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October 28, 2022
File: 22298

King Paving & Construction Ltd.
% Solution Stream
1445 Caroline Street,
Burlington, Ontario
L7S 1H7

Attention: Mr. John Doyle, Managing Partner – Solution Stream

Dear Mr. Doyle,

Re: Geotechnical Investigation Letter Report
Proposed Asphalt Batching Plant, 291 North Service Road, Burlington, Ontario

Landtek Limited (herein "*Landtek*") is pleased to submit this updated Geotechnical Investigation letter report for the proposed new Asphalt Batching Plant at the site identified as civic address 291 North Service Road in Burlington, Ontario. Authorization to proceed with the work was received from Mr. John Hutter of King Paving & Construction Ltd. (herein "*King Paving*") on July 26, 2022.

Background

The proposed Asphalt Batching Plant is to be constructed and will include for a new access road, hoppers, material storage areas and a storm water management system. No subsurface structures or grade changes are anticipated, with all proposed structures understood to be of an at-grade construction.



A new turning lane is also proposed leading from North Service Road to the site.

The purpose of the investigation was to determine the subsurface soil and groundwater conditions underlying the site, and to provide design parameters recommendations with regards to foundations and floor slabs for the proposed structure and machinery.

The information provided by this letter report addresses the ground conditions and soil parameters required to assist the design of the new batching plant. The considerations and recommendations pertaining to the proposed turning lane to be constructed on North Service Road are provided under separate cover

This letter report has been prepared for the Client, their nominated engineers, designers, and project managers pertaining to the proposed Asphalt Batching Plant at 291 North Service Road in Burlington, Ontario. Further dissemination of this report is not permitted without Landtek's prior written approval. Further details of the limitations of this report are presented as Enclosure A.

Site Description and Topography

The site is located in Burlington, Ontario, is centered at approximate grid reference 592885, 4797135 (UTM 17T coordinates) and is currently a forested greenspace area, and formerly used as the Burlington North Service Road Landfill (now closed). The Geodetic elevation of the ground surface at the site ranges between approximately 118 m and 134 m. The site is approximately 60,260 m^2 (6.03 hectares) in plan area.

The site is bound to the south by North Service Road. Operations of the former landfill site and a current brickworks plant bound the site to the north, with dense vegetation and commercial properties bounding the site to the east and west.

Subsurface Characterization

Based on a review of the existing geological publication for the site area, Ontario Geological Survey (herein "*OGS*") Map 2509: "*Quaternary Geology of the Hamilton Area*", the native subsurface soil conditions in the vicinity of the site are anticipated to consist of clay and silt deposits of the Halton Till formation.

According to the OGS Map P2336 "*Paleozoic Geology of the Hamilton area*", the superficial geology is underlain by red shale of the Queenston Formation. Bedrock is anticipated at shallow depth beneath the site, in the order of approximately 4.0 m to 6.0 m below ground level.

Information provided by historical borehole records located in the vicinity of the site and held by the OGS, generally confirms the anticipated geological conditions beneath the site. Based on the data from records for Borehole ID 621749 located southwest of the site, the superficial soil profile confirms the presence of gravel and sand to 3.4 m, underlain by silt and clay till deposits to a depth of approximately 6.1 m. Red shale bedrock was encountered underlying the overburden soils at 6.1 m.

Fieldwork and Investigation Methodology

Fieldwork undertaken at the site by Landtek included clearance of underground services, borehole layout, borehole drilling, soil sampling, and field supervision. Of the seven boreholes proposed, a total of five (boreholes BH2 to BH6) were completed, with the remaining two boreholes located in inaccessible areas or in conflict with services at the site.

The five boreholes completed at the site drilled on September 29th, 2022 and were logged , sampled and backfilled under the supervision of a representative of Landtek using those standard symbols and terms defined in Enclosure B. The Borehole Location Plan, Drawing 22298-01, and associated borehole logs are provided in Enclosure C.

The boreholes were drilled using a Diedrich D-50 track-mounted drilling rig equipped with continuous flight, solid stem augers, and were advanced to depths of approximately 6.0 m below existing ground level. Standard Penetration Tests (SPT's) and split spoon samples were taken at frequent depth intervals during drilling.

All soil samples were transported to Landtek's in-house, Canadian Council of Independent Laboratories (CCIL) certified laboratory and visually examined to determine their classification. Moisture contents were carried out on all samples. No chemical laboratory testing was completed during this investigation.

Borehole locations were established on site by Landtek with reference to existing site structures and features. Depth related remarks for each borehole were made relative to the ground level at each respective borehole location.

Subsurface Conditions

<u>Organic Soils</u>

An approximately 75 mm thick layer of organic soil was encountered from ground surface at one location (borehole BH6). It should be noted that organic soil presence and thicknesses may vary across the site, and the thicknesses measured during this investigation may not be representative of the organic soil depths throughout the site area.

Granular Surface

A layer of granular materials was encountered from ground surface in all boreholes except borehole BH6. The granular material thicknesses range between approximately 125 mm and 150 mm. The granular materials comprise of sand and gravel with trace clay and silt and are generally brown and black in colour.

Fill Material

Fill materials comprising predominantly of silty clay was encountered in all boreholes underlying the topsoil and granular material and extends to depths of approximately 1.5 m to 6.0 m below existing ground level. The fill is red and brown in colour and contains variable fractions of silty sand, gravel, grey clay, asphalt pieces, red shale fragments, red brick fragments and sand.

SPT ''N'' values ranging from 4 to 37 were reported, indicating the fill to be of a poor to moderate level of compaction and are as expected for a fill material placed under uncontrolled conditions. Moisture content results of 3 % to 26 % were recorded within fill material samples collected during drilling.

The moisture content results are presented on the borehole logs in Appendix C.

Silty Clay Till

Native silty clay till was encountered in boreholes BH5 and BH6 underlying the fill materials and extends to depths of approximately 2.3 m to 2.6 m below existing ground level. The silty clay till includes traces of gravel and grey and red shale fragments.

SPT ''N'' values ranging between 13 and 31 were recorded, indicating the silty clay deposits to be of a stiff to hard, but generally stiff consistency. Moisture contents ranging from 12 % to 23 % were reported, which is as to be expected of a moist soil with silt and clay as primary constituents. The moisture content testing results are presented on the borehole logs in Enclosure C.

Bedrock

Red shale of the Queenston Formation was encountered underlying the existing fill materials and silty clay till deposits at depths between approximately 2.3 m (borehole BH5) and 6.0 m (boreholes BH1, BH2 and BH3) below existing ground level.

The shale is generally weak and highly to slightly weathered on initial contact, being recovered and behaving as a "*residual soil*" in the upper 1.0 m to 1.5 m and becoming more competent at depth. The shale bedrock can be classified as having a strength grade of R4 and being generally "*weak*" according to the Canadian Foundation Engineering Manual.

Though not encountered during this investigation, discontinuous green/grey and red siltstone layers are often encountered within the red shale and tend to be much sounder and harder than the shale strata. Occasional limestone seams may be also present within the bedrock horizon beneath the site, that also tend to be much sounder than the shale strata.

Groundwater

Groundwater was not encountered during the drilling process, with all boreholes remaining open to full drill depth and dry upon completion.

It should be noted that groundwater conditions and surface water flow conditions are expected to vary according to the time of year and seasonal precipitation levels. Water seepage is also expected from the transition zone between the existing fill materials and the native, fine-grained soils.

Engineering Considerations

Foundations in Native Strata

The existing fill materials and sporadic silty clay till deposits encountered in the boreholes are considered unsuitable as a bearing stratum due to the high risk of unacceptable settlements in the case of the fill materials, and the anticipated moderate loading of the proposed structures in the case of the silty clay till.

Consequently, the foundations for the proposed structures should be extended to the underlying, more competent native strata. On this basis and given the anticipated moderate loading of the

proposed plant structures, it is considered by Landtek that bearing conditions to support concrete footings (extended through '*trench and pour*' methodologies, if and where required) or piles (e.g., concrete caissons, driven piles etc.) for the proposed new Asphalt Batching Plant can be provided by the highly weathered shale.

Table 1 summarizes the recommended geotechnical reactions at the Serviceability Limit State (herein "*SLS*") and factored geotechnical resistances at the Ultimate Limit State (herein "*ULS*") for the native soils. It should be noted that the design parameters have been determined by Landtek for the design stage only.

Table 1: Recommended Limit State Foundation Design Values

Founding Depth Range	Founding Stratum	Foundation Design Value	
		SLS [1,2]	ULS [3,4]
1.5± to 2.5±	Silty Clay Till (where encountered)	150 kPa	225 kPa
2.5± to 6.0±	Highly Weathered Shale	500 kPa	750 kPa

Notes:
1. The National Building Code general safety criterion for the serviceability limit states is: SLS resistance ≥ effect of service loads.
2. Recommended SLS bearing values conform to Estimated Values based on soil types given in Tables K-8 and K-9 of the National Building Codes User's Guide.
3. The ULS resistance factor for shallow foundations is 0.5, as given in Table K-1 of the National Building Code User's Guide.
4. The National Building Code general safety criterion for the ultimate limit states is: factored ULS resistance ≥ effect of factored loads.

Where the bearing levels of the footings are at different design elevations, the footing base levels should be stepped along a line of 7V:10H, drawn upwards from the lowest footing, to avoid overlapping stresses.

Subsurface conditions can vary over relatively short distances and the subsurface conditions revealed at the test locations may not be representative of subsurface conditions across the site. Therefore, a Geotechnical Engineer should be engaged during construction to examine the exposed sub-soil quality and condition, and confirm the subsurface conditions are consistent with design assumptions. This is in compliance with field review requirements in the National Building Code, Volume 1, Clause 4.2.2.3.

Foundations on Engineered Fill

If engineered fill is required to support the proposed building or equipment foundations, it is considered by Landtek that such structures can be adequately supported by conventional strip or pad footings founded on the engineered earth fill for a geotechnical reaction at the SLS of 100 kPa, and a factored geotechnical resistance at the ULS of 150 kPa.

It should be noted that achieving the desired bearing capacities is very much dependent upon the nature and condition of the fill placed, the condition of the sub-grade upon which it is being placed, and the methods adopted for the placement and compaction of the fill materials. Particularly for granular fill material, it will be necessary to place a separation blanket across the subgrade prior to granular material placement to prevent material mixing and granular material loss into the finer-grained subgrade soils.

Where there is a requirement to raise the existing grade and generate the necessary founding subgrade, the engineered fill must be selected with care, then placed and compacted under strictly controlled conditions. The following recommendations are provided to address the selection of fill material as well as the placement and compaction of engineered fill.

- Processed imported granular material or consistent quality imported clean earth fill, can be considered for engineered fill provided the soil moisture content is within about 2 % of the optimum value of the material. Imported fill should meet the environmental requirements established for the site;
- Engineered fill should only be placed in an area that has been satisfactorily prepared by stripping all existing fill materials and organic soils, and proof rolling the exposed native subgrade soils with at least five passes of a minimum 10-ton static pad-foot steel drum type roller;

- Engineered fill should be placed in maximum 300 mm, loose lifts and compacted to a target value of 100 % Standard Proctor Maximum Dry Density (herein "*SPMDD*"). If placing during the winter period (i.e., November to March), the maximum lift thickness should be reduced to 200 mm;
- The placement and compaction of each lift should be monitored full time by Landtek, with in-place compaction determined using nuclear moisture/density testing equipment;
- Fill layers that do not meet the compaction requirements, or become wet or frozen, should not be approved for the placement of additional material; and,
- For engineered fill placement over large areas of varying elevation, the locations of quality control density tests should be recorded by total station survey.

As a precautionary measure and to mitigate cracking in building foundations, it is recommended that reinforcing steel be provided in footings on engineered fill, and at the top of poured concrete foundation walls. Two 15M bars (continuous) are recommended as a minimum for footing placement. The Structural Engineer should be consulted to confirm the design of such steel reinforcement.

Frost Susceptibility

The fine-grained, native soils encountered at shallow depths across the site should be considered sensitive to water and frost, and their physical and mechanical properties are dependent on in-situ moisture content. As such, the founding soils at the site are considered to have a moderate to high frost susceptibility, being classified as Frost Group "*F4*" (Table 13.1 of the "*Canadian Foundation Engineering Manual*", 4th Edition). However, the previously identified depths for foundations are considered to be below the maximum depth for frost penetration of 1.2 m in the Burlington area.

Should any re-grading be required as part of the proposed development and adjacent to the new structures, it will be important to ensure that the associated exterior footings will have a minimum of 1.2 m of soil cover, or equivalent suitable insulation, for frost protection.

Settlement Considerations

Based on the outline information provided for the nature of the proposed development of the site, it is anticipated that the loads to be applied to the native soils and residual soil of the red shale will be of a generally moderate intensity. As such, associated settlements are not expected to be significant. Therefore, the general limiting of the total settlement to 25 mm and the differential settlement to 19 mm by the recommended geotechnical reaction at the SLS is considered appropriate.

Seismic Design Consideration

Based on the soils conditions encountered, and in accordance with Table 4.1.8.4.A. of the current Ontario Building Code (herein "*OBC*"), the site is considered to be a 'D' Site Class for foundations seated within the native soils. The acceleration and velocity-based site coefficients, F_a and F_v, should be determined from Tables 4.1.8.4.B. and 4.1.8.4.C. respectively of the OBC for the above recommended Site Class. The seismic design data given in Table 1.2 of Supplementary Standard SB-1 in Volume 2 of the OBC, for selected Municipal locations, should be used to complete the seismic analysis.

Damp Proofing Considerations

Damp-proofing will not be required for at-grade structures. In the event that any subsurface or basement structures are included in the final design, then the subsurface areas should be damp proofed and comply with the OBC requirements.

As a minimum it is recommended that such a damp proofing system include a Delta Drainage Board or MiraDrain 2000 series product, or an approved alternative, along with an asphalt-based spray on wall coating.

Floor Slab Considerations

Based on the information provided to Landtek, it is anticipated that the floor slab subgrade will comprise of existing fill materials or (potentially) native silty clay till. The silty clay till will provide adequate support for standard floor slab construction.

For existing fill subgrade conditions, it is recommended that the existing fill materials are sub-excavated to approximately 1.0 m below the required subgrade or to native soils, whichever is shallower, and the required subgrade reinstated using select subgrade material placed per the "*General Backfill Considerations*" section of this letter report. The select subgrade material should be compacted to a target compaction of 100 % SPMDD, with no individual test below 98 % SPMDD.

The design of concrete slabs may be made on the basis of a value of modulus of sub-grade reaction of 15 MPa/m on the surface of any required engineered fill and 25 MPa/m for the native silty clay till.

It is recommended that a minimum 200 mm layer of clear 19 mm crushed quarried stone be used as the vapour barrier under the floor slab. The vapour barrier stone should meet the requirements of Ontario Provincial Standard Specifications (herein "*OPSS*") 1004 for 19 mm Type II clear stone. If a graded crushed stone is substituted for clear stone, the material should be limited to a maximum of 5 % fines (passing the 0.075 mm sieve).

The floor slab thickness should meet the specifications of the project based on anticipated floor loadings. The finished exterior ground surface should be sloped away from the building at a grade in the order of 2 %.

The concrete properties should meet the requirements of OPSS 1350. Contraction and isolation jointing practices should be in accordance with current Portland Cement Association recommendations, as given in the engineering bulletin "*Concrete Floors on Ground*", second edition, by R. E. Spears, and W. C. Panarese.

Excavation and Backfill Considerations

General Considerations

All temporary excavations and unbraced side slopes in the soils should conform to standards set out in the Occupational Health and Safety Act, Ontario Regulation 213/91 "*Construction Projects*" (herein "*OHSA*"). The subsurface soils to be encountered during excavation at the site are expected to behave as "*Type 3"* and "*Type 2*" materials according to the OHSA classification in Part III. Type 3 soils are characteristic of the "*fill material*" while the "… *generally stiff clayey silt till*" and "*highly weathered shale"* are considered Type 2 soils.

It should be possible to excavate the overburden soils and residual soil of the red shale with a hydraulic backhoe. Moist Type 2 and Type 3 soils are expected to be stable for short construction periods at slopes of approximately 45° to the horizontal (i.e., 1V:1H).

Consideration should be given to any existing trench excavations and associated backfill that may be present directly behind cut slopes within the native soils that may appear to be stable on first excavation. In these circumstances, slopes can suddenly slough or collapse due to the affects of the adjacent backfill. Consequently, for excavation conditions that cannot satisfy the OHSA requirements for unbraced 1H:1V side slopes, a trench box system should be used, or temporary shoring should be installed to maintain safe working conditions. This may be more applicable to service trench excavations, particularly when in close proximity to new or existing infrastructure.

It should be noted that the design of a temporary shoring system, should one be required, is the responsibility of the Contractor. Therefore, a specialist shoring contractor should be consulted to provide the most appropriate shoring type method and associated installation procedures. In any event, the shoring design should be based on the procedures outlined in the latest edition of the "*Canadian Foundation Engineering Manual*". It is also recommended that lateral and vertical movement of the shoring system be monitored during construction to ensure that movements are within the acceptable range.

Dewatering Consideration

Groundwater was not encountered during the investigation. This given, any localized groundwater seepages that may be encountered during excavation work should be able to be controlled by standard pumping equipment drawing from sumps at the base of the excavation.

Water seepage into open excavations is not expected to be a construction issue or be experienced to an extent that the project requires either registration under the Environmental Activity and Sector

Registry (herein "*EASR*") framework (i.e., exceeding 50,000 l/day but less than 400,000 l/day) or a Permit To Take Water (herein "*PTTW*") for amounts greater than 400,000 l/day.

General Backfill Considerations

Backfill next to foundation walls and in utility trenches should be selected to be compactable in narrow trench conditions. The native silty clay soils and residual soils of the red shale encountered at the site are expected to be reusable as trench backfill and backfill around the proposed structures on the site. Any variation in the moisture contents of the soils encountered may require selective separation of material to avoid the use of wet soil.

Site servicing trench backfill should be uniformly compacted to a density that minimizes the risk of long-term settlements. It is recommended that the target compaction specification for trench backfill be 97 % SPMDD with no individual test below 95 % SPMDD.

During inclement weather the native soils may become too wet to achieve satisfactory compaction. If construction is proposed for late in the year, a reduced level of trench compaction with a higher risk of future settlements is to be anticipated, and it is recommended that provisional contract quantities be established for the supply and placement of imported granular fill under such circumstances. The imported granular should meet the requirements of OPSS 1010 for Granular B Type I material as a minimum requirement.

Pavement Design Considerations

The proposed scope of paving works is anticipated to include for a new access road and all associated access points, turning areas and parking lots. The pavement structures are likely to comprise of both granular and asphaltic concrete surface finishes.

Based on the findings of the investigation, it is considered that though being of fill materials, the existing pavement structure subgrade is sufficiently stable to support a new pavement structure.

Landtek recommends that new asphalt and granular pavement structures should consist of the pavement layer thicknesses provided in Table 2 below. This pavement structure design thickness meets the minimum standards for an arterial-grade pavement for Corporation of the City of Burlington (herein "*City of Burlington*") design requirements.

Table 2: Recommended Minimum Pavement Structure Layer Thicknesses

Pavement Layer	Recommended Pavement Layer Thickness	
	Asphalt Pavement	Granular Pavement
Surface Course HL-3 HS Asphaltic Concrete	50 mm	-
Binder Course HDBC Asphaltic Concrete	80 mm	-
Granular Base OPSS 1010 Granular A	150 mm	200 mm
Granular Subbase OPSS 1010 Granular B Type II	350 mm	350 mm
Total Thickness	630 mm	550 mm

The above recommended pavement layer thicknesses are considered to yield a design life of 20 years, with first maintenance required after approximately seven to ten years.

Pavement Construction Considerations

Subgrade Preparation and Drainage

The overall performance of a pavement structure will greatly depend upon the support provided by the subgrades. A number of factors should be considered at the construction stages to ensure that an acceptable subgrade condition is developed and maintained:

- Any soft areas of notable deflection to the subgrade should be sub-excavated and replaced with a suitable backfill material approved by a qualified geotechnical engineer and compacted to 98 % of its Standard Proctor Maximum Dry Density (herein "*SPMDD*");
- The subgrade should be properly shaped, crowned and then proof-rolled under the full-time observation of a geotechnical representative of this office to delineate any soft areas which may require repair before placing the granular materials; and,
- Surface water should not be allowed to pond on the surface of or adjacent to the outside edges of any developed subgrade.

It is important to ensure that any necessary repairs are undertaken to the subgrades prior to pavement construction to avoid creating "*bathtub*" conditions in the subgrade that will ultimately translate through the overlying pavement structure.

This given, it is also recommended that subdrains and associated positive connections are installed along the full length of any asphalt pavement structure, and in accordance with the City of Burlington's Engineering Standards.

General Reconstruction Considerations

The following considerations should be maintained during paving:

- The requirements defined by OPSS 310 and OPSS.PROV.313 for the design and construction of lap joints between and transitions from existing and new asphaltic concrete pavements when connecting the new pavement construction to the existing pavements of adjacent roads;
- A tack coat should be applied to all contact surfaces prior to placing any hot mix asphalt layers or between asphaltic layers as per OPSS 308; and,
- The placing, spreading and rolling of the asphalt should be in accordance with current provincial standards or the City of Burlington's Engineering Standards.

Granular Base Course and Subbase

The granular base course materials should meet OPSS "*Granular A*" specifications. Quarried 19 mm limestone crushed to Granular A gradation specifications is recommended. Granular subbase material should meet OPSS "*Granular B Type II*" requirements for 100 % crushed quarried bedrock (50 mm crusher-run limestone).

Hot Mix Asphalt

The binder course and surface course asphalt should meet current specifications for HDBC and HL-3 HS respectively, as prescribed by the City of Burlington for commercial/industrial road pavements or, alternatively, OPSS 1150. The standard asphalt binder grade for the climate conditions in Burlington is PG 58-28.

Given the volume of commercial truck traffic is to be high, consideration may be given towards bumping up the binder grade to a higher PG grade of asphalt cement.

Compaction

Granular base course and subbase course fill material should be compacted to 100 % SPMDD. Hot mix asphalt should be compacted to the criteria set out by the City of Burlington's Engineering Standards.

Closure

The Limitations of Report, as stated in Enclosure A, are an integral part of this report.

Soil samples will be retained and stored by Landtek for a period of three months after the issuing of this letter report. The samples will be disposed of at the end of the three-month period unless a written request from the Client to extend the storage period is received.

We trust that this letter report is satisfactory for your purposes, and please do not hesitate to contact our office if you have any questions.

Yours sincerely,

LANDTEK LIMITED



James Dann, B.Eng. (Hons) ACSM
Manager, Geotechnical Projects

Ralph Di Cienzo, P.Eng.
Consulting Engineer

Attachments

Enclosure A: Limitations of Report
Enclosure B: Symbols and Terms Used in the Report
Classification of Soils for Engineering Purposes
Enclosure C: Drawing 22298-01 – Borehole Location Plan
Borehole Logs

ENCLOSURE A
LIMITATIONS OF REPORT

The conclusions and recommendations given in this report are based on information determined at the borehole locations. Subsurface and ground water conditions between and beyond the Boreholes may be different from those encountered at the borehole locations, and conditions may become apparent during construction that could not be detected or anticipated at the time of the geotechnical investigation. It is recommended practice that Landtek be retained during construction to confirm that the subsurface conditions throughout the site are consistent with the conditions encountered in the Boreholes.

The comments made in this report on potential construction problems and possible remedial methods are intended only for the guidance of the designer. The number of Boreholes may not be sufficient to determine all the factors that may influence construction methods and costs. For example, the thickness and quality of surficial topsoil or fill layers may vary markedly and unpredictably. Additionally, bedrock contact depths throughout the site may vary significantly from what was encountered at the exact borehole locations. Contractors bidding on the project, or undertaking construction on the site should make their own interpretation of the factual borehole information, and establish their own conclusions as to how the subsurface conditions may affect their work.

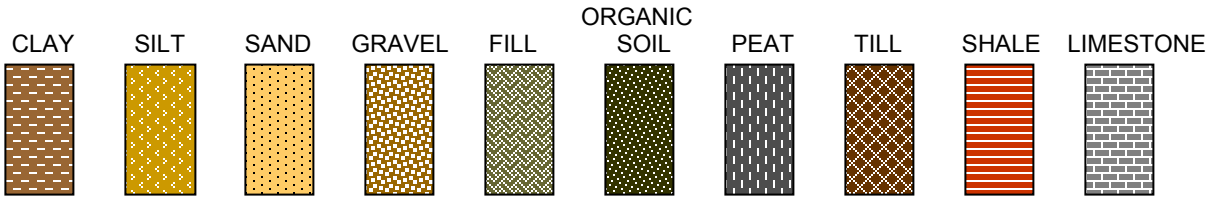
The survey elevations in the report were obtained by Landtek Limited or others, and are strictly for use by Landtek in the preparation of the geotechnical report. The elevations should not be used by any other parties for any other purpose.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Landtek Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

This report does not reflect environmental issues or concerns related to the property unless otherwise stated in the report. The design recommendations given in the report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, it is recommended that Landtek Limited be retained during the final design stage to verify that the design is consistent with the report recommendations, and that the assumptions made in the report are still valid.

ENCLOSURE B

SYMBOLS AND TERMS USED IN THE REPORT



RELATIVE PROPORTIONS

Term	Range
Trace	0 - 5%
A Little	5 – 15%
Some	15 – 30%
With	30 – 50%

CLASSIFICATION BY PARTICLE SIZE

Boulder ---------- > 200 mm
Cobble ---------- 80 mm – 200 mm
Gravel -
Coarse ---------- 19 mm – 80 mm
Fine ---------- 4.75 mm – 19 mm
Sand -
Coarse ---------- 4.75 mm – 2 mm
Medium -------- 2 mm – 0.425 mm
Fine ---------- 0.425 mm – 0.75 mm
Silt ---------- 0.075 mm – 0.002 mm
Clay ---------- < 0.002 mm

DENSITY OF NON-COHESIVE SOILS

Descriptive Term	Relative Density	Standard Penetration Test
Very Loose	0 – 15%	0 – 4 Blows Per 300 mm Penetration
Loose	15 – 35%	4 – 10 Blows Per 300 mm Penetration
Compact	35 – 65%	10 – 30 Blows Per 300 mm Penetration
Dense	65 – 85%	30 – 50 Blows Per 300 mm Penetration
Very Dense	85 – 100%	Over 50 Blows Per 300 mm Penetration

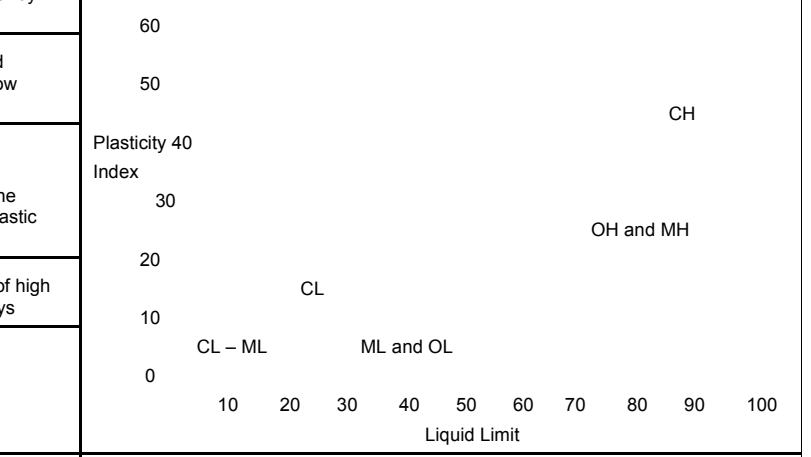
CONSISTENCY OF COHESIVE SOILS

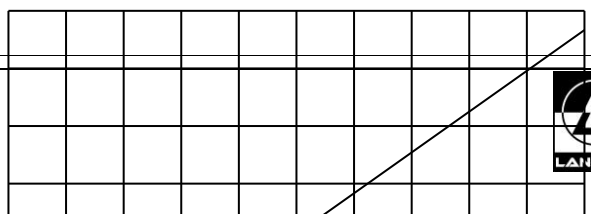
Descriptive Term	Undrained Shear Strength kPa (psf)	N Value Standard Penetration Test	Remarks
Very Soft	< 12 (< 250)	< 2	Can penetrate with fist
Soft	12 – 25 (250 – 500)	2 – 4	Can indent with fist
Firm	25 – 50 (500 –1000)	4 – 8	Can penetrate with thumb
Stiff	50 – 100 (1000 – 2000)	8 – 15	Can indent with thumb
Very Stiff	100 – 200 (2000 – 4000)	15 – 30	Can indent with thumb-nail
Hard	> 200 (> 4000)	> 30	Can indent with thumb-nail

Notes: 1. Relative density determined by standard laboratory tests.
2. N value – blows/300 mm penetration of a 623 N (140 Lb.) hammer falling 760 mm (30 in.) on a 50 mm O.D. split spoon soil sampler. The split spoon sampler is driven 450 mm (18 in.) or 610 mm (24 in.). The “N” value is the Standard Penetration Test (SPT) value and is normally taken as the number of blows to advance the sampler the last 300 mm.

ENCLOSURE B CONTINUED
CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES
ASTM Designation: D 2487 - 69 AND D 2488 – 69
(Unified Soil Classification System)

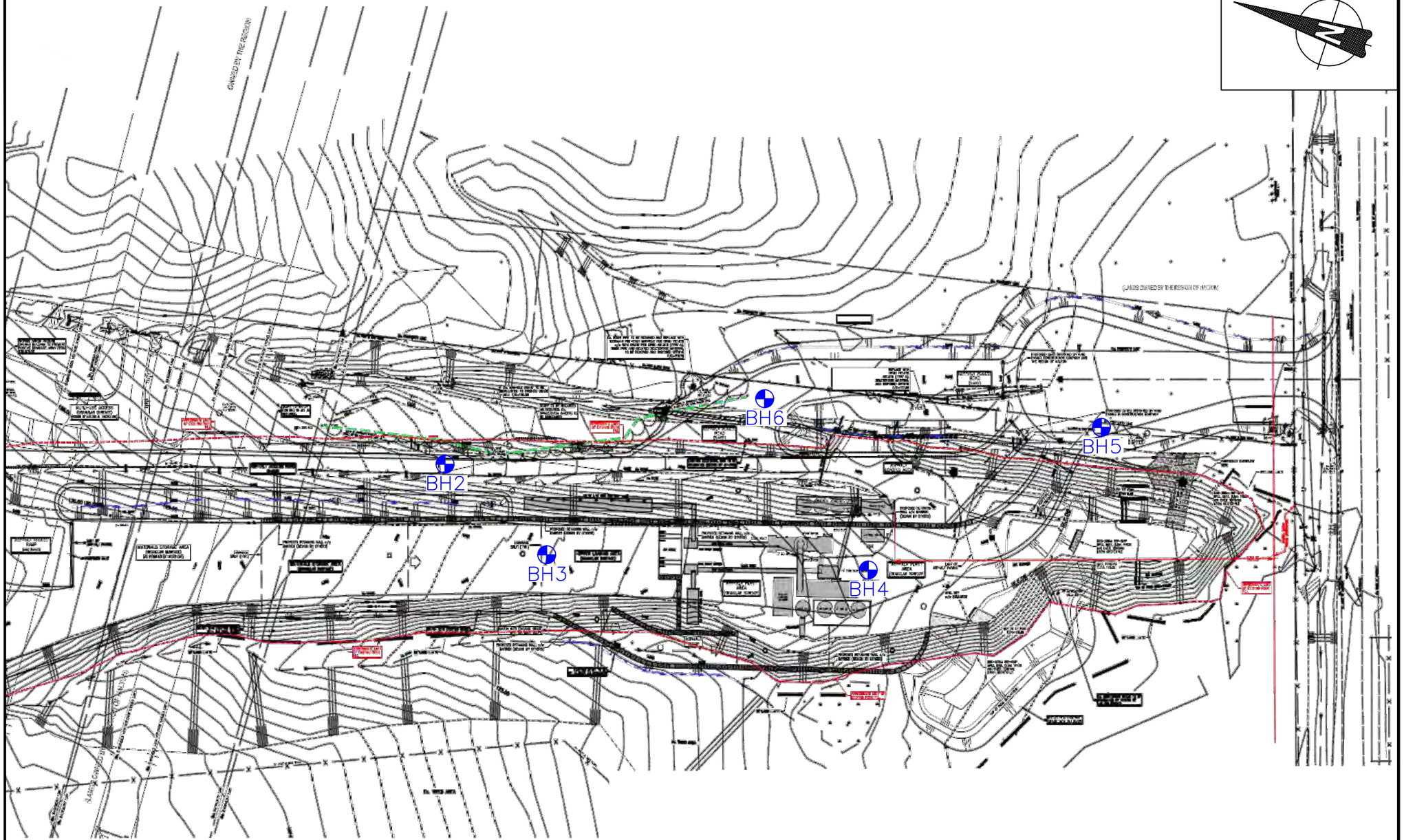
Major Divisions			Group Symbols	Typical Names	Classification Criteria		
Coarse-grained soils More than 50% retained on No. 200 sieve *	Gravels 50% or more of coarse fraction retained on No. 4 sieve	Clean gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	Classification on basis of percentage of fines Less than 5% pass No. 200 sieve . . . . . GW, GP, SW, SP More than 12% pass No. 200 sieve . . . . . GM, GC, SM, SC 5 to 12% pass No.200 sieve . . . . . Borderline classifications requiring use of dual symbols	C_u=D60/D10 greater than 4; C_z = $(D30)^2$/(D10xD60) between 1 and 3	
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines		Not meeting both criteria for GW	
		Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
	Sands More than 50% of coarse fraction passes No. 4 sieve	Clean Sands	SW	Well-graded sands and gravelly sands, little or no fines		C_u=D60/D10 greater than 6; C_z = $(D30)^2$/ (D10xD60) between 1 and 3	
			SP	Poorly graded sands and gravelly sands, little or no fines		Not meeting both criteria for SW	
		Sands with fines	SM	Silty sands, sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
Fine-grained soils 50% or more passes No. 200 sieve *	Silts and clays Liquid limit 50% or less		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands	Plasticity Chart For classification of fine-grained soils and fine fraction of coarse-grained soils. Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols. Equation of A-line: PI=0.73 (LL-20)		
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silts			
			OL	Organic silts and organic silts of low plasticity			
	Silts and clays Liquid limit greater than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts			
			CH	Inorganic clays of high plasticity, fat clays			
			OH	Organic clays of medium to high plasticity			
	Highly organic soils		Pt	Peat, much and other highly organic soils	* Based on the material passing the 3 in. (76mm) sieve.		





ENCLOSURE C

DRAWING 22298-01 – BOREHOLE LOCATION PLAN
BOREHOLE LOGS



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project location



Location plan an extract from burlington.maps.arcgis.com*

Legend:

Approximate location of boreholes 2 - 6 drilled by Landtek Limited on September 29th, 2022.

Notes:

Base drawing provided by S. LLewellyn & Associates Limited

revisions

#	date	revision/comment

client
King Paving & Construction Ltd.
% Solution Stream

municipality
The Corporation of the
City of Burlington

project
Geotechnical Investigation
291 North Service Road

sheet
Borehole Location Plan

date: October 25th, 2022
drawn: MDC
checked: JDC
project #: 22298
scale: NTS

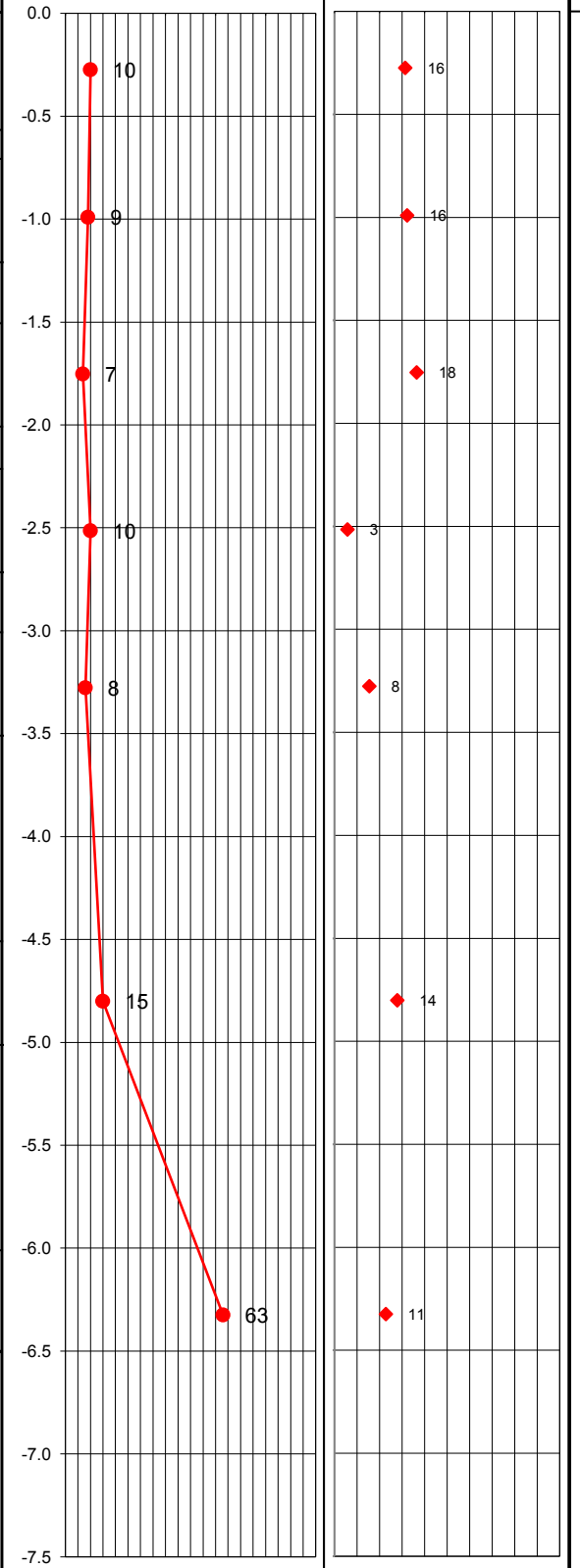
22298-01

LANDTEK LIMITED

BH 2

Project No.:	22298	Drill Date:	September 29, 2022
Project:	Proposed Asphalt Batching Plant Development	Drill Method:	[ ] solid stem [x] hollow stem [ ] vibratory
Location:	291 North Service Road, Burlington, Ontario	Datum:	Ground Surface

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	Scale (m)	SPT "N" Value	Soil Moisture (%)	GWL	Monitor Details	Test Data
Ground Surface										
±125 mm of Sand and Gravel		0.0								
FILL: silty clay, trace grey clay. Brown and red, stiff, moist.		0.1	1	SS		10	16			
…trace asphalt pieces, trace red brick fragments.			2	SS		9	16			
…no asphalt pieces, no red brick fragments. Firm.			3	SS		7	18			
…trace gravel, trace sand. Stiff.			4	SS		10	3			
…firm to stiff.			5	SS		8	8			
…stiff to very stiff.			6	SS		15	14			
SHALE BEDROCK: highly weathered, red. Hard, dry. Residual soil.		6.0	7	SS		63	11			
BOREHOLE TERMINATED AT TARGET DEPTH		6.5								



Notes:
1. Borehole open to approximately 6.0 m depth on completion.
2. Groundwater or water seepage was not encountered.

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

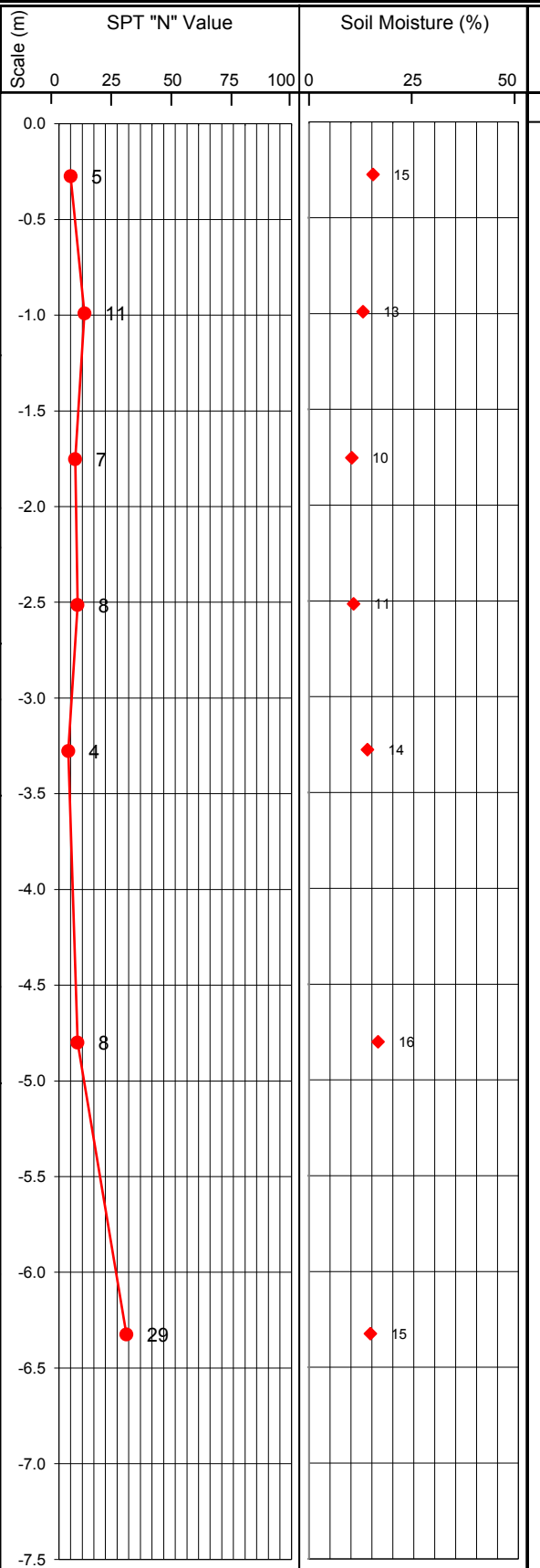
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LANDTEK LIMITED

BH 3

Project No.:	22298	Drill Date:	September 29, 2022
Project:	Proposed Asphalt Batching Plant Development	Drill Method:	[ ] solid stem [x] hollow stem [ ] vibratory
Location:	291 North Service Road, Burlington, Ontario	Datum:	Ground Surface

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	Scale (m)	SPT "N" Value	Soil Moisture (%)	GWL	Monitor Details	Test Data
Ground Surface										
±125 mm of Sand and Gravel		0.0								
FILL: silty clay, trace grey clay. Red and brown, firm, moist.		0.1	1	SS						
…trace asphalt pieces, trace red brick fragments.			2	SS						
…no asphalt pieces. Firm.			3	SS						
…trace gravel, trace sand. Stiff.			4	SS						
…sand with silty clay, trace red shale fragments. Loose.			5	SS						
			6	SS						
SHALE BEDROCK: highly weathered, red. Hard, dry. Residual soil.		6.0	7	SS						
BOREHOLE TERMINATED AT TARGET DEPTH		6.5								



Notes:
1. Borehole open to approximately 6.0 m depth on completion.
2. Groundwater or water seepage was not encountered.

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

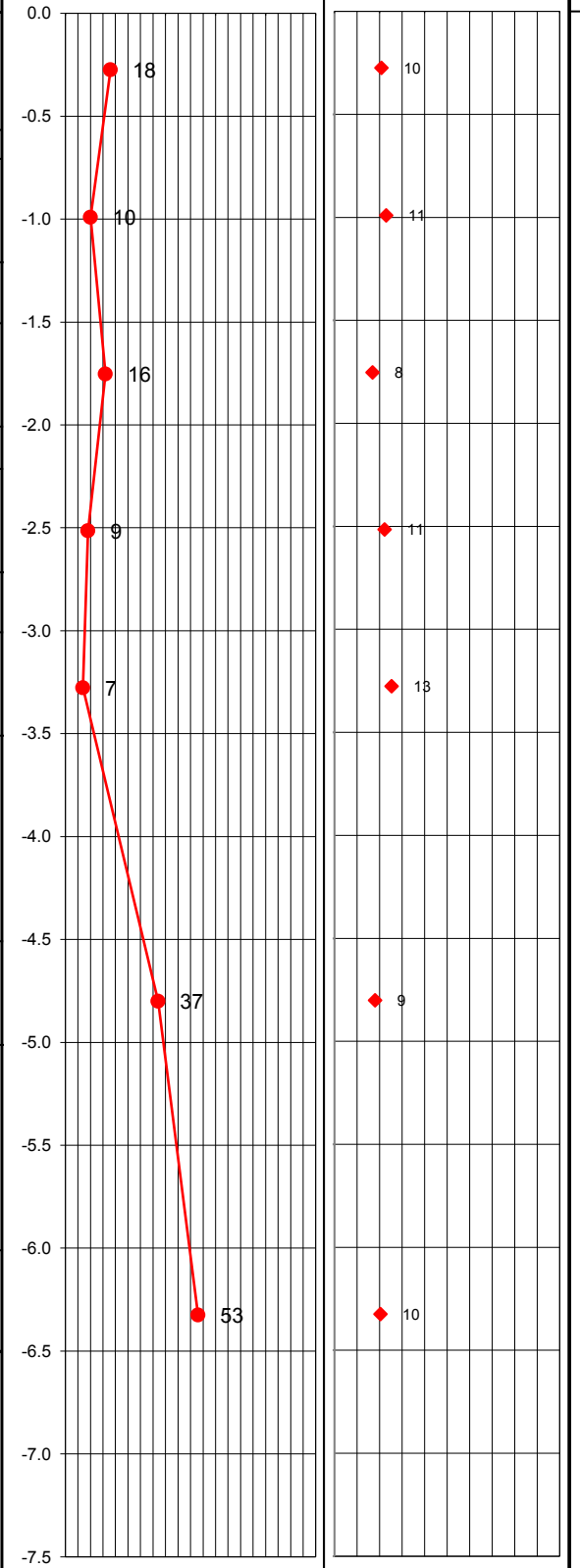
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LANDTEK LIMITED

BH 4

Project No.:	22298	Drill Date:	September 29, 2022
Project:	Proposed Asphalt Batching Plant Development	Drill Method:	[ ] solid stem [x] hollow stem [ ] vibratory
Location:	291 North Service Road, Burlington, Ontario	Datum:	Ground Surface

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	Scale (m)	SPT "N" Value	Soil Moisture (%)	GWL	Monitor Details	Test Data
Ground Surface										
±150 mm of Sand and Gravel		0.0								
FILL: silty clay, some gravel. Grey, very stiff, moist.		0.2	1	SS		18	10			
…stiff.			2	SS		10	11			
…silty sand, trace silty clay. Very stiff.			3	SS		16	8			
…trace asphalt pieces. Stiff.			4	SS		9	11			
…silty clay. Red, firm.			5	SS		7	13			
…hard.			6	SS		37	9			
SHALE BEDROCK: highly weathered, red. Hard, dry. Residual soil.		6.0	7	SS		53	10			
BOREHOLE TERMINATED AT TARGET DEPTH		6.5								



Notes:
1. Borehole open to approximately 6.0 m depth on completion.
2. Groundwater or water seepage was not encountered.

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

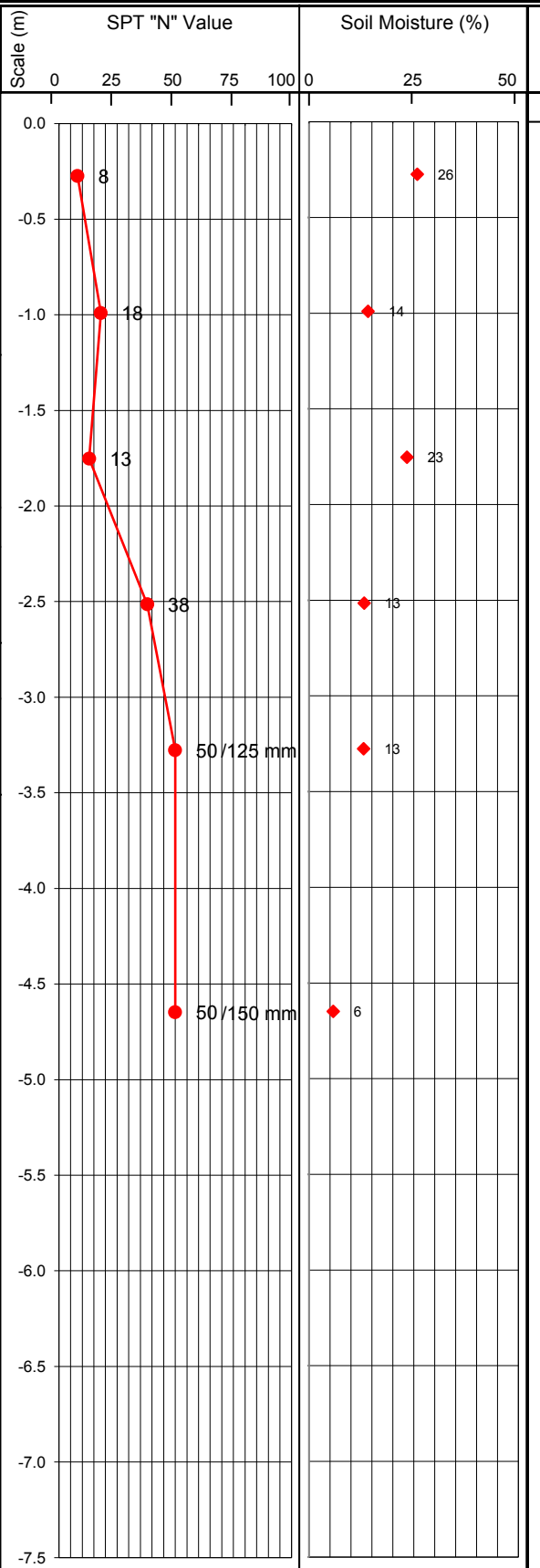
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LANDTEK LIMITED

BH 5

Project No.:	22298	Drill Date:	September 29, 2022
Project:	Proposed Asphalt Batching Plant Development	Drill Method:	[ ] solid stem [x] hollow stem [ ] vibratory
Location:	291 North Service Road, Burlington, Ontario	Datum:	Ground Surface

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	Scale (m)	SPT "N" Value	Soil Moisture (%)	GWL	Monitor Details	Test Data
Ground Surface										
±150 mm of Sand and Gravel		0.0								
FILL: silty clay, trace grey clay. Brown and red, stiff, moist.		0.2	1	SS						
			2	SS						
SILTY CLAY TILL: trace gravel, trace grey clay fragments. Brown, stiff, moist. Possible Fill.		1.5	3	SS						
SHALE BEDROCK: highly weathered, grey. Hard, dry.		2.3	4	SS						
			5	SS						
…red.			6	SS						
BOREHOLE TERMINATED AT TARGET DEPTH		4.7								



Notes:
1. Borehole open to approximately 4.5 m depth on completion.
2. Groundwater or water seepage was not encountered.

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

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LANDTEK LIMITED

BH 6

Project No.:	22298	Drill Date:	September 29, 2022
Project:	Proposed Asphalt Batching Plant Development	Drill Method:	[ ] solid stem [x] hollow stem [ ] vibratory
Location:	291 North Service Road, Burlington, Ontario	Datum:	Ground Surface

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	Scale (m)	SPT "N" Value	Soil Moisture (%)	GWL	Monitor Details	Test Data
Ground Surface										
±75 mm of Topsoil		0.0								
FILL: silty clay, trace grey clay, trace gravel, trace red brick fragments. Red, very stiff, moist.		0.2	1	SS		19	11			
			2	SS		22	11			
…no red brick fragments. Soft to firm.			3	SS		4	9			
SILTY CLAY TILL: trace gravel, trace red shale fragments. Red, hard, dry to moist.		2.3	4	SS		31	12			
SHALE BEDROCK: highly weathered, red. Hard, dry.		2.6	5	SS		44	16			
			6	SS		50/75 mm	15			
BOREHOLE TERMINATED AT TARGET DEPTH		4.7								

Scale (m): 0.0, -0.5, -1.0, -1.5, -2.0, -2.5, -3.0, -3.5, -4.0, -4.5, -5.0, -5.5, -6.0, -6.5, -7.0, -7.5

SPT "N" Value: 0, 25, 50, 75, 100

Soil Moisture (%): 0, 25, 50

Notes:
1. Borehole open to approximately 4.5 m depth on completion.
2. Groundwater or water seepage was not encountered.

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

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