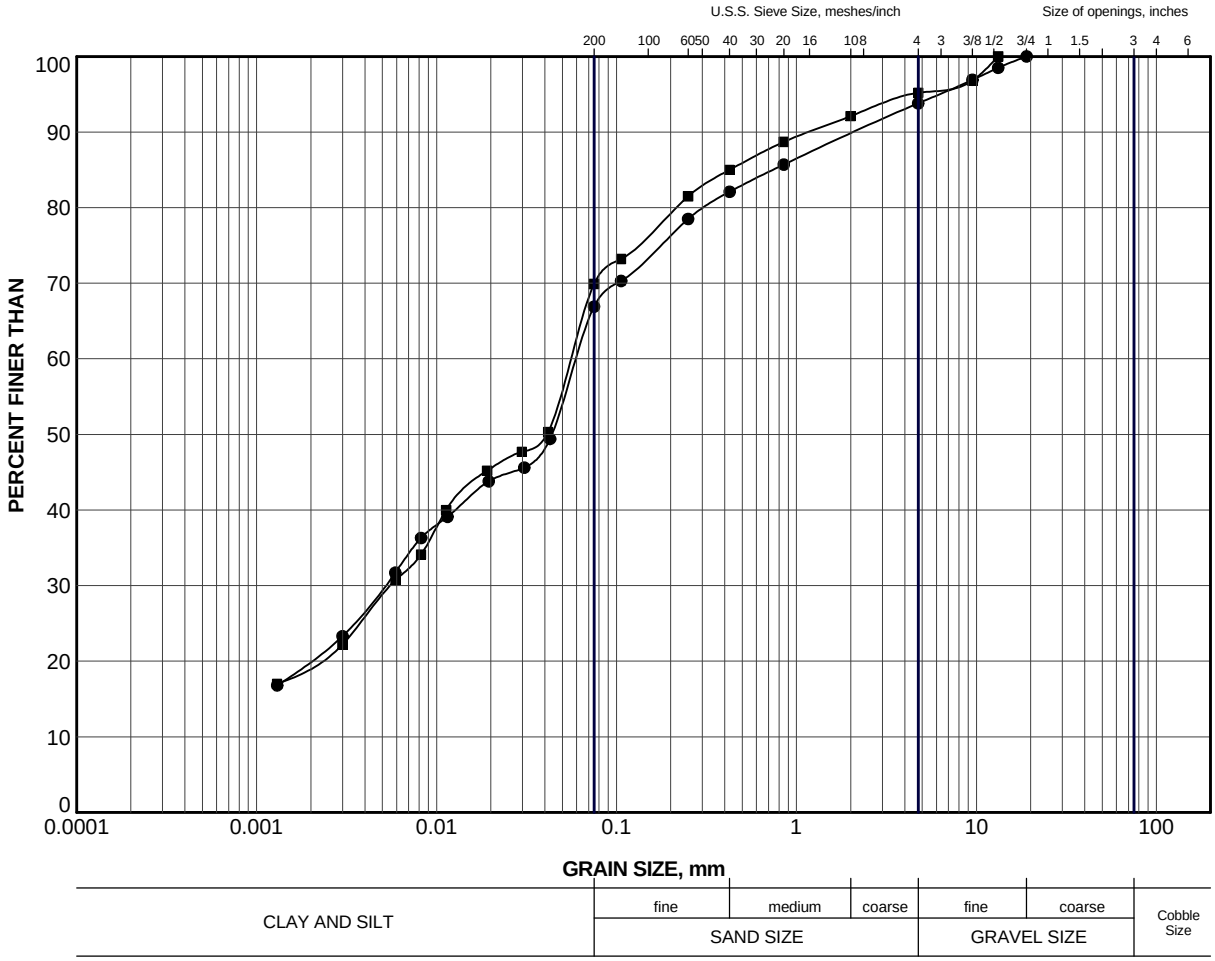
PLASTICITY CHART

(CLAYEY SILT TILL)

Golder Associates
LONDON, ONTARIO

PROJECT No.		021-4216-1-3	FILE No.	021-4216-P.GPJ
			SCALE	N/A REV.
DRAWN	WDF	Oct 18/04		
CHECK	AMH	Oct 18/04		**FIGURE C-6**

MTO_PI GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	101	4	164.0
■	103	7	163.1

PROJECT

MTO FERRY DOCK
PELEE ISLAND, ONTARIO

TITLE

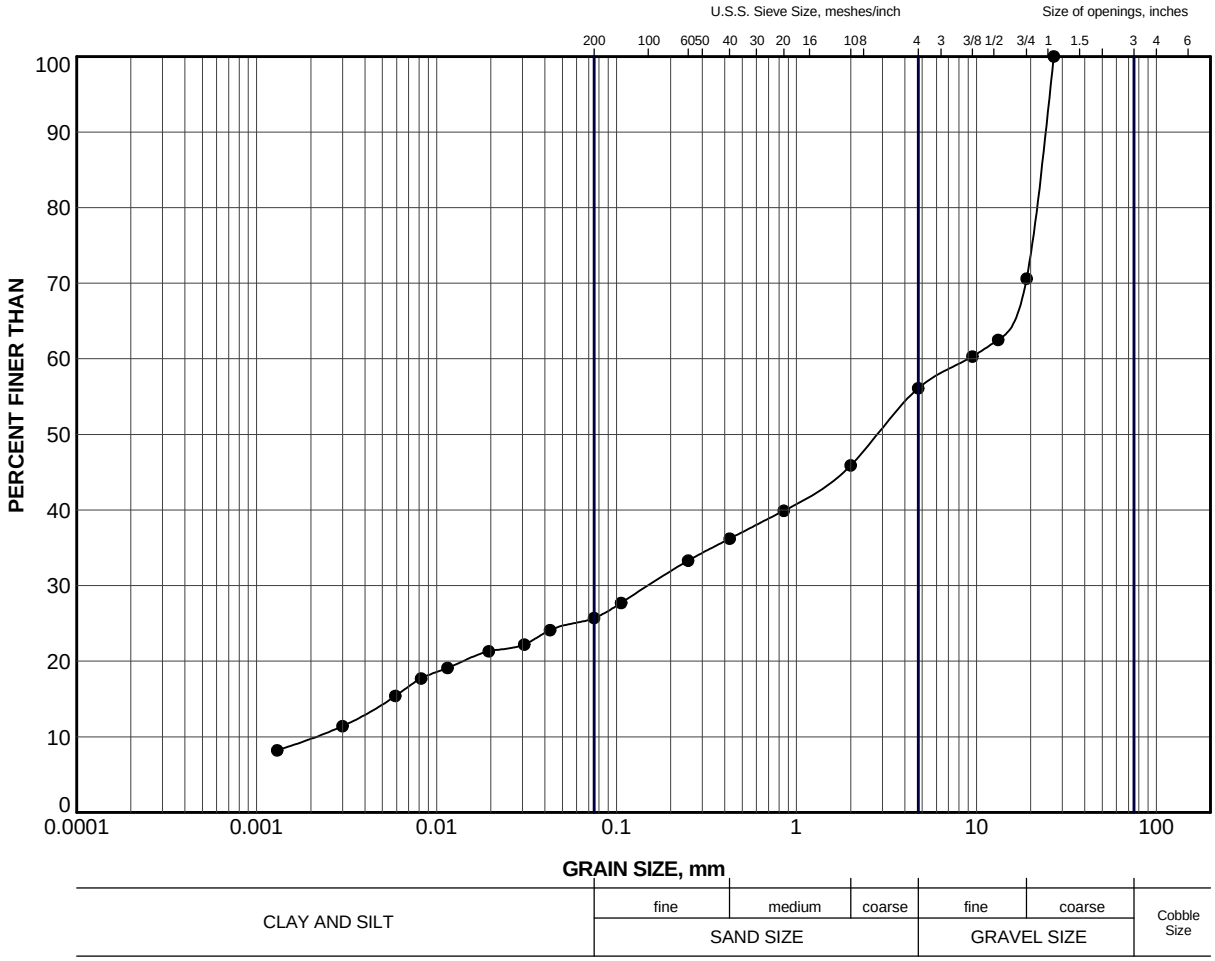
GRAIN SIZE DISTRIBUTION

CLAYEY SILT TILL

Golder Associates
LONDON, ONTARIO

PROJECT No.		021-4216-1-3	FILE No.	021-4216-P.GPJ
			SCALE	N/A REV.
DRAWN	WDF	Oct 18/04		
CHECK	AMH	Oct 18/04	**FIGURE**	**C-7**

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	102	8	161.8

PROJECT

MTO FERRY DOCK
PELEE ISLAND, ONTARIO

TITLE

GRAIN SIZE DISTRIBUTION

SANDY SILT TILL

Golder Associates
LONDON, ONTARIO

PROJECT No.		021-4216-1-3	FILE No.	021-4216-P.GPJ
			SCALE	N/A REV.
DRAWN	WDF	Oct 18/04		
CHECK	AMH	Oct 18/04		FIGURE C-8

LDN_MTO_NEW GLDR_LDN.GDT