Trow

# Preliminary
# Geotechnical Investigation
# Proposed Residential Development
# 37719 Lake Line
# Port Stanley, Ontario

Prepared for:

Glover Holdings
4171 Colonel Talbot Road
London, Ontario N6P 1A1

Attention: Mr. James Glover



## Trow Associates Inc.

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LNGE00009215A
October, 2007

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## Drawings



## Appendices

# 1. Introduction

As requested, Trow Associates Inc. (Trow) has conducted a preliminary geotechnical investigation in conjunction with a proposed residential development to be located at 37719 Lake Line in Port Stanley, Ontario. This report summarizes the results of the investigation, and provides preliminary geotechnical engineering guidelines to assist with the preliminary design of the proposed development.

## 1.1 Terms of Reference

The geotechnical investigation was generally done in accordance with Trow's email proposal dated July 16, 2007, and a follow-up email proposal dated July 19, 2007. Written authorization to proceed with the investigation was received from Mr. James Glover on July 18, 2007.

The purpose of the investigation was to examine the subsoil and groundwater conditions at the site by advancing a series of sampled test holes at the locations illustrated on the attached Test Hole Location Plan (Drawing 1).

Based on an interpretation of the factual borehole data, and a review of soil and groundwater information from test holes advanced at and near the site, Trow Associates Inc. has provided preliminary engineering guidelines for the preliminary geotechnical design of the proposed residential subdivision. More specifically, this report provides preliminary comments on excavations, site preparation, foundations, bedding, backfill and pavement design.

This report is provided on the basis of the terms of reference presented above and on the assumption that the design will be in accordance with applicable codes and standards. If there are any changes in the design features relevant to the geotechnical analyses, or if any questions arise concerning geotechnical aspects of the codes and standards, this office should be contacted to review the design.

The information in this report in no way reflects on the environmental aspects of the soil. Should specific information in this regard be needed, additional testing may be required.

## 2. Methodology

The initial site reconnaissance and fieldwork was carried out on July 18, 2007, and consisted of the advancement of five (5) test pits at the locations denoted on Drawing 1 as TP1 to TP5, inclusive. The test pits were excavated with a rubber tire loader/backhoe provided by the client, and terminated depths ranging between about 1.5 m and 4.4 m. Samples of the various strata encountered were recovered from the excavation sidewalls and/or the excavated material.

Due to the extent and nature of largely incompetent soils encountered during the initial test pit investigation, Trow (at the request of the client) returned to the site on September 5-7, 2007 to advance a series of sampled boreholes using a locally contracted track-mounted drill. The boreholes locations are denoted as BH1 to BH12, inclusive on Drawing 1, attached. The subcontracted drill was equipped with continuous flight hollow stem augers, soil testing and soil sampling equipment. Boreholes were terminated at depths ranging between about 5.0 m and 12.6 m.

Within the boreholes, Standard Penetration Tests (SPTs) were performed to assess the compactness or consistency of the underlying soils and to obtain representative samples.

The stratigraphy in the test holes was examined and logged in the field by Trow geotechnical personnel. Representative samples of the various soil strata encountered at the test locations were taken to our laboratory in London for further examination by a geotechnical engineer and laboratory classification testing. Laboratory testing for this investigation comprised of routine moisture content determinations; results presented on the borehole logs.

Following the drilling, water levels were measured in the open boreholes, upon which the boreholes were backfilled with the excavated materials and bentonite.

Samples remaining after the classification testing will be stored for a period of three months following the date of sampling (i.e., until January, 2008). After this time, they will be discarded unless prior arrangements have been made for longer storage.

# 3. Site and Subsurface Conditions

## 3.1 Site Description

The study area is currently being used for agricultural purposes (sod farming). The north side of the site is bound by Lake Line, while the west side is bound by a wooded area.

The site generally slopes downward from north to south; local relief within the study area was estimated to be about 5 metres.

## 3.2 Site Physiography

The physiographic mapping for the area indicates that the site is situated within the Ekfrid Clay Plain (Chapman and Putnam, 1984). The Ekfrid Clay Plain physiographic region consists of stratified clays. The surface is nearly level except where it is cut by gullies near the Thames River. Knolls or low smooth ridges of sand and gravel are sparsely superimposed on the clay.

## 3.3 Soil Stratigraphy

The detailed stratigraphy encountered in each test hole and the results of routine laboratory tests carried out on representative samples of the subsoils are given of the attached Borehole Logs and Test Pit Summary Table. It must be noted that boundaries of soil indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect transition zones for the purposes of geotechnical design and should not be interpreted as exact planes of geological change.

The subsurface soil conditions encountered in the test holes are detailed on the Borehole Logs and Test Pit Summary provided in Appendix A, and summarized as follows.

### 3.3.1 Topsoil and Organics

Each borehole was surfaced with a layer of topsoil. The topsoil, generally described as brown, soft, moist sandy silt loam, extended to depths ranging between about 0.3 m and 1.5 m.

In addition to the surficial topsoil, a 2.5 m thick deposit of peat was encountered at borehole BH11 below a depth of about 2.4 m. The peat was described as brown to black, fibrous trace traces of sand, and soft.

### 3.3.2 Sand and Silt

The predominant native mineral soils encountered beneath the topsoil was alluvial sand and silt. The sand and silt was generally described as brown becoming grey with depth, and loose to compact, based on SPT N-values ranging between 4 and 26 blows per 300 mm penetration of the split-spoon sampler. Moisture contents of the silt and sand soil (presented graphically on the Borehole Logs) ranged between about 10.7 and 27.4 percent, indicative of moist to wet conditions.

### 3.3.3 Clayey Silt

In addition to the sand and silt, lacustrine deposits of clayey silt were also encountered within test holes BH12 and TP2 to TP5. The clayey silt was generally described as grey, soft (based on observed excavator resistance, and very moist to wet, based on *in situ* moisture contents ranging between about 27.0 and 44.0 percent.

### 3.3.4 Coarse Sand with Gravel

Underlying the alluvial silt and sand, a layer of sand with some gravel was generally encountered. The sand was generally described as coarse grained with trace silt, compact to dense (based on SPT N-values ranging between about 11 and 36 blows per 300 mm of sampler penetration), and wet, base on observations of free water egress and *in situ* moisture contents ranging between about 9.4 and 18.6 percent.

### 3.3.3 Glacial Till

With the exception of borehole BH2, the boreholes each extended into an underlying glacial till stratum, encountered at depths ranging between about 3.4 m and 8.5 m below existing grades. The glacial till was generally comprised of clayey silt with traces of sand and gravel, and was described as grey and stiff to hard (based on SPT N-Values ranging between about 18 and 62 blows per 300 mm of sampler penetration). Based on laboratory testing, the *in situ* moisture content of the till ranged between about 16.5 and 22.7, indicative of generally moist to very moist conditions.

## 3.4 Groundwater Conditions

Observations of groundwater conditions during the investigation, and measures depths to the groundwater are provided on the Borehole Logs and Test Pit Summary table, attached.

With the exception of test pit TP1, free groundwater egress was encountered within each of the test holes during the investigation. Upon completion of the drilling, groundwater was measured at depths ranging between about 0.6 m and 3.7 m within the open boreholes. Evidence of groundwater seepage was observed within TP2 to TP5 below depths ranging between about 1.4 m and 2.7 m.

It is noted that the depth to the groundwater table may vary in response to climatic or seasonal conditions, and, as such, may differ at the time of construction, with higher levels in wet seasons. Capillary rise effects should also be anticipated within fine grained soil deposits.

# 4. Discussion and Preliminary Recommendations

## 4.1 General

It is understood that the proposed development will consist primarily of single family residential dwellings. The residential subdivision is expected to have complete municipal servicing, and will be accessed with paved local roads.

The following sections of this report provides geotechnical comments and preliminary recommendations regarding site preparation, excavations and dewatering, foundations and basement design, site servicing and pavement design requirements. Additional site investigation and sampling will be required to support detailed design of the proposed development.

## 4.2 Residential Foundations

As discussed in the previous Section 3, the upper soil strata at the site are generally characterized by loose silt and sand, with areas of soft clayey silt and localized (thick) peat deposits. In addition, shallow groundwater was encountered in nearly all of the test holes. Accordingly, based on the results of the investigation the site will generally not support the construction of residences with basements on conventional strip and spread footings without excessive differential and total settlements.

Based on the results of the investigation, the following paragraphs outline various alternative construction measures which will facilitate the construction of the proposed residences.

### 4.2.1 Stiffened Slab-on-Grade Foundation

In general, based on the results of the investigation, the site will support the construction of lightly loaded structures (i.e., maximum two storey residences) on a shallow stiffened slab-on-grade foundation, with no basement, constructed in accordance with the following preliminary recommendations.

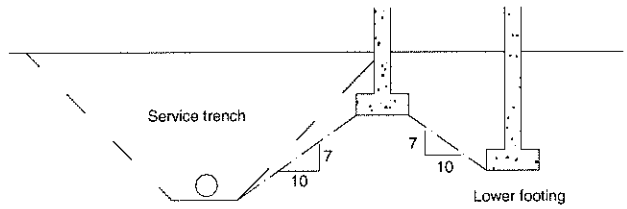
In general, a stiffened slab foundation consists of a reinforced concrete slab-on-grade, with thickened sections beneath exterior and load-bearing walls in lieu of footings. Provided the following preliminary recommendations are adhered to, a bearing pressure of 75 kPa can be used beneath the thickened slab sections, constructed on a minimum of 0.45 m of granular fill as discussed below.

Prior to placement of foundations, all topsoil, organics and obvious deleterious soils must be removed from the footprint of the proposed structure. In addition, the subexcavation must extend to a minimum depth of 0.45 m below the design underside of the foundation to facilitate the placement of a minimum of 0.45 m of structural (i.e., granular) fill. Verification of the soil subgrade should be carried out by a geotechnical engineer prior to the placement of the structural fill.

The structural fill should consist of OPSS Granular 'B', and should be compacted to a minimum of 100 percent Standard Proctor Maximum Dry Density (SPMDD). The structural fill should also extend laterally beyond the edges of the proposed building footprint for a distance equal to the depth of structural fill beneath the footing.

In the event groundwater conditions preclude the compaction of the structural fill to the required density, a well-graded clear stone (such as HL4 stone), or recycled concrete could be used in lieu of the OPSS Granular 'B'.

Footings and service trenches at different elevations should be located such that the higher footings are set beyond a line drawn up at 10 horizontal to 7 vertical from the near edge of the lower element to ensure that undermining is not a problem. Where service trenches extend within close proximity to foundations, the trench should be backfilled with structural fill, well graded clear stone, or lean mix concrete.




FOOTINGS NEAR SERVICE TRENCHES OR AT DIFFERENT ELEVATIONS

Provided that the footing bases are not disturbed due to construction activity, precipitation, freezing and thawing action, etc., and the aforementioned bearing pressures are not exceeded, the total and differential settlements of footings designed in accordance with the recommendations of this report and with careful attention to construction detail are expected to be less than 25 mm and 20 mm (1 and ¾ inch), respectively.

Construction of this nature with foundation depths of less than about 1 metre will require additional protection against frost protection. For a stiffened slab-on-grade with an edge thickness of about 450 mm, a minimum of 50 mm of rigid board extruded polystyrene insulation, such as DOW SM, should be provided, and should have a minimum lateral extension of 1.2 m. In addition, a minimum soil cover of 300 mm should be provided over the insulation. The insulation should be slope in a manner that promotes any groundwater drainage away from the foundation.

Perimeter subdrains may be required due to site grading and groundwater conditions. Further evaluation and ongoing liaison will be required from the office.

### 4.2.2 Foundation Preloading

In general, where a grade raise of more than about 0.5 m is required, preloading of the residential building footprint may be required in order to facilitate soil improvement prior to placement of the stiffened slab-on-grade foundation, thereby reducing the potential for excessive total and

differential settlements beneath the residential foundations. In general, preloading involves the placement of a surcharge over the development area with a bearing pressure equivalent to that of the proposed development. During and following the preload, settlement of the grade is monitored using settlement plates in order to ensure that the predicted settlements are achieved, and that overall settlement has stabilized. In order to accelerate the settlement and further reduce the risk of long term settlements, additional surcharge may also be provided.

The amount of preloading required for this site, if any, will vary depending upon the area of the site and the amount of grade raise required. Accordingly, ongoing liaison with this office will be required.

### 4.2.3 Construction in Areas of Peat Deposits

As discussed in Section 3, a 2.5 m thick peat deposit was encountered below a depth of about 2.4 m near the south east corner of the study area (i.e., at borehole BH11). Additional investigation will be required to ascertain the limits of the peat deposit in this area.

Since the peat deposit extends to a depth of 4.9 m below grade, excavation of the peat deposit and replacement with structural fill will be extensive, challenging given the site groundwater conditions, and costly. Accordingly, development of the peat area with non-structural development (i.e., park) may be warranted.

In the event further consideration will be given to construction of residences within the peat area, the following comments are offered.

In general, there are two issues which should be considered for construction over peat deposits; settlements, and methane gas emissions. In order to reduce the potential for excessive total and differential settlements of the residential stiffened slab-on-grade foundation, pre-loading of the proposed building sites will be required. Discussion pertaining to preloading of the site is provided in the previous Section 4.2.2.

In order to minimize the risk of methane gas buildup within residences, a passive methane gas venting system should be provided. In general, the venting system should consist of slotted piping (positively vented to the exterior) incorporated within a crushed clear stone foundation base (having a minimum thickness of 450 mm). Further detail pertaining to the design and construction of a passive methane gas emission system can be provided upon request.

## 4.3 General Excavation and Dewatering Comments

Side slopes of temporary excavations must conform to Regulation 213/91 of the Occupational Health and Safety Act of Ontario. The predominant silt and sand soils encountered throughout the site are classified as Type 3 soil. Temporary excavation sidewalls which extend through Type 3 soils must be cut back at a maximum inclination of 1 horizontal to 1 vertical from the base of the excavation. Where groundwater egress is encountered, flatter slopes may be required.

If imported fill material is utilized at the site, verification of the suitability of the fill may be required from an environmental standpoint. Conventional geotechnical testing will not determine the suitability of the material in this regard. Analytical testing and environmental site assessment may be required at the source. This will best be assessed prior to the selection of the material source. A quality assurance program should be implemented to ensure that the fill material will comply with the current Ministry of Environment standards for placement and transportation. The disposal of excavated materials must conform to the MOE Guidelines and requirements. Trow can be of assistance if an assessment of the materials is required.

Localized base improvement may be required for services bedded in wet silty soils, particularly in wet weather seasons. Some areas of crushed stone bedding enclosed with a geotextile may be required upon the recommendation of a geotechnical engineer when additional information becomes available through field inspections during the construction stage.

Groundwater infiltration should be anticipated within the service trench excavations, particularly at depths below about 2 metres. Groundwater infiltration can likely be accommodated using using conventional sump pumping techniques; however, if groundwater infiltration persists, more extensive dewatering measures may be required.

For projects requiring positive groundwater control with a removal rate in excess of 50,000 litres per day, a Permit to Take Water (PTTW) will be required. PTTW applications will need to be approved by the Ministry of Environment according to Sections 34 and 98 of the Ontario Water Resources Act R.S.O. 1990 and the Water Taking and Transfer Regulation O. Reg. 387/04. It is noted that a standard geotechnical investigation will not determine all the groundwater parameters which may be required to support the application. Accordingly, a detailed hydrogeological assessment from a quantitative point of view may be required to estimate the quantity of water to be removed. Trow can assist if the need arises.

## 4.4 Pipe Bedding and Trench Backfill

The subgrade soils beneath the water and sewer pipes which will service the site are generally expected to comprise of native silt and sands. For services constructed on the native mineral soil or engineered fill, the bedding should conform to OPS Standards. As indicated in the previous Section 4.3, localized base improvements may be required for services bedded in wet silty soils, particularly in wet weather seasons. Some areas of crushed stone bedding enclosed with a geotextile may be required. This is best determined onsite during construction by a geotechnical engineer. Bedding aggregate should also be placed around the pipe to at least 300 mm (12 inch) above the pipe, and be compacted to a minimum 95 percent SPMDD.

Water and sewer lines installed outside of heated areas should be provided with a minimum 1.2 m (4 ft) of soil cover for frost protection.

Base stability should not be an issue if the pipes are bedded on firm, competent soil. However, if soft soil is excavated, bedding improvements may be required such as the incorporation of geotextile.

The trenches above the specified pipe bedding should be backfilled with inorganic soils placed in maximum 300 mm thick lifts and uniformly compacted to at least 95% SPMDD. A program of *in situ* density testing should be set up to ensure that satisfactory levels of compaction are achieved. If the depth of services is significantly lower than the groundwater table, the backfill load will need to be reduced.

Based on the results of this investigation, the majority of the excavated native sand and silt material may be used for construction backfill provided reasonable care is exercised in handling, and construction is carried out in favorable weather. In this regard the material should be within 3 percent of the optimum moisture as determined in the standard Proctor density test, and stockpiling of material for prolonged periods of time should be avoided. This is particularly important if construction is carried out in wet or otherwise adverse weather.

Soils excavated from below the stabilized groundwater table may be too wet for reuse as backfill unless adequate time is allowed for drying, or if the material is blended with approved dry fill; otherwise, it may be stockpiled onsite for reuse as landscape fill.

As noted previously, disposal of excavated materials off site should conform to current Ministry of Environment guidelines.

## 4.5 Preliminary Pavement Design

Areas to be paved should be stripped of all topsoil, organics and other obviously unsuitable material. The exposed subgrade must then be thoroughly proof-rolled. Any soft spots revealed by this or any other observations must be over-excavated and backfilled with approved material. All fill required to backfill service trenches, or to raise the subgrade to design levels must conform to requirements discussed previously. Preferably, the natural inorganic excavated soils should be used to maintain uniform subgrade conditions, provided adequate compaction can be achieved.

Provided the preceding recommendations are followed, the pavement thickness design requirements given in the following table are recommended for the anticipated specified street classifications and subgrade conditions.

| Recommended Pavement Structure Thickness | | | |
|---|---|---|---|
| Pavement Layer | Compaction Requirements | Local Road | Collector Road |
| Asphaltic Concrete | 97% Marshall Density | 35 mm HL-3<br>45 mm HL-8 | 45 mm HL-3<br>65 mm HL-8 |
| Granular 'A' (Base) | 100% SPMDD* | 150 mm | 150 mm |
| Granular 'B' (Subbase) | 100% SPMDD* | 350 mm** | 450 mm** |
| *Notes: 1) SPMDD denotes Standard Proctor Maximum Dry Density.<br>2) The subgrade must be compacted to 98% SPMDD.<br>3) The above recommendations are minimum requirements.<br>** Additional granular base may be required if the moisture content of the subgrade is high. | | | |

Other granular configurations may also be possible provided the granular base equivalency (GBE) thickness is maintained. These recommendations on thickness design are not intended to support heavy and concentrated construction traffic, particularly where only a portion of the pavement section is installed.

If construction is undertaken under adverse weather conditions (i.e., wet or freezing conditions) subgrade preparation and granular sub-base requirements should be reviewed by the geotechnical engineer. As well, if only a portion of the pavement will be in place during construction, the granular subbase may have to be thickened, and/or the subgrade improved with a geotextile separator.

Samples of both the Granular 'A' and Granular 'B' aggregates should be checked for conformance to OPSS 1010 prior to utilization on site, and during construction. The Granular 'B' subbase and the Granular 'A' base courses must be compacted to 100 percent SPMDD.

The asphaltic concrete paving materials should conform to the requirements of OPSS 1150. The asphalt should be placed in accordance with OPSS 310 and compacted to at least 97 percent of the Marshall mix design bulk density.

Good drainage provisions will optimize pavement performance. The finished pavement surface should be free of depressions and should be sloped (preferably at a minimum grade of two percent) to provide effective surface drainage toward catchbasins. Surface water should not be allowed to pond adjacent to the outside edges of pavement areas. In low areas, subdrains should be installed to intercept excess subsurface moisture and prevent subgrade softening, as shown on Drawing 2. This is particularly important in heavier traffic areas at the site entrances. The locations and extent of subdrainage required within the paved areas should be reviewed by this office in conjunction with the proposed grading.

A program of *in situ* density testing must be carried out to verify that satisfactory levels of compaction are being achieved.

To minimize the effects of differential settlements of service trench fill, it is recommended that wherever practical, placement of binder asphalt be delayed for approximately six months after the granular sub-base is put down. The surface course asphalt should be delayed for a further one year. Prior to the surface asphalt being placed, it is recommended that a pavement evaluation be carried out on the base asphalt to identify repair areas or areas requiring remedial works prior to surface asphalt being placed.

## 4.6 Curbs and Sidewalks

The concrete for the curbs and gutters should be proportioned, mixed, placed and cured in accordance with the requirements of OPSS 353 and OPSS 1350.

During cold weather, the freshly placed concrete should be covered with insulating blankets to protect against freezing.

The subgrade for the sidewalks should comprise of undisturbed natural soil or well-compacted fill. A minimum 150 mm thick layer of compacted (100 percent SPMDD) Granular 'A' should be placed below the sidewalk slabs. Construction traffic should be kept off the placed curbs and sidewalks as they are not designed to withstand heavy traffic load.

## 5. General Comments

The comments given in this report are intended only for the guidance of design engineers. The number of test holes required to determine the localized underground conditions between test holes affecting construction costs, techniques, sequencing, equipment, scheduling, etc. would be much greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should in this light, decide on their own investigations, as well as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

As indicated previously, the current investigation constitutes a preliminary investigation only, and is provided to support the preliminary design of the proposed development. Depending upon the proposed design of the development, additional investigation and/or reporting will be required.

Trow Associates Inc. should be retained for a general review of the design and specifications to verify that this report has been properly interpreted and implemented. If not afforded the privilege of making this review, Trow Associates Inc. will assume no responsibility for interpretation of the recommendations in this report.

We trust that this report is satisfactory to your present requirements and we look forward to assisting you in the completion of this project. Should you have any questions, please contact the undersigned at your convenience.

All the foregoing and attachments respectfully submitted,

**Trow Associates Inc.**

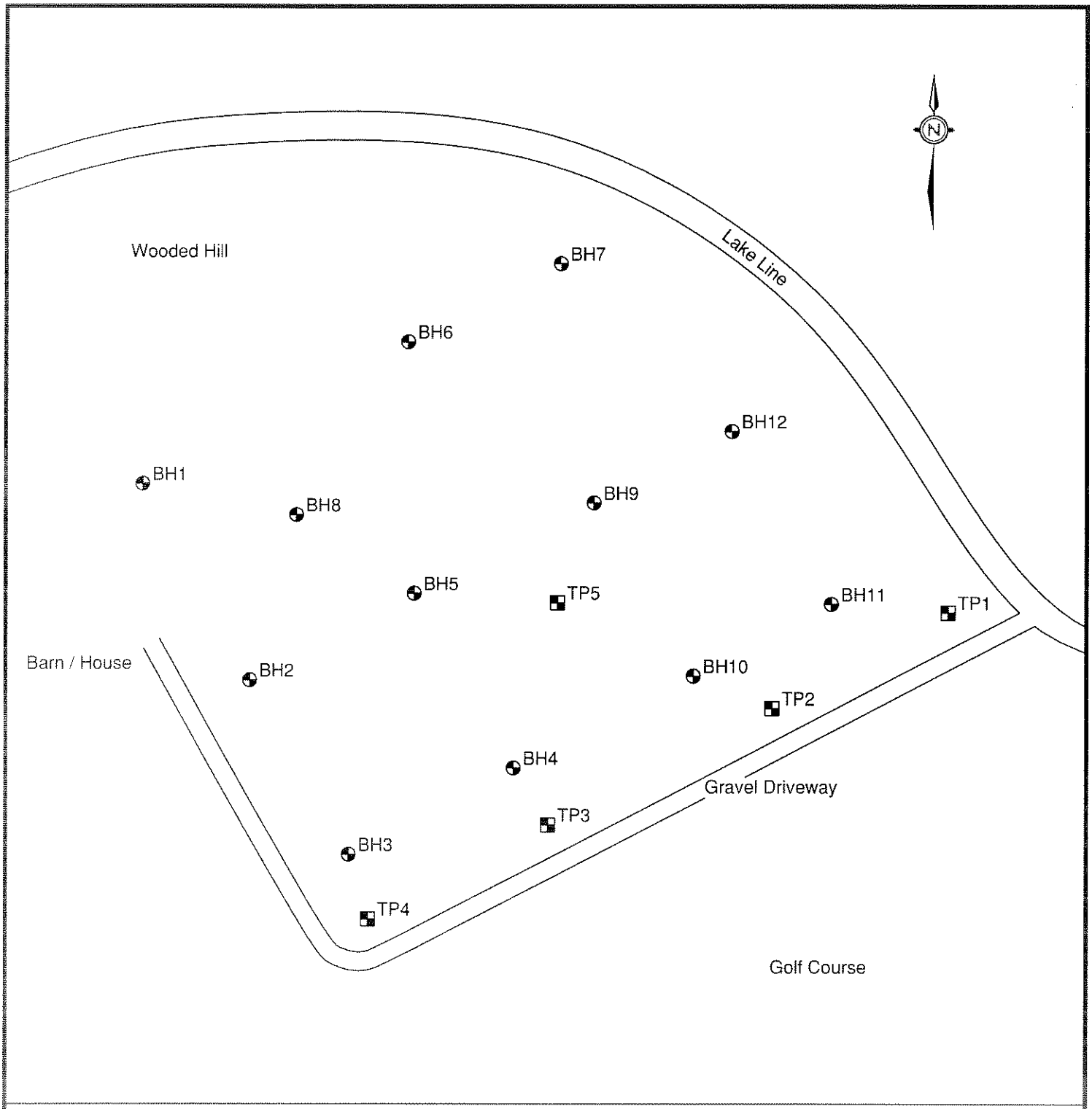
DRAFT

John Lobbezoo, P. Eng.
Geotechnical Services

DRAFT

Botel Chiu, P. Eng.
London Branch Manager

# Drawings




*Notes:*

1. Reference: Site plan based on site sketch by Trow field technician.
2. The boundaries and soil types have only been established at the test pit locations. Between test holes they are assumed and may be subject to considerable error.
3. Soil samples will be retained in storage for three months and then destroyed unless client advises that an extended time period is required.
4. Topsoil/Fill quantities should not be established from the information provided at the test hole locations.

*Legend:*

TP1 Test Pit Location

BH1 Borehole Location

Trow

Trow Associates Inc.
London, Ontario

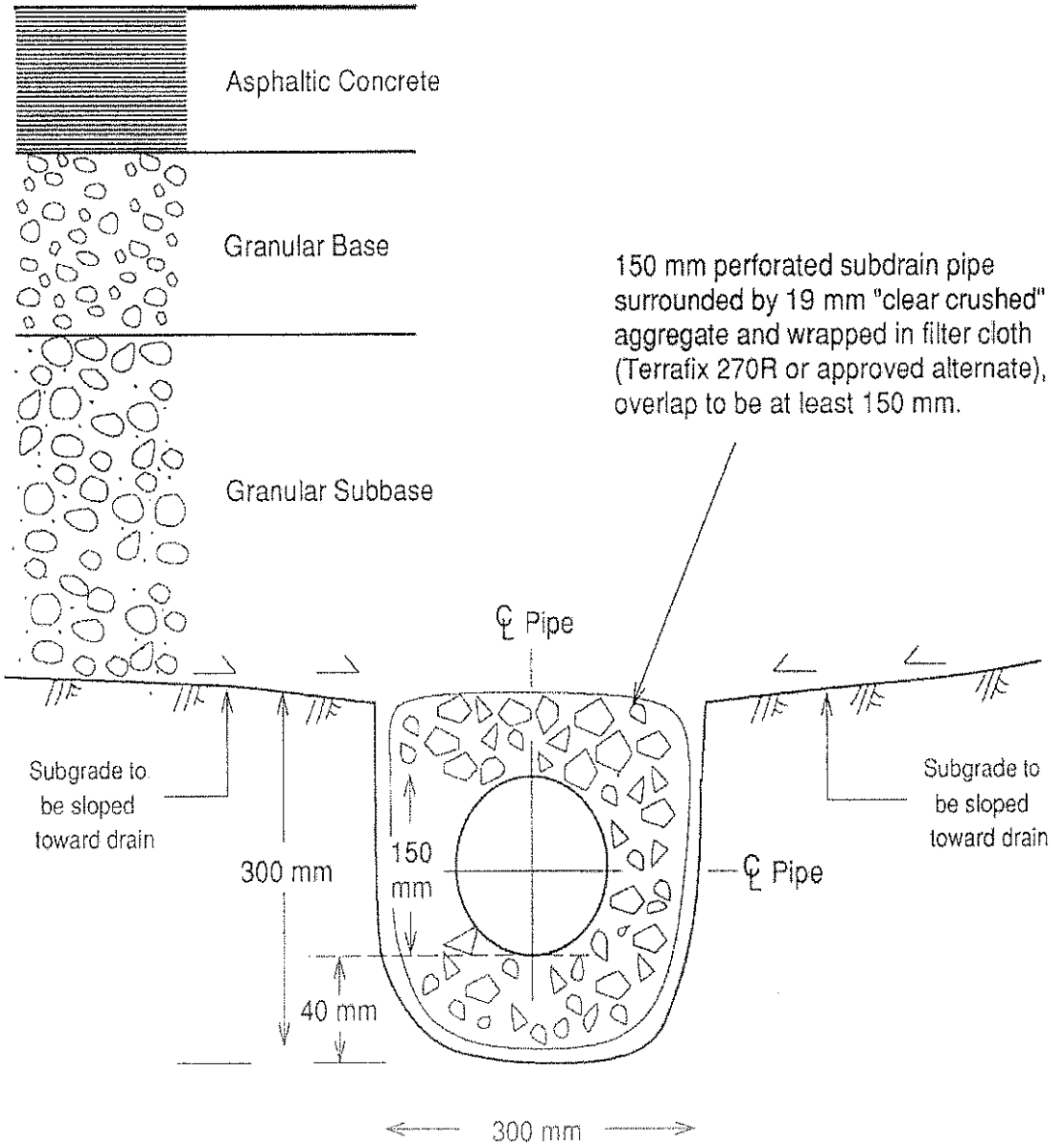
DWG. 1

# TEST HOLE LOCATION PLAN

Preliminary Geotechnical Investigation
Proposed Residential Development
317719 Lake Line, Port Stanley, ON

| | |
|---|---|
| PROJECT NO.: | LNGE00009215A |
| SCALE: | n.t.s. |
| DRAWN BY: | JL |
| CHECKED BY: | BC |
| DATE: | Oct. 12, 2007 |

# PAVEMENT SUBDRAIN DETAIL




**NOTES:**

1. All dimensions in millimetres.
2. All subdrains to be set on at least 1% grade draining to a positive outlet.

Scale: NTS

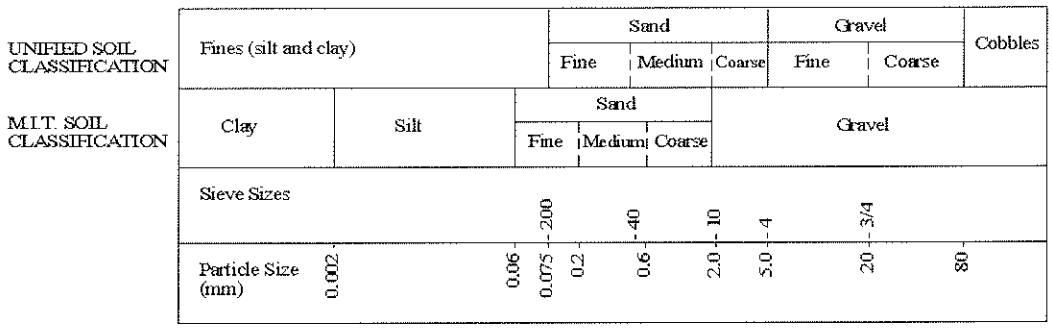
# Appendix A

**Borehole Logs**
**& Test Pit Summary**

Trow

# NOTES ON SAMPLE DESCRIPTIONS

1. All descriptions included in this report follow the 'modified' Massachusetts Institute of Technology (M.I.T.) soil classification system. The laboratory grain-size analysis also follows this classification system. Others may designate the Unified Classification System as their source; a comparison of the two is shown for your information. Please note that, with the exception of those samples where the grain size analysis has been carried out, all samples are classified visually and the accuracy of the visual examination is not sufficient to differentiate between the classification systems or exact grain sizing. The M.I.T. system has been modified and the TROW classification includes a designation for cobbles above the 75 mm size and boulders above the 200 mm size.




2. **Fill**: Where fill is designated on the borehole log, it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description therefore, may not be applicable as a general description of the site fill material. All fills should be expected to contain obstructions such as large concrete pieces or subsurface basements, floors, tanks, even though none of these obstructions may have been encountered in the borehole. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact and correct composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. The fill at this site has been monitored for the presence of methane gas and the results are recorded on the borehole logs. The monitoring process neither indicates the volume of gas than can be potentially generated nor pinpoints the source of the gas. These readings are to advise of a potential or existing problem (if they exist) and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic waste that renders the material unacceptable for deposition in any but designated land fill sites; unless specifically stated, the fill on the site has not been tested for contaminants that may be considered hazardous. This testing and a potential hazard study can be carried out if you so request. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common, but not detectable using conventional geotechnical procedures.

3. **Glacial Till**: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process, the till must be considered heterogeneous in composition and as such, may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (75 to 200 mm in diameter) or boulders (greater than 200 mm diameter) and therefore, contractors may encounter them during excavation, even if they are not indicated on the borehole logs. It should be appreciated that normal sampling equipment can not differentiate the size or type of obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited area; therefore, caution is essential when dealing with sensitive excavations or dewatering programs in till material.

Trow
London Branch

# BOREHOLE LOG

**BH1**

Sheet 1 of 1

PROJECT **Proposed Residential Development** PROJECT NO. **LNGE00009215A**

CLIENT **Glover Holdings** DATUM **Local**

DRILL TYPE/METHOD **Track-mounted Auger Drill** DATES: Boring **Sept 4/2007** Water Level **Sept 4/2007**

| DEPTH (m) | ELEVATION (m) | STRATA DESCRIPTION | SAMPLES TYPE | SAMPLES NUMBER | SAMPLES RECOVERY (mm) or (%) | SAMPLES N VALUE (blows) or RQD (%) |
|---|---|---|---|---|---|---|
| 0 | | | | | | |
| | 0.46 | **TOPSOIL**, brown, sandy silt loam, rootlets, loose, moist | | | | |
| 1 | | **SANDY SILT**, brown/grey, fine grained, some rust staining, compact, moist | | S1 | 140 | 16 |
| | | -becoming dilatant and wet at 1.5 m depth | | S2 | 230 | 17 |
| 2 | 2.30 | | | | | |
| | | -becoming **SILT**, trace sand, loose to compact below 2.3m depth | | S3 | 90 | 8 |
| 3 | 3.10 | | | | | |
| | | -becoming **SANDY SILT** below 3.1m depth | | S4 | 140 | 10 |
| 4 | | | | | | |
| | 4.90 | | | S5 | 365 | 19 |
| 5 | | -becoming **SILT**, dark grey, trace to some sand below 4.9 m depth | | | | |
| 6 | | | | S6 | 365 | 15 |
| 7 | | | | | | |
| 8 | | | | S7 | 460 | 6 |
| | 8.53 | | | | | |
| 9 | | **CLAYEY SILT TILL**, grey, trace fine sand and gravel, hard, moist | | | | |
| | 9.60 | | | S8 | 365 | 48 |
| 10 | | End of Borehole at 9.60 m depth | | | | |
| 11 | | | | | | |

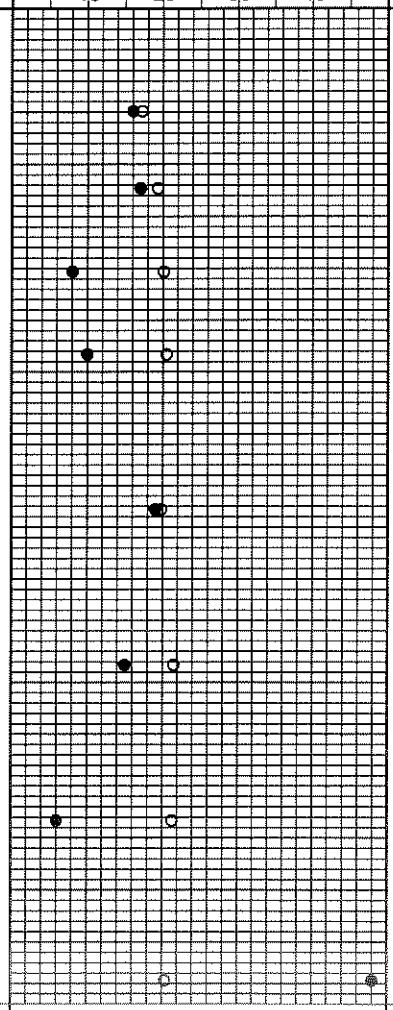
STRATA PLOT

WELL LOG

OTHER TESTS

SHEAR STRENGTH
✤ S Field Vane Test (#=Sensitivity)
▲ Penetrometer ■ Torvane
40 80 kPa

Atterberg Limits and Moisture
$W_P$ W $W_L$
● SPT N Value × Dynamic Cone
10 20 30 40



***NOTES***

1) Borehole interpretation requires assistance by Trow before use by others. Borehole Logs must be read in conjunction with Trow Report LNGE00009215A. For definition of terms used on logs, see sheets prior to logs.

2) Borehole open to 2.44 m depth upon completion; groundwater measured at 2.36 m depth upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
▥ Rock Core (eg. BQ, NQ, etc.) ▥ VN Vane Sample

OTHER TESTS

| | |
|---|---|
| G Specific Gravity | C Consolidation |
| H Hydrometer | CD Consolidated Drained Triaxial |
| S Sieve Analysis | CU Consolidated Undrained Triaxial |
| γ Unit Weight | UU Unconsolidated Undrained Triaxial |
| P Field Permeability | UC Unconfined Compression |
| K Lab Permeability | DS Direct Shear |

WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

Trow
London Branch

# BOREHOLE LOG

**BH2**

Sheet 1 of 1

PROJECT **Proposed Residential Development** PROJECT NO. **LNGE00009215A**

CLIENT **Glover Holdings** DATUM **N/A**

DRILL TYPE/METHOD **Track-mounted Auger Drill** DATES: Boring **Sept 4/2007** Water Level **Sept 4/2007**

| DEPTH (m) | ELEVATION (m) | STRATA DESCRIPTION | STRATA PLOT | WELL LOG | SAMPLES TYPE | SAMPLES NUMBER | SAMPLES RECOVERY (mm) or (%) | SAMPLES N VALUE (blows) or RQD (%) | OTHER TESTS |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | | |
| | 0.46 | **TOPSOIL**, brown, sandy silt loam, rootlets, loose, moist | | | | | | | |
| | | **SAND & SILT**, brown (rust stained), trace fine gravel, compact, moist | | | | S1 | 365 | 13 | |
| 1 | | | | ▼ | | | | | |
| | | -some wet silt layering at 1.5 m depth | | | | S2 | 230 | 16 | |
| 2 | | | | | | | | | |
| | | -becoming wet (dilatent) below 2.3m depth | | | | S3 | 230 | 10 | |
| 3 | | | | | | | | | |
| | | | | | | S4 | 230 | 11 | |
| 4 | | | | | | | | | |
| 5 | | | | | | S5 | 230 | 11 | |
| 6 | | | | | | | | | |
| | 6.40 | | | | | S6 | 365 | 11 | |
| | | **SAND** , grey, coarse grained, trace to some silt, trace to some gravel, compact to dense, wet | | | | | | | |
| 7 | | | | | | | | | |
| 8 | 8.08 | | | | | S7 | 365 | 36 | |
| | | End of Borehole at 8.08 m depth | | | | | | | |
| 9 | | | | | | | | | |
| 10 | | | | | | | | | |

SHEAR STRENGTH
✚ S Field Vane Test (#=Sensitivity)
▲ Penetrometer ■ Torvane
40 80 kPa

Atterberg Limits and Moisture
$W_P$ W $W_L$

● SPT N Value × Dynamic Cone
10 20 30 40

***NOTES***

1) Borehole interpretation requires assistance by Trow before use by others. Borehole Logs must be read in conjunction with Trow Report LNGE00009215A. For definition of terms used on logs, see sheets prior to logs.

2) Borehole open to 3.76 m depth upon completion; groundwater measured at 2.45 m depth upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ▩ ST Shelby Tube
▥ Rock Core (eg. BQ, NQ, etc.) ▥ VN Vane Sample

OTHER TESTS

| | |
|---|---|
| G Specific Gravity | C Consolidation |
| H Hydrometer | CD Consolidated Drained Triaxial |
| S Sieve Analysis | CU Consolidated Undrained Triaxial |
| γ Unit Weight | UU Unconsolidated Undrained Triaxial |
| P Field Permeability | UC Unconfined Compression |
| K Lab Permeability | DS Direct Shear |

WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

Trow
London Branch

# BOREHOLE LOG

**BH3**

Sheet 1 of 1

PROJECT **Proposed Residential Development** PROJECT NO. **LNGE00009215A**

CLIENT **Glover Holdings** DATUM **N/A**

DRILL TYPE/METHOD **Track-mounted Auger Drill** DATES: Boring **Sept 4/2007** Water Level **Sept 4/2007**

| DEPTH (m) | ELEVATION (m) | STRATA DESCRIPTION | SAMPLES TYPE | SAMPLES NUMBER | SAMPLES RECOVERY (mm) or (%) | SAMPLES N VALUE (blows) or RQD (%) | OTHER TESTS |
|---|---|---|---|---|---|---|---|
| 0 | | **TOPSOIL**, brown, sandy silt loam, rootlets, loose, moist | | | | | |
| | 0.46 | **SAND & SILT**, brown, some rust staining, compact, moist | | S1 | 365 | 15 | |
| 1 | | | | | | | |
| | | -becoming dilatant and wet at 1.5 m depth | | S2 | 140 | 13 | |
| 2 | | | | | | | |
| | | -becoming **SAND**, trace to some silt from 2.3m to 3.0m depth | | S3 | 230 | 11 | |
| 3 | | | | S4 | 230 | 10 | |
| 4 | | | | | | | |
| | | -becoming grey below 4.6 m depth | | | | | |
| | 4.89 | | | S5 | 230 | 10 | |
| 5 | | **SAND** , grey, coarse grained, trace silt, trace to some gravel, compact, wet | | | | | |
| 6 | | | | S6 | 90 | 11 | |
| 7 | | | | | | | |
| | 7.92 | | | S7 | 365 | 30 | |
| 8 | 8.08 | **CLAYEY SILT TILL**, grey, trace fine sand and gravel, very stiff, moist | | | | | |
| | | End of Borehole at 8.08 m depth | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |

**SHEAR STRENGTH**

♣ S Field Vane Test (#=Sensitivity) ▲ Penetrometer ■ Torvane

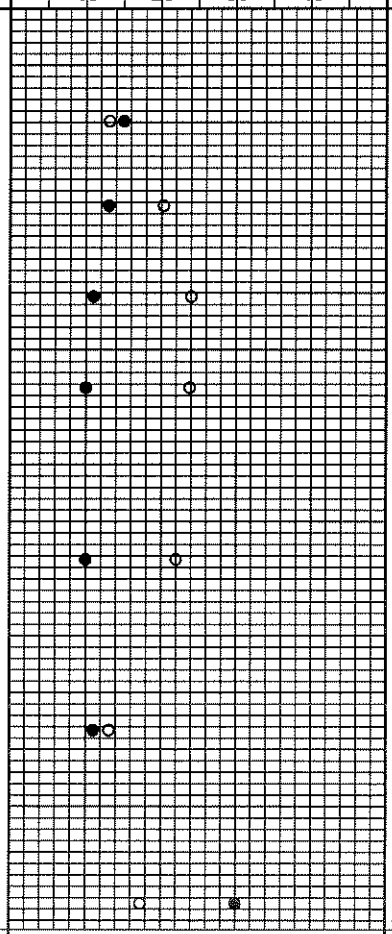
40 80 kPa

**Atterberg Limits and Moisture**

$W_P$ W $W_L$

● SPT N Value × Dynamic Cone

10 20 30 40



***NOTES***

1) Borehole interpretation requires assistance by Trow before use by others. Borehole Logs must be read in conjunction with Trow Report LNGE00009215A. For definition of terms used on logs, see sheets prior to logs.

2) Borehole open to 4.04 m depth upon completion; groundwater measured at 2.51 m depth upon completion of drilling.

SAMPLE LEGEND

☒ AS Auger Sample ▨ SS Split Spoon ▩ ST Shelby Tube

▥ Rock Core (eg. BQ, NQ, etc.) ▥ VN Vane Sample

OTHER TESTS

| | |
|---|---|
| G Specific Gravity | C Consolidation |
| H Hydrometer | CD Consolidated Drained Triaxial |
| S Sieve Analysis | CU Consolidated Undrained Triaxial |
| γ Unit Weight | UU Unconsolidated Undrained Triaxial |
| P Field Permeability | UC Unconfined Compression |
| K Lab Permeability | DS Direct Shear |

WATER LEVELS

▽ Apparent ▼ Measured ▲ Artesian (see Notes)

Trow
London Branch

# BOREHOLE LOG

**BH4**

Sheet 1 of 1

PROJECT **Proposed Residential Development** PROJECT NO. **LNGE00009215A**

CLIENT **Glover Holdings** DATUM **N/A**

DRILL TYPE/METHOD **Track-mounted Auger Drill** DATES: Boring **Sept 4/2007** Water Level **Sept 4/2007**

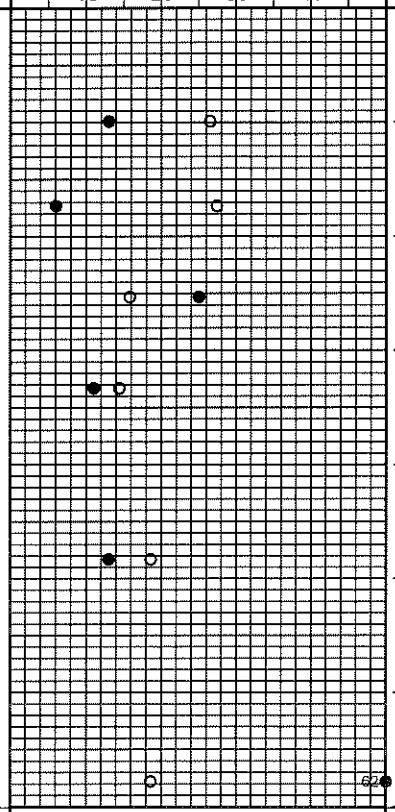
| DEPTH (m) | ELEVATION (m) | STRATA DESCRIPTION | SAMPLES TYPE | SAMPLES NUMBER | SAMPLES RECOVERY (mm) or (%) | SAMPLES N VALUE (blows) or RQD (%) |
|---|---|---|---|---|---|---|
| 0 | 0.31 | **TOPSOIL**, brown, sandy silt loam, rootlets, loose, moist | | | | |
| 1 | | **SAND & SILT**, brown/grey (some rust staining), trace fine gravel, dilatant silt layering, compact, very moist to wet | | S1 | 365 | 13 |
| 2 | | -some silt, trace clay layering at 1.5 m depth | | S2 | 230 | 6 |
| | 2.30 | | | | | |
| 3 | | **SAND** , grey, coarse grained, some gravel, trace silt, compact, wet | | S3 | 460 | 25 |
| 4 | | | | S4 | 460 | 11 |
| | 4.70 | | | | | |
| 5 | | **CLAYEY SILT TILL**, grey, trace fine sand and gravel, stiff, moist to very moist | | S5 | 365 | 13 |
| 6 | | -becoming hard below 6.1 m depth | | | | |
| 7 | 7.01 | | | S6 | 50 | 62 |
| | | End of Borehole at 7.01 m depth | | | | |
| 8 | | | | | | |
| 9 | | | | | | |
| 10 | | | | | | |

STRATA PLOT

WELL LOG

OTHER TESTS

SHEAR STRENGTH
S Field Vane Test (#=Sensitivity)
Penetrometer Torvane
40 80 kPa
Atterberg Limits and Moisture
$W_P$ W $W_L$
SPT N Value × Dynamic Cone
10 20 30 40




*NOTES*

1) Borehole interpretation requires assistance by Trow before use by others. Borehole Logs must be read in conjunction with Trow Report LNGE00009215A. For definition of terms used on logs, see sheets prior to logs.

2) Borehole open to 2.82 m depth upon completion; groundwater measured at 1.35 m depth upon completion of drilling.

SAMPLE LEGEND
AS Auger Sample SS Split Spoon ST Shelby Tube
Rock Core (eg. BQ, NQ, etc.) VN Vane Sample

OTHER TESTS
G Specific Gravity
H Hydrometer
S Sieve Analysis
γ Unit Weight
P Field Permeability
K Lab Permeability
C Consolidation
CD Consolidated Drained Triaxial
CU Consolidated Undrained Triaxial
UU Unconsolidated Undrained Triaxial
UC Unconfined Compression
DS Direct Shear

WATER LEVELS
Apparent Measured Artesian (see Notes)

Trow
London Branch

# BOREHOLE LOG

**BH5**

Sheet 1 of 1

PROJECT **Proposed Residential Development** PROJECT NO. **LNGE00009215A**

CLIENT **Glover Holdings** DATUM **N/A**

DRILL TYPE/METHOD **Track-mounted Auger Drill** DATES: Boring **Sept 5/2007** Water Level **Sept 5/2007**

| DEPTH (m) | ELEVATION (m) | STRATA DESCRIPTION | SAMPLES TYPE | SAMPLES NUMBER | SAMPLES RECOVERY (mm) or (%) | SAMPLES N VALUE (blows) or RQD (%) |
|---|---|---|---|---|---|---|
| 0 | 0.31 | **TOPSOIL**, brown, sandy silt loam, rootlets, loose, moist | | | | |
| 1 | | **SILT & SAND**, brown, trace fine gravel, some dilatant layering, compact, moist to very moist | | S1 | 365 | 13 |
| 2 | | -some silt layering at 1.5m depth | | S2 | 90 | 10 |
| 3 | 3.20 | -becoming loose to very loose below 1.5m depth | | S3 | 90 | 3 |
| 4 | | **SAND AND GRAVEL**, grey, coarse grained, trace to some silt, compact, wet | | S4 | 275 | 12 |
| 5 | | | | S5 | 460 | 14 |
| 6 | 6.20 | | | | | |
| 7 | | **CLAYEY SILT TILL**, grey, trace fine sand and gravel, very stiff to hard, moist to very moist | | S6 | 365 | 24 |
| 8 | | | | S7 | 460 | 52 |
| 9 | | | | S8 | 365 | 50 |
| 10 | | | | | | |
| 11 | | | | S9 | 365 | 54 |
| 12 | 12.65 | | | S10 | 230 | 46 |
| 13 | | End of Borehole at 12.65 m depth | | | | |
| 14 | | | | | | |
| 15 | | | | | | |

WELL LOG: ▼ (Measured water level at 3.20 m)

OTHER TESTS

**SHEAR STRENGTH**

✚ S Field Vane Test (#=Sensitivity) ▲ Penetrometer ■ Torvane

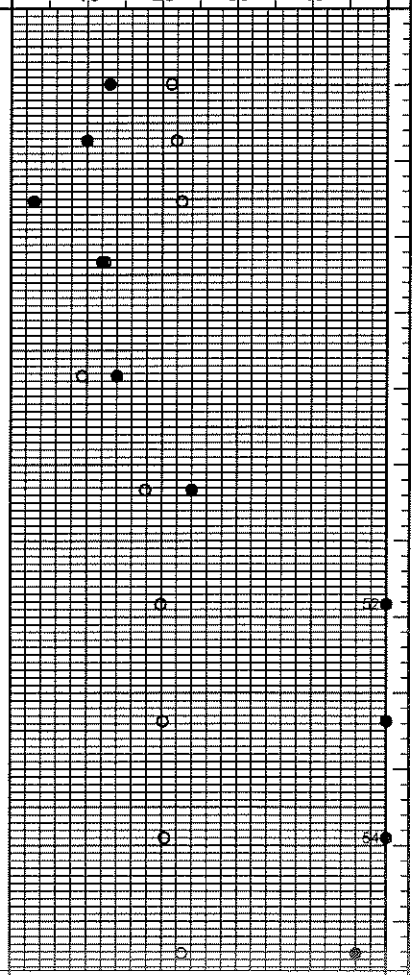
40 80 kPa

**Atterberg Limits and Moisture**

$W_P$ W $W_L$

● SPT N Value × Dynamic Cone

10 20 30 40



***NOTES***

1) Borehole interpretation requires assistance by Trow before use by others. Borehole Logs must be read in conjunction with Trow Report LNGE00009215A. For definition of terms used on logs, see sheets prior to logs.

2) Borehole open to 3.05 m depth upon completion; groundwater measured at 1.52 m depth upon completion of drilling.

SAMPLE LEGEND

☒ AS Auger Sample ▨ SS Split Spoon ▬ ST Shelby Tube

▥ Rock Core (eg. BQ, NQ, etc.) ▣ VN Vane Sample

OTHER TESTS

| | |
|---|---|
| G Specific Gravity | C Consolidation |
| H Hydrometer | CD Consolidated Drained Triaxial |
| S Sieve Analysis | CU Consolidated Undrained Triaxial |
| γ Unit Weight | UU Unconsolidated Undrained Triaxial |
| P Field Permeability | UC Unconfined Compression |
| K Lab Permeability | DS Direct Shear |

WATER LEVELS

▽ Apparent ▼ Measured ▲ Artesian (see Notes)

Trow
London Branch

# BOREHOLE LOG

**BH6**

Sheet 1 of 1

PROJECT **Proposed Residential Development** PROJECT NO. **LNGE00009215A**

CLIENT **Glover Holdings** DATUM **N/A**

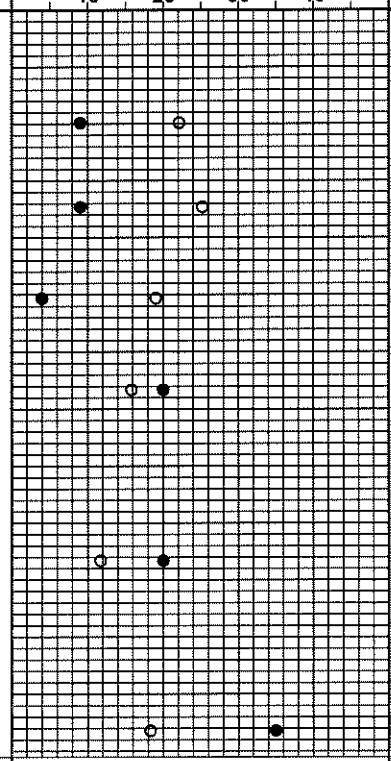
DRILL TYPE/METHOD **Track-mounted Auger Drill** DATES: Boring **Sept 5/2007** Water Level **Sept 5/2007**

| DEPTH (m) | ELEVATION (m) | STRATA DESCRIPTION | STRATA PLOT | WELL LOG | SAMPLES TYPE | SAMPLES NUMBER | SAMPLES RECOVERY (mm) or (%) | SAMPLES N VALUE (blows) or RQD (%) | OTHER TESTS |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | | |
| | 0.46 | **TOPSOIL**, brown, sandy silt loam, rootlets, loose, moist | | | | | | | |
| 1 | | **SILTY SAND**, brown, weathered, trace rootlets, some dilatant layering, loose, very moist to wet | | ▼ | | S1 | 90 | 9 | |
| | 1.50 | | | | | | | | |
| 2 | | -becoming **SILT**, trace sand, grey, loose, wet below 1.5m depth | | | | S2 | 230 | 9 | |
| | 2.70 | -some clay, trace organics at 2.6m depth | | | | S3 | 90 | 4 | |
| 3 | | **SAND**, grey, coarse grained, trace to some gravel, trace silt, compact, wet | | | | S4 | 365 | 20 | |
| 4 | | | | | | | | | |
| 5 | | | | | | S5 | 460 | 20 | |
| 6 | 6.20 | | | | | | | | |
| | 6.55 | **CLAYEY SILT TILL**, grey, trace fine sand and gravel, hard, moist to very moist | | | | S6 | 365 | 35 | |
| | | **End of Borehole at 6.55 m depth** | | | | | | | |
| 7 | | | | | | | | | |
| 8 | | | | | | | | | |
| 9 | | | | | | | | | |
| 10 | | | | | | | | | |

**SHEAR STRENGTH**
✤ S Field Vane Test (#=Sensitivity)
▲ Penetrometer ■ Torvane
40 80 kPa

**Atterberg Limits and Moisture**
$W_P$ W $W_L$

● SPT N Value × Dynamic Cone
10 20 30 40



***NOTES***

1) Borehole interpretation requires assistance by Trow before use by others. Borehole Logs must be read in conjunction with Trow Report LNGE00009215A. For definition of terms used on logs, see sheets prior to logs.

2) Borehole open to 2.29 m depth upon completion; groundwater measured at 1.32 m depth upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ▩ ST Shelby Tube
▥ Rock Core (eg. BQ, NQ, etc.) ▣ VN Vane Sample

OTHER TESTS

| | |
|---|---|
| G Specific Gravity | C Consolidation |
| H Hydrometer | CD Consolidated Drained Triaxial |
| S Sieve Analysis | CU Consolidated Undrained Triaxial |
| γ Unit Weight | UU Unconsolidated Undrained Triaxial |
| P Field Permeability | UC Unconfined Compression |
| K Lab Permeability | DS Direct Shear |

WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

Trow
London Branch

# BOREHOLE LOG

BH7
Sheet 1 of 1

PROJECT **Proposed Residential Development** PROJECT NO. **LNGE00009215A**

CLIENT **Glover Holdings** DATUM **N/A**

DRILL TYPE/METHOD **Track-mounted Auger Drill** DATES: Boring **Sept 5/2007** Water Level **Sept 5/2007**

| DEPTH (m) | ELEVATION (m) | STRATA DESCRIPTION | STRATA PLOT | WELL LOG | SAMPLES TYPE | SAMPLES NUMBER | SAMPLES RECOVERY (mm) or (%) | SAMPLES N VALUE (blows) or RQD (%) | OTHER TESTS |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | **TOPSOIL / ORGANICS**, brown, sandy silt loam, rootlets, loose to compact, moist | | ▼ | | | | | |
| 1 | 1.37 | | | | | S1 | 50 | 10 | |
| | | **SILT**, grey, trace to some fine sand, dilatant, loose to compact, wet | | | | S2 | 230 | 7 | |
| 2 | | -trace clayey layering at 2.3m depth | | | | S3 | 365 | 12 | |
| 3 | 3.00 | | | | | | | | |
| | 3.40 | -becoming **SILTY SAND**, fine grained, compact below 3.0m depth | | | | S4 | 460 | 12 | |
| 4 | | **SAND AND GRAVEL**, grey, coarse grained, trace silt, compact, wet | | | | | | | |
| 5 | | | | | | S5 | 365 | 20 | |
| | 5.64 | | | | | | | | |
| 6 | | **CLAYEY SILT TILL**, grey, trace fine sand and gravel, very stiff to hard, moist | | | | S6 | 320 | 27 | |
| | 6.55 | | | | | | | | |
| 7 | | **End of Borehole at 6.55 m depth** | | | | | | | |
| 8 | | | | | | | | | |
| 9 | | | | | | | | | |
| 10 | | | | | | | | | |

**SHEAR STRENGTH**
● S Field Vane Test (#=Sensitivity)
▲ Penetrometer ■ Torvane
40 80 kPa

**Atterberg Limits and Moisture**
$W_P$ W $W_L$

● SPT N Value × Dynamic Cone
10 20 30 40

*NOTES*

1) Borehole interpretation requires assistance by Trow before use by others. Borehole Logs must be read in conjunction with Trow Report LNGE00009215A. For definition of terms used on logs, see sheets prior to logs.

2) Borehole open to 2.74 m depth upon completion; groundwater measured at 0.79 m depth upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ▩ ST Shelby Tube
▥ Rock Core (eg. BQ, NQ, etc.) ▣ VN Vane Sample

OTHER TESTS

| | |
|---|---|
| G Specific Gravity | C Consolidation |
| H Hydrometer | CD Consolidated Drained Triaxial |
| S Sieve Analysis | CU Consolidated Undrained Triaxial |
| γ Unit Weight | UU Unconsolidated Undrained Triaxial |
| P Field Permeability | UC Unconfined Compression |
| K Lab Permeability | DS Direct Shear |

WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

Trow
London Branch

# BOREHOLE LOG

**BH8**

Sheet 1 of 1

PROJECT **Proposed Residential Development** PROJECT NO. **LNGE00009215A**

CLIENT **Glover Holdings** DATUM **N/A**

DRILL TYPE/METHOD **Track-mounted Auger Drill** DATES: Boring **Sept 5/2007** Water Level **Sept 5/2007**

| DEPTH (m) | ELEVATION (m) | STRATA DESCRIPTION | SAMPLES TYPE | SAMPLES NUMBER | SAMPLES RECOVERY (mm) or (%) | SAMPLES N VALUE (blows) or RQD (%) | OTHER TESTS |
|---|---|---|---|---|---|---|---|
| 0 | | | | | | | |
| | 0.46 | **TOPSOIL**, brown, sandy silt loam, rootlets, loose, moist | | | | | |
| 1 | | **SILTY SAND**, brown, weathered, fine grained, some dilatant layering, compact, moist | | S1 | 320 | 13 | |
| 2 | | -becoming very moist below 1.5m depth | | S2 | 320 | 13 | |
| 3 | | -becoming loose, wet below 2.3m depth | | S3 | 320 | 9 | |
| 4 | | | | S4 | | | |
| 5 | 5.03 | -becoming grey with trace clay at 4.6 m depth | | S5 | 230 | 6 | |
| 6 | | **SAND** , grey, coarse grained, trace to some gravel, some silt, compact, wet | | S6 | 320 | 13 | |
| 7 | 7.60 | | | | | | |
| 8 | 8.08 | **CLAYEY SILT TILL**, grey, trace fine sand and gravel, very stiff, very moist | | S7 | 320 | 21 | |
| 9 | | End of Borehole at 8.08 m depth | | | | | |
| 10 | | | | | | | |

**SHEAR STRENGTH**
S Field Vane Test (#=Sensitivity)
Penetrometer Torvane
40 80 kPa

**Atterberg Limits and Moisture**
$W_P$ W $W_L$
SPT N Value × Dynamic Cone
10 20 30 40

***NOTES***

1) Borehole interpretation requires assistance by Trow before use by others. Borehole Logs must be read in conjunction with Trow Report LNGE00009215A. For definition of terms used on logs, see sheets prior to logs.

2) Borehole open to 4.34 m depth upon completion; groundwater measured at 3.18 m depth upon completion of drilling.

SAMPLE LEGEND
AS Auger Sample SS Split Spoon ST Shelby Tube
Rock Core (eg. BQ, NQ, etc.) VN Vane Sample

OTHER TESTS
G Specific Gravity C Consolidation
H Hydrometer CD Consolidated Drained Triaxial
S Sieve Analysis CU Consolidated Undrained Triaxial
γ Unit Weight UU Unconsolidated Undrained Triaxial
P Field Permeability UC Unconfined Compression
K Lab Permeability DS Direct Shear

WATER LEVELS
Apparent Measured Artesian (see Notes)

Trow
London Branch

# BOREHOLE LOG

**BH9**

Sheet 1 of 1

PROJECT **Proposed Residential Development** PROJECT NO. **LNGE00009215A**

CLIENT **Glover Holdings** DATUM **N/A**

DRILL TYPE/METHOD **Track-mounted Auger Drill** DATES: Boring **Sept 7/2007** Water Level **Sept 7/2007**

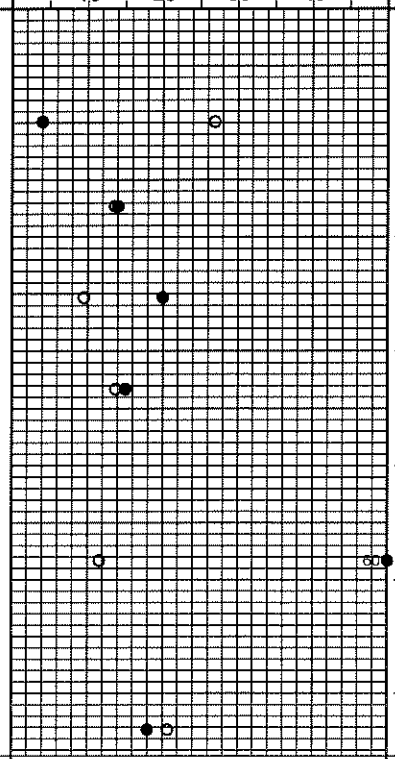
| DEPTH (m) | ELEVATION (m) | STRATA DESCRIPTION | SAMPLES TYPE | SAMPLES NUMBER | SAMPLES RECOVERY (mm) or (%) | SAMPLES N VALUE (blows) or RQD (%) |
|---|---|---|---|---|---|---|
| 0 | 0.31 | **TOPSOIL**, brown, sandy silt loam, rootlets, loose, moist | | | | |
| | | **SILT**, grey, trace clay, trace fine sand, weathered, dilatant, loose to compact, wet | | S1 | 320 | 4 |
| 1 | 1.80 | | | S2 | 140 | 14 |
| 2 | | **SAND**, grey, coarse grained, trace to some silt, trace gravel, compact, wet | | S3 | 140 | 20 |
| 3 | | -trace to some gravel below 3.1 m depth | | S4 | 140 | 15 |
| 4 | | | | | | |
| 5 | 5.10 | -becoming very dense below 4.6 m depth | | S5 | 320 | 60 |
| | | **CLAYEY SILT TILL**, grey, trace fine sand and gravel, very stiff, moist to very moist | | | | |
| 6 | 6.55 | | | S6 | 140 | 18 |
| 7 | | **End of Borehole at 6.55 m depth** | | | | |
| 8 | | | | | | |
| 9 | | | | | | |
| 10 | | | | | | |

OTHER TESTS

SHEAR STRENGTH
✤ S Field Vane Test (#=Sensitivity)
▲ Penetrometer ■ Torvane
40 80 kPa

Atterberg Limits and Moisture
$W_P$ W $W_L$

● SPT N Value × Dynamic Cone
10 20 30 40



*NOTES*

1) Borehole interpretation requires assistance by Trow before use by others. Borehole Logs must be read in conjunction with Trow Report LNGE00009215A. For definition of terms used on logs, see sheets prior to logs.

2) Borehole open to 2.44 m depth upon completion; groundwater measured at 1.22 m depth upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ▩ ST Shelby Tube
▥ Rock Core (eg. BQ, NQ, etc.) ▣ VN Vane Sample

OTHER TESTS
G Specific Gravity
H Hydrometer
S Sieve Analysis
γ Unit Weight
P Field Permeability
K Lab Permeability
C Consolidation
CD Consolidated Drained Triaxial
CU Consolidated Undrained Triaxial
UU Unconsolidated Undrained Triaxial
UC Unconfined Compression
DS Direct Shear

WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

Trow
London Branch

# BOREHOLE LOG

**BH10**
Sheet 1 of 1

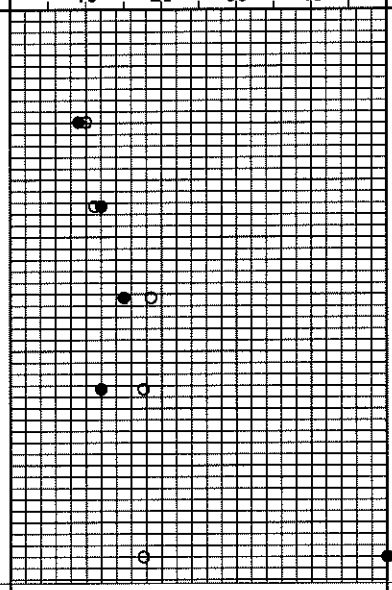
PROJECT **Proposed Residential Development** PROJECT NO. **LNGE00009215A**
CLIENT **Glover Holdings** DATUM **N/A**
DRILL TYPE/METHOD **Track-mounted Auger Drill** DATES: Boring **Sept 7/2007** Water Level **Sept 7/2007**

| DEPTH (m) | ELEVATION (m) | STRATA DESCRIPTION | SAMPLES TYPE | SAMPLES NUMBER | SAMPLES RECOVERY (mm) or (%) | SAMPLES N VALUE (blows) or RQD (%) | OTHER TESTS |
|---|---|---|---|---|---|---|---|
| 0 | | | | | | | |
| | 0.46 | **TOPSOIL**, brown, sandy silt loam, rootlets, loose, moist | | | | | |
| | 0.91 | **SANDY SILT**, brown, trace rootlets, loose, moist | | | | | |
| 1 | | **SAND**, brown/grey, coarse grained, trace to some gravel, trace silt, loose to compact, wet | | S1 | 90 | 9 | |
| | | | | S2 | 50 | 12 | |
| 2 | | | | | | | |
| | | | | S3 | 140 | 15 | |
| 3 | | | | | | | |
| | 3.40 | | | S4 | 230 | 12 | |
| | | **CLAYEY SILT TILL**, grey, trace fine sand and gravel, stiff, moist to very moist | | | | | |
| 4 | | | | | | | |
| | 4.60 | | | | | | |
| | 5.03 | **SILT TILL**, grey, trace to some fine sand, trace to some clay, some wet layering, very dense, very moist | | S5 | 230 | 50 | |
| 5 | | **End of Borehole at 5.03 m depth** | | | | | |
| 6 | | | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |

**SHEAR STRENGTH**
✚ S Field Vane Test (#=Sensitivity)
▲ Penetrometer ■ Torvane
40 80 kPa

**Atterberg Limits and Moisture**
$W_P$ W $W_L$

● SPT N Value × Dynamic Cone
10 20 30 40



***NOTES***

1) Borehole interpretation requires assistance by Trow before use by others. Borehole Logs must be read in conjunction with Trow Report LNGE00009215A. For definition of terms used on logs, see sheets prior to logs.

2) Borehole open to 1.98 m depth upon completion; groundwater measured at 0.61 m depth upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ▩ ST Shelby Tube
▥ Rock Core (eg. BQ, NQ, etc.) ▣ VN Vane Sample

OTHER TESTS

| | |
|---|---|
| G Specific Gravity | C Consolidation |
| H Hydrometer | CD Consolidated Drained Triaxial |
| S Sieve Analysis | CU Consolidated Undrained Triaxial |
| γ Unit Weight | UU Unconsolidated Undrained Triaxial |
| P Field Permeability | UC Unconfined Compression |
| K Lab Permeability | DS Direct Shear |

WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

Trow
London Branch

# BOREHOLE LOG

**BH11**

Sheet 1 of 1

PROJECT **Proposed Residential Development** PROJECT NO. **LNGE00009215A**

CLIENT **Glover Holdings** DATUM **N/A**

DRILL TYPE/METHOD **Track-mounted Auger Drill** DATES: Boring **Sept 7/2007** Water Level **Sept 7/2007**

| DEPTH (m) | ELEVATION (m) | STRATA DESCRIPTION | SAMPLES TYPE | SAMPLES NUMBER | SAMPLES RECOVERY (mm) or (%) | SAMPLES N VALUE (blows) or RQD (%) | OTHER TESTS |
|---|---|---|---|---|---|---|---|
| 0 | 0.31 | **TOPSOIL**, brown, sandy silt loam, rootlets, loose, moist | | | | | |
| | | **SILTY SAND**, brown/grey, some wet layering, loose, moist to very moist | | S1 | 140 | 4 | |
| 1 | 1.50 | | | | | | |
| | | **SANDY SILT**, grey, trace clay, trace to some organics, dilatant, loose, wet | | S2 | 230 | 4 | |
| 2 | 2.40 | | | | | | |
| | | **PEAT**, brown to black, fibrous, trace sand, soft, moist to very moist | | S3 | 230 | 5 | |
| 3 | | | | S4 | 320 | 5 | |
| 4 | 4.90 | | | | | | |
| 5 | 5.40 | **SANDY SILT**, grey, trace fine gravel, dilatant, loose, wet | | S5 | 230 | 6 | |
| | | **SAND**, grey, coarse grained, trace to some gravel, compact, wet | | | | | |
| 6 | 6.20 | | | | | | |
| | 6.55 | **SILT TILL**, grey, trace fine sand and gravel, dilatant, dense, wet | | S6 | 230 | 37 | |
| | | **End of Borehole at 6.55 m depth** | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |

**SHEAR STRENGTH**
♣ S Field Vane Test (#=Sensitivity)
▲ Penetrometer ■ Torvane
40 80 kPa

**Atterberg Limits and Moisture**
$W_P$ W $W_L$

● SPT N Value × Dynamic Cone
10 20 30 40

203.8
230.9

*NOTES*

1) Borehole interpretation requires assistance by Trow before use by others. Borehole Logs must be read in conjunction with Trow Report LNGE00009215A. For definition of terms used on logs, see sheets prior to logs.

2) Borehole open to 5.03 m depth upon completion; groundwater measured at 3.66 m depth upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ▩ ST Shelby Tube
▥ Rock Core (eg. BQ, NQ, etc.) ▥ VN Vane Sample

OTHER TESTS
G Specific Gravity C Consolidation
H Hydrometer CD Consolidated Drained Triaxial
S Sieve Analysis CU Consolidated Undrained Triaxial
γ Unit Weight UU Unconsolidated Undrained Triaxial
P Field Permeability UC Unconfined Compression
K Lab Permeability DS Direct Shear

WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

Trow
London Branch

# BOREHOLE LOG

**BH12**
Sheet 1 of 1

PROJECT **Proposed Residential Development** PROJECT NO. **LNGE00009215A**
CLIENT **Glover Holdings** DATUM **N/A**
DRILL TYPE/METHOD **Track-mounted Auger Drill** DATES: Boring **Sept 7/2007** Water Level **Sept 7/2007**

| DEPTH (m) | ELEVATION (m) | STRATA DESCRIPTION | SAMPLES TYPE | SAMPLES NUMBER | SAMPLES RECOVERY (mm) or (%) | SAMPLES N VALUE (blows) or RQD (%) | OTHER TESTS |
|---|---|---|---|---|---|---|---|
| 0 | | **TOPSOIL**, brown, sandy silt loam, rootlets, loose, moist | | | | | |
| | 0.91 | | | | | | |
| 1 | | **CLAYEY SILT**, grey, some sand, loose, very moist<br>-some organics to 2m depth | | S1 | 50 | 5 | |
| 2 | | | | S2 | 50 | 5 | |
| | | | | S3 | 90 | 6 | |
| 3 | 3.10 | | | | | | |
| | | **SILT** , grey, trace to some fine sand, trace clay, trace fine gravel, dilatant, loose, moist | | S4 | 90 | 6 | |
| 4 | | | | | | | |
| | 4.60 | | | | | | |
| 5 | 5.03 | **CLAYEY SILT TILL** grey, trace fine sand and gravel, very stiff, moist | | S5 | 320 | 19 | |
| | | **End of Borehole at 5.03 m depth** | | | | | |
| 6 | | | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |

WELL LOG: ▼ (Measured)

**SHEAR STRENGTH**
✤ S Field Vane Test (#=Sensitivity) ▲ Penetrometer ■ Torvane
40 80 kPa

**Atterberg Limits and Moisture**
$W_P$ W $W_L$
● SPT N Value × Dynamic Cone
10 20 30 40

***NOTES***

1) Borehole interpretation requires assistance by Trow before use by others. Borehole Logs must be read in conjunction with Trow Report LNGE00009215A. For definition of terms used on logs, see sheets prior to logs.

2) Borehole open to 3.81 m depth upon completion; groundwater measured at 1.98 m depth upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
▯ Rock Core (eg. BQ, NQ, etc.) ▯ VN Vane Sample

OTHER TESTS

| | |
|---|---|
| G Specific Gravity | C Consolidation |
| H Hydrometer | CD Consolidated Drained Triaxial |
| S Sieve Analysis | CU Consolidated Undrained Triaxial |
| γ Unit Weight | UU Unconsolidated Undrained Triaxial |
| P Field Permeability | UC Unconfined Compression |
| K Lab Permeability | DS Direct Shear |

WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

**Table 1**
**Test Pit Summary**

| Depth (m) | Moisture Content (%) | Soil Description |
|---|---|---|
| **TP #1** | | |
| 0.0 – 0.1 | | TOPSOIL – brown sandy silt loam, moist, loose |
| 0.1 – 1.8 | 17.9 | SILTY SAND – brown, fine grained, mottled, compact, moist |
| 1.8 – 3.7 | 21.5 | SANDY SILT – grey, trace organics, dilatant, compact, wet |
| 2.1 – 4.4 | 26.8 | SILTY SAND – grey, medium to coarse grained, dilatant, compact, wet |
| 4.4 | | TEST PIT TERMINATED |
| | | *Minor cave at 2.3 m and dry upon completion* |
| **TP #2** | | |
| 0.0 – 1.5 | | TOPSOIL – brown sandy silt loam, moist, loose |
| 1.5 – 2.7 | 44.0 | SILTY CLAY – grey, mottled, soft, very moist |
| 2.7 – 4.1 | 46.1 | SAND AND GRAVEL – grey, coarse grained, loose, wet |
| 4.1 – 4.2 | | |
| 4.2 | | TEST PIT TERMINATED |
| | | *Test pit open with minor groundwater seepage upon completion* |
| **TP #3** | | |
| 0.0 – 0.3 | | TOPSOIL – brown sandy silt loam, moist, loose |
| 0.3 – 1.4 | 27.8 | SANDY SILT – brown, trace to some clay, compact, very moist to wet |
| 1.4 – 1.7 | | CLAYEY SILT – grey, soft, very moist |
| 1.7 – 2.1 | 19.4 | SAND AND GRAVEL – grey, coarse grained, loose, wet |
| 2.1 | | TEST PIT TERMINATED |
| | | *Sidewalls unstable at 1.1 m with groundwater seepage at 1.7 m depth* |
| **TP #4** | | |
| 0.0 – 0.6 | | TOPSOIL – brown sandy silt loam, moist, loose |
| 0.6 – 1.8 | 21.5 | SANDY SILT – brown, trace clay, weathered, compact, moist |
| 1.8 – 2.7 | 40.6 | -becoming grey, dilatant and wet |
| 2.7 – 3.2 | 39.8 | SILTY CLAY – dark grey, trace fine sand, soft, very moist |
| 2.1 | | TEST PIT TERMINATED |
| | | *Sidewalls unstable at 2.1 m with minor groundwater seepage upon completion* |
| **TP #5** | | |
| 0.0 – 0.6 | | TOPSOIL – brown sandy silt loam, moist, loose |
| 0.6 – 0.9 | 16.6 | SILTY SAND – grey, trace to some clay, medium grained, compact, very moist |
| 0.9 – 1.2 | 37.5 | SILTY CLAY – grey, some fine sand and gravel, soft, very moist |
| 1.2 – 1.5 | 11.1 | SAND AND GRAVEL – grey, coarse grained, compact, wet |
| 1.5 | | TEST PIT TERMINATED |
| | | *Sidewalls unstable at 1.1 m with groundwater seepage at 1.4 m depth* |

Test pits excavated by excavator (provided by client) on July 18, 2007. Test pit summary should be read in conjunction with Trow Report LNGE00009215A.