June 21, 2021 LON-21011260-A0

Mr. Greg Hussey
President and Owner
Karwood Ontario Ltd.
1429D Topsail Road
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Attention: Mr. Hussey

Geotechnical Investigation
Canterbury Place Development
Belmont, Ontario

Further to your request, an EXP representative was on site at the property located southwest of Canterbury Place and Caesar Road in Belmont, Ontario to supervise the excavation of three (3) test pits. The purpose of the program was to assess the subsoil and groundwater conditions and to provide geotechnical engineering guidelines to support the proposed site development. It is understood that the proposed development will consist of single-family residences with municipal servicing and an access road.

On June 21, 2021, three (3) test pits were excavated at various locations in the existing grassed field, using a back-hoe excavator. The test pits were terminated at depths of approximately 4.0 m below ground surface (bgs). The locations of the test pits are shown on **Drawing 1**, appended.

During the excavation, the stratigraphy in the test pits was examined and logged in the field by EXP geotechnical personnel. Short-term groundwater level observations within the open test pits are recorded on the test pit summary attached.

Following excavation of each test pit, groundwater observations were made. The test pits were then backfilled with the excavated material and surfaced with the reclaimed topsoil.

The following sections of this letter provide geotechnical recommendations to assist with the design and construction of the proposed project.

Summarized Soil Conditions

Topsoil

Each test pit was surfaced with a layer of topsoil ranging between 250 mm and 360 mm in thickness.

It should be noted that topsoil quantities should not be established from the information provided at the test hole 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.

Silt

Beneath the topsoil in Test Pits TP2 and TP3 and extending to 0.6 m below ground surface (bgs) was a layer of silt. The silt was brown in colour, contained some clay, some sand, and trace gravel. The silt was described as loose (based on observed excavation resistance) and moist (based on an *in situ* moisture content of 17 percent).

Clayey Silt

A clayey silt layer was encountered underlying the topsoil or silt in each test pit and extended to between 0.6 m and 0.9 m bgs. The brown clayey silt contained trace sand, trace gravel and was firm in consistency (observed excavation resistance). Based on tactile examination, the clayey silt was described as moist.

Glacial Till

Each test pit was terminated in a stratum of glacial till. The till predominantly comprised clayey silt and was brown becoming grey in colour with depth. The clayey silt till contained trace sand, trace gravel, and was stiff to very stiff in consistency (based on observed excavation resistance). Laboratory testing of the clayey silt till yielded an *in situ* moisture content of 15 percent, indicative of moist conditions.

Very moist to wet sand and gravel/sand lenses were encountered near 3.0 m bgs and 2.6 m bgs in Test Pits TP1 and TP3 respectively.

Frequent cobbles were encountered in the till layer below 2.7 m to 3.0 m in Test Pits TP2 and TP3.

Groundwater Observations

Minor groundwater seepage was observed in Test Pits TP1 and TP3 near depths of 3.4 m and 2.8 m bgs respectively. Test Pit TP2 was dry upon completion of excavation.

It is noted that insufficient time was available for the measurement of the depth to the stabilized groundwater table prior to backfilling the test hole. However, the observed/measured groundwater is trapped in permeable sand and gravel/sand lenses, perched within or above the less permeable glacial till.

It is also 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.

Site Preparation

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 deleterious materials 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 soils 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 used 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 any excess excavated materials must conform to the MECP Guidelines and requirements. EXP can be of assistance if an assessment of the materials is required.

Excess Soil Management

It should be noted that Ontario Regulation 406/19 made under the Environmental Protection Act (November 28, 2019) was implemented on January 1, 2021. The new regulation dictates the testing protocol that will be 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 volume of soil to be managed. 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.

The following is the regulated sampling and testing regiment.

Table 1 – Recommended Ex-Situ (e.g., Stockpiles)

Soil Volume	Sampling Frequency
<130 m^3	Minimum of 3
>130 - 220 m^3	4
>220 - 5000 m^3	5-32*
>5000 m^3	N = 32 + (Volume – 5000) / 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 2 – Recommended *In Situ*

Soil Volume	Sampling Frequency
<600 m^3	Minimum of 3
>600 m3 - 10,000 m^3	1 sample per every additional 200 m^3
>10,000 m3 – 40,000 m^3	1 sample per every additional 450 m^3
>40,000 m^3	1 sample per every additional 2000 m^3

Soil Analytical Testing Requirements:

- Samples to be tested for a minimum of Petroleum Hydrocarbons (PHCs) – Fractions F1-F4, Benzene, Toluene, Ethylbenzene & Xylenes (BTEX), Metals & Hydrides, including Electrical Conductivity (EC) and Sodium Absorption Ration (SAR), only if from an area where de-icing has historically occurred.

- Any potential Contaminant of Concern identified in past uses report (comes into effect January 1, 2022)
- Leachate analysis (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). Note, leachate not required unless address and Area of Potential Environmental Concern (APEC), as identified in the past uses report (January 1, 2022).

Excavations

All work associated with design and construction relative to excavations must be carried out in accordance with Part III of Ontario Regulation 213/91 under the Occupational Health and Safety Act. Based on the results of the geotechnical investigation and in accordance with Section 226 of Ontario Regulation 213/91, the clayey silt till soil encountered within the test holes is classified as Type 2 soils, while the silt and clayey silt soils are classified as Type 3 soils.

Temporary excavation sidewalls which extend through and terminate within Type 2 soils may be cut vertical in the bottom 1.2 m (4 ft.) and cut back at an inclination of 1 horizontal to 1 vertical above that level. Where excavations extend into or through Type 3 soils, excavation side slopes must be cut back at a maximum inclination of about 1H:1V from the base of the excavation. Should groundwater egress loosen the side slopes, slopes of 3H:1V or flatter will be required.

Geotechnical inspection at the time of excavation can confirm the soil type present.

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

Excavation Support

The recommendations for side slopes given in the above section would apply to most of the conventional excavations expected for the proposed development. However, in areas adjacent to 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 silty 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 or to minimize disturbance to surrounding lands, shoring such as sheeting or soldier piles and lagging can be considered. Alternatively, the option of a prefabricated trench box system may be available depending on the required depths. The prefabricated trench box system, if utilized, must be designed by a professional engineer to withstand the soil and hydrostatic loading. 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/m3 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.

Groundwater Control

Minor groundwater seepage was observed in Test Pits TP1 and TP3 near depths of 3.4 m and 2.8 m bgs respectively. Test Pit TP2 was dry upon completion of excavation.

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 4 m). 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 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) or Permit to Take Water (PTTW) will be required. PTTW applications are required for removal rates more than 400,000 L per day and will need to be approved by the MECP per 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.

Building Foundations

Conventional Strip and Spread Footings

Based on information provided by the client, it is understood that the development will consist of single-family residential buildings with basements. The low rise 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.

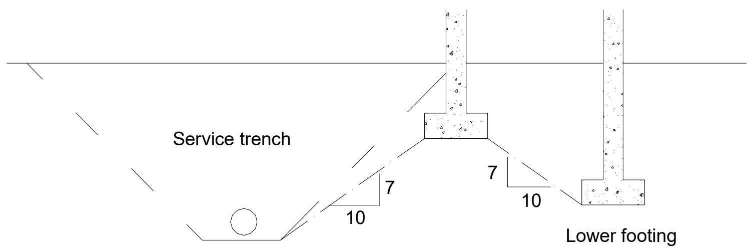
The following allowable bearing pressures (net stress increase) can be used on the natural, undisturbed soils below a typical depth of approximately 1.2 m below existing grade throughout the site:

Bearing Resistance at Serviceability Limit States (SLS)	145 kPa (3,000 psf)
Factored Bearing Resistance at Ultimate Limit States (ULS)	215 kPa (4,500 psf)

If the grades are to be raised or restored, engineered fill can be used for foundation support. The geometric requirements for the fill placement are shown on **Drawing 2**, appended. The available SLS and ULS bearing capacities for the engineered fill is 145 kPa (3,000 psf) and 215 kPa (4,500 psf) respectively. 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. Verification of the soil conditions and the extent of reinforcement are best determined by the Geotechnical Engineer at the time of excavation.

Foundations – General

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

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.

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.

It should be noted that the recommended bearing capacities have been calculated by EXP from the test hole 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 test holes when foundation construction is underway. The interpretation between the test holes 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.

Basements

The basement 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 titled 'Site Preparation'.

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. Alternatively, a 300 mm thick layer of Granular 'A' can be considered in place of the compacted stone layer.

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 depth h;

K = earth pressure coefficient, assumed to be 0.4;

γ = natural unit weight, a value of 20.4 kN/m3 may be assumed;

h = depth of point of interest in m;

q = equivalent value of any surcharge on the ground surface in kPa.

If basements are planned, installation of perimeter drains is required. 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**.

Foundation Backfill

In general, the existing natural soils excavated from the foundation area should be suitable for re-use as foundation wall backfill beyond the free-draining zone subject that 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. The upper 0.8 m of the backfill should be sealed with clay soil. Any excavated soils proposed for re-use as backfill should be examined by a Geotechnical Engineer. The materials to be re-used should be within three percent of optimum moisture for best compaction results. If the weather conditions are very wet during construction, then consideration should be given to the use of imported granular material such as OPSS Granular 'B' as backfill material.

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The backfill must be brought up evenly on both sides of walls not designed to resist lateral earth pressures. The backfill materials should be compacted to 95 to 98 percent SPMDD. Drainage and backfill recommendations are given in **Drawing 3**.

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. It is recommended that an impermeable soil seal such as clay, asphalt or concrete be provided on the surface to minimize water infiltration.

Site Servicing

The subgrade soils beneath the water and sewer pipes which will service the site are generally expected to comprise silt, clayey silt, or glacial till. For services constructed on the natural soils or engineered fill, the bedding should conform to 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 natural soils are expected to remain stable for the short construction period. For bases terminated in wet silty layers, localized improvement will be required. Base improvement may also be required if 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 loose 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 OPS requirements. A summary of the general recommendations for trench backfill is presented on **Drawings 4** and **5**. 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 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.

Seismic Considerations

The recommendations for the geotechnical aspects to determine the earthquake loading for design using the OBC 2020 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 2020. The subsoils at the Site generally consist of topsoil over silt, clayey islt, and glacial till deposits. It is anticipated that the proposed structures will be founded on the natural deposits, below any loose or soft zones.

Table 4.1.8.4.A. Site Classification for Seismic Site Response in OBC 2020 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 test pits advanced at this Site were excavated to a maximum depth of 4.0 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 2020.

Site 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 outlined 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 traffic loading and anticipated subgrade conditions.

Table 3 – Recommended Pavement Structure Thicknesses

Pavement Layer	Compaction Requirements	Light Duty Pavement Structure (Cars Only)	Heavy Duty Pavement Structure (Cars and Trucks)
Asphaltic Concrete	92% MRD[1] or 97% BRD[1]	40 mm HL-3 50 mm HL-8	50 mm HL-3 60 mm HL-8
Granular 'A' (Base)	100% SPMDD[1]	150 mm	150 mm
Granular 'B' (Subbase)	100% SPMDD[1]	300 mm	450 mm

*Notes: 1) SPMDD denotes Standard Proctor Maximum Dry Density, MRD denotes Maximum Relative Density, BRD denotes Bulk Relative Density.
2) The subgrade must be compacted to 98% SPMDD.
3) The above recommendations are minimum requirements.

The recommended pavement structures provided in the above table are based on the existing 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. If the sub-base is set on wet or dilatant silty soils, a geotextile will be required. A woven type geotextile such as Terrafix 200W or equivalent would be suitable for this application.

If only a portion of the pavement will be in place during construction, the granular subbase may have to be thickened. This is best determined in the field during the site servicing stage of construction, prior to road construction.

Samples of both the Granular 'A' and Granular 'B' aggregate 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 MUNI 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 should be installed to intercept excess subsurface moisture and prevent subgrade softening. 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.

Curbs and Sidewalks

If considered, the concrete for the curbs and gutters and sidewalks 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 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 of 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.

Low Impact Development (LID)

It is understood that LID stormwater management design requires the practical availability of unsaturated, sufficiently pervious soil with depth and aerial extent to accommodate the infiltration of stormwater run-off created by land development.

Based on the information collected at the test pit locations, and the above cited criteria, the materials encountered at the test hole locations have limited potential for use in LID stormwater management design. The following table summarizes the elevations where the upper surface of the silt was encountered, and the elevation of the underlying lower permeability soil.

Table 4 – Low Impact Development Potential

Test Pit No.	Ground Surface Elevation (m)	Elevation of Top of LID Soil (m)	Elevation of Underlying Less Pervious Soil (m)	Comments
TP1	260.99	-	260.63	Clayey silt soils throughout. Little LID opportunity available
TP2	261.15	260.90	260.54	0.36 m of silt above less permeable clayey silt till.
TP2	261.25	260.95	260.64	0.31 m of silt above less permeable clayey silt till.

Note: Thickness of LID material available for design is typically taken as 1 m above the impermeable strata or seasonal high groundwater table.

Two (2) grain size distribution analyses were carried out on samples obtained from the silt and glacial till strata in Test Pit TP1 (1.8 to 2.4 m depth) and TP3 (0.3 to 0.6 m depth). The results are appended to this report.

For consideration in design, based on the grain size distribution, the estimated hydraulic conductivity of the silt was approximately 10^{-6} cm/s and the clayey silt till was 10^{-8} to 10^{-9} cm/s. This corresponds with estimated infiltration rates of 12 mm/hour in the silt and 4 to 2 mm/hour in the clayey silt till.

It is understood that recommended factors of safety will be applied to the estimated parameters cited above for use in design.

Inspection and Testing Recommendations

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

- Subgrade examination prior to engineered fill placement, footing base evaluation;
- Inspection and Materials testing during engineered fill placement (full-time supervision is recommended), including soil sampling, laboratory testing (moisture contents and Standard Proctor density test on the engineered fill material), monitoring of fill placement, and *in situ* density testing;
- Materials testing for concrete curbs and sidewalks.
- Inspection and Materials testing during paved area construction, including subgrade examination of the paved area 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), and *in situ* density testing;
- Inspection and Materials testing for base and surface asphalt, including laboratory testing on asphalt sampling to confirm conformance to project specifications and standards.

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

General Comments

The comments given in this letter 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 test holes 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 letter 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 letter.

We trust that this letter 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.

Yours very truly,

EXP Services Inc.

LICENSED PROFESSIONAL ENGINEER
E. M. BUCHANAN
100217631
PROVINCE OF ONTARIO

Eric Buchanan, P. Eng.
Geotechnical Services

Craig Swinson, P. Eng.
Geotechnical Services

Attachments:	Drawings Test Pit Summary Grain Size Analyses Limitations and Use of Report	
Distribution:	Mr. Greg Hussey	Greg@karwood.com

-LEGEND-

TP1 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 should be read in conjunction with EXP Geotechnical Report LON-21011260-A0.

Geotechnical Investigation

Canterbury Place Development

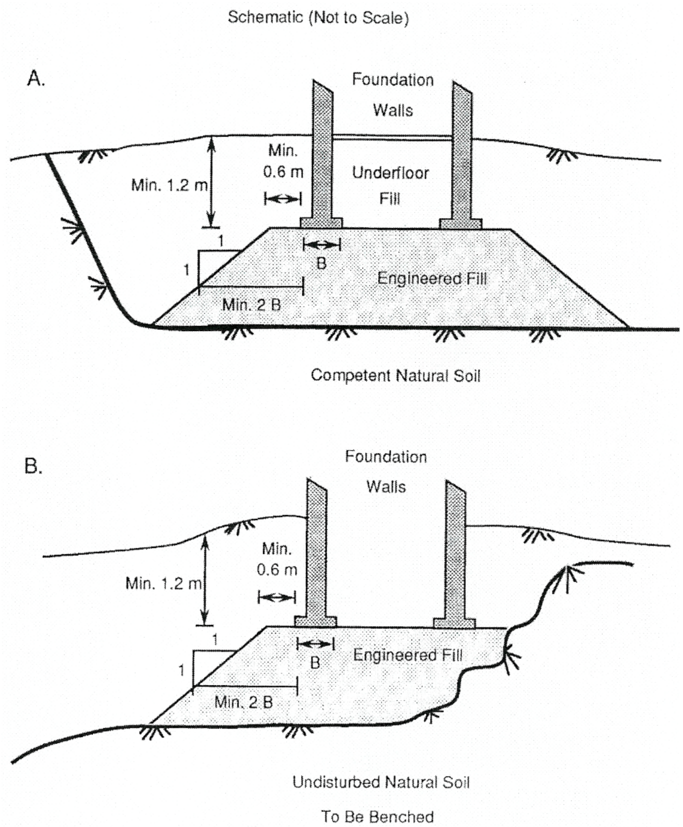
Belmont, Ontario

CLIENT	Karwood Ontario Ltd.
TITLE	Test Pit 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.
JUNE 2021	1:1,500	LON-21011260-A0	1

DRAWING 2 – GEOMETRIC REQUIREMENTS FOR FOUNDATIONS ON ENGINEERED FILL

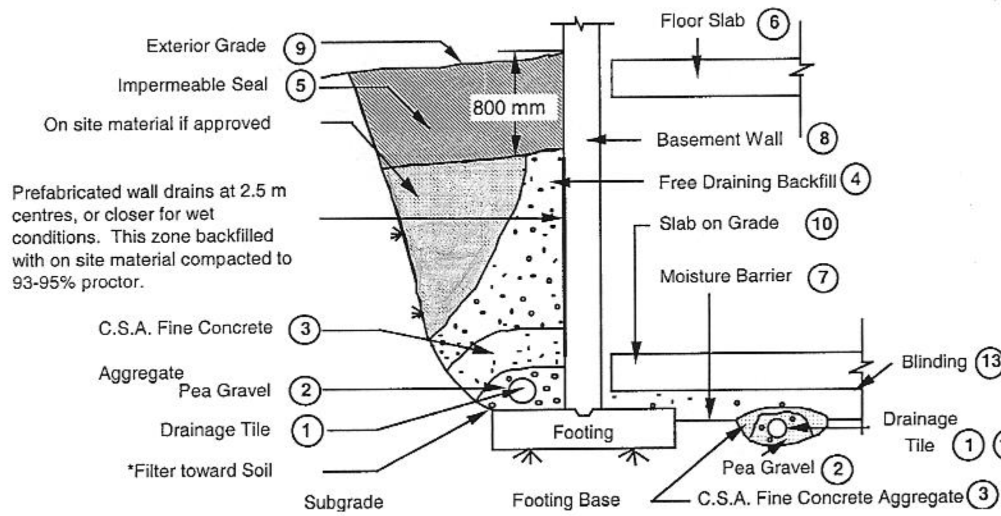


- SECTION VIEW

NOTES:

1. The area must be stripped of all topsoil contaminated fill material and proof rolled. Soft spots must be dug out. The stripped native subgrade must be examined and approved by an EXP Engineer prior to placement of fill.
2. The approved engineered fill must be compacted to 100% Standard Proctor dry density throughout. Granular fill is required.
3. Fulltime geotechnical inspection by EXP is required during placement of the engineered fill.
4. The fill must be placed such that the specified geometry is achieved. Refer to sketches for minimum requirements.
5. An allowable SLS bearing pressure of 145 kPa (3,000 psf) may be used provided that all conditions outlined above, are adhered to.
6. All excavations must be done in accordance with the Occupational Health and Safety Regulation of Ontario (Construction Projects - O.Reg. 213.91)
7. These guidelines are to be read in conjunction with the attached EXP Report for Project Number LON-21011260-A0.

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

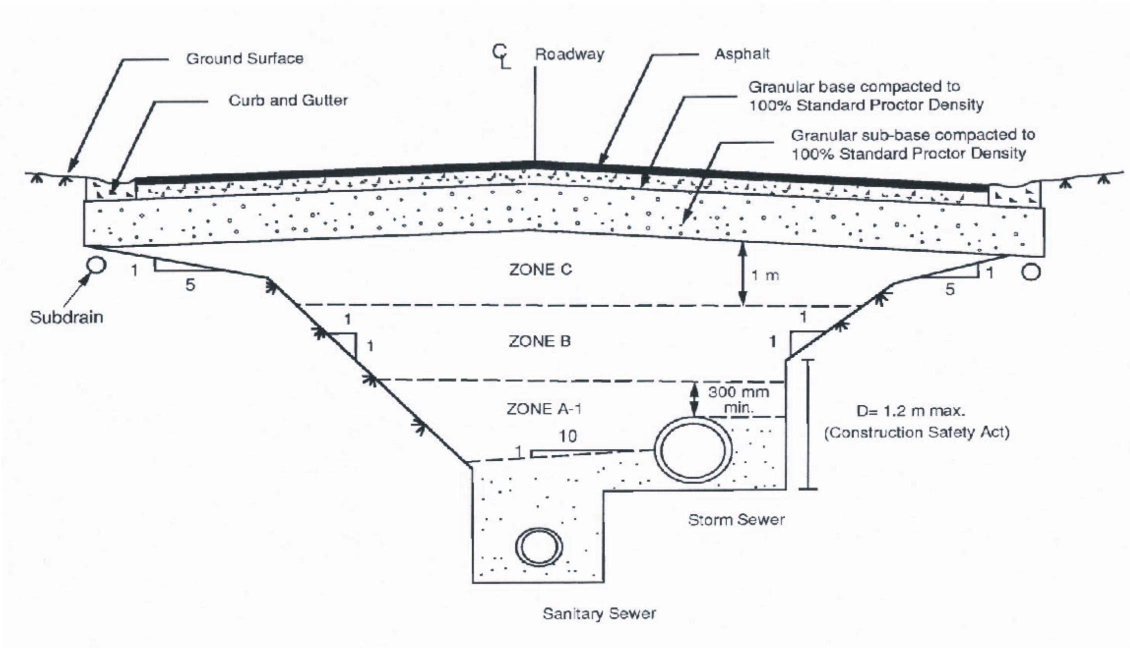


NOTES:

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



SECTION VIEW

NOTES:

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

ZONE A-l
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 5 – TRENCH BACKFILL REQUIREMENTS

Requirements for backfill in service trenches, etc. should conform to current OPSS requirements. A summary of the general recommendations for trench backfill is presented on **Drawing 4**.

The bedding materials for the services designated as Zone A on the attached drawings should consist of approved granular material satisfying the current OPS 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.

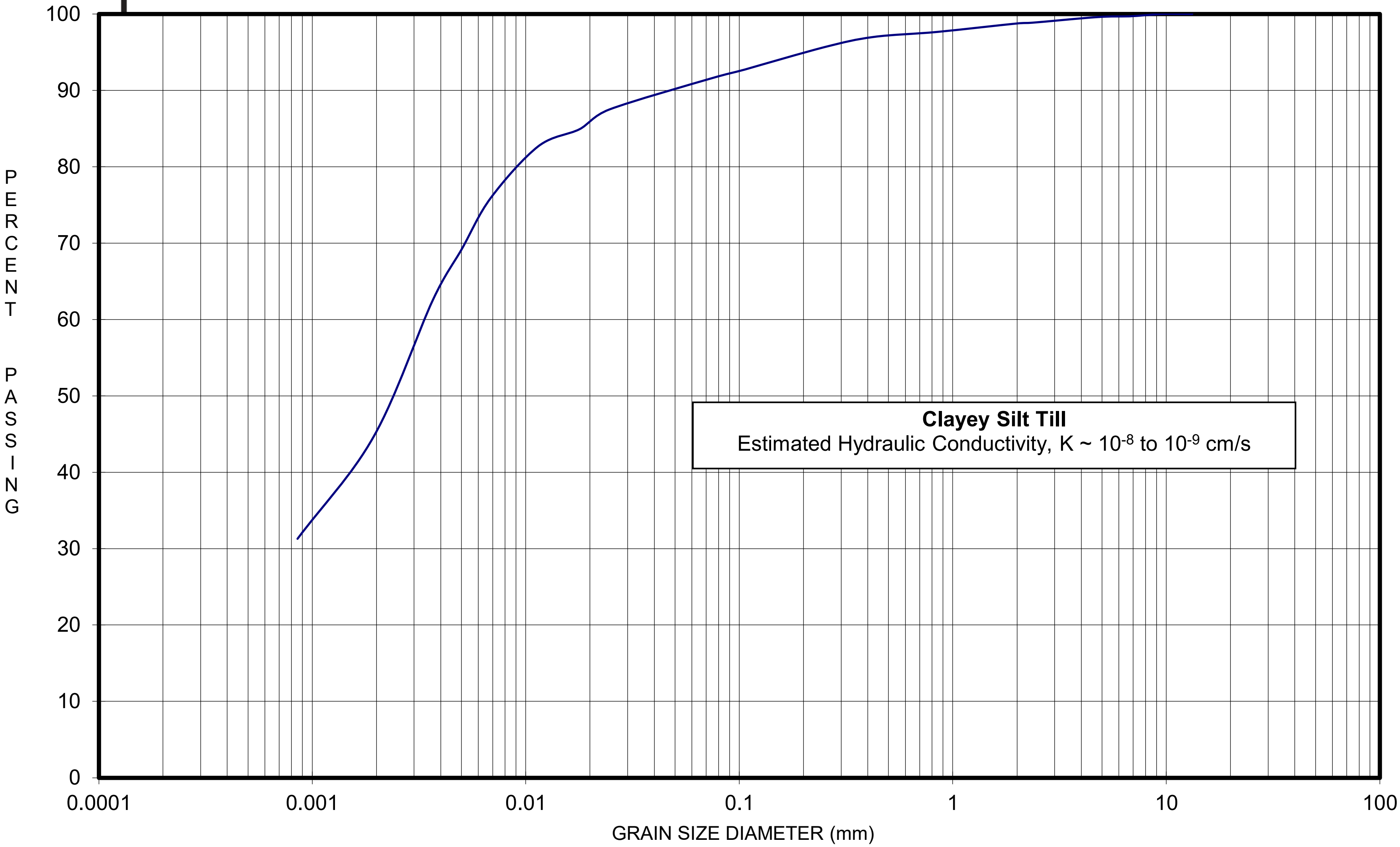
The upper 1 meter of the general backfill (i.e. Zone C) should be placed in loose lifts not exceeding 300 mm (12 inches) and be uniformly compacted to at least 98 percent of the standard Proctor maximum dry density. To achieve satisfactory compaction, the fill material should be within 3 percent of standard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

Depth (m below grade)	**Moisture Content** (%)	**Soil Description**
TP1		Geodetic Elevation: 260.99 m
0.00 – 0.36		TOPSOIL – 360 mm
0.36 – 0.61		CLAYEY SILT – brown, trace sand, trace gravel, firm, moist
0.61 – 4.0	15	CLAYEY SILT TILL – brown, weathered, trace sand, trace gravel, stiff to very stiff, moist
3.0		- 700 mm thick sand and gravel/sand lens, very moist to wet
4.0		*Test pit terminated.*
		Test pit was open upon completion of excavation. Minor groundwater seepage observed near 3.4 m depth. Groundwater measured near 3.5 m depth after 1 hour.
TP2		Geodetic Elevation: 261.15 m
0.00 – 0.25		TOPSOIL – 250 mm
0.25 – 0.61		SILT – brown, some clay, some sand, trace gravel, loose, moist
0.61 – 0.91		CLAYEY SILT – brown, trace sand, trace gravel, firm, moist
0.91 – 4.0		CLAYEY SILT TILL – brown, trace sand, trace gravel, very stiff, moist
2.7		- becoming grey with occasional cobbles near 2.7 m depth
4.0		*Test pit terminated.*
		Test pit was open and dry upon completion of excavation.
TP3		Geodetic Elevation: 261.25 m
0.00 – 0.30		TOPSOIL – 300 mm
0.30 – 0.61	17	SILT – brown, some clay, some sand, trace gravel, loose, moist
0.61 – 0.91		CLAYEY SILT – brown, trace sand, trace gravel, firm, moist
0.91 – 4.0		CLAYEY SILT TILL – brown, trace sand, trace gravel, very stiff, moist
2.6		- 400 mm thick sand and gravel lens, very moist to wet
3.0		- becoming grey with occasional cobbles near 3.0 m depth
4.0		*Test pit terminated.*
		Test pit was open upon completion of excavation. Minor groundwater seepage observed near 2.8 m depth.

Notes: 1. Test pits were excavated on June 10, 2021.

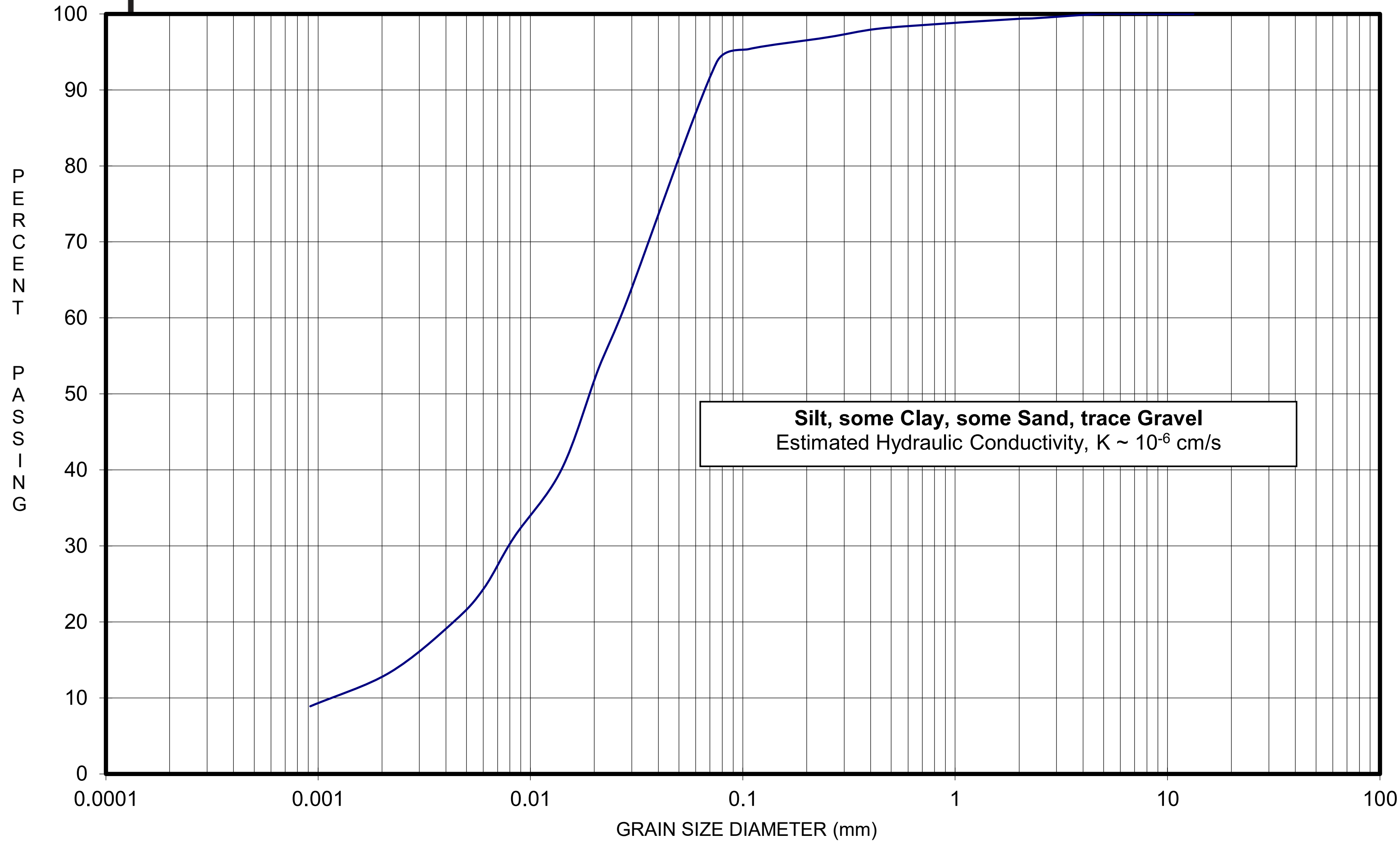
2. Ground surface elevations at the test pit locations were provided by Cyril J. Demeyere Ltd.

MECHANICAL GRAIN SIZE ANALYSIS



CLAY	SILT			SAND			GRAVEL			
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	
MODIFIED M.I.T. CLASSIFICATION	**Sample Description: Clayey Silt Till (TP1 S1, 1.8 to 2.4 m depth)**					**Canterbury Place Development Project: LON-21011260-A0**			**Figure 1**	

MECHANICAL GRAIN SIZE ANALYSIS



CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE
	SILT			SAND			GRAVEL		
MODIFIED M.I.T. CLASSIFICATION	**Sample Description:** **Silt (TP3 S1, 0.3 to 0.6 m depth)**					**Canterbury Place Development** **Project: LON-21011260-A0**			**Figure 2**

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.