Geotechnical Investigation

Mr. Brody Luis

Project Name:
Proposed Development
130 Beech Street
Strathroy, Ontario

Project Number:
LON-22012100-A0

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Date Submitted:
August 31, 2022

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Date Submitted:

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Appendices

1. Introduction and Background

1.1 Introduction

EXP Services Inc. (EXP) was retained by **Mr. Brody Luis** to carry out a geotechnical investigation and prepare a geotechnical report relating to the proposed development located at 130 Beech Street East in Strathroy, Ontario, hereinafter referred to as the 'Site'.

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. Authorization to proceed with this investigation was received from Mr. Brody Luis through email correspondence.

The purpose of the investigation was to examine the subsoil and groundwater conditions at the site by advancing a series of test pits at the locations chosen by EXP and illustrated on the attached Test Pit Location Plan (**Drawing 1**).

Based on an interpretation of the factual test pit data, and a review of soil and groundwater information from test holes advanced 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 site preparation, excavations, dewatering, 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.

Reference is made to **Appendix D** of this report, which contains further information necessary for the proper interpretation and use of this report.

2. Methodology

The fieldwork was carried out on May 6, 2022. In general, the geotechnical investigation consisted of the advancement of three (3) test pits at the locations denoted on **Drawing 1** as TP1 to TP3, inclusive.

Prior to excavation, buried service clearances were obtained for the test hole locations by the Client.

The test holes were advanced using an excavator provided by the client under the full-time supervision of EXP geotechnical staff.

During the excavation, the stratigraphy in the test pits were 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, the water levels were measured in the open test pits. They were then backfilled with the excavated material and surfaced with the reclaimed topsoil.

Simultaneously, three monitoring wells were installed adjacent to the test pits by a specialist contractor.

Representative samples of the various soil strata encountered at the test pit locations were taken to our laboratory in London for further examination by a Geotechnical Engineer and laboratory classification testing.

Samples remaining after the classification testing will be stored for a period of three months following the issuance of report (i.e., until August 2022). After this time, they will be discarded unless prior arrangements have been made for longer storage.

The location of each test pit was established in the field in conjunction with a preliminary site plan provided by the Client. Ground surface elevations at each test pit locations were surveyed and referenced to a temporary benchmark. The temporary benchmark was a manhole across the street from the site and assigned an assumed elevation of 100.00 m and is shown in **Drawing 1**.

3. Site and Subsurface Conditions

3.1 Site Description

The subject area is currently occupied by a single family dwelling. The Site is situated in an area of single family dwellings and small multiplexes. The following sections provide a summary of the soil and groundwater conditions.

3.2 Soil Stratigraphy

The detailed stratigraphy encountered in each test hole is shown on the test pit summary found in **Appendix A** and summarized in the following paragraphs. It must be noted that boundaries of soil indicated in the test pit summary are based on observations during excavation. These boundaries are intended to reflect transition zones for geotechnical design and should not be interpreted as exact planes of geological change.

3.2.1 Topsoil

All three test pits were surfaced with a layer of topsoil. The topsoil thickness typically ranged between 300 mm and 400 mm.

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 additional shallow test pits) is recommended to accurately quantify the amount of topsoil to be removed for construction purposes.

3.2.2 Sand

Underlying the topsoil at each test pit location was sand. Each test pit was terminated in the sand. In general, the sand was described as compact, brown to grey, fine to medium grained with trace silt and moist.

3.3 Groundwater Conditions

Details of the groundwater conditions observed within the test holes are provided on the attached test pit summary and water level observations in the monitoring wells. Upon completion of excavation, the open test pits were examined for the presence of groundwater and groundwater seepage. Groundwater was measured between 1.5 m and 1.7 m bgs (Assumed Elevation 98.24 m to 97.38 m) Monitoring wells were installed next to each test pit for future observation.

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.

The following table summarizes water levels in the monitoring wells during the period May 6 to July 21, 2022.

date	6-May	12-May	24-May	21-Jul
MW1	98.24	98.22	98.2	98.06
MW2	98.38	98.36	98.34	98.21
MW3	98.31	98.29	98.28	98.15

4. Discussion and Recommendations

It is understood that the proposed development consists of replacing the existing dwelling with a fourplex dwelling.

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.

4.1 Site Preparation

Prior to placement foundations and/or engineered fill, all surficial topsoil, vegetation and/or otherwise deleterious materials should be stripped. Thicker areas of topsoil may be anticipated in areas with trees and/or heavy vegetative cover. It is anticipated that the surficial topsoil may be stockpiled on site for possible reuse as landscaping fill.

It is understood that the existing structure on site will demolished. The removal of the buildings should include all building debris, foundation walls, footings and concrete floor slabs. The removal and disposal of the previously occupied building and associated fill must satisfy the local building standards, Ontario Building Code (OBC), Ministry of Labour (MOL) and the Ministry of Environment, Conservation and Parks (MECP) requirements. If any potable wells are present on site, they should be properly decommissioned by a licensed well contractor, in accordance with Ontario Regulation 903.

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 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 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.

4.2 Excavation and Groundwater Control

4.2.1 General

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 soils encountered at the site are classified as Type 3 soils.

Where excavations extend into or through Type 3 soil, 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 of Type 3 soils, slopes of 3H:1V or flatter will be required.

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

4.2.2 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, 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/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.

4.2.3 Construction Dewatering

Groundwater seepage was measured between 1.5 m and 1.7 m below ground surface (bgs) (Assumed Elevation 98.24 m to 97.38 m). For excavations extending below the groundwater table, suitable groundwater control measures will be required to maintain a dry and stable excavation base and sides.

To ensure the stability of excavations, it is recommended that the base of any excavations on site be set a minimum of 0.5 m higher than the above-mentioned elevations. If the above recommendation is followed, it is expected that any minor groundwater infiltration can be accommodated using conventional sump pumping techniques. In the event groundwater infiltration persists, positive groundwater control may be required.

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.

It is important to mention that for any projects requiring positive groundwater control with a removal rate of 50,000 liters to less than 400,000 liters (L) per day, an Environmental Activity and Sector Registry (EASR) will be required. Permit to take Water (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. Accordingly, a detailed hydrogeological assessment from a quantitative point of view may be required to estimate the quantity of water to be removed. EXP can assist if the need arises.

4.3 Foundations

4.3.1 Conventional Strip and Spread Footings

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.

For preliminary purposes, the following allowable bearing pressures (net stress increase) can be assumed 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)	100 kPa (2,100 psf)
Factored Bearing Resistance at Ultimate Limit States (ULS)	133 kPa (2,790 psf)

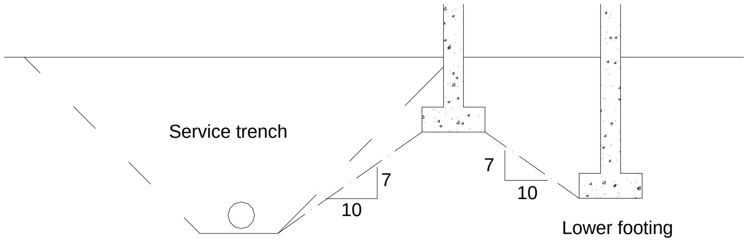
Sand deposits of the nature observed in the test pits are known to have localized variably looser and more compact pockets. During inspection, proof rolling or plate tamping the founding subgrade in conjunction with nominal concrete reinforcement in the footings may be recommended at the time of construction if conditions warrant.

It should be noted that the recommended founding depths are the minimum depths. As discussed in Section 4.2.3, groundwater seepage was measured between 1.5 m and 1.7 m bgs (Assumed Elevation 98.24 m to 97.38 m) in the test pits and monitoring wells. It is recommended that the footing depths of any permanent structures be founded at a maximum depth of 0.6 m above the stabilized groundwater table.

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 bearing capacity for the engineered fill is 75 kPa (1,550 psf). 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.

4.3.2 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 pit 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 pits when foundation construction is underway. The interpretation between the test pits 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.

4.4 Basements

If the development includes buildings with 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 4.1.

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. Geotechnical filter cloth should be placed between clear stone and the native sand to prevent possible loss of ground.

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/m3 may be assumed;

h = depth to point of interest in m and,

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

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**.

Ideally, a minimum separation distance of 1 m is recommended between the basement floor slab and the groundwater table. In the event that less than 1 m is provided (at least 0.5 m above the water table), then the basement design and foundation construction should include water-proofing measures such as installation of a water-stop between the footings and foundation walls, and foundation wall backfill using low-permeability soils, perimeter weeping tiles and underfloor drains, dedicated pumps and sumps to a positive outlet. Where less than 0.5 m of separation distance is available, full water-proofing on the slab and foundations would also be required. EXP can provide further assistance in this regard, upon request.

4.5 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 comprises 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. See **Drawing 4** for Drainage and Backfill recommendations for slab-on-grade construction.

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. A layer of filter cloth should be placed between the native sand and the stone moisture barrier.

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.

4.6 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.

4.7 Site Servicing

The subgrade soils beneath the water and sewer pipes which will service the site are generally expected to comprise sand. 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 sand are expected to remain stable for the short construction period. For bases terminated in the 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.

Test Pits encountered groundwater below 1.5 m to 1.7 m bgs. If sewer excavations encounter shallow groundwater and moderate groundwater seepage occurs, the use of clay collars or concrete collars may be considered at strategic locations to minimize groundwater flow along the granular bedding material. A schematic diagram is appended for review (**Drawing 5**). The indiscriminate use of clay collars is not recommended. Site review by a Geotechnical Engineer will be required to determine appropriate locations and suitable conditions for the use of clay collars. Also, if excavating penetrates below these levels, positive groundwater control and base stabilization will be required. Ongoing liaison from this office will be needed.

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 OPS requirements. A summary of the general recommendations for trench backfill is presented on **Drawings 6** and **7**. 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 sand 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. 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.

4.8 Groundwater Assessment – Preliminary

It is understood that stormwater management will be incorporated into the design of the proposed development.

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. The separation distance for LID is typically taken as 1.0 m above the seasonal high groundwater table.

Based on the information collected at the test pit locations, and the above cited criteria, while the sand material encountered at the test hole locations has potential for use in LID stormwater management design, consideration needs to be given to the observed groundwater levels of 1.5 to 1.7 m bgs.

Four (4) grain size distribution analyses were carried out on samples obtained from the sand stratum in Test Pits TP1 to TP3. The results are presented in **Appendix B**.

For consideration in design, based on the grain size distribution, the estimated hydraulic conductivity (K) of the sand ranged between 1.0 x 10^{-2} and 2.9 x 10^{-2} cm/s.

Unfactored infiltration rates ranging between 75 mm/hour and 150 mm/hour were calculated using the grain size distribution data and single well response tests carried out at the site as part of the geotechnical and hydrogeological assessments carried out at the site. A conservative unfactored infiltration rate of 110 mm/hour should be assumed for the sand soils at the site.

Based on the information gathered from the test pits and monitoring wells and in conjunction with Table C2 of the TRCA's *Low Impact Development Stormwater Management Planning and Design Guide*, a safety correction factor of 2.5 should be applied to the unfactored rate. In this regard, a design infiltration rate of 45 mm/hour should be used in the design of LID systems at the site.

During construction, short term impacts to the shallow groundwater quantity may be anticipated as a result of temporary construction dewatering where wet sand and gravel soils are present in open excavations. The length of time where this impact would occur would be limited to the time when active pumping of the groundwater is being carried out.

Construction activities should be reviewed to ensure that groundwater conservation measures are considered in the construction dewatering plan. Once construction activities are complete, actual groundwater levels would be expected to stabilize.

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 over sand 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 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 test pits advanced at this Site were excavated to a maximum depth of 2.2 m below existing grade. Therefore, the Site Classification recommendation would be based on the available information as well as our interpretation of conditions below the test pits 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 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 areas 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 specified classification (local roads internal to the site) and anticipated subgrade conditions.

Table 1 – Recommended Pavement Structure Thicknesses

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' (Base)	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.

4) The existing natural sand may be used and form part of the granular subbase structure, subject to review and acceptance from a Geotechnical Engineer.

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, as shown on **Drawing 8**. 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 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 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 Inspection and Testing Requirements

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) 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;
- 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.

5. 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 test pit 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 **Mr. Brody Luis** 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

Notes:

1.The boundaries and soil types have been established only at the test hole locations. Between test holes they are assumed and may be subject to considerable error.
2.Topsoil quantities should not be established from the information provided at the test hole locations.
3.Soil samples will be retained in storage for 3 months and discarded unless Client advises that an extended period is required.
4.The site plan has been reproduced from Google Earth and should be read in conjunction with EXP Report LON-22012100

Geotechnical Investigation

Proposed Redevelopment

130 Beech Street, Strathroy, ON

CLIENT Brody Luis

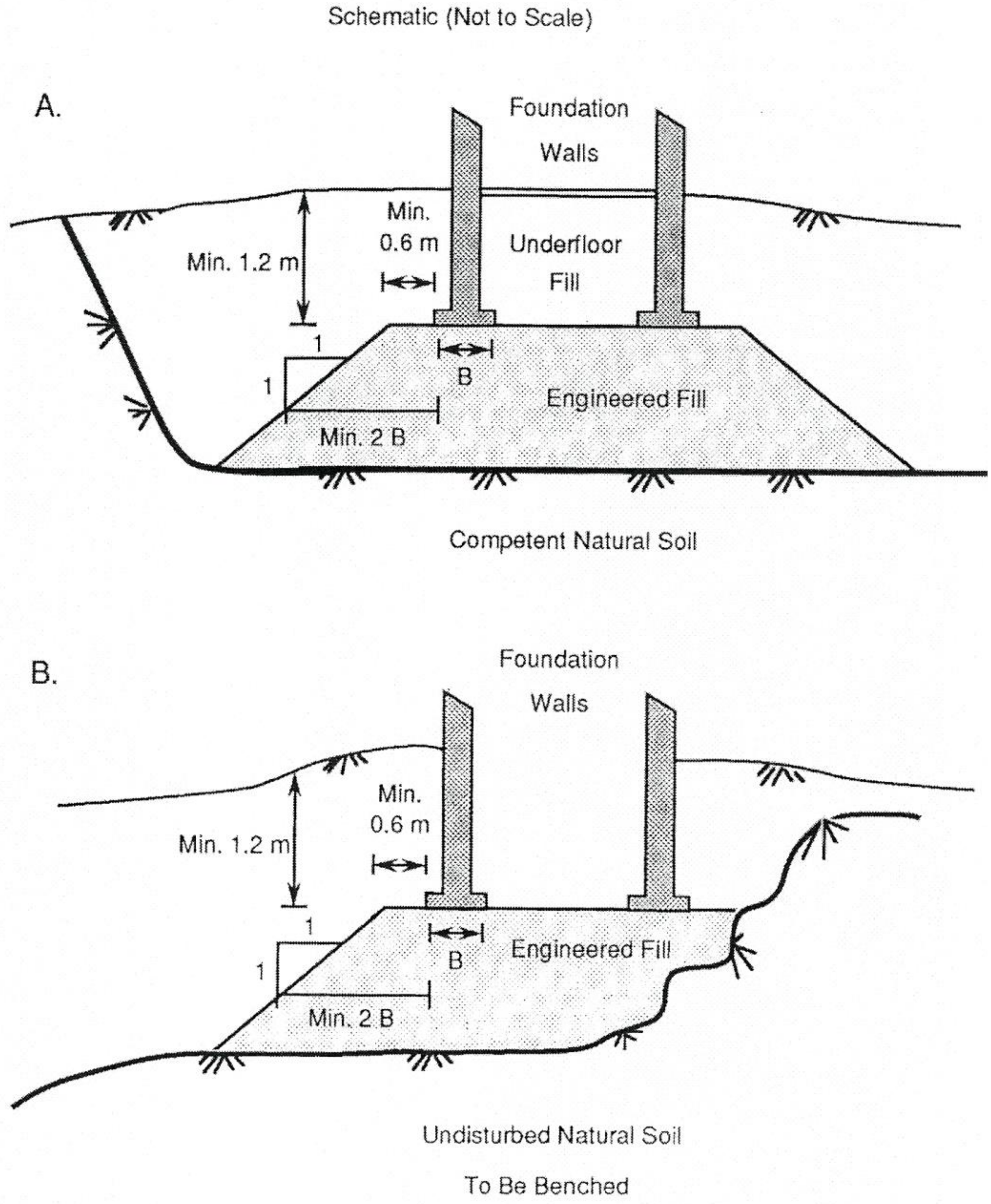
TITLE Test Pit and Monitoring Well Locations

DWG BY BCW **REVIEWED** BCW **SCALE** NTS

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

DATE May 2022 **PROJECT** LON-22012100 **DWG** 1

DRAWING 2 – GEOMETRIC REQUIREMENTS FOR FOUNDATIONS ON ENGINEERED FILL



SECTION VIEW

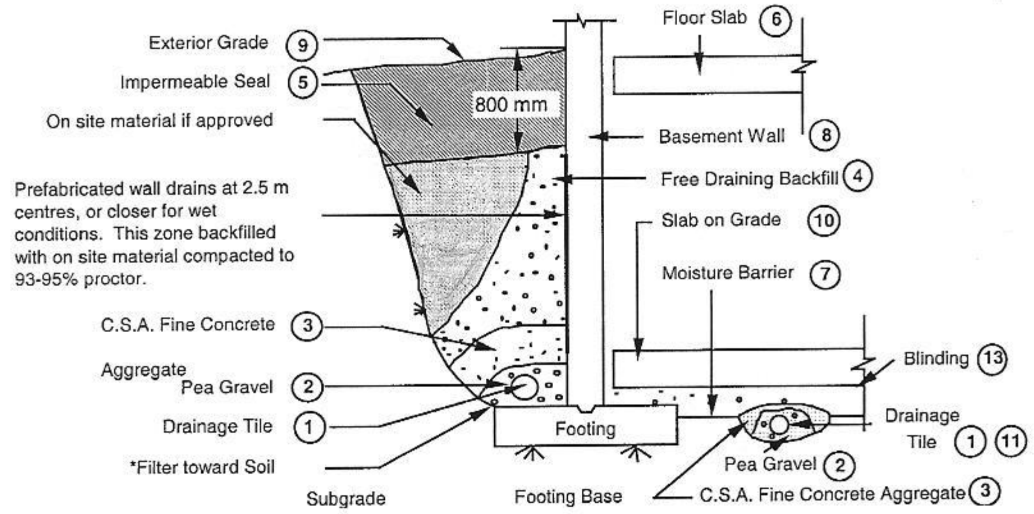
Section A – Typical Section of Slab-on-Grade Building
Section B – Typical Section of Building with Basement

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 MECP regulations and requirements.
6. Full time geotechnical monitoring, inspection and in situ 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 75 kPa (1550 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-21008023-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.

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

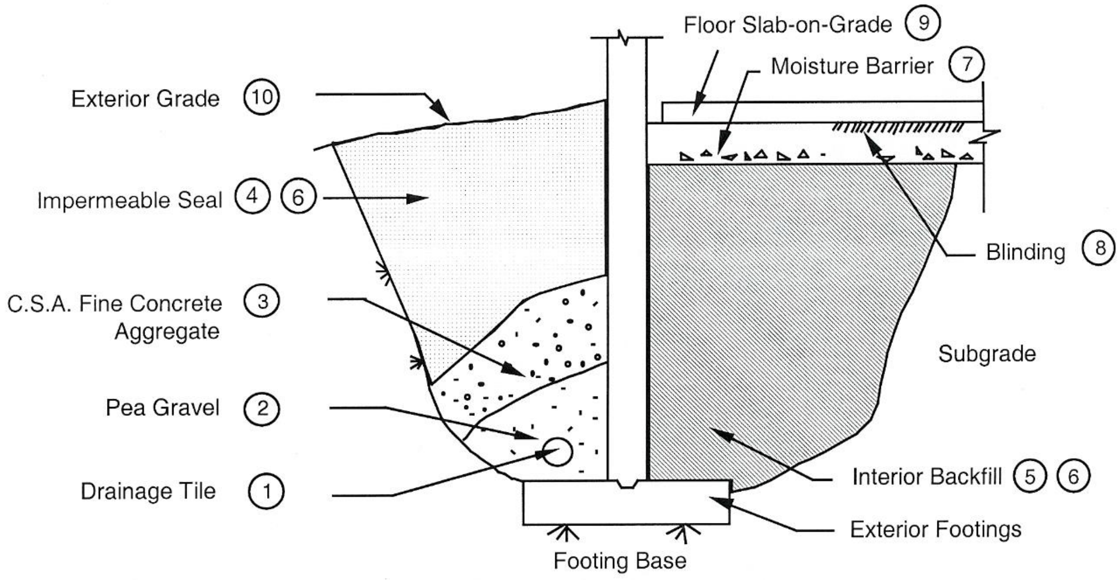


NOTES:

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 I.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)



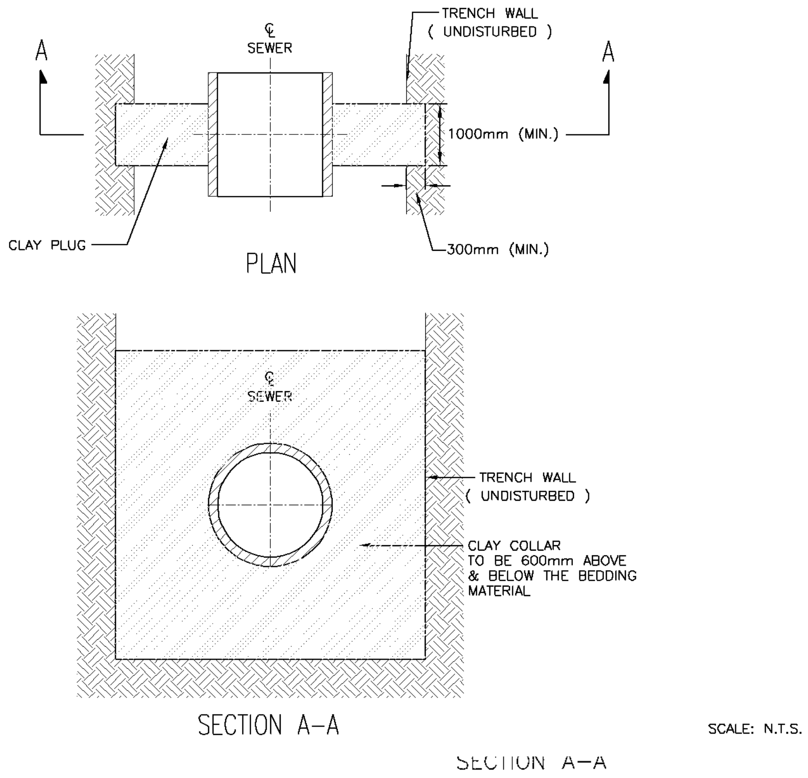
NOTES:

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 – SCHEMATIC CONCEPT OF CLAY COLLAR/TRENCH PLUG

PLAN AND SECTION VIEW



NOTES:

i) Clay collar/trench plug can be installed strategically along the sewer line to slow down the groundwater transfer through bedding materials.

ii) Clay collar/plug shall be constructed of plastic silty clay with moisture content about 3 percent above optimum moisture as determined by the standard Proctor density test.

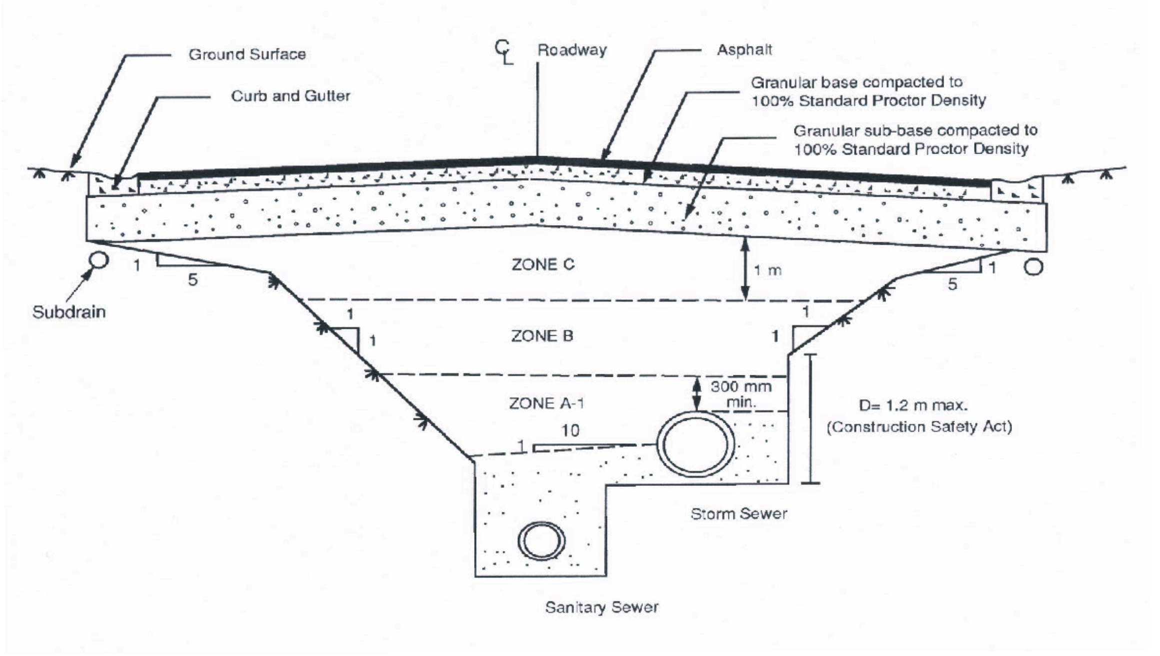
iii) Excavation shall be carried out to the minimum dimensions indicated on the sketches. Excavation below 600 mm depth below the groundwater table through the granular soils may require dewatering to maintain the stability.

iv) The excavation shall be backfilled with compacted silty clay or approved native materials to at least 98 percent SPMDD with the material specified in Item ii) to minimize settlement.

v) Clay collar locations, if required, can typically be installed at 50 m intervals or as determined on site by the geotechnical consultant.

vi) Required height of the clay collar shall be determined by the engineer and should be at least 600 mm above and below the pipe.

DRAWING 6 – 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 7 – TRENCH BACKFILL REQUIREMENTS

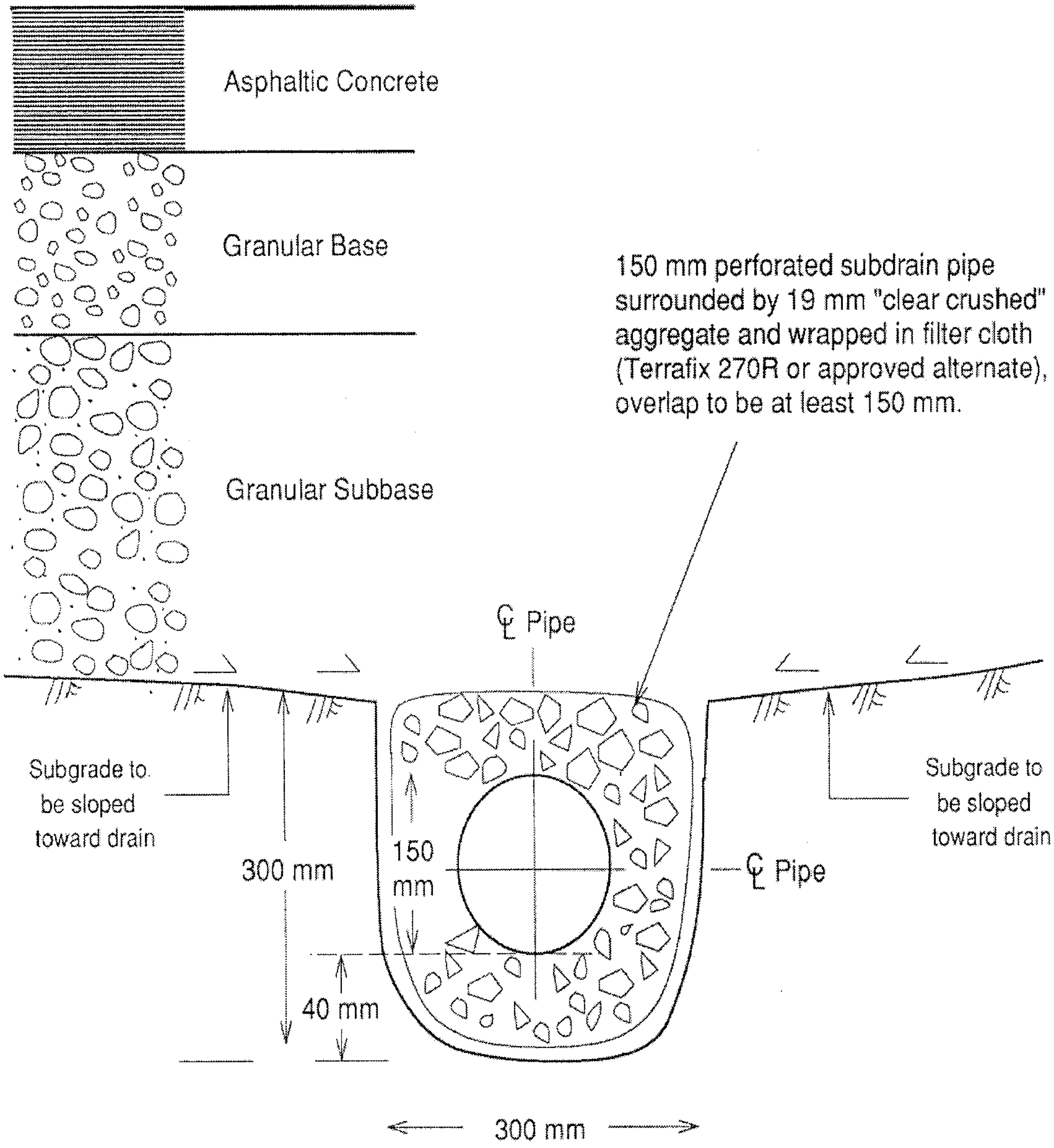
Requirements for backfill in service trenches, etc. should conform to current OPSS requirements. A summary of the general recommendations for trench backfill is presented on **Drawing 6**.

The bedding materials for the services designated as Zone A on the attached drawings should consist of approved granular material satisfying the current OPSS 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 8 – 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 – Test Pit Summary

TEST PIT LOG

TP1
Sheet 1 of 1

CLIENT **Brody Luis**
PROJECT NO. **LON-22012100-A0**
PROJECT **130 Beech Street**
DATUM **Manhole at street 100.0 m**
LOCATION **Strathroy, ON**
DATES: Boring **May 6, 2022**
Water Level **May 6, 2022**

SHEAR STRENGTH
✚ S Field Vane Test (#=Sensitivity)
▲ Penetrometer ■ Torvane
100 200 kPa
Atterberg Limits and Moisture
W_P W W_L
● SPT N Value × Dynamic Cone
10 20 30 40

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	100.14	**TOPSOIL** - 300 mm						
	99.84	**SAND** - silty, fine, light brown, moist, compact						
		- becoming grey near 0.7 m bgs						
1								
			▼	GS	SA 1			6
		- water encountered near 1.7 m bgs						
2				GS	SA 2			24
	97.94							
		End of test pit at 2.2 m bgs.						
3								

NOTES

1) Test pit log interpretation requires assistance by EXP before use by others. Test pit log must be read in conjunction with EXP Report LON-22012100-A0.
2) Test pit log is based on observations of the excavator resistance.
3) Test pit open to 2.2 m bgs and water apparent near 1.7 m bgs upon completion of excavation.
4) bgs denotes below ground surface.
5) Water Level Readings:
May 6, 2022 - 1.7 m bgs

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

TEST PIT LOG

TP2
Sheet 1 of 1

CLIENT **Brody Luis**
PROJECT NO. **LON-22012100-A0**
PROJECT **130 Beech Street**
DATUM **Manhole at street 100.0 m**
LOCATION **Strathroy, ON**
DATES: Boring **May 6, 2022** Water Level **May 6, 2022**

DEPTH (m bgs)	ELEVATION (~m) 100.06	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)	SHEAR STRENGTH ✚ S Field Vane Test (#=Sensitivity) ▲ Penetrometer ■ Torvane 100 200 kPa Atterberg Limits and Moisture W_P W W_L ● SPT N Value × Dynamic Cone 10 20 30 40
0		**TOPSOIL** - 400 mm								
	99.66	**SAND** - silty, fine, light brown, moist, compact								
		- becoming grey near 0.7 m bgs								
1										
					GS	SA 1			6	o
		- water encountered near 1.7 m bgs		▼						
2	97.96									
		End of test pit at 2.1 m bgs.								
3										

NOTES

1) Test pit log interpretation requires assistance by EXP before use by others. Test pit log must be read in conjunction with EXP Report LON-22012100-A0.
2) Test pit log is based on observations of the excavator resistance.
3) Test pit open to 2.1 m bgs and water apparent near 1.7 m bgs upon completion of excavation.
4) bgs denotes below ground surface.
5) Water Level Readings:
   May 6, 2022 - 1.7 m bgs

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

TEST PIT LOG

TP3
Sheet 1 of 1

CLIENT **Brody Luis**
PROJECT NO. **LON-22012100-A0**
PROJECT **130 Beech Street**
DATUM **Manhole at street 100.0 m**
LOCATION **Strathroy, ON**
DATES: Boring **May 6, 2022**
Water Level **May 6, 2022**

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)	SHEAR STRENGTH / Atterberg Limits and Moisture
0	99.87	**TOPSOIL** - 400 mm								
	99.47	**SAND** - silty, fine, light brown, moist, compact								
		- becoming grey near 0.7 m bgs								
1										
		- caving encountered near 1.4 m bgs		▼						
		- becoming wet near 1.5 m bgs								
					GS	SA 1			25	○
	97.97	**End of test pit at 1.9 m bgs.**								
2										
3										

SHEAR STRENGTH
✚ S Field Vane Test (#=Sensitivity)
▲ Penetrometer ■ Torvane
100 200 kPa
Atterberg Limits and Moisture
W_P W W_L
● SPT N Value × Dynamic Cone
10 20 30 40

NOTES

1) Test pit log interpretation requires assistance by EXP before use by others. Test pit log must be read in conjunction with EXP Report LON-22012100-A0.
2) Test pit log is based on observations of the excavator resistance.
3) Test pit caved at 1.4 m bgs and water apparent near 1.5 m bgs upon completion of excavation.
4) bgs denotes below ground surface.
5) Water Level Readings:
May 6, 2022 - 1.5 m bgs

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

OTHER TESTS

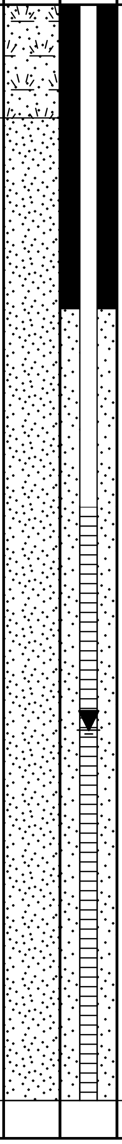
G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

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

MONITORING WELL LOG

MW1
Sheet 1 of 1

CLIENT **Brody Luis**
PROJECT NO. **LON-22012100-A0**
PROJECT **130 Beech Street**
DATUM **Manhole at street 100.0 m**
LOCATION **Strathroy, ON**
DATES: Boring **May 6, 2022**
Water Level **May 12, 2022**



DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)	SHEAR STRENGTH ✚ S Field Vane Test (#=Sensitivity) ▲ Penetrometer ■ Torvane 100 200 kPa Atterberg Limits and Moisture W_P W W_L ● SPT N Value × Dynamic Cone 10 20 30 40
0	100.14	**TOPSOIL**								
	99.84	**SAND**								
1										
2										
	97.24									
		End of monitoring well at 2.9 m bgs.								
3										

NOTES

1) Monitoring well log interpretation requires assistance by EXP before use by others. Monitoring well log must be read in conjunction with EXP Report LON-22012100-A0.
2) Monitoring well advanced to 2.9 m bgs by Laskey's Well Drilling Services and soil stratigraphy interpreted from observation only.
3) bgs denotes below ground surface.
4) Water Level Readings:
   May 6, 2022 - 1.90 m bgs
   May 12, 2022 - 1.92 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)

MONITORING WELL LOG

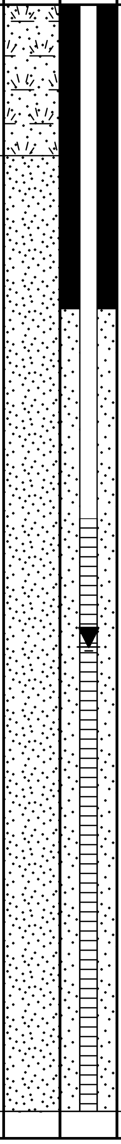
MW2
Sheet 1 of 1

CLIENT **Brody Luis**
PROJECT NO. **LON-22012100-A0**
PROJECT **130 Beech Street**
DATUM **Manhole at street 100.0 m**
LOCATION **Strathroy, ON**
DATES: Boring **May 6, 2022**
Water Level **May 12, 2022**

SAMPLES: TYPE, NUMBER, RECOVERY (mm), N VALUE (blows)
MOISTURE CONTENT (%)

SHEAR STRENGTH
✚ S Field Vane Test (#=Sensitivity)
▲ Penetrometer ■ Torvane
100 200 kPa
Atterberg Limits and Moisture
W_P W W_L
● SPT N Value ✕ Dynamic Cone
10 20 30 40

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION
0	100.06	**TOPSOIL**
	99.66	**SAND**
1		
2		
	97.13	
3		**End of monitoring well at 2.9 m bgs.**



NOTES

1) Monitoring well log interpretation requires assistance by EXP before use by others. Monitoring well log must be read in conjunction with EXP Report LON-22012100-A0.
2) Monitoring well advanced to 2.9 m bgs by Laskey's Well Drilling Services and soil stratigraphy interpreted from observation only.
3) bgs denotes below ground surface.
4) Water Level Readings:
   May 6, 2022 - 1.68 m bgs
   May 12, 2022 - 1.70 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

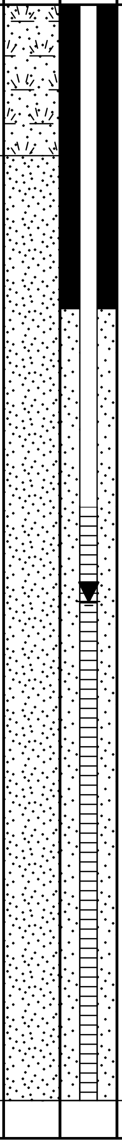
WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

MONITORING WELL LOG

MW3
Sheet 1 of 1

CLIENT **Brody Luis**
PROJECT NO. **LON-22012100-A0**
PROJECT **130 Beech Street**
DATUM **Manhole at street 100.0 m**
LOCATION **Strathroy, ON**
DATES: Boring **May 6, 2022**
Water Level **May 12, 2022**

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)	SHEAR STRENGTH ✚ S Field Vane Test (#=Sensitivity) ▲ Penetrometer ■ Torvane 100 200 kPa Atterberg Limits and Moisture W_P W W_L ● SPT N Value × Dynamic Cone 10 20 30 40
0	99.87	**TOPSOIL**								
	99.47	**SAND**								
1										
2										
	96.97	**End of monitoring well at 2.9 m bgs.**								
3										



NOTES

1) Monitoring well log interpretation requires assistance by EXP before use by others. Monitoring well log must be read in conjunction with EXP Report LON-22012100-A0.
2) Monitoring well advanced to 2.9 m bgs by Laskey's Well Drilling Services and soil stratigraphy interpreted from observation only.
3) bgs denotes below ground surface.
4) Water Level Readings:
   May 6, 2022 - 1.56 m bgs
   May 12, 2022 - 1.58 m bgs

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

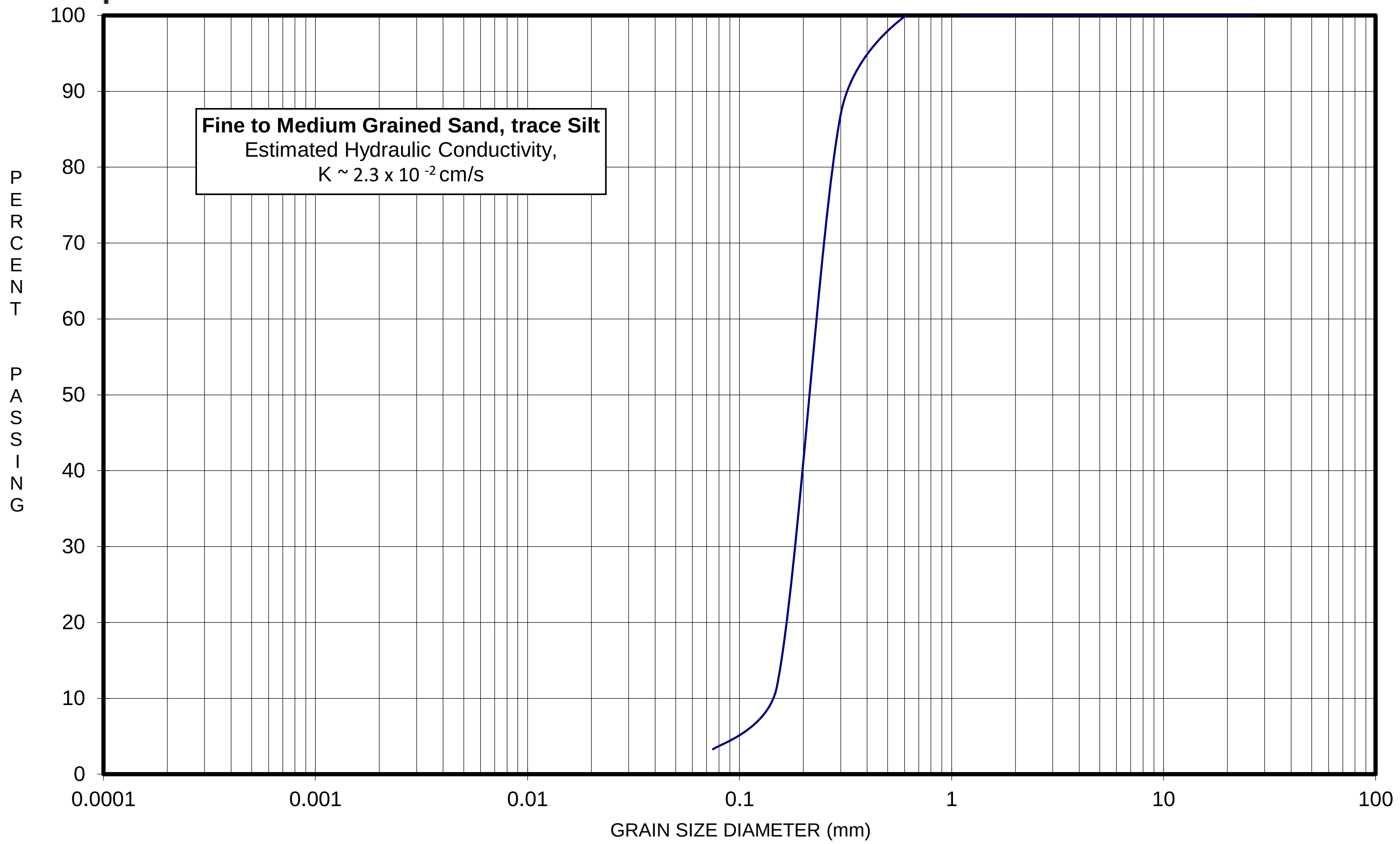
OTHER TESTS

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)

Appendix B – Grain Size Distribution Analyses

MECHANICAL GRAIN SIZE ANALYSIS



Fine to Medium Grained Sand, trace Silt
Estimated Hydraulic Conductivity,
K ~ 2.3×10^{-2} cm/s

CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE
	SILT			SAND			GRAVEL		

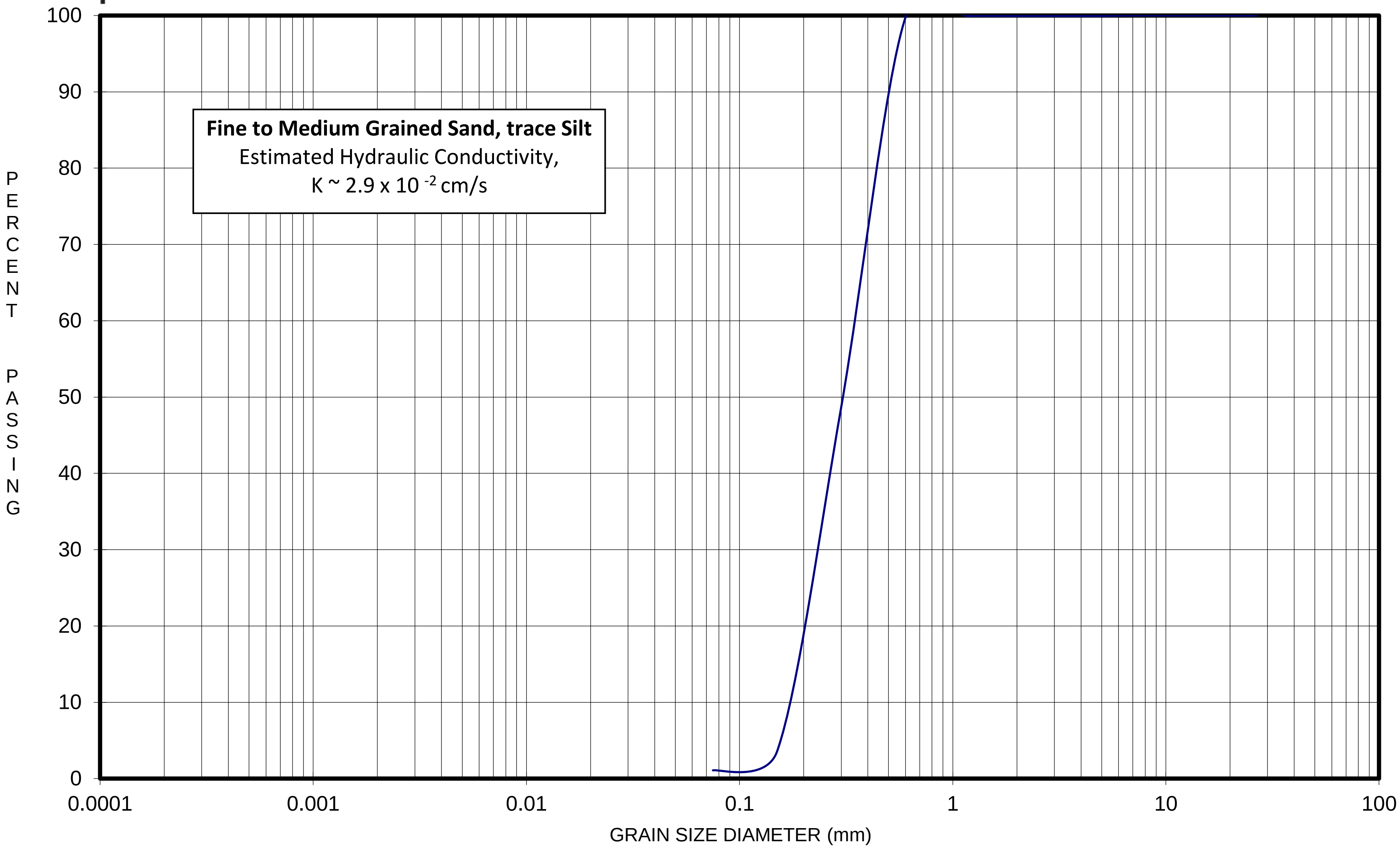
MODIFIED M.I.T. CLASSIFICATION

Sample Description: TP 1 SA 1 1.4 m

Project: 22012100

Figure 1

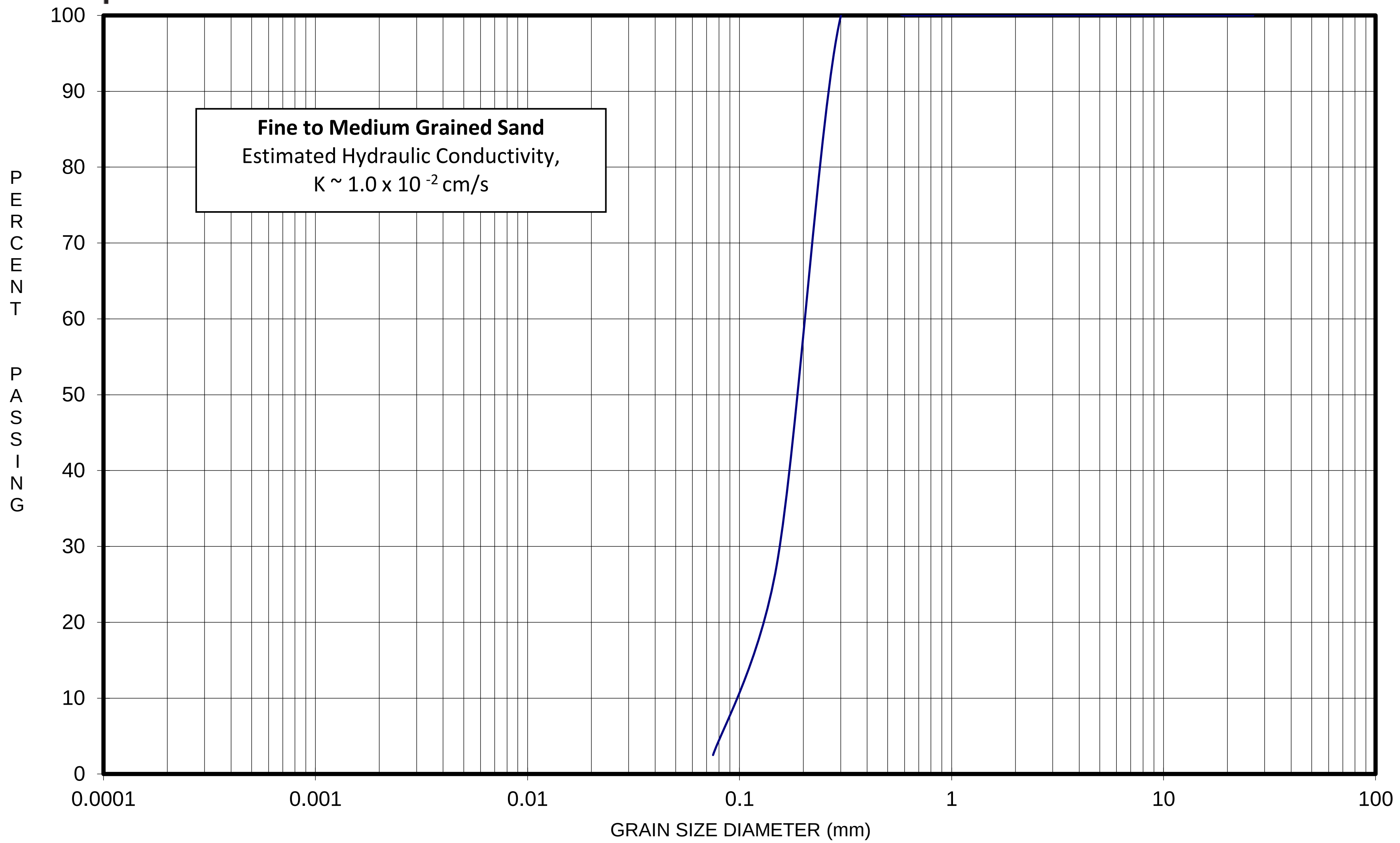
MECHANICAL GRAIN SIZE ANALYSIS



Fine to Medium Grained Sand, trace Silt
Estimated Hydraulic Conductivity,
K ~ 2.9 x 10 $^{-2}$ cm/s

CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE
	SILT			SAND			GRAVEL		
MODIFIED M.I.T. CLASSIFICATION	**Sample Description: TP 1 SA 2 2.2 m**					**Project: 22012100**			**Figure 2**

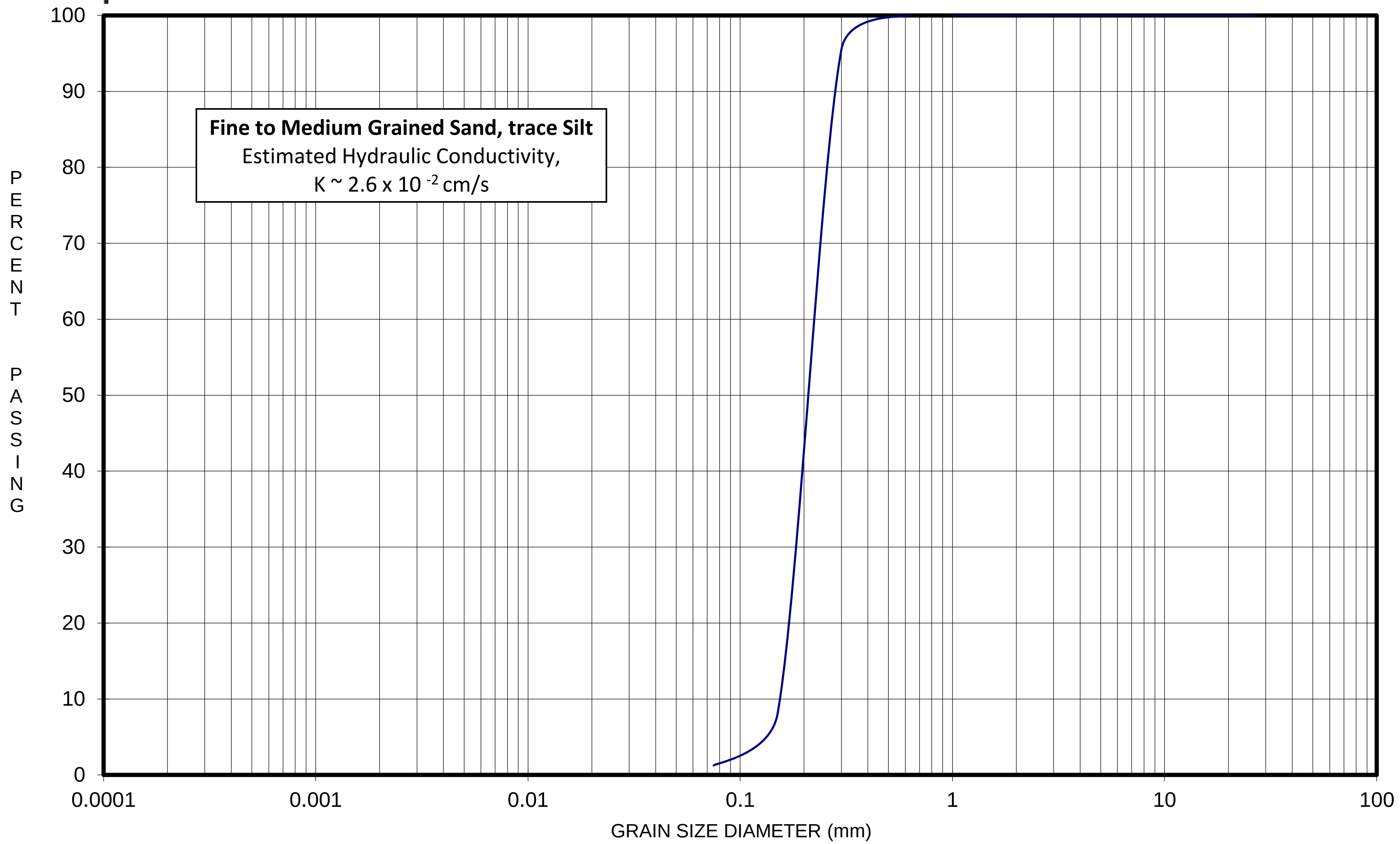
MECHANICAL GRAIN SIZE ANALYSIS



Fine to Medium Grained Sand
Estimated Hydraulic Conductivity,
K ~ 1.0 x 10 $^{-2}$ cm/s

CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE
	SILT			SAND			GRAVEL		
MODIFIED M.I.T. CLASSIFICATION	**Sample Description: TP 2 SA 1 1.3 m**				**Project: 22012100**			**Figure 3**	

MECHANICAL GRAIN SIZE ANALYSIS



Fine to Medium Grained Sand, trace Silt
Estimated Hydraulic Conductivity,
K ~ 2.6 x 10 $^{-2}$ cm/s

CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE
	SILT			SAND			GRAVEL		

MODIFIED M.I.T. CLASSIFICATION	**Sample Description: TP 3 SA 1 1.7 m**	**Project: 22012100**	**Figure 4**

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 test pit results contained in the Report. The number of test pits 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.

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The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. No other party may use or rely upon the Report in whole or in part without the written consent of EXP. Any use of the Report, or any portion of the Report, by a third party are the sole responsibility of such third party. EXP is not responsible for damages suffered by any third party resulting from unauthorized use of the Report.

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