Southside Construction Management Limited

Geotechnical Investigation

Project Name
Proposed Talbot Village Phase 8
3095 Bostwick Road
London, Ontario

Project Number
LON-00016262-GE

Prepared by:
EXP Services Inc.
15701 Robin's Hill Road
London, ON N5V 0A5
Canada

Date Submitted
May 30, 2024
Updated August 16, 2024

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1.0 Introduction

1.1 Introduction

As requested, EXP Services Ltd. has conducted a geotechnical investigation in conjunction with a proposed residential development to be located at 3095 Bostwick Road in London, Ontario, hereinafter referred to as the 'Site'.

Based on a Draft Plan of Subdivision prepared by Zelinka Priamo Ltd., it is understood that the Talbot Village Phase 8 development will consist of 74 single family homes and 38 townhouse units. The residential subdivision is expected to have complete municipal servicing, and will be accessed with paved local roads.

Based on an interpretation of the factual test hole data and a review of soil and groundwater information from test holes advanced at the Site, EXP has provided geotechnical engineering guidelines to support the proposed Site development.

1.2 Terms of Reference

The geotechnical investigation was generally completed in accordance with the scope of work outlined through email correspondence with the client. Authorization to proceed with this investigation was received from Mr. Michael Frijia of **Southside Construction Management Limited** through email correspondence.

A geotechnical investigation was conducted in 2018 for a larger area of the Talbot Village development and consisted of the advancement of eleven (11) boreholes, 5 of which were equipped with monitoring wells. Six (6) of these boreholes and 3 of the monitoring wells were advanced in general location of Phase 8 of the development. The locations of the boreholes advanced as part of the previous assessments are shown on the attached Borehole Location Plan (**Drawing 1**). The purpose of this investigation was to carry out a desktop review of the existing subsoil and groundwater conditions.

Based on an interpretation of the factual borehole data, and a review of soil and groundwater information from test holes excavated at the Site, EXP Services Inc. has provided engineering guidelines for the geotechnical design and construction of the proposed development. More specifically, this report provides comments on excavations, dewatering, site preparation, foundations, slab-on-grade and basement construction, bedding and backfill, earthquake design considerations, pavement recommendations, and curbs and sidewalks.

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.

2.0 Methodology

The fieldwork was carried out on May 28th, 29th, 30th and May 31st, 2018. In general, the geotechnical investigation consisted of the advancement of eleven (11) boreholes. Of the 11 boreholes, 6 were advanced in general location of Phase 8 of the development. These borehole locations are denoted on **Drawing 1** as BH1, BH5, BH6 and BH9 to BH11. MW was suffixed to the borehole symbol (BH) at locations where monitoring wells were installed.

Prior to the drilling, buried service clearances were obtained for the test hole locations by EXP**.**

The boreholes and the monitoring well installations were completed by a specialist drilling subcontractor under the full-time supervision of EXP geotechnical staff. The boreholes and the monitoring well installations were advanced utilizing a track-mounted drill rig equipped with continuous flight solid and hollow stem augers, soil sampling and soil testing equipment. In each borehole, disturbed soil samples were recovered at depth intervals of 0.75 m and 1.5 m using conventional split spoon sampling equipment and Standard Penetration Test (SPT) methods or auger samples.

During the drilling, the stratigraphy in the boreholes was examined and logged in the field by EXP geotechnical personnel.

Short-term groundwater levels within the open boreholes were observed. These observations pertaining to groundwater conditions and stabilized groundwater levels at the test hole locations are recorded in the borehole logs found in **Appendix A**. Following the drilling, the boreholes were backfilled with the excavated materials and bentonite, to satisfy the requirements of O.Reg. 903.

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 routine moisture content determinations, with results presented on the borehole logs found in **Appendix A**.

Samples remaining after the classification testing will be stored for a period of three months following the issuance of report. After this time, they will be discarded unless prior arrangements have been made for longer storage.

The location of each borehole was established in the field using UTM coordinates. Ground surface elevations at each borehole location were surveyed to a City of London Vertical Control Monument (BM02-117, Geodetic Elevation 273.494 m).

3.0 Site and Subsurface Conditions

3.1 Site Description

The subject area is currently undeveloped and, at the time of investigation, in agricultural use with a woodlot in the centre and southwest area. The Site is bounded by residential development to the west and south, a residence and vacant land to the north, and residential construction to the east.

The following sections provide a summary of the soil conditions and groundwater conditions.

3.2 Soil Stratigraphy

The detailed stratigraphy encountered in the boreholes is shown in the borehole logs found in **Appendix A**, and summarized in the following paragraphs. It must be noted that boundaries of soil indicated in 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.

It must be noted that the boreholes were advanced in 2018. Grading changes and material stockpiling works may have taken place since and thus, the depths and thicknesses of the surficial soils may vary from the findings of the previous investigation.

3.2.1 Topsoil

Each borehole was surfaced with a layer of topsoil. The topsoil thickness ranged between approximately 300 mm and 450 mm.

It should be noted that topsoil quantities should not be established from the information provided at the borehole locations only. If required, a more detailed analysis (involving shallow test pits) is recommended to accurately quantify the amount of topsoil to be removed for construction purposes.

3.2.2 Fill

Underlying the topsoil and extending to between 1.4 m and 2.1 m below ground surface (bgs) in Boreholes BH6/MW, and BH10 was a layer of fill. The fill varied in composition, compactness, and moisture content.

3.2.4 Silt

Borehole BH9/MW was terminated in a layer of silt. The brown silt contained trace clay, some sand, and was occasionally dilatant. The silt was very dense in compactness (SPT N Value of 85 blows per 300 mm split spoon sampler penetration) and moist to very moist (based on tactile examination and an *in situ* moisture content of 17 percent).

3.2.5 Sand

From 8.6 m to 14.7 m bgs in Borehole BH9/MW and from 5.6 m to the termination of Borehole BH11/MW, a sand layer was observed. The sand was generally brown, fine to medium grained, with trace silt and compact to very dense (SPT N Values of 28 to 85). Laboratory testing of the sand revealed *in situ* moisture contents of 1 to 4 percent, indicative of damp to moist conditions.

The sand in Borehole BH11/MW was described as gravelly near 6.1 m bgs.

3.2.6 Sand and Gravel

A stratum of sand and gravel was encountered in Borehole BH6/MW between 5.6 m and 7.1 m bgs. It was brown in colour, with trace silt and compact (SPT N Value of 24). Based on an *in situ* moisture content of 9 percent and water level readings, the sand and gravel was described and very moist to wet.

3.2.7 Glacial Till

Each borehole encountered a stratum of glacial till. With the exception of Boreholes BH9/MW and BH11/MW, each borehole was terminated in the stratum. The till predominantly comprised silty clay and was brown, typically becoming grey with depth. It typically contained trace sand, trace gravel, and was stiff to hard in consistency (SPT N Values of 11 to 59). Laboratory testing of the silty clay till revealed *in situ* moisture contents of 11 to 23 percent, indicative of moist conditions.

Silt till was encountered in Borehole BH9/MW from 7.1 m to 8.6 m bgs and in Borehole BH10 from 4.0 m bgs to the termination depth of the borehole. It was described as brown with trace clay, some sand, and trace gravel. The silt till was in a very dense (SPT N Values of 60 blows per 300 mm to greater than 50 blows per 150 mm split spoon sampler penetration) and moist (*in situ* moisture contents of 8 to 13 percent) state.

Possible cobbles were encountered at 3.1 m bgs in Borehole BH11/MW.

3.3 Groundwater Conditions

Three (3) monitoring wells were installed during the drilling on May 28th and 30th, 2018 at the Site. The wells were installed to depths of approximately 8.4 m to 15.2 m bgs. The summary of well construction details is presented in the tables below.

Table 1 – Summary of Monitoring Well Construction Details

Well ID	Ground Elevation (m)	Completion Depth (m bgs)	Screen Length (m)
BH6/MW	277.3	8.4	1.5
BH9/MW	279.2	15.2	3.0
BH11/MW	277.8	15.2	3.0

Groundwater levels in the monitoring wells were monitored between May 2018 and May 2024. A summary table of the stabilized groundwater levels is attached in **Appendix B**.

The monitoring wells have been registered with the Ministry of Environment, Conservation and Parks (MECP), in accordance with Ontario Regulation 903, and remain intact for the purposes of ongoing monitoring of stabilized groundwater conditions, as needed. The measurements provided in **Appendix B** indicate a variation of the shallow overburden groundwater table between elevations of 269.0 m and 272.8 m over the monitored period.

Details of the groundwater conditions observed within the boreholes are provided on the attached Borehole Logs. Upon completion of drilling, the open borehole excavations were examined for the presence of groundwater and groundwater seepage. In Borehole BH5, groundwater was measured near 5.8 m bgs upon completion of drilling. All other boreholes without monitoring wells installed were open and dry upon completion of drilling.

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 in fine-grained soil deposits.

3.4 Methane Gas

No methane gas producing materials or significant organic matter was encountered at the borehole locations, except a thin veneer of topsoil.

An RKI Gx-2012 Gas Detector was used in the upper levels of the open boreholes. The unit measures LEL combustibles, methane gas, oxygen content, carbon monoxide and hydrogen sulfide in standard confined space gases. No methane gas was detected in the boreholes.

4.0 Discussion and Recommendations

4.1 General

Based on a Draft Plan of Subdivision prepared by Zelinka Priamo Ltd., it is understood that the Talbot Village Phase 8 development will consist of 74 single family homes and 38 townhouse units. The residential subdivision is expected to have complete municipal servicing, and will be accessed with paved local roads.

The following sections of this report provide geotechnical comments and recommendations regarding site preparation, excavations and dewatering, foundations, slab-on-grade and basement design, bedding and backfill, earthquake design considerations, pavement design and curbs and sidewalks.

4.2 Site Preparation

Based on existing site grades, it is expected that some minor re-grading and excavation will be required. Prior to placement of foundations, pipe bedding and/or engineered fill, all surficial topsoil, vegetation and/or otherwise deleterious materials should be stripped. The surficial topsoil may be stockpiled on site for possible reuse for landscaping.

Following the removal of the topsoil and building debris and prior to fill placement, the exposed subgrade should be inspected by a Geotechnical Engineer. Any loose or soft zones noted in the inspection should be over-excavated and replaced with approved fill.

It is recommended that construction traffic be minimized on the finished subgrade, and that the subgrade be sloped to promote surface drainage and runoff.

In the building areas where the grade will be raised, the fill material should comprise imported granular or approved onsite (excavated) material. The fill material should be inspected and approved by a Geotechnical Engineer and should be placed in maximum 300 mm (12 inch) thick loose lifts and uniformly compacted to 100 percent Standard Proctor Maximum Dry Density (SPMDD) within 3 percent of optimum moisture content. The geometric requirements for engineered fill are provided on **Drawing 2**.

The natural and inorganic fill materials on site would be suitable for reuse as engineered fill. The material should be examined and approved by a geotechnical engineer prior to reuse.

In areas along the proposed roadways, fill material used to raise grades may comprise onsite excavated soils, or imported granular fill approved by an Engineer. The fill should be placed in maximum 300 mm (12 inch) thick loose lifts and uniformly compacted to 95/98 percent SPMDD, depending on depth, within 3 percent of optimum moisture content in order to provide adequate stability for the new pavements.

In situ compaction testing should be carried out during the fill placement to ensure that the specified compaction is being achieved.

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, Conservation and Parks (MECP) standards for placement and transportation. The disposal of excavated materials must also conform to the MECP Guidelines and requirements. EXP can be of assistance if an assessment of the materials is required.

4.3 Excavation and Groundwater Control

4.3.1 Excess Soil Management

Ontario Regulation 406/19 made under the Environmental Protection Act (November 28th, 2019) was implemented on January 1st, 2021. The new regulation dictates the testing protocol that is required for the management and disposal of Excess Soils. As set forth in the Regulation, specific analytical testing protocols will need to be implemented and followed based on the quality and quantity of soil to be managed. The quality of soils is assessed through an Assessment of Past Uses (APU) including the provision of an Ecolog ERIS database report to determine if there are any Areas of Potential Environmental Concern (APEC). The parameters to be tested will be determined by the APU results.

The testing protocols are specific as to whether the soils are stockpiled or in-situ. In either scenario, the testing protocols are far more onerous than have been historically carried out as part of standard industry practices. These decisions should be factored in and accounted for prior to the initiation of the project-defined scope of work. EXP would be pleased to assist with the implementation of a soil management and testing program that would satisfy the requirements of Ontario Regulation 406/19.

Soil sampling requirements related to the new standard effective January 1st, 2022 are provided below.

Table 2 – Ex-Situ (e.g., Stockpiles)

Soil Volume	Sampling Frequency
<130 m^3	Minimum of 3
>130 – 220 m^3	4
>220 – 5,000 m^3	5-32*
>5,000 m^3	N = 32 + (Volume – 5,000) / 300

*refer to stockpile sampling frequency in O.Reg. 153/04 for specifics. Essentially, one sample for every 150 m^3 after 800 m^3

Table 3 – *In Situ*

Soil Volume	Sampling Frequency
<600 m^3	Minimum of 3
>600 – 10,000 m^3	1 sample per every additional 200 m^3
>10,000 – 40,000 m^3	1 sample per every additional 450 m^3
>40,000 m^3	1 sample per every additional 2,000 m^3

In addition to the above tables, one field duplicate should be submitted for approximately every 10 samples taken for quality control/quality assurance purposes.

Soil Analytical Testing Requirements:

- Samples to be tested for a minimum of Petroleum Hydrocarbons (PHCs) – Fractions F1-F4, Benzene, Toluene, Ethylbenzene & Xylenes (BTEX), Metals & Inorganics, including Electrical Conductivity (EC) and Sodium Absorption Ration (SAR);
- Any additional potential Contaminant of Concern identified in past uses report (comes into effect January 1st, 2022); and,
- mSPLP Leachate testing (metals and VOCs) (not required for volumes under 350 m^3: between 350 m^3 and 600 m^3 (minimum of 3); greater than 600 m^3 (10 % of samples).

Other components of the new regulation include:

- The Sampling and Analysis Plan (SAP) which follows the APU;
- The Soil Characterization Report (SCR) which follows the sampling program;
- The Excess Soil Destination Assessment Report (ESDAR) which follows the SCR;
- Notice of Project on the Resource Productivity and Recovery Authority (RPRA) which is usually the responsibility of the Contractor during the construction phase; and,
- Tracking Requirements on the RPRA, again, usually the responsibility of the Contractor during the construction phase.

In general, it is most economical to provide a site grading plan that keeps all excess soils on site so that O. Reg 406/19 is not invoked.

4.3.2 Excavations

Side slopes of temporary excavations must conform to Regulation 213/91 of the Occupational Health and Safety Act of Ontario. The very stiff to hard silty clay till is classified as Type 2 soil, while the fill, silt, sand, sand and gravel, silt till and stiff silty clay till materials are classified as Type 3 soil.

For excavations which extend through and terminate in Type 2 soil, temporary excavation side slopes may be cut near vertical in the bottom 1.2 m (4 ft.), and should be cut at an inclination of 1 horizontal to 1 vertical above that level. For excavations which extend through and/or terminating in Type 3 soils, temporary excavation side slopes must be cut at an inclination of 1 horizontal to 1 vertical from the base of the excavation. In the event excessive groundwater infiltration through the trench walls is encountered, flatter slopes of 3H:1V or flatter will be required.

It should be noted that the presence of cobbles and boulders in glacial till deposits may influence the progress of excavation and construction.

4.3.3 Excavation Support

The recommendations for side slopes given in Section 4.3.2 would apply to most of the conventional excavations expected for the proposed development. However, in areas adjacent to existing structures and buried services that are located above the base of the excavations, side slopes may require support to prevent possible disturbance or distress to these structures. This concept also applies to connections to existing services. In granular soils above the groundwater and in cohesive natural soils, bracing will not normally be required if the structures are behind a 45-degree line drawn up from the toe of the excavation. In wet sandy or silt soils, the setback should be about 3H to 1V if bracing is to be avoided.

For support of excavations such as for any deep manholes, shoring such as sheeting or soldier piles and lagging can be considered. The design and use of the support system should conform to the requirements set out in the most recent version of the Occupational Health and Safety Act for Construction Projects and approved by the Ministry of Labour. Excavations should conform to the guidelines set out in the proceeding section and the Safety Act. The shoring should also be designed in accordance with the guidelines set out in the Canadian Foundation Engineering Manual, 4th Edition. Soil-related parameters considered appropriate for a soldier pile and lagging system are shown below.

Where applicable, the lateral earth pressure acting on the excavation shoring walls may be calculated from the following equation:

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

where, p = lateral earth pressure in kPa acting at depth h;
γ = natural unit weight, a value of 20.4 kN/m^3 may be assumed;
h = depth of point of interest in m;
q = equivalent value of any surcharge on the ground surface in kPa.

The earth pressure coefficient (K) may be taken as 0.25 where small movements are acceptable and adjacent footing or movement sensitive services are not above a line extending at 45 degrees from the bottom edge of the excavation; 0.35 where utilities, roads, sidewalks must be protected from significant movement; and 0.45 where adjacent building footings or movement sensitive services (gas and water mains) are above a line of 60 degrees from the horizontal extending from the bottom edge of the excavation.

For long term design, a K at rest (K_o) of a minimum of 0.5 should be considered.

The above expression assumes that no hydrostatic pressure will be applied against the shoring system. It should be recognized that the final shoring design will be prepared by the shoring contractor. It is not possible to comment further on specific design details until this design is completed.

If the shoring is exposed to freezing temperatures, appropriate insulation may be provided to prevent outward movement.

The performance of the shoring must be checked through monitoring for lateral movement of the walls of the excavation to ensure that the shoring movements remain within design limits. The most effective method for monitoring the shoring movements can best be devised by this office when the shoring plans become available. The shoring designer should however assess the specific site requirements and submit the shoring plans to the engineer for review and comment.

4.3.4 Construction Dewatering

Based on the soil texture encountered during the investigation, significant groundwater infiltration is not anticipated within service trench and foundation excavations at conventional depths (i.e. less than 5 m depth). Any minor groundwater infiltration can likely be accommodated using conventional sump pumping techniques; however, if groundwater infiltration persists, more extensive dewatering measures may be required. EXP would be pleased to provide further information in this regard, upon request.

The collected water should be discharged a sufficient distance away from the excavated area to prevent the discharge water from returning to the excavation. Sediment control measures should be provided at the discharge point of the dewatering system. Caution should also be taken to avoid any adverse impacts to the environment.

Although not anticipated for foundation excavations to conventional depths, it is important to mention that for any projects requiring positive groundwater control with a removal rate of 50,000 litres to less than 400,000 litres per day, an Environmental Activity and Sector Registry (EASR) will be required for dewatering. Positive groundwater control with a removal rate of 400,000 litres per day or more will require a Permit to Take Water (PTTW). PTTW applications will need to be approved by the MECP 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.

4.4 Building Foundations

As mentioned in Section 4.1, the development will consist of 74 single family homes and 38 townhouse units. The low rise residential buildings can be supported on conventional spread and strip footings founded below the topsoil or unsuitable soils on the natural competent subgrade soils, or engineered fill.

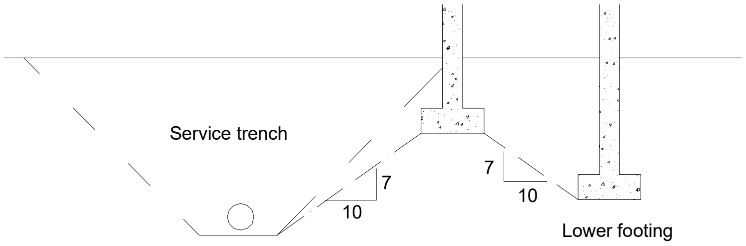
The following allowable bearing pressures (net stress increase) can be used on the natural, undisturbed soils below a typical depth of approximately 1.2 m below existing grade throughout the site:

Bearing Resistance at Serviceability Limit States (SLS)	145 kPa (3,000 psf)
Factored Bearing Resistance at Ultimate Limit States (ULS)	190 kPa (4,000 psf)

Fill soils were encountered underlying the topsoil in Boreholes BH6 and BH10, and extended to about 1.4 m to 2.1 m below found surface (bgs). In the area of these boreholes, the footings will be set lower to found on the natural silty clay till subgrade soils.

All footings exposed to seasonal freezing conditions should be protected from frost action by at least 1.2 m (4 ft.) of soil cover or equivalent insulation.

Footings at different elevations should be located such that the higher footings are set below a line drawn up at 10 horizontal to 7 vertical from the near edge of the lower footing. This concept should also be applied to service excavation, etc. to ensure that undermining is not a problem.



FOOTINGS NEAR SERVICE TRENCHES OR AT DIFFERENT ELEVATIONS

If the grades are to be raised or restored due to unsuitable soils, engineered fill can be used over the competent subgrade, as described in Section 4.2. The geometric requirements for the fill placement are shown on **Drawing 2**, appended. For footings placed on engineered fill, it is recommended that the strip footings be widened to 500 mm (20 inches), and contain nominal concrete reinforcing steel. An allowable bearing capacity of 145 kPa may be used for foundations set on engineered fill. Verification of the soil conditions and the extent of reinforcement is best determined by the Geotechnical Engineer, at the time of excavation.

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.

It should be noted that the recommended bearing capacities have been calculated by EXP from the borehole information for the design stage only. The investigation and comments are necessarily on-going as new information of underground conditions becomes available. For example, if more specific information becomes available with respect to conditions between boreholes when foundation construction is underway. The interpretation between the boreholes and the recommendations of this report must therefore be checked through field inspections provided by EXP to validate the information for use during the construction stage.

4.5 Basements

If the development includes buildings with basements, the below ground floors can be constructed using cast slab-on-grade techniques provided the subgrade is stripped of all topsoil and other obviously objectionable material. The subgrade should then be proof-rolled thoroughly. Any soft zones detected should be dug out and replaced with compactable excavated material placed in accordance with the requirements outlined in the previous Section 4.2.

A 200 mm (8 inch) compacted layer of 19 mm (¾ inch) clear stone should be placed between the prepared subgrade and the floor slab to serve as a moisture barrier.

The installation and requirement of a vapour barrier under the floor slab, where applicable, should conform to the flooring manufacturer's and designer's requirements. Moisture emission testing is recommended to determine the concrete condition prior to flooring installation.

All basement walls should be damp-proofed and must be designed to resist a horizontal earth pressure 'p' at any depth 'h' below the surface as given by the following expression:

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

where:

P = lateral earth pressure in kPa acting at a depth h:
K = earth pressure coefficient, assumed to be 0.4;
γ = unit weight of backfill, a value of 20.4 kN/m^3 may be assumed;
h = depth to point of interest in m and,
q = equivalent value of any surcharge on the ground surface.

Installation of perimeter drains is required for basements at the Site. The above expression assumes that the perimeter drainage system prevents the build-up of any hydrostatic pressure behind the wall. Suggestions for permanent perimeter drainage are given on **Drawing 3**.

4.6 Slab-on-Grade Construction

Preparation of the subgrade should include the removal of all topsoil and/or deleterious material from the proposed building area. The entire floor slab area should then be thoroughly proof-rolled with a heavy roller and examined by a geotechnical engineer. Any excessively soft or loose areas should be sub-excavated and replaced with suitable compacted fill. Where the exposed subgrade requires reconstruction to achieve the design elevations, structural fill should be used. It is recommended that structural fill comprise granular material, such as OPSS Granular 'B', or approved alternative material. The fill should be placed in maximum 300 mm thick lifts and compacted to a minimum of 98 percent Standard Proctor Maximum Dry Density (SPMDD). For best compaction results, the *in situ* moisture content of the fill should be within about three percent of optimum, as determined by Standard Proctor density testing.

No special underfloor drains are required provided that the exterior grades are lower than the floor slab, and positively sloped away from the slab. It is recommended that an impermeable soil seal such as clay, asphalt or concrete be provided on the surface to minimize water infiltration from the exterior of the building. Drainage and backfill recommendations for slab-on-grade construction are provided on **Drawing 4**.

A moisture barrier, consisting of a 200 mm (8 in.) thick, compacted layer of 19 mm (3/4 in.) clear stone, should be then placed between the prepared granular sub-base and the floor slab.

The installation and requirement of a vapour barrier under a concrete slab should conform to the flooring manufacturer's and designer's requirements. Moisture emission testing will be required to determine the concrete condition prior to flooring installation. In order to minimize the potential for excess moisture in the floor slab at the time of the flooring installation, a concrete mixture with a low water-to-cement ratio (i.e., 0.45 to 0.55) should be used. Chemical additives may be required at the time of placement to make the concrete workable, and should be used in place of additional water at the point of placement. Ongoing liaison from this office will be required.

For slab on grade design, the modulus of subgrade reaction (*k*) can be taken as 20 MPa/m for the compacted stone layer over the compacted granular subbase.

The water-to-cement ratio and slump of concrete utilized in the floor slabs should be strictly controlled to minimize shrinkage of the slabs. Adequate joints should be provided in the floor slab to further control cracking. During placement of concrete at the construction site, testing should be performed on the concrete.

4.7 Foundation Backfill

In general, the existing natural soils excavated from the foundation area should be suitable for re-use as foundation wall backfill if the work is carried out during relatively dry weather. The materials to be re-used should be within three percent of optimum moisture for best compaction results. Materials should be stockpiled per their composition; i.e. sandy soils should not be mixed with clayey soils.

If the weather conditions are very wet during construction, then imported granular material such as OPSS Granular 'B' should be used. Site review by the geotechnical consultant may be advised.

The backfill must be brought up evenly on both sides of walls not designed to resist lateral earth pressures.

During construction, the fill surface around the perimeter of structures should be sloped in such a way that the surface runoff water does not accumulate around the structure.

4.8 Pipe Bedding and Trench Backfill

The subgrade soils beneath the water and sewer pipes which will service the site are generally expected to comprise silty clay till or silt till. For services constructed on the natural soils or engineered fill, the bedding should conform to City of London and OPS Standards. The bedding course may be thickened if portions of the subgrade become wet during excavation. Bedding aggregate should 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.

The bases of excavations which cut into and terminate in competent glacial till are expected to remain stable for the short construction period. Localized improvement may be required in areas where wet silty soils are present, and work is carried out in wet weather seasons. The extent of base improvement or stabilization is best determined in the field during construction, with consultation from a Geotechnical Engineer.

To minimize disturbance to the base, pipe laying should be carried out in short sections, with backfilling following closely after laying and no section of trench should be left open overnight.

The trenches above the specified pipe bedding should be backfilled with inorganic on-site soils placed in 300 mm thick lifts and uniformly compacted to at least 95% SPMDD. For trench backfill within 1 metre below the roadway subbase, the fill should be uniformly compacted to at least 98% SPMDD. A program of *in situ* density testing should be set up to ensure that satisfactory levels of compaction are achieved.

Requirements for backfill in service trenches, etc. should also have regard for City of London requirements. A summary of the general recommendations for trench backfill is presented on **Drawings 5** and **6**. A program of *in situ* density testing should be set up to ensure that satisfactory levels of compaction are achieved.

Based on the results of this investigation, the majority of the excavated natural soils and fill material may be used for construction backfill provided that reasonable care is exercised in handling. 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 MECP guidelines.

4.9 Earthquake Design Considerations

The recommendations for the geotechnical aspects to determine the earthquake loading for design using the OBC 2012 are presented below.

The subsoil and groundwater information at this Site have been examined in relation to Section 4.1.8.4 of the OBC 2012. The subsoils at the Site generally consist of topsoil and fill over glacial till, sand, sand and gravel, and silt deposits. It is anticipated that the proposed structures will be founded on the glacial till deposits, below any loose or soft zones.

Table 4.1.8.4.A. Site Classification for Seismic Site Response in OBC 2012 indicated that to determine the site classification, the average properties in the top 30 m (below the lowest basement level) are to be used. The boreholes advanced at this Site were excavated to a maximum depth of 15.7 m bgs. Therefore, the Site Classification recommendation would be based on the available information as well as our interpretation of conditions below the boreholes based on our knowledge of the soil conditions in the area.

Based on the above assumptions, interpretations in combination with the known local geological conditions, the Site Class for the proposed development is “D” as per Table 4.1.8.4.A, Site Classification for Seismic Site Response, OBC 2012. Additional depth drilling may be advised to determine if the soil conditions below the current depth of exploration can support a higher Site Classification.

4.10 Pavement Design

Areas to be paved should be stripped of all topsoil, organics and other obviously unsuitable material. The exposed subgrade must then be 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 classification (neighbourhood streets internal to the site) and anticipated subgrade conditions.

Table 4 – Recommended Pavement Structure Thicknesses

Pavement Layer	Compaction Requirements	Neighbourhood Street
Asphaltic Concrete	92% MRD[1] or 97% BRD[1]	40 mm HL-3 or SP12.5 50 mm HL-8 or SP19
Granular ‘A’ (Base)	100% SPMDD[1]	150 mm
Granular ‘B’ (Subbase)	100% SPMDD[1]	300 mm

*Notes:
1) MRD denotes Maximum Relative Density, BRD denotes Bulk Relative Density, SPMDD denotes Standard Proctor Maximum Dry Density.
2) The subgrade must be compacted to 98% SPMDD.
3) The above recommendations are minimum requirements.
4) For the pavement configuration, the City of London pavement design is based on allowable deflection as determined by Benkleman Beam Rebound testing.

The recommended pavement structures provided in the above table are based on the natural subgrade soil properties determined from visual examination and textural classification of the soil samples. Consequently, the recommended pavement structures should be considered for preliminary design purposes only. 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 and City of London Standards 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 relative density or 92% of maximum relative density. A tack coat should be applied between the surface and binder asphalt courses.

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 catch basins. Surface water should not be allowed to pond adjacent to the outside edges of pavement areas. In low areas, sub drains may be required to intercept excess subsurface moisture and prevent subgrade softening, as shown on **Drawing 7**, depending upon soil conditions at the time of construction. This is particularly important in heavier traffic areas at the site entrances. The locations and extent of sub drainage 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.

4.11 Curbs and Sidewalks

It is recommended that the concrete for curb and gutter and sidewalks should be proportioned, mixed, placed, and cured in accordance with the requirements of City of London Specifications for Curbs and Sidewalks (refer to current City of London Drawings).

During cold weather, the freshly placed concrete must be covered with insulating blankets to protect against freezing. Three cylinders from each day's pour should be taken for compressive strength testing. Air entrainment, temperature, and slump tests should be made from the same batch of concrete from which test cylinders are made.

The subgrade for the sidewalks should comprise undisturbed natural competent soil of well-compacted fill. A minimum 150 mm thick layer of compacted Granular 'A' type aggregate should be placed beneath the sidewalk slabs. It is recommended that the Granular 'A' be compacted to a minimum 100 percent SPMDD, to provide adequate support for the concrete sidewalk. Construction traffic should be kept off the placed curbs and sidewalks as they are not designed to withstand heavy traffic load.

4.12 Methane Gas Testing

No methane gas producing materials or significant organic matter was encountered at the borehole locations, except a thin veneer of topsoil.

An RKI Gx-2003 Gas Detector was used in the upper levels of the open boreholes. The unit measures LEL combustibles, methane gas, oxygen content, carbon monoxide and hydrogen sulfide in standard confined space gases. No methane gas was detected in the boreholes.

Based on the present information, no special methane gas abatement measures are indicated at this site.

4.12 Inspection and Testing Requirements

An effective inspection and testing program is an essential part of construction monitoring. The Inspection and Testing Program for residential developments typically include the following items:

- Subgrade examination prior to engineered fill placement;
- Inspection and Materials testing during engineered fill placement (full-time supervision is recommended) and site servicing works, including soil sampling, laboratory testing (moisture contents and Standard Proctor density test on the pipe bedding, trench backfill and engineered fill material), monitoring of fill placement, and *in situ* density testing;
- Inspection and Materials testing during the road construction, including subgrade examination of the road subgrade soils following site servicing, laboratory testing (grain size analyses and Standard Proctor density tests on the Granular A and B material placed on site roadways), *in situ* density testing, and concrete sampling and testing for curbs and sidewalks;
- Inspection and Materials testing for base and surface asphalt, including laboratory testing on asphalt sampling to confirm conformance to project specifications and standards;
- Footing Base Examinations for residential footings set on engineered fill to confirm its suitability to support the design bearing pressures; and,
- Visual examination of concrete reinforcing steel placement in footings set on engineered fill

EXP would be pleased to prepare an inspection and testing work program prior to construction, incorporating the above items.

5.0 General Comments

The information presented in this report is based on a limited investigation designed to provide information to support an assessment of the current geotechnical conditions within the subject property. The conclusions and recommendations presented in this report reflect site conditions existing at the time of the investigation. Consequently, during the future development of the property, conditions not observed during this investigation may become apparent. Should this occur, EXP Services Inc. should be contacted to assess the situation, and the need for additional testing and reporting. EXP has qualified personnel to provide assistance in regards to any future geotechnical and environmental issues related to this property.

Our undertaking at EXP, therefore, is to perform our work within limits prescribed by our clients, with the usual thoroughness and competence of the engineering profession.

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.

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

This report was prepared for the exclusive use of **Southside Construction Management Limited** and may not be reproduced in whole or in part, without the prior written consent of EXP, or used or relied upon in whole or in part by other parties for any purposes whatsoever. Any use which a third party makes of this report, or any part thereof, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. EXP Services Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

We trust this report is satisfactory for your purposes. Should you have any questions, please do not hesitate to contact this office.

Drawings

-LEGEND-

⌖ BH1 Approximate Borehole Location

-NOTES-

1. The boundaries and soil types have been established only at test hole locations. Between test holes they are assumed and may be subject to considerable error.
2. Soil samples will be retained in storage for 3 months and then destroyed unless client advises that an extended time period is required.
3. Topsoil quantities should not be established from the information provided at the test hole locations.
4. The site plan was reproduced from Google Earth Pro and drawing provided by the client and should be read in conjunction with EXP Geotechnical Report LON-00016262-GE.

Geotechnical Investigation

Talbot Village Phase 8

London, Ontario

CLIENT Southside Construction Management Limited

TITLE Borehole Location Plan

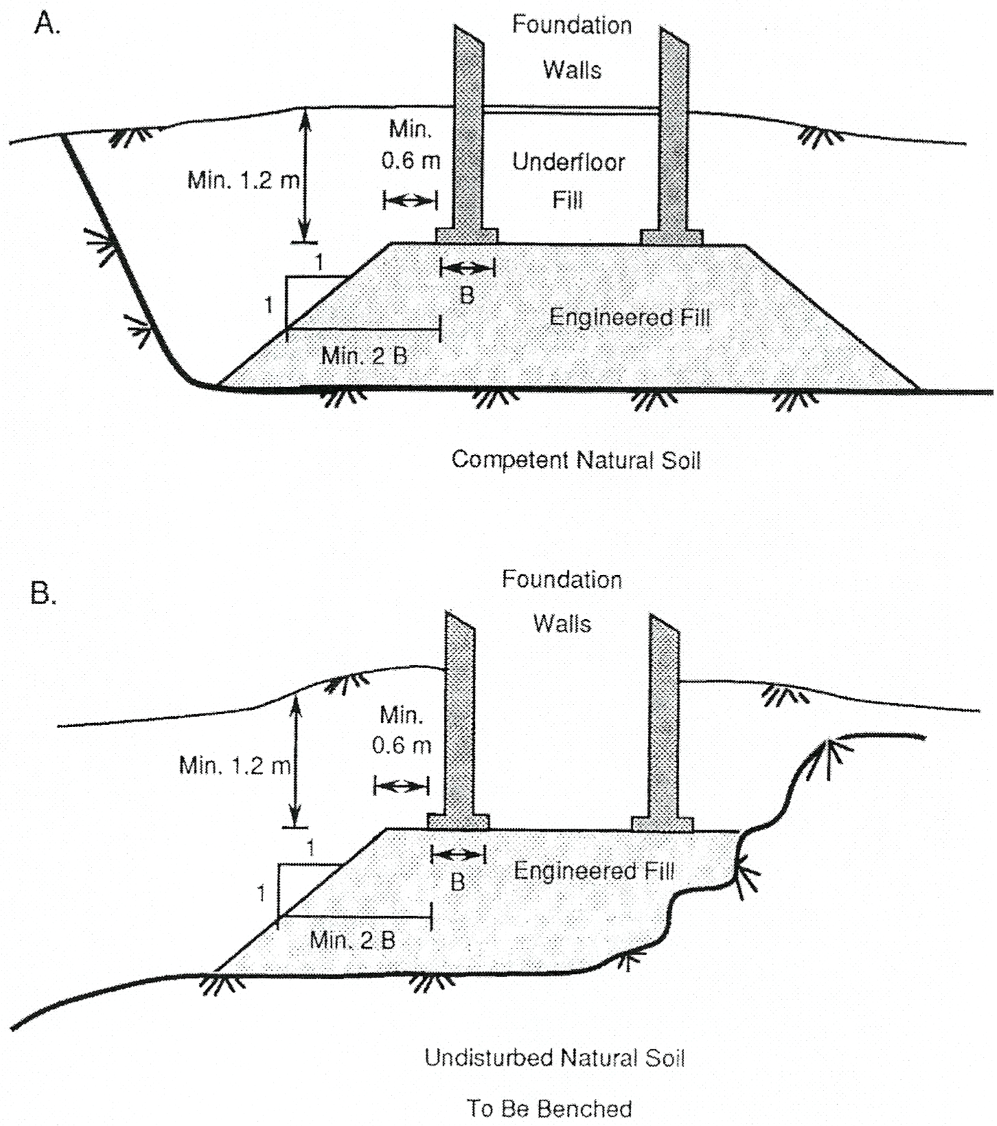
Prepared By: E.B.
Reviewed By: C.S.

exp.
EXP Services Inc.
15701 Robin's Hill Road, London, ON, N5V 0A5

DATE	APPROXIMATE SCALE	PROJECT NO.	DWG.
AUGUST 2024	1:4,000	LON-00016262-GE	1

DRAWING 2 – GEOMETRIC REQUIREMENTS FOR FOUNDATIONS ON ENGINEERED FILL

Schematic (Not to Scale)



SECTION VIEW

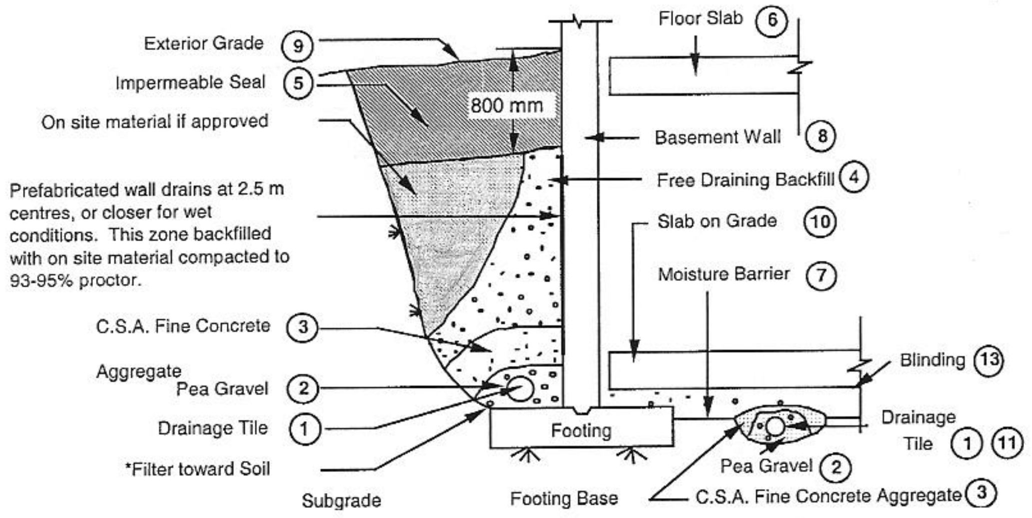
Section A – Typical Section of Slab-on-Grade Building
Section B – Typical Section of Building with Basement

Refer to Detailed Notes on following page.

NOTES FOR ENGINEERED FILL PLACMENT:

1. The area must be stripped of all topsoil contaminated fill material, and other unsuitable soils, and proof rolled. Soft spots must be dug out. The stripped natural subgrade must be examined and approved by an EXP Engineer prior to placement of engineered fill.
2. In areas where engineered fill is placed on a slope, the fill should be benched into the approved subgrade soils. EXP would be pleased to provide additional comments and recommendations in this regard, if required.
3. All excavations must be carried out in accordance with the Occupational Health and Safety Regulation of Ontario (Construction Projects - O.Reg. 213.91)
4. Material used for engineered fill must be free of topsoil, organics, frost and frozen material, and otherwise unsuitable or compressible soils, as determined by a Geotechnical Engineer. Any material proposed for use as engineered fill must be examined and approved by EXP, prior to use onsite. Clean compactable granular fill is preferred.
5. Approved engineered fill should be placed in maximum 300 mm thick lifts, and uniformly compacted to 100% Standard Proctor dry density throughout. For best compaction results, engineered fill should be within 3 percent of its optimum moisture content, as determined by the Standard Proctor density test. Imported fill should satisfy the MOECC regulations and requirements.
6. Full time geotechnical monitoring, inspection and insitu density (compaction) testing by EXP is required during placement of the engineered fill.
7. Site grades should be maintained during area grading activities to promote drainage, and to minimize ponding of surface water on the engineered fill mat. Rutting by construction equipment should be kept to a minimum, where possible. Additional work to ensure suitability of engineered fill may be required if fill is placed in extreme (hot/cold) weather.
8. The fill must be placed such that the specified geometry is achieved. Refer to sketches (previous page) for minimum requirements. Proper environmental protection will be required, such as providing frost penetration during construction, and after the completion of the engineered fill mat.
9. An allowable bearing pressure of 145 kPa (3000 psf) may be used provided that all conditions outlined above, and in the Geotechnical Report are adhered to.
10. These guidelines are to be read in conjunction with the attached Geotechnical Report. (EXP Project No. LON-00016262-GE)
11. For foundations set on engineered fill, footing enhancement and/or concrete reinforcing steel placement is recommended. The footing geometry and extent of concrete reinforcing steel will depend on site specific conditions. In general, consideration may be given to having a minimum strip footing width of 500 mm (20 inches), containing nominal steel reinforcement. Alternatively, concrete reinforcement may be recommended in the top and bottom of the foundation wall strip. The final footing geometry and extent of reinforcement is best determined in the field, by a Geotechnical Engineer.
12. For residential sites in the City of London, a letter from the Geotechnical Consultant will be required to verify the extent of engineered fill placement, prior to issuance of Building Permits. Footing Base inspections are required to verify the suitability of the subgrade soils, at the time of construction. Insitu density tests may also be required at the footing base level to confirm material density.

DRAWING 3 – BACKFILL AND BASEMENT DRAINAGE DETAIL (NOT TO SCALE)

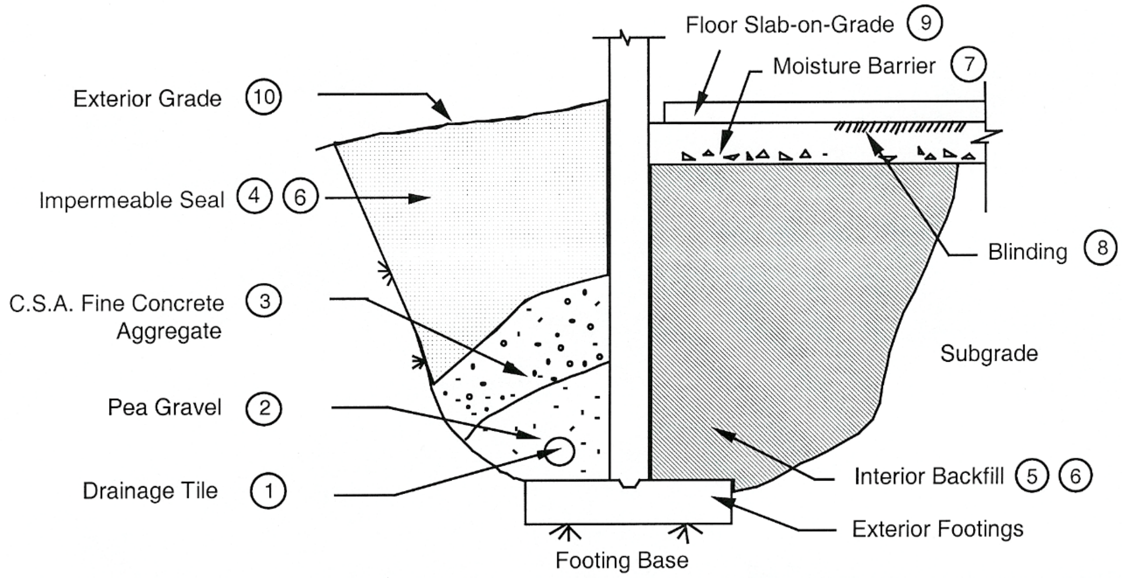


NOTES:

1. Drainage tile to consist of 100 mm (4 in.) diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet. Invert to be minimum of 150 mm (6 in.) below underside of floor slab.
2. Pea gravel 150 mm (6 in.) top and sides of drain. If drain is not on footing, place 100 mm (4 in.) of pea gravel below drain. 20 mm (3/4 in.) clear stone may be used provided if it is covered by an approved porous geotextile fabric membrane (Terrafix 270R or equivalent).
3. C.S.A. fine concrete aggregate to act as filter material. Minimum 300 mm (12 in.) top and side of drain. This may be replaced by an approved porous geotextile membrane (Terrafix 270R or equivalent).
4. Free-draining backfill - OPSS Granular B or equivalent compacted to 93 to 95 (maximum) percent Standard Proctor density. Do not compact closer than l.8 m (6 ft) from wall with heavy equipment. Use hand controlled light compaction equipment within 1.8 m (6 ft) of wall.
5. Impermeable backfill seal of compacted clay, clayey silt or equivalent. If original soil is free-draining, seal may be omitted.
6. Do not backfill until wall is supported by basement and floor slabs or adequate bracing.
7. Moisture barrier to consist of compacted 20 mm (3/4 in.) clear, crushed stone or equivalent free-draining material. Layer to be 200 mm (8 in.) minimum thickness.
8. Basement walls to be damp-proofed.
9. Exterior grade to slope away from wall.
10. Slab on grade should not be structurally connected to wall or footing.
11. Underfloor drain invert to be at least 300 mm (12 in.) below underside of floor slab. Drainage tile placed in parallel rows 6 to 8 m (20 to 25 ft.) centres one way. Place drain on 100 mm (4 in.) of pea gravel with 150 mm (6 in.) of pea gravel top and sides. CSA fine concrete aggregate to be provided as filter material or an approved porous geotextile membrane (as in 2 above) may be used.
12. Do not connect the underfloor drains to perimeter drains.
13. If the 20 mm (3/4 in.) clear stone requires surface binding, use 6 mm (1/4 in.) clear stone chips.

Note: a) Underfloor drainage can be deleted where not required (see report).
b) Free draining backfill, item 4 may be replaced by wall drains, as indicated, if more economical.

DRAWING 4 – DRAINAGE AND BACKFILL RECOMMENDATIONS (NOT TO SCALE)

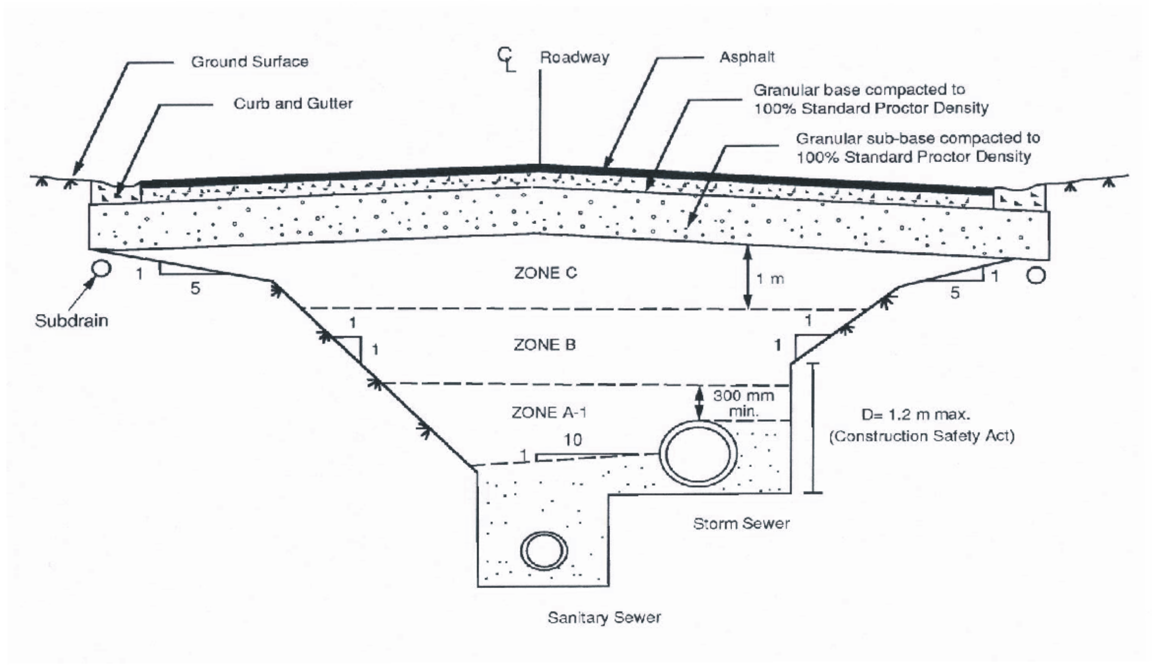


NOTES:

1. Drainage tile to consist of 100 mm (4 in.) diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet. Invert to be minimum of 150 mm (6 in.) below underside of interior floor slab.
2. Pea gravel 150 mm (6 in.) top and sides of drain. If drain is not on footing, place 100 mm (4 in.) of pea gravel below drain. 20 mm (3/4 in.) clear stone may be used provided if it is covered by an approved porous geotextile fabric membrane (Terrafix 270R or equivalent).
3. C.S.A. fine concrete aggregate to act as filter material. Minimum 300 mm (12 in.) top and side of drain. This may be replaced by an approved porous geotextile membrane (Terrafix 270R or equivalent).
4. Impermeable backfill seal of compacted clay, clayey silt or equivalent. If original soil is free-draining, seal may be omitted. Compact backfill to 95 percent Standard Proctor Maximum Dry Density.
5. The interior fill may be any clean, inorganic soil which may be compacted to at least 95 percent Standard Proctor density in this confined space.
6. Do not use heavy compaction equipment within 450 mm (18 in.) of the wall. Do not fill or compact within 1.8 m (6 ft) of wall unless fill is placed on both sides simultaneously.
7. Moisture barrier to be at least 200 mm (8 in.) of compacted 20 mm (3/4 in.) clear, crushed stone or equivalent free-draining material.
8. If the 20 mm (3/4 in.) clear stone requires surface binding, use 60 mm (1/4 in.) clear stone chips.
9. Slab on grade should not be structurally connected to wall or footing.
10. Exterior grade to slope away from building.

This system is not normally required if the floor is at least 300 mm (1 ft.) above exterior grade.

DRAWING 5 – TYPICAL BACKFILL DETAIL STORM AND SANITARY SEWER (COMMON TRENCH)



SECTION VIEW

NOTES:

ZONE A
Granular bedding satisfying current City of London Standards compacted to 95% Standard Proctor maximum dry density.

ZONE A-I
To be compacted to 95% Standard Proctor maximum dry density.

ZONE B
To be compacted to 95% Standard Proctor maximum dry density.

ZONE C
To be compacted to 98% Standard Proctor maximum dry density.

The excavations shown above are for Type 1 or 2 soils. Where excavations extend through Type 3 soils, the side walls should be sloped back at a maximum inclination of 1 horizontal to 1 vertical from the base (Reference O.Reg 219/31).

DRAWING 6 – TRENCH BACKFILL REQUIREMENTS

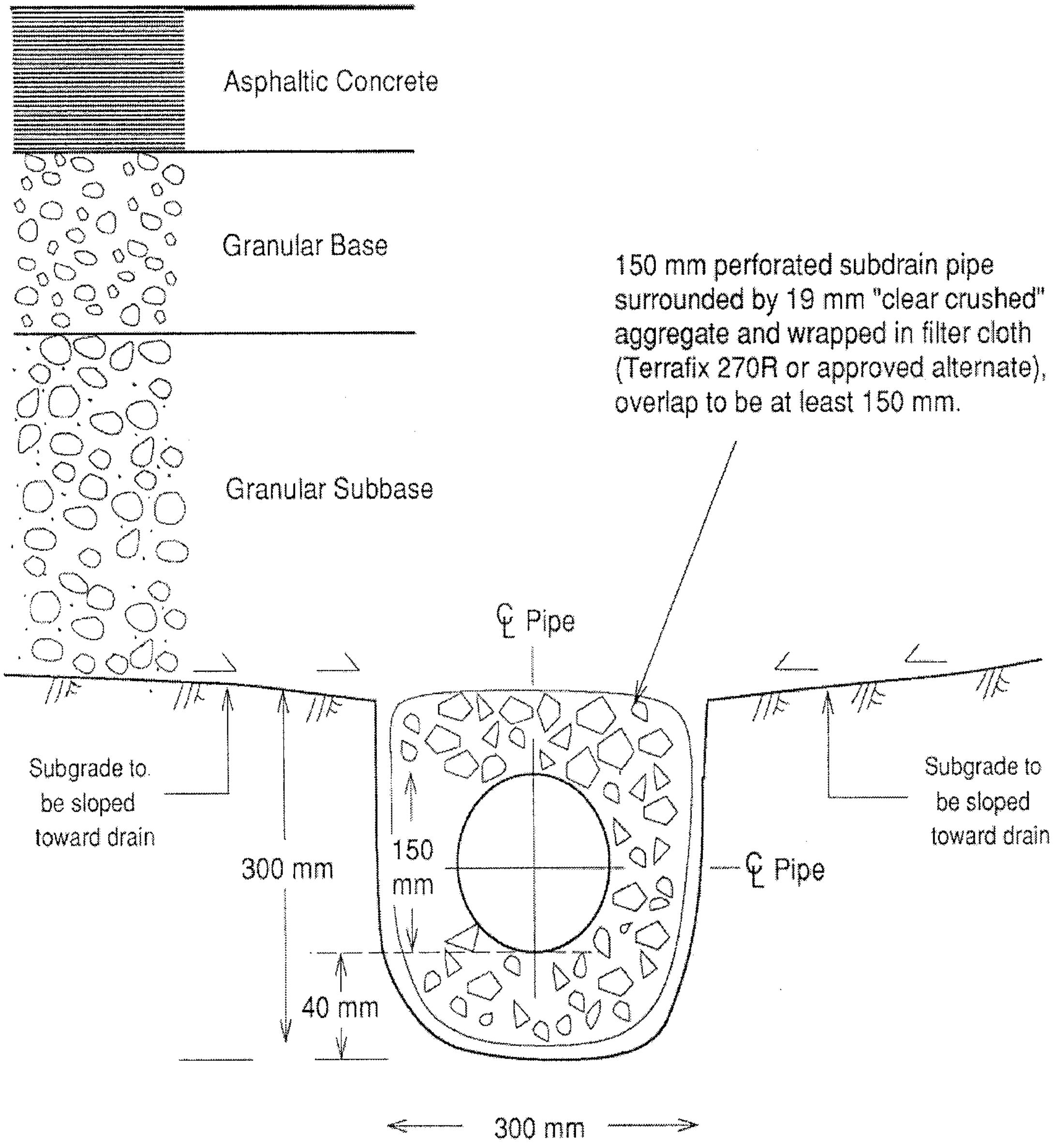
Requirements for backfill in service trenches, etc. should conform to current City of London and OPSS requirements. A summary of the general recommendations for trench backfill is presented on **Drawing 5**.

The bedding materials for the services designated as Zone A on the attached drawings should consist of approved granular material satisfying the current City of London minimum standards and specifications. (Class B bedding should provide adequate support for the pipes). These materials should be uniformly compacted to 95 percent of standard Proctor dry density. Some problems may be encountered in maintaining alignment when bedding pipes in wet sandy soil. If Granular 'A' or other sandy material is used for bedding, they may become 'spongy' when saturated. If significant amounts of clear stone are used to stabilize the base, a geotextile should be incorporated to avoid problems with migration of fine grained materials and differential settlement under the pipes as the groundwater rises after backfilling. For minor local use of crushed stone without a geotextile filter, a graded HL3 stone is preferable.

The backfill in Zone B will consist of the native material. This material should be placed in loose lifts not exceeding 300 mm (12 inches) and be uniformly compacted to 95 percent of the standard Proctor maximum dry density. Material wetter than 5 percent above optimum must be allowed to dry sufficiently or should be discarded or used in landscaped areas.

The upper 1 meter of the general backfill (i.e. Zone C) should be placed in loose lifts not exceeding 300 mm (12 inches) and be uniformly compacted to at least 98 percent of the standard Proctor maximum dry density. To achieve satisfactory compaction, the fill material should be within 3 percent of standard Proctor optimum moisture content at placement.

DRAWING 7 – PAVEMENT SUBDRAIN DETAIL



NOTES:

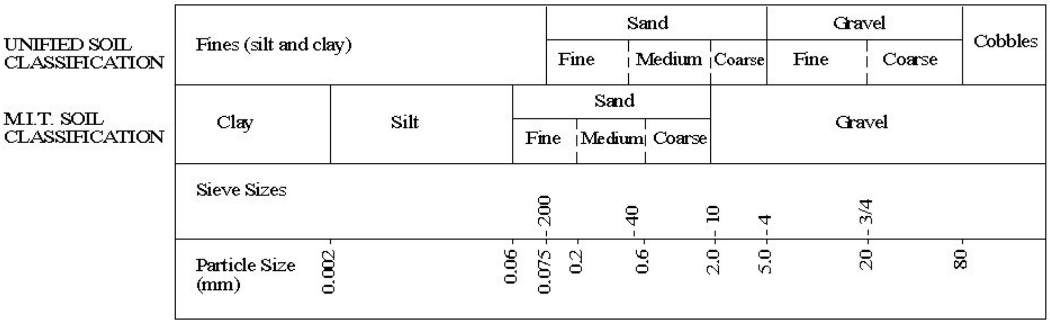
1. All dimensions in millimetres.
2. All sub drains to be set on at least 1% grade draining to a positive outlet.
3. Subgrade soil conditions should be verified onsite, during subgrade preparation works, following site servicing installations.

Scale: NTS

Appendix A – Borehole Logs

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 EXP 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 that can be potentially generated or 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.

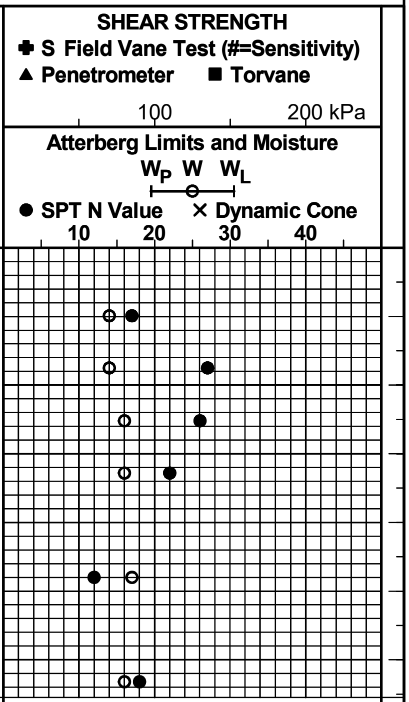
3. **Glacial Till**: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process, the till must be considered heterogeneous in composition and as such, may contain pockets and/or seams of material such 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.

BOREHOLE LOG

BH1
Sheet 1 of 1

CLIENT **Southside Construction Management Limited**
PROJECT NO. **LON-00016262-GE**
PROJECT **Proposed Talbot Village Phase 8**
DATUM **Geodetic**
LOCATION **3095 Bostwick Road, London, ON**
DATES: Boring **May 28, 2018**
Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	279.0								
	278.6	**TOPSOIL** - 400 mm							
		SILTY CLAY TILL - brown, trace sand, trace gravel, stiff to very stiff, moist							
1					SS	S1	400	17	14
					SS	S2	450	27	14
2									
		- becoming grey near 2.1 m bgs			SS	S3	450	26	16
3					SS	S4	300	22	16
4									
5					SS	S5	400	12	17
6									
	272.5				SS	S6	450	18	16
		End of Borehole at 6.6 m bgs.							
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									



NOTES

1) Borehole interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00016262-GE.
2) Borehole open and dry upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected 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

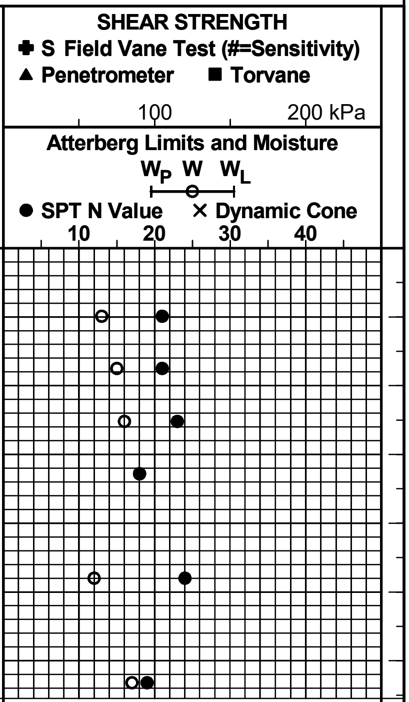
WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH5
Sheet 1 of 1

CLIENT **Southside Construction Management Limited**
PROJECT NO. **LON-00016262-GE**
PROJECT **Proposed Talbot Village Phase 8**
DATUM **Geodetic**
LOCATION **3095 Bostwick Road, London, ON**
DATES: Boring **May 28, 2018** Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	277.4								
	277.1	**TOPSOIL** - 300 mm							
		SILTY CLAY TILL - brown, trace sand, trace gravel, very stiff, moist			▨ SS	S1	400	21	13
					▨ SS	S2	450	21	15
					▨ SS	S3	450	23	16
					▨ SS	S4	400	18	18
		- becoming grey near 3.5 m bgs							
					▨ SS	S5	450	24	12
		- wet sand and gravel seam encountered near 5.2 m bgs		∇					
	270.9				▨ SS	S6	450	19	17
		End of Borehole at 6.6 m bgs.							



Depth scale (m bgs): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16

NOTES

1) Borehole interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00016262-GE.
2) Borehole open to 6.1 m bgs and groundwater measured near 5.8 m bgs upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected 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

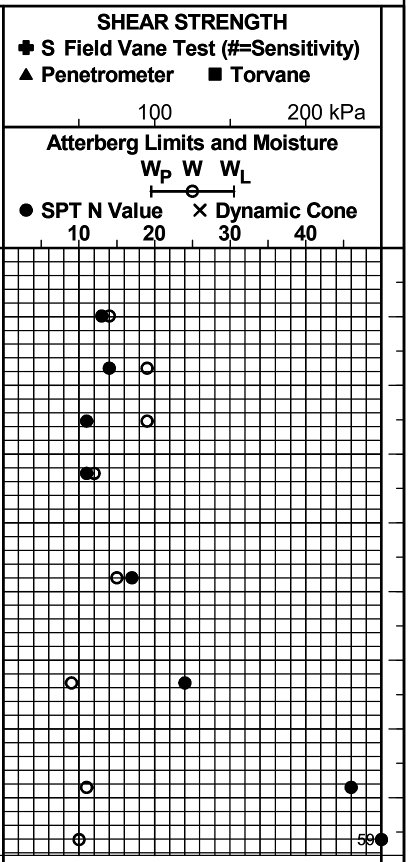
WATER LEVELS
∇ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH6/MW
Sheet 1 of 1

CLIENT **Southside Construction Management Limited**
PROJECT NO. **LON-00016262-GE**
PROJECT **Proposed Talbot Village Phase 8**
DATUM **Geodetic**
LOCATION **3095 Bostwick Road, London, ON**
DATES: Boring **May 30, 2018**
Water Level **Oct 28/20**

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	277.3						
	277.0	**TOPSOIL** - 300 mm					
1		**FILL** - sandy silt, brown, some clay, trace gravel, compact, moist to very moist	SS	S1	400	13	14
			SS	S2	400	14	19
2	275.2						
		SILTY CLAY TILL - grey, trace sand, trace gravel, stiff to very stiff, moist	SS	S3	450	11	19
3			SS	S4	450	11	12
4							
5			SS	S5	450	17	15
	271.8						
6		**SAND AND GRAVEL** - brown, trace silt, compact, very moist to wet	SS	S6	400	24	9
7	270.2						
		SILTY CLAY TILL - brown, some sand, trace gravel, hard, moist - occasional sand lenses	SS	S7	450	46	11
8							
	268.5		SS	S8	375	59	10
9		**End of Borehole at 8.8 m bgs.**					
10							
11							
12							
13							
14							
15							
16							



NOTES

1) Borehole interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00016262-GE.
2) bgs denotes below ground surface.
3) No significant methane gas concentration was detected 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

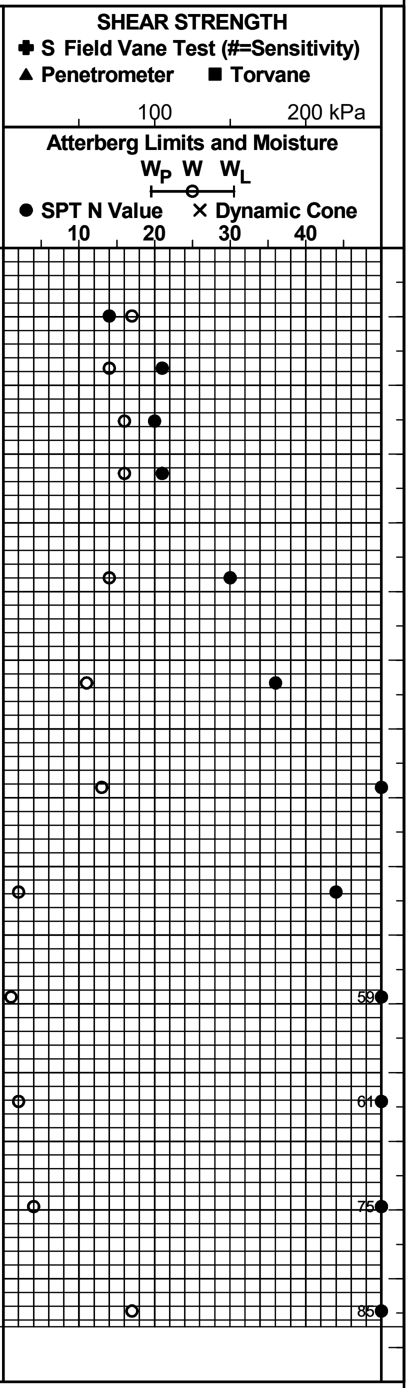
WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH9/MW
Sheet 1 of 1

CLIENT **Southside Construction Management Limited**
PROJECT NO. **LON-00016262-GE**
PROJECT **Proposed Talbot Village Phase 8**
DATUM **Geodetic**
LOCATION **3095 Bostwick Road, London, ON**
DATES: Boring **May 28, 2018** Water Level

ELEVATION (~m)	STRATA DESCRIPTION	TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)	MOISTURE CONTENT (%)
279.2						
278.7	**TOPSOIL** - 450 mm					
	SILTY CLAY TILL - brown, trace sand, trace gravel, stiff to very stiff, moist	SS	S1	400	14	17
		SS	S2	450	21	14
		SS	S3	450	20	16
		SS	S4	450	21	16
	- becoming grey near 3.8 m bgs					
		SS	S5	450	30	14
	- 100 mm thick wet sand and gravel seam encountered near 6.1 m bgs	SS	S6	450	36	11
272.1	**SILT TILL** - brown, trace clay, some sand, trace gravel, very dense, moist	SS	S7	450	50*	13
270.6	**SAND** - brown, fine to medium grained, trace silt, trace gravel, dense to very dense, damp to moist	SS	S8	400	44	2
		SS	S9	400	59	1
		SS	S10	400	61	2
		SS	S11	400	75	4
264.5	**SILT** - brown, trace clay, some sand, dilatant lenses, moist to very moist	SS	S12	450	85	17
263.5	**End of Borehole at 15.7 m bgs.**					



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)

NOTES

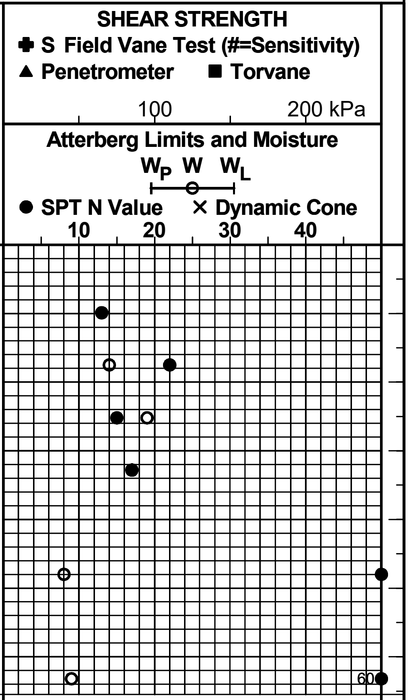
1) Borehole interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00016262-GE.
2) bgs denotes below ground surface.
3) No significant methane gas concentration was detected upon completion of drilling.
4) * denotes 50 blows per 130 mm split spoon sampler penetration.

BOREHOLE LOG

BH10
Sheet 1 of 1

CLIENT **Southside Construction Management Limited**
PROJECT NO. **LON-00016262-GE**
PROJECT **Proposed Talbot Village Phase 8**
DATUM **Geodetic**
LOCATION **3095 Bostwick Road, London, ON**
DATES: Boring **May 28, 2018**
Water Level

DEPTH (m bgs)	ELEVATION (~m) 279.6	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	279.3	**TOPSOIL** - 300 mm							
1	278.2	**FILL** - silty clay, brown, trace sand, trace gravel, stiff, moist			SS	S1	400	13	13
2		**SILTY CLAY TILL** - brown, trace sand, trace gravel, very stiff, moist			SS	S2	450	22	14
					SS	S3	425	15	19
3					SS	S4	450	17	17
4	275.6	**SILT TILL** - brown, trace clay, some sand, trace gravel, very dense, moist							
5					SS	S5	350	50*	8
6	273.0	- occasional sand seams encountered near 6.0 m bgs			SS	S6	450	60	9
7		**End of Borehole at 6.6 m bgs.**							



NOTES

1) Borehole interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00016262-GE.
2) Borehole open and dry upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.
5) * denotes 50 blows per 75 mm split spoon sampler penetration.

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

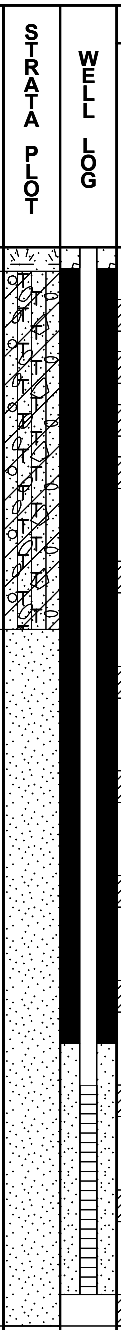
WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

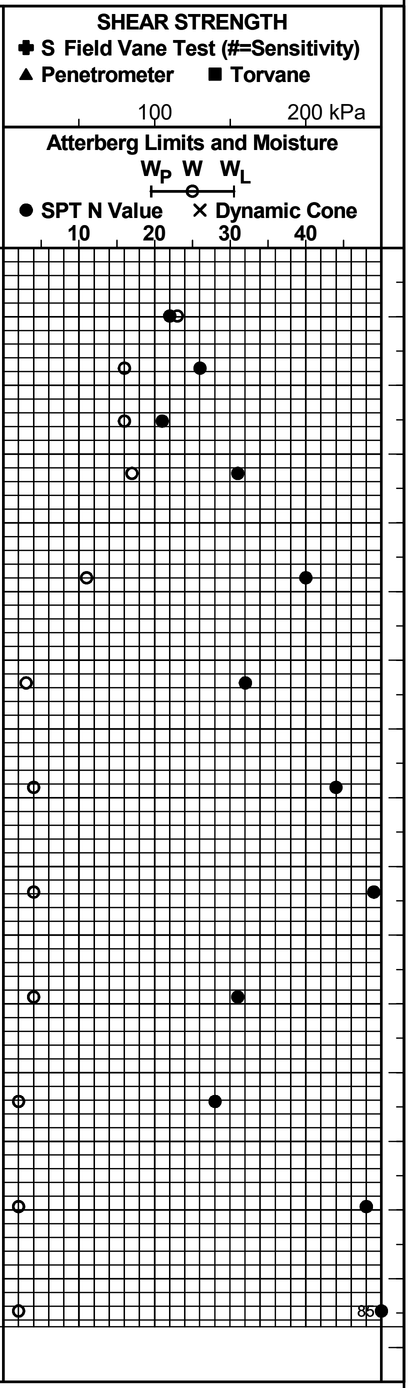
BOREHOLE LOG

BH11/MW
Sheet 1 of 1

CLIENT **Southside Construction Management Limited**
PROJECT NO. **LON-00016262-GE**
PROJECT **Proposed Talbot Village Phase 8**
DATUM **Geodetic**
LOCATION **3095 Bostwick Road, London, ON**
DATES: Boring **May 30, 2018**
Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)	MOISTURE CONTENT (%)
0	277.8						
	277.5	**TOPSOIL** - 350 mm					
		SILTY CLAY TILL - brown, trace sand, trace gravel, very stiff to hard, moist					
1			SS	S1	400	22	23
2			SS	S2	450	26	16
			SS	S3	450	21	16
3		- possible cobble encountered near 3.1 m bgs	SS	S4	400	31	17
5			SS	S5	400	40	11
	272.3	**SAND** - brown, fine to medium grained, trace silt, compact to very dense, damp to moist - gravelly near 6.1 m bgs					
6			SS	S6	400	32	3
8			SS	S7	400	44	4
9			SS	S8	450	49	4
11			SS	S9	450	31	4
12			SS	S10	450	28	2
14			SS	S11	450	48	2
	262.1		SS	S12	450	85	2
16		**End of Borehole at 15.7 m bgs.**					





NOTES

1) Borehole interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00016262-GE.
2) bgs denotes below ground surface.
3) No significant methane gas concentration was detected 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)

Appendix B – Stabilized Groundwater Measurements

LON-00016262-GE
Talbot Village Phase 8, London, Ontario

Groundwater Elevation Monitoring

Well ID	BH6/MW	BH9/MW	BH11/MW
Ground Surface Elevation (m amsl)	277.26	279.19	277.82
Groundwater Elevation (m amsl)			
31-May-18	270.78	Dry	Dry
20-Jun-18	270.61	Dry	Dry
25-Jul-18	269.94	Dry	Dry
23-Aug-18	269.64	Dry	Dry
18-Sep-18	269.44	Dry	Dry
18-Oct-18	269.10	Dry	Dry
26-Nov-18	268.98	Dry	Dry
12-Dec-18	269.10	Dry	Dry
16-Jan-19	269.35	Dry	Dry
15-Feb-19	269.72	Dry	Dry
20-Mar-19	269.80	Dry	Dry
9-Apr-19	270.35	Dry	Dry
13-May-19	270.56	Dry	Dry
25-Jun-19	270.44	Dry	Dry
26-Jul-19	270.27	Dry	Dry
12-Aug-19	270.25	Dry	Dry
29-Nov-19	-	-	-
13-Dec-19	-	-	Dry
28-Jan-20	-	-	Dry
17-Feb-20	-	-	Dry
14-Mar-20	-	-	Dry
27-Apr-20	-	-	Dry
23-May-20	270.50	Dry	Dry
10-Jun-20	270.74	Dry	Dry
11-Jul-20	270.31	Dry	Dry
26-Aug-20	269.99	Dry	Dry
17-Sep-20	269.91	Dry	Dry
28-Oct-20	269.80	Dry	Dry
14-Nov-20	269.66	Dry	Dry
18-Dec-20	269.54	Dry	Dry
21-Jan-21	269.64	Dry	Dry
24-Feb-21	269.60	Dry	Dry
25-Mar-21	269.62	Dry	Dry
30-Apr-21	269.81	Dry	Dry
28-May-21	269.88	-	Dry
31-May-21	-	Dry	-
18-Jun-21	272.82	Dry	Dry
6-Jul-21	269.73	Dry	Dry
20-Oct-23	-	Dry	Dry
17-Nov-23	269.63	Dry	Dry
7-Dec-23	269.47	Dry	Dry
3-Jan-24	269.23	Dry	Dry
8-Feb-24	269.74	Dry	Dry
1-Mar-24	269.65	Dry	Dry
2-Apr-24	270.34	Dry	Dry
16-May-24	270.35	Dry	Dry

Appendix C – Inspection and Testing Schedule

INSPECTION & TESTING SCHEDULE

The following program outlines suggested minimum testing requirements during backfilling of service trenches and construction of pavements. In adverse weather conditions (wet/freezing), increased testing will be required. The testing frequencies are general requirements and may be adjusted at the discretion of the engineer based on test results and prevailing construction conditions.

I TRENCH BACKFILL

ZONE A	- one in situ density test per 100 cubic meters or 50 linear metres of trench whichever is less - one laboratory grain size and Proctor density test per 50 density tests or 4000 cubic metres or on change of material (source, visual)
ZONE A1	- one in situ density test per 75 cubic metres of material or 25 linear metres of each lift of fill - one laboratory grain size and Proctor density test per each 50 density tests or 4000 cubic metres of material placed or as directed by the engineer
ZONES B & C	- one in situ density test per 150 cubic metres of material or 50 linear metres or each lift whichever is less - one laboratory grain size and Proctor density test per 50 density tests or 4000 cubic metres of material placed or as directed by the engineer

II PAVEMENT MATERIALS

GRANULAR SUBBASE	- one in situ density test per 50 linear metres of road - one laboratory grain size and standard Proctor test per 50 density tests or 4000 cubic metres or each change of material (visual, source), as determined by the engineer
GRANULAR BASE	- one in situ density test per 50 linear metres of road - one laboratory grain size and Proctor per 50 density tests or 8000 cubic metres or change in material (visual, source), as determined by the engineer - Benkelman beam testing at 10 metre intervals per lane, after final grading and compaction. Asphaltic concrete should not be placed until rebound criteria have been satisfied.
ASPHALTIC CONCRETE	- one in situ density test per 25 linear metres of roadway - one complete Marshall Compliance test including stability flow, etc. for each mix type to check mix acceptability. One extraction and gradation test per each day of paving to be compared to job mix formula

NOTES: Where testing indicates inadequate compaction, additional fill should not be placed until the area is recompacted and retested at the discretion of the engineer.

Appendix D – Limitations and Use of Report

LIMITATIONS AND USE OF REPORT

BASIS OF REPORT

This report ("Report") is based on site conditions known or inferred by the geotechnical investigation undertaken as of the date of the Report. Should changes occur which potentially impact the geotechnical condition of the site, or if construction is implemented more than one year following the date of the Report, the recommendations of exp may require re-evaluation.

The Report is provided solely for the guidance of design engineers and on the assumption that the design will be in accordance with applicable codes and standards. Any changes in the design features which potentially impact the geotechnical analyses or issues concerning the geotechnical aspects of applicable codes and standards will necessitate a review of the design by exp. Additional field work and reporting may also be required.

Where applicable, recommended field services are the minimum necessary to ascertain that construction is being carried out in general conformity with building code guidelines, generally accepted practices and exp's recommendations. Any reduction in the level of services recommended will result in exp providing qualified opinions regarding the adequacy of the work. exp can assist design professionals or contractors retained by the Client to review applicable plans, drawings, and specifications as they relate to the Report or to conduct field reviews during construction.

Contractors contemplating work on the site are responsible for conducting an independent investigation and interpretation of the borehole results contained in the Report. The number of boreholes necessary to determine the localized underground conditions as they impact construction costs, techniques, sequencing, equipment and scheduling may be greater than those carried out for the purpose of the Report.

Classification and identification of soils, rocks, geological units, contaminant materials, building envelopment assessments, and engineering estimates are based on investigations performed in accordance with the standard of care set out below and require the exercise of judgment. As a result, even comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations or building envelope descriptions involve an inherent risk that some conditions will not be detected. All documents or records summarizing investigations are based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated. Some conditions are subject to change over time. The Report presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special considerations or requirements, these should be disclosed to exp to allow for additional or special investigations to be undertaken not otherwise within the scope of investigation conducted for the purpose of the Report.

RELIANCE ON INFORMATION PROVIDED

The evaluation and conclusions contained in the Report are based on conditions in evidence at the time of site inspections and information provided to exp by the Client and others. The Report has been prepared for the specific site, development, building, design or building assessment objectives and purpose as communicated by the Client. exp has relied in good faith upon such representations, information and instructions and accepts no responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of any misstatements, omissions, misrepresentation or fraudulent acts of persons providing information. Unless specifically stated otherwise, the applicability and reliability of the findings, recommendations, suggestions or opinions expressed in the Report are only valid to the extent that there has been no material alteration to or variation from any of the information provided to exp.

STANDARD OF CARE

The Report has been prepared in a manner consistent with the degree of care and skill exercised by engineering consultants currently practicing under similar circumstances and locale. No other warranty, expressed or implied, is made. Unless specifically stated otherwise, the Report does not contain environmental consulting advice.

COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment form part of the Report. This material includes, but is not limited to, the terms of reference given to exp by its client ("Client"), communications between exp and the Client, other reports, proposals or documents prepared by exp for the Client in connection with the site described in the Report. In order to properly understand the suggestions, recommendations and opinions expressed in the Report, reference must be made to the Report in its entirety. exp is not responsible for use by any party of portions of the Report.