TOWN OF INNISFIL

PRELIMINARY PAVEMENT INVESTIGATION AND DESIGN REPORT FOR THE UPCOMING ROADWAY IMPROVEMENT AND ACTIVE TRANSPORTATION PROJECT ON 25TH SIDE ROAD FROM BIG BAY POINT ROAD TO INNISFIL BEACH ROAD, INNISFIL, ONTARIO

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TOWN OF INNISFIL

PROJECT NO.: 211-06027-00
DATE: APRIL 8, 2021

WSP CANADA INC.
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WSP.COM

April 8, 2022

Town of Innisfil

Attention: Bobbi-Jo Duncan

Subject: Preliminary Pavement Design Report – 25th Side Road, Innisfil, ON

We are pleased to submit our final report, comprising preliminary pavement design recommendations for the rehabilitation of the upcoming 25th Side Road roadway improvement and active transportation project between Big Bay Point Road and Innisfil Beach Road, and the construction of a new roundabout at the intersection of 25th Side Road and 9th Line. A geotechnical investigation of approximately 6.92 kilometers of road has been completed. The study is based on data that was gathered during borehole exploration and lab testing in September 2021.

We trust that this report meets your present requirements. Please contact us if you have any questions.

Yours sincerely,

Mohammed Qado, P. Eng.
Pavement Engineer
WPS Canada Inc, Toronto

WSP ref.: 211-06027-00

QUALITY MANAGEMENT

ISSUE/REVISION	FIRST ISSUE	REVISION 1	REVISION 2	REVISION 3
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1 GENERAL DATA

1.1 INTRODUCTION

WSP Canada Inc. (WSP) was retained by Town of Innisfil to support the completion of geotechnical investigation and pavement design services for the upcoming roadway improvement and active transportation project on 25th Side Road from Big Bay Point Road to Innisfil Beach Road. The purpose of this pavement investigation was to determine the strength and composition of the existing pavement structure and subsoil types, as well as local groundwater conditions, and to collect samples for laboratory testing for the proposed upcoming rehabilitation work on the aforementioned project roadway, which includes the following:

- Rehabilitation/resurfacing of 25th Side Road;
- Intersection improvements along 25th Side Road;
- Construction of a new roundabout at the intersection of 25th Side Road and 9th Line;
- Construction of a new multi-use path (active transportation), as well as pedestrian sidewalks.

The following report will summarize the field investigation and laboratory findings, as well as outline preliminary pavement design recommendations based on AASHTO design methodology and traffic data inputs provided by the Town.

1.2 SITE DESCRIPTION

The existing 25th Side Road is trending in the north /south direction and extends from Big Bay Point Road southerly to Innisfil Beach Road, for a total project length of 6.92 km. The project's northern limit is located south of the Big Bay Point Road and 25th Side Road intersection in the Town of Innisfil, Ontario.

The existing road is a two-lane, two-direction roadway and can be classified as collector roadway with a posted speed limit ranging from 50 km/hr. Within the study limits the existing road is a flexible pavement with a rural cross-section (i.e. surface water drains towards ditches on either side of road crown).

It is worth mentioning that two sections of 25th Side Road have recently been resurfaced and/or patched; the two sections observed are as follows:

- southbound lane from Candaras Street to Lockhart Road for a length of approximately 2.3 km.
- southbound and northbound lanes from Lockhart Road to Big Bay Point Road for a length of approximately 2.7 km.

Site photographs are presented in **Appendix A.**

2 PHYSIOGRAPHY AND GEOLOGY

Based on available geological information (MNDM Map 2556), the physiography of this local region is generally characterized by Newmarket till (Simcoe lobe), including beach, bar, or shallow-water sediments consisting of gravel, sandy silt to silt matrix sand, and silty sand. Underlying this, the bedrock generally consists of the Limestone, dolostone, shale, arkose which is a grey shale with light grey siltstone and/or limestone interbeds. The frost penetration depth within the study area is 1.5 m based on MTO OPSD 3090.101.

3 INVESTIGATION PROCEDURES

3.1 PERMITS AND UTILITY LOCATES

The borehole and hand-dug hole locations were predetermined and established in the field by WSP personnel. The borehole and hand-dug hole locations were selected to avoid conflicts with existing above ground and underground utilities, including wind farm conduits, hydro, gas, and telecommunications using Ontario One-call.

Approval was obtained from the Town of Innisfil to carry out the fieldwork. Traffic control was provided during the investigation and was implemented in accordance with Book 7 of the Ontario Traffic Manual (January 2014).

3.2 FIELD INVESTIGATION

3.2.1 3.2.1 PAVEMENT CONDITION SURVEY

A visual condition survey was performed in August 2021 based on the Ontario Ministry of Transportation's (MTO) SP-024 guidelines. The detailed visual condition survey was carried out to classify the extent and severity of observed distresses, and to identify any particularly poor performing areas.

- Frequent slight to moderate ravelling and coarse aggregate loss;
- Intermittent slight to moderate pavement edge cracking;
- Intermittent slight to moderate random cracking;
- Few slight to moderate centreline joint and longitudinal cracking;
- Few slight to moderate alligator cracking;
- Intermittent slight to moderate wheel-path rutting;
- Intermittent slight to severe wheel-path cracking;
- Few slight flushing;
- Frequent moderate to severe longitudinal and transverse cracking; and
- Occasional asphalt patches in fair to good condition.

Generally, the sections of 25th Side Road within the project limits were observed to be in fair condition with localized areas in poor to very poor condition. Site photographs of the typical road conditions and observed distresses are presented in **Appendix A**.

3.2.2 BOREHOLE PROGRAM

Table 3-1: Borehole/Corehole Program

Road	Number of Coreholes	Number of Boreholes	Borehole Depths (m)	Number of Hand Auger Holes	Depths (m)
25th Side Road	7	14	1.5m to 2.1m	6	0.5 to 0.7

The borehole and corehole investigation were conducted on September 16, 2021. A total of fourteen (14) boreholes ranging between 1.5 m to 2.1 m depth below ground surface (bgs) and 7 coreholes were advanced through the existing road surface within the study limit to determine the type and thickness of the pavement structure. Six (6) hand-dug holes were advanced to confirm topsoil thickness for the proposed new active transportation facilities (cycle tracks, multi-use paths, and sidewalks) within the study limits.

The boreholes were advanced using a truck-mounted drilling machine equipped with solid stem augers or manual split-spoon penetration testing. Samples were retrieved from the augers of the encountered granular fill and subgrade materials, and at select locations, samples were taken with a 50 mm Outer Diameter (O.D.), split-barrel sampler driven with a hammer weighing 624 N and dropping 760 mm in accordance with the Standard Penetration Test (ASTM D 1586) method. This sampling method recovers samples from the soil strata, and the number of blows required to drive the samples 300 mm depth into the undisturbed soil (SPT 'N'-values) gives an indication of the compactness condition or consistency of the sampled soil material based on the cohesionless or the cohesive nature of the material, respectively.

Algarve Sampling Inc. performed the drilling, and a qualified WSP geotechnical engineering technician logged and retrieved samples from the borehole. Soil samples were recovered and retained in labeled air-tight containers for subsequent review by the project engineer and laboratory testing, as required. Asphalt and granular fill material thicknesses were recorded at each borehole location.

The boreholes were then promptly backfilled upon completion in conformance with Ontario Regulations 903 requirements (as amended).

The borehole log detailing the individual soil profiles are provided in **Appendix B.**

3.3 LABORATORY TESTING PROGRAM

3.3.1 GEOTECHNICAL TESTING

Select soil samples were submitted to WSP's certified soils laboratory for geotechnical testing as shown in Table 3-2. Geotechnical laboratory test results are presented on the borehole logs in **Appendix B**. A copy of the geotechnical laboratory test results is provided in **Appendix C.**

Table 3-2 Geotechnical Laboratory Testing Summary

Geotechnical Test	Procedure/Methodology	Number of Tests
Moisture Content	LS 701	40
Sieve Hydrometer of Subgrade	LS 702	6
Sieve Analysis	LS 602	6

4 SUBSURFACE CONDITIONS

4.1 GENERAL

The subsurface conditions encountered at the borehole locations are described in the following sections. The soil descriptions are based on visual and tactile observations and complemented by the results of field and laboratory testing results.

It should be noted that the subsurface conditions and the pavement thicknesses encountered might vary around and beyond the borehole location. Unless otherwise stated, all SPT 'N' values quoted are from 300 mm of penetration.

An overview of subsurface conditions is described below. All depths quoted are below the existing ground surface.

The individual borehole logs are presented in **Appendix C** and the laboratory result can be found in **Appendix D**.

4.2 EXISTING TOPSOIL

A total of six (6) test pits/hand-dug holes were advanced through the existing grass surface along the proposed trail and topsoil was encountered. The topsoil thickness ranged from 100 mm to 400 mm, with an average thickness of 225 mm. The measured thicknesses of the encountered topsoil are presented in Table 4-1 below.

Table 4-1 Existing Topsoil Thicknesses

Test-pit ID	Offset	Thickness (mm)
HD1	7.7m W of C/L	300
HD2	8.5m E of C/L	150
HD3	8.2m W of C/L	100
HD4	7m E of C/L	300
HD5	8.8 m E of C/L	400
HD6	9m W of C/L	100
	Average Thickness:	**225**

4.3 EXISTING PAVEMENT STRUCTURE

In general, a flexible pavement structure (asphalt over granular fill material) was encountered within the study limits of 25th Side Road. The existing pavement structure along the subject roadway was measured and recorded from the advanced boreholes. The measured asphalt, granular thicknesses were noted and are presented in the table below.

Table 4-2 Existing Pavement Structure Layer Thicknesses Mainlanes

Borehole ID	Asphalt Thickness (mm)	Granular Base Thickness (mm)	Granular Subbase Thickness (mm)	Total Pavement Structure Thickness(mm)
Main lanes				
BH1	100	180	270	550
BH2	170	180	320	670
BH3	150	200	300	650
BH4	160	200	300	660
BH5	160	360	300	820
BH6	130	180	300	610
BH7	125	200	325	650
BH8	130	180	300	610
BH9	180	190	300	670
BH11	100	180	220	500
BH12	120	170	330	620
BH14	100	180	220	500
Range	**100-180**	**170-360**	**220-325**	**500-820**
Average	**135**	**200**	**290**	**625**
Shoulder				
BH10	N/A	170	300	470
BH13	N/A	180	300	480
Range	N/A	**170-180**	**300**	**470-480**
Average	N/A	**175**	**300**	**475**

The complete results of the coring program conducted in August 2021 are provided in Table 4-3 below.

Table 4-3 Existing Asphalt Base Thicknesses

Corehole ID	Thickness (mm)
CH1	125
CH2	120
CH3	120
CH4	190
CH5	80
CH6	160
CH7	80
Range:	**80-190**
Average:	**125**

4.3.1 CHARACTERISTICS OF EXISTING GRANULAR MATERIAL

4.3.1.1 GRANULAR BASE

Granular base was encountered in the advanced boreholes directly below the asphalt, with an average thickness of 200mm. The granular material was generally found to be gravelly sand, trace soil fines (silt and clay sized particles) and brown in colour. The measured moisture content ranged from 1 to 4 %, with an average moisture content of 3%.

As noted in Table 4-2, two boreholes, BH10 and BH13, were advanced on the gravel shoulder of the 25th Side Road, and the granular base at these locations varied from 170 to 180 mm, with an average of 175 mm. The granular base encountered in each borehole consists of sand and gravel. The measured moisture content ranged from 3 to 4%, with an average moisture content of 3.5%.

Two (2) laboratory particle size distribution analyses were conducted on samples recovered from the granular base under the travel lanes. The results are provided in Table 4-4.

Table 4-4 Granular Fill Particle Size Distribution Analysis Results

BH No.	Sample No.	Location	Gravel (%)	Sand (%)	Fines (%)	Soil Classification	Acceptability – OPSS Granular A	Acceptability – OPSS Granular B Type I
BH2	AS1	NBL	39	56	5	Gravelly sand, trace soil fines	Not Acceptable	Acceptable
BH6	AS1	NBL	30	62	8	Gravelly sand, trace soil fines	Not Acceptable	Acceptable

The results of the sieve analyses were compared against the gradation requirements in Ontario Provincial Standards and Specifications (OPSS) 1010 for Granular A and Granular B Type I. Generally, the tested samples were found to not meet the requirements of Granular A due to a high percentage of finer materials, and the samples were found to meet the requirements of Granular B Type I.

The results of the particle size distribution curve are provided in **Appendix C**.

4.3.1.2 GRANULAR SUBBASE

Granular subbase was encountered in the advanced boreholes directly below the granular base under the existing pavement, with an average thickness of 290mm. The subbase material was generally found to be gravel and sand, with trace soil fines (silt and clay sized particles) and brown in colour. The measured moisture content ranged from 1 to 4%, with an average moisture content of 3%.

The granular subbase (below the granular base) encountered in the two boreholes advanced on the gravel shoulder (BH 10 and BH 13) has a thickness of about 300 mm and it consists of sand with gravel and soil fines (silt and clay-sized particles).

Three (3) laboratory particle size distribution analyses were conducted on samples recovered from the granular subbase (two from under the travel lanes and one from under the gravel shoulder). The results are provided in Table 4.5.

Table 4-5 Granular Fill Particle Size Distribution Analysis Results

BH No.	Sample No.	Location	Gravel (%)	Sand (%)	Fines (%)	Soil Classification	Acceptability – OPSS Granular A	Acceptability – OPSS Granular B Type I
BH4	AS2	NBL	54	42	4	Sand and gravel, trace soil files	Acceptable	Acceptable
BH9	AS2	SBL	42	54	4	Sand and gravel, trace soil files	Not Acceptable	Acceptable
BH13	AS2	SB-SH	27	58	21	Sand with gravel and soil fines	Not Acceptable	Not Acceptable

The results of the sieve analyses were compared against the gradation requirements in Ontario Provincial Standards and Specifications (OPSS) 1010 for Granular A and Granular B Type I. Generally, just one tested sample, BH4-AS2, was found to fulfil the requirements of Granular A and only BH4 and BH9 tested samples were found to match the requirements of Granular B Type I.

The results of the particle size distribution curve are provided in **Appendix C**.

4.4 SUBGRADE MATERIALS

4.4.1 *SAND*

A deposit of sand with a trace to some gravel, silt and clay was encountered below the granular subbase in all the boreholes, except BH 1 and BH5, at a depth ranging from 0.47m to 0.8m and was present up to borehole termination depth.

The measured moisture content ranged from 2 to 22%, with an average moisture content of 11%. The SPT N-Values ranged between 5 and 24 blows for 300 mm of penetration, indicating a loose to compact state of compactness.

Four (4) representative samples of the subgrade were selected for particle size analysis. Laboratory testing results from the particle size analysis indicated the following:

Table 4-6 Granular Fill Particle Size Distribution Analysis Results

BH No.	Sample No.	Location	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Soil Classification
BH3	SS3	SBL	15	76	7	2	Sand, some gravel, trace silt, trace clay
BH7	SS3	SBL	0	69	20	11	Sand, some silt, some clay
BH12	SS3	NBL	6	86	5	3	Sand, trace gravel, trace silt, trace clay
BH14	SS3	NBL	5	82	9	4	Sand, trace gravel, trace silt, trace clay

Based on the particle size distribution, the subgrade materials are generally found to be of low susceptibility to frost heaving (LSFH).

The results of the laboratory testing are presented in **Appendix D.**

4.4.2 *SILTY CLAY*

A deposit of silty clay with a trace to some gravel and sand was encountered below the granular subbase in Boreholes BH 1 and BH5 at a depth ranging between 0.52m to 0.66m and was present up to borehole termination depth.

The measured moisture content ranged from 14 to 24%, with an average moisture content of 19%. The SPT N-Values were recorded between 4 and 7 blows for 300 mm of penetration, indicating a firm consistency. Additionally, due to the impervious condition of the subgrade in the area of BH1 and BH5, consideration should be given to delineating the silty clay subgrade during the detailed design phase.

Two (2) representative samples of the subgrade were selected for particle size analysis. Laboratory testing results from the particle size analysis indicated the following:

Table 4-7 Granular Fill Particle Size Distribution Analysis Results

BH No.	Sample No.	Location	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Soil Classification
BH1	SS3	SBL	1	19	41	39	Silty clay, some sand, trace gravel
BH5	SS3	SBL	0	13	50	37	Silty clay, some sand

Based on the particle size distribution, the subgrade materials are generally found to be of low susceptibility to frost heaving (LSFH). The results of the laboratory testing are presented in **Appendix D.**

4.4.3 *SUBGRADE PERMEABILITY*

The permeability (i.e. hydraulic conductivity) of the subgrade is estimated by comparing the particle size distribution curves of the subject material with established permeability correlation data (Hazen's D10 Permeability). Table 4-8 presents the subgrade permeability of the encountered subgrade soil samples.

Table 4-8 Subgrade Permeability Values

BH No.	Sample No.	Soil Type	Permeability (m/s)	Comment
BH3	SS3	Sand, some gravel, trace silt, trace clay	1×10^{-4}	Medium permeability
BH12	SS3	Sand, trace gravel, trace silt, trace clay	8×10^{-5}	Medium to low permeability
BH1	SS3	Silty clay, some sand, trace gravel	10^{-8} to 10^{-10}	Impermeable
BH5	SS3	Silty clay, some sand	10^{-8} to 10^{-10}	impermeable

4.4.4 *FROST SUSCEPTIBILITY*

Based on the laboratory testing performed on the subgrade soil materials observed within the project limits, the soils were considered to be of low susceptibility to frost heave (LSFH).

4.5 25TH SIDE ROAD AND 9TH LINE ROUNDABOUT

4.5.1 EXISTING PAVEMENT STRUCTURE

Peto MacCallum Ltd. (PML) conducted a geotechnical investigation in 2018 on the 9th Line between Ralph Street and Lake Simcoe, a total of 12 boreholes were drilled to a depth of 2 m. For the preliminary design of the roundabout, the recommended pavement design will be based on the findings of BH 17 from the PML geotechnical investigation report (18BF060) dated February 19, 2019, which was drilled approximately 30 metres east of the intersection. From BH 17, the existing pavement structure along the subject roadway was measured and its log is presented in Appendix C. The asphalt and granular thicknesses measured were recorded and are included in the table below. Additional drilling and testing were not planned for this assignment since the data obtained from the PML report is sufficient for developing a preliminary pavement design; however, additional boreholes and/or testing may be required if a detailed design is required.

Table 4-9 Existing Pavement Structure Layer Thicknesses

Borehole ID	Asphalt Thickness (mm)	Granular Base Thickness (mm)	Granular Subbase Thickness (mm)	Total Pavement Structure Thickness (mm)
9TH LINE				
BH 17	70	150	280	500

4.5.2 CHARACTERISTICS OF EXISTING GRANULAR MATERIAL

4.5.2.1 GRANULAR BASE

Granular base was encountered in the advanced boreholes directly below the asphalt, with a thickness of 150mm.

4.5.2.2 GRANULAR SUBBASE

Granular subbase was encountered in the advanced boreholes directly below the granular base, with a thickness of 280mm.

below the granular subbase in BH 17 at a depth of 0.5m and was present up to borehole termination depth (2m).

4.5.3 SUBGRADE MATERIALS

A deposit of sand with a trace to some gravel, silt was encountered below the granular subbase in BH 17 at a depth of 0.5m and was present up to borehole termination depth (2m).

4.6 GROUNDWATER CONDITION

Groundwater was not encountered during the investigation, and all of the boreholes remained open and dry upon completion. It should be noted that the groundwater levels can vary and are prone to seasonal fluctuations in response to major weather events.

5 PAVEMENT STRUCTURE

5.1 25TH SIDE ROAD - PAVEMENT STRUCTURE DESIGN VALUES

Based on the values shown in Table 4-3, the chosen design values to represent the existing pavement structure are as follows:

- **Asphalt Thickness:** *125mm
- **Granular Base Thickness:** 200mm
- **Granular Subbase Thickness:** 290mm
- **Total Pavement Structure Thickness:** 615mm
- **Subgrade Type:** Mostly sand, except in areas of BH1 and BH5 where silty clay was observed.

*Average core thickness was considered during design.

It should be noted and stressed that the above design values are based on a limited investigation which included fourteen (14) boreholes and seven (7) asphalt cores. Although the borehole location was chosen based on what appeared to be representative conditions on the surface, the pavement structure and soil types within the site limits may differ from those described in this report. Any contractor performing rehabilitation activities on this roadway is advised to confirm and supplement the data presented herein.

Existing Structural Numbers

The existing pavement structure SN (structural number) for 25th Side Road was calculated using the following inputs:

- Existing Asphalt: 0.25
- Existing Granular A: 0.11
- Existing Granular B: 0.08
- Drainage Coefficient for Base: 1.0

Using the design values presented above, the existing SN is 76.

5.1.1 EQUIVALENT SINGLE AXLE LOADS

Traffic data was provided by the Town of Innisfil, and the traffic inputs selected for the pavement design analysis are presented below in Table 5-1.

Table 5-1: Adopted Traffic Inputs

AADT Year	Average Annual Daily Traffic (AADT)	% Growth	% Truck Vehicles
25th Side Road			
2019	3768[1]	2	4
25th Side Road and 9th Line Roundabout			
2019	4224[2]	2	4

1. An average AADT was considered for the pavement design of 25th Side Road since it is applicable for 65% of the project length.
2. The highest AADT of the four legs was used for the pavement design of the 25th Side Road and 9th Line Roundabout.

Truck factors for major vehicle classes were assigned, as presented in the Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions, 2008. The factors assigned to each vehicle are presented in the table below, along with the percentage distributions obtained from the provided traffic data, which was used to calculate the total truck factor.

Table 5-2: Truck Factor

Truck Category	Average Truck Distribution (%)	Typical Truck Factor	Resultant Truck Factor Fraction
Buses	30	2.0	0.6
2 and 3-axle trucks	50	0.5	0.25
4-axle trucks	5	2.3	0.115
5-axle trucks	10	1.6	0.16
6-axle trucks	5	5.5	0.275
Total Truck Factor			**1.4**

Table 5-3 shows the input parameters used to compute ESALs for 25th Side Road and the planned roundabout:

Table 5-3: ESAL Design Inputs

Base year AADT[1]	Commercial (%)	Avg. Truck Factor	DD[2]	Annual Traffic Growth (%)[3]	LD[4]	20-Yr Design Life Cumulative ESAL's
25th Side Road						
4079	4	1.4	0.5	2	1	1,100,000
25th Side Road and 9th Line Roundabout						
4572	4	1.4	1	2	1	2,300,000

1. Base Year = 2023
2. Directional Distribution
3. Annual Growth Rate
4. Lane Distribution Factor

5.2 PAVEMENT REHABILITATION DESIGN

The new flexible pavement structure thickness design for the design lane was determined using the AASHTO design method and the Town of Innisfil Minimum Pavement Structure Standards (May 2021). Input parameters are shown in the Table below, and the design output sheets are presented in **Appendix B**. Cumulative ESALs are presented for a variety of expected design life values.

Table 5-4: Input Parameters for New Flexible Pavement Structure Calculations

Route	Initial/Terminal Serviceability	Cumulative ESAL's		Subgrade Modulus
25th Side Road	$p_i = 4.4$ $p_t = 2.2$	5 Year	300,000	30 (Fair condition)
		10 Year	500,000	
		15 Year	800,000	
		20 Year	1,100,000	
25th Side Road and 9th Line Roundabout	$p_i = 4.5$ $p_t = 2.3$	5 Year	500,000	30 (Fair condition)
		10 Year	1,100,000	
		15 Year	1,700,000	
		20 Year	2,300,000	
Reliability and Standard Deviation: R=85%; S=0.49				

The required SN (Structural Number) values for the rehabilitation area are based on the AASHTO design method for flexible pavement. For the input parameters considering the LSFH soil subgrade, the required SN is shown in Table 5-5 below:

Table 5-5: Required SN for 5, 10, 15 and 20 Year Design Life – 25th Side Road

Design Life	Required SN
25th Side Road	
5 Years	79
10 Years	89
15 Years	95
20 Years	99
25th Side Road and 9th Line Roundabout	
5 Years	89
10 Years	100
15 Years	106
20 Years	112

As indicated in Table 5-5 and the existing Structural Number (SN) given, the existing pavement on 25th Side Road is structurally inadequate to withstand the predicted traffic volumes on the subject route for the next 20 years. Section 5.3 below discusses rehabilitation strategies and their associated design lives.

5.3 25TH SIDE ROAD - PAVEMENT REHABILITATION OPTIONS

The following Sections 5.3.1, 5.3.2 and 5.3.3 present pavement rehabilitation options for 25th Side Road. The following structural layer coefficients have been chosen based on the MTO publication MI-183 *'Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions'* and *'Procedures for Estimating Traffic Loads for Pavement Design, 1995'.*

- New Hot Mix Asphalt: 0.42
- Existing Hot Mix Asphalt: 0.25
- New Granular A: 0.14
- Existing Granular A: 0.11
- New Granular B Type I: 0.09
- Existing Granular B Type I: 0.08
- Drainage Coefficient for Granular Material: 1.0

AASHTO Design Outputs are presented in **Appendix C.**

5.3.1 OPTION 1 - MILL 60MM AND PAVE 60MM

Milling of 60 mm of the existing asphalt and paving 60 mm of new hot-mix asphalt may be performed to temporarily restore the rideability of the pavement surface. This option should be considered a holding strategy as it is at risk of premature failure in areas of moderate to severe distress. This option will maintain the existing pavement grade. The resultant pavement structure is presented below:

Table 5-6: Option 1 Summary Pavement Structure

Depth	Thickness (mm)
New Asphalt	60
Existing Asphalt	65
Existing Granular Base	200
Existing Granular Subbase	290
Total Thickness	**615**

The above pavement rehabilitation has an estimated design life of 8 years based on the AASHTO 1993 design methodology (SN of 87), with a high likelihood of premature asphalt cracking reflecting in areas of weak base support or where existing cracks have penetrated deeper than the asphalt surface course.

5.3.2 OPTION 2 – PARTIAL DEPTH RECONSTRUCTION

Partial-depth reconstruction of 25th Side Road is where the existing asphalt and some of the granular base will be replaced with new materials. This design relies on the full depth removal of the existing asphalt and underlying granular materials to a maximum depth of 270 mm, installing 150 mm of new Granular A, and paving with 120 mm of new hot mix. The resultant pavement structure is presented below:

Table 5-7: Option 2 Summary Pavement Structure

Depth	Thickness (mm)
New Asphalt	120
New Granular A	150
Existing Granular Subbase	345
Total Thickness	**615**

The above pavement rehabilitation has an estimated design life of 15 years under ideal conditions based on the AASHTO 1993 design methodology (SN of 99). This strategy will address all the distresses and replace some of the granular base and subbase materials, which can improve the overall strength and subsurface drainage. This option will maintain the existing pavement grade. Furthermore, this strategy will allow for the exposure of the granular base and identify soft areas that warrant improvement.

5.3.3 OPTION 3 – FULL DEPTH RECONSTRUCTION - TOWN OF INNISFIL

Full-depth reconstruction of 25th Side Road is where the existing asphalt and all of the granular materials will be replaced with new materials as recommended in the Town of Innisfil Engineering Design Standards and Specification, Section 2.0. This design relies on the full depth removal of the existing asphalt and underlying granular materials and installing 400mm of new Granular B, 150mm of new Granular A, and paving with 100mm of new hot-mix asphalt. The resultant pavement structure is presented below:

Table 5-8: Option 3 Summary Pavement Structure

Depth	Thickness (mm)
New Asphalt	100
New Granular A	150
New Granular B Type I	400
Total Thickness	**650**

The above pavement design has an estimated design life of 20 years under ideal conditions based on the Town of Innisfil Engineering Design Standards and Specifications, Section 2.0 (SN of 99). This strategy will address all the cracking distresses and replace all of the granular base and subbase materials, which can improve the overall strength and subsurface drainage.

5.3.4 OPTION 4 – FULL DEPTH RECONSTRUCTION – MTO MANUAL

The AASHTO and Town of Innisfil design methods were compared against the MTO routine method for flexible pavement design. The subject road is classified as a minor collector, with an AADT of 3768. From Table 3.3.2 (Structural Design

Guidelines for Flexible Pavements), the pavement structure thickness recommended for an estimated 20-year design life is shown in Table 5-9.

When comparing the AASHTO and MTO routine methods, the MTO method recommends a greater pavement structure for 25th Side Road.

Table 5-9: Option 4 Summary Pavement Structure

Depth	Thickness (mm)
New Asphalt	130
New Granular A	150
New Granular B	450
Total Thickness	**730**

The above pavement design has an estimated design life of 20 years under ideal conditions based on the MTO Manual Design Standards and Specifications (SN of 116). This strategy will address all the cracking distresses and replace all of the granular base and subbase materials, which can improve the overall strength and subsurface drainage. It should be noted, however, that this design will result in a roughly 100mm grade raise, which may not be appropriate given the number of driveways along this roadway.

5.4 DESIGN CONSIDERATIONS

Each of the above presented rehabilitation options considered the following:

- Pavement surface condition;
    - Fair to Poor with frequent to extensive, moderate to severe pavement distresses;
- Existing pavement type:
    - Flexible Pavement (Asphalt and Granular)
    - Presence of unacceptable granular base material underneath the existing HMA.
    - Inadequate thickness of acceptable granular materials underneath the existing HMA.
- Existing pavement structural layers at the investigated location;
    - Existing Pavement Structure is structurally deficient to accommodate the projected future traffic.
- Alignment of the existing roadway:
    - Within the study limits, the 25th Side Road will be urbanized, and as a result, the roadway's alignment may shift slightly, limiting pavement/reconstruction strategies.
- Subgrade soils;
    - Sand and silty clay – subgrade M_R of 30 MPa assigned.
- Traffic Loading Requirements;
    - Mainly 2 & 3-axle trucks and bus traffic.

- Quality of existing granular materials;
  - Failed to meet Granular A (OPSS 1010) and Marginally Acceptable as Granular B Type I based on the tested material underneath the flexible pavement structures of AS1 and not acceptable as Granular B Type I based on the tested material of AS2 (OPSS 1010).
- Frost susceptibility of subgrade soils; and
  - Low susceptibility to frost heave (LSFH)
- Traffic Category (Minimum); and
  - B – 0.3 to 3 million ESALs (PDRG, 2019)
- Asbestos Content
  - Not tested.

5.5 LIFECYCLE COST ANALYSIS

The three pavement design options outlined for 25th Side Road were evaluated based on a 30-year lifecycle cost model as outlined in the City's Pavement Design and Rehabilitation Guidelines (2019). The lifecycle cost analysis model is the simplified LCCA method developed by the Ministry of Transportation. The model used representative cost-per-unit analysis to determine an estimated initial capital expenditure followed by rehabilitation and maintenance costs over a 30-year time horizon over the project limits of 6920m of 25th Side Road of two-lane pavement with lane widths of 3.5 m.

Costs used for comparison are representative and based on historical data, and may need to be adjusted, if required. Using a standard discount rate of 5%, capital expenditures were adjusted using the present-worth method for all three design options and compared. The following Table displays the summarized initial estimated expenditure for each option along with the 30-year lifecycle cost, ranked by lowest total lifecycle cost, with the full analysis presented in Appendix H.

Table 5-10: LIFECYCLE COST ANALYSIS

Rank	Design	Estimated Design Life	Initial Estimated Construction Cost	30 Year Lifecycle Cost	Cost Differential Between Options
25th Side Road					
1	Option 1- One Lift 60mm Mill and Overlay	8	$1,144,482	$2,829,371	-
2	Option 2- Partial Depth Reconstruction	15+	$2,266,624	$2,888,270	+2%
3	Option 3- Full Depth Reconstruction	20	$2,714,190	$3,600,834	+26%
4	Option 4- Full Depth Reconstruction- MTO Manual	20	$3,071,571	$4,209,039	+48%

Based on a lifecycle cost analysis, Design Option 1 is the most cost-effective option over this time horizon, whereas Design Option 2 being within 2% of this cost. It is worth mentioning that given the upcoming urbanization of the 25th Side Road, Option 1 may be deemed unfeasible due to the likelihood of a slight alteration in the alignment of the existing roadway. Additionally, Option 1 has a lower service life and will require a higher number of localized spot repairs in the long term.

5.6 PRELIMINARY PAVEMENT RECOMMENDATIONS

Based on the results of the visual condition survey, the lifecycle cost analysis and the field investigation findings, it was determined that Option 2- partial depth reconstruction is the optimal option for 25th Side Road.

As a result of the factors noted above, the reconstruction is recommended to proceed as follows:

- Remove existing pavement structure to a depth of 270 mm.
- Place 150 mm new Granular 'A' (OPSS 1010);
- Pave 70 mm SP 19.0 for Base Asphalt; and
- Pave 50 mm SP 12.5 for Surface Course.

The above pavement reconstruction will result in an estimated pavement service life of up to 15 years. The final reconstructed pavement structure is listed below:

Table 5-11: 25th Side Road – Recommended Pavement Profile (sand subgrade)

Component	Material Thickness
New Asphalt Surface Course	50 mm
New Asphalt Base Course	70 mm
New Granular 'A' Base	150 mm
Existing Granular Subbase	345 mm
Total	**615 mm**

In areas where minor widening is planned, the new pavement should be constructed as follows:

Table 5-12 25th Side Road – Recommended Pavement Profile - Road Widening (sand subgrade)

Component	Material Thickness
New Asphalt Surface Course	50 mm
New Asphalt Base Course	70 mm
New Granular 'A' Base	150 mm
New Granular 'B Type I' Subbase	350 mm
Total	**620 mm**

Furthermore, it is recommended that a thicker asphalt be used in areas where a silty clay subgrade was observed, as was the case in BH1 and BH5. As a result of the factors noted above, the reconstruction is recommended to proceed as follows:

- Remove existing pavement structure to a depth of 320 mm.
- Place 150 mm new Granular 'A' (OPSS 1010);
- Pave 120 mm SP 19.0 for Base Asphalt; and
- Pave 50 mm SP 12.5 for Surface Course.

The following table summarizes the final pavement structure reconstruction in the silty clay subgrade areas:

Table 5-13 25th Side Road – Recommended Pavement Profile (silty clay subgrade)

Component	Material Thickness
New Asphalt Surface Course	50 mm
New Asphalt Base Course	120 mm
New Granular 'A' Base	150 mm
Existing Granular Subbase	295 mm
Total	**615 mm**

In areas where minor widening is planned, the new pavement should be constructed as follows:

Table 5-14 25th Side Road – Recommended Pavement Profile - Road Widening (silty clay subgrade)

Component	Material Thickness
New Asphalt Surface Course	50 mm
New Asphalt Base Course	120 mm
New Granular 'A' Base	150 mm
New Granular 'B Type I' Subbase	350 mm
Total	**670 mm**

The above pavement strategy assumes that the subgrade has been adequately prepared. It is recommended that qualified geotechnical personnel be retained to complete an inspection of the subgrade and placement of new granular during construction prior to placement of any hot-mix asphalt, or an approved geotextile/geogrid material installed, if required.

5.7 25TH SIDE ROAD AND 9TH LINE ROUNDABOUT

The Town of Innisfil provided the traffic data. The 2019 AADT between James Street and the 9th Line (North Leg) was 4224, as was the AADT between the 9th Line and William Street. The pavement structure is designed using the BH 12 borehole drilled on 25th Side Road by WSP and the BH 17 borehole drilled on the 9th Line by PML. The input values required to compute ESALs for the roundabout are identical to those used for 25th Side Road design, with an AADT of 4224.The following flexible pavement structure is recommended for the new proposed 25th Side Road and 9th Line roundabout:

Table 5-15 25th Side Road & 9th Line Roundabout – Recommended Pavement Profile

Component	Material Thickness
New Asphalt Surface Course	50 mm
New Asphalt Base Course	140 mm
New Granular 'A' Base	150 mm
Existing Granular Subbase	160 mm
Total	**500 mm**

5.8 SIDEWALKS

Based on the six (6) hand auger holes (HD1 to HD6) drilled in the ditch, the site's existing subgrade soils range from sand to sand and gravel. The Town of Innisfil requires that sidewalks adhere to the OPSD 310.010 Standard and should be constructed in the following manner:

— Excavate to a depth of 300 mm

— Place 150 mm new 19mm Granular 'A' Crusher Run Limestone; and

— Place 150 mm new Portland Cement Concrete.

Table 5-16 Sidewalk- Recommended Pavement Profile

Component	Material Thickness
New Portland Cement Concrete (PCC)	150 mm
New Granular 'A' or 19mm Crusher Run Limestone	150 mm
Total	**300 mm**

5.9 MULTI-USE PATH AND CYCLE TRACK PAVEMENT STRUCTURE

Based on the limited six (6) hand auger holes (HD1 to HD6) drilled in the ditch, the existing subgrade soils present at the site are sand to sand and gravel. The recommended pavement structure for the Multi-Use Path is listed below:

Table 5-17: Recommended Flexible Pavement Structure – Multi-Use Path

Layer Material Type	Material Thickness
New Asphalt Surface Course	40 mm
New Asphalt Base Course	60 mm
New Granular 'A' or 19mm Crusher Run Limestone	200 mm
Total Pavement Structure	**300 mm**

5.10 MATERIALS, STANDARDS AND SPECIFICATIONS

The following materials, standards and specifications are considered acceptable for the rehabilitation of 25th Side Road & Construction of the Roundabout:

5.10.1 ASPHALT

For this project, the following hot mix asphalt types are considered suitable for use:

- Surface Course – SuperPave 12.5; and
- Binder Course – SuperPave 19.0.

New asphalt materials should meet the requirements of OPSS.MUNI 310 (Nov 2017), OPSS.MUNI 1101 (Nov 2016), OPSS.MUNI 1151 (Apr 2018) and be compacted to a minimum of 92 percent of the Maximum Relative Density (MRD) for asphalt materials.

PGAC 58-34 is recommended for hot mix asphalt courses.

5.10.2 GRANULAR BASE AND SUBBASE

The granular base and subbase materials shall meet the OPSS 1010 gradation requirements for Granular 'A'/19mm Crusher Run Limestone and Granular B Type I/50mm Crusher Run Limestone, respectively. The granular base and subbase should be compacted to 100% of Standard Proctor Maximum Dry Density (SPMDD).

Quality testing of all new aggregate imported to site during construction should be completed to ensure that all material adheres to OPSS specification. Granular should be laid in accordance with OPSS.MUNI 314 (Nov 2015).

5.10.3 TACK COAT

Tack coat shall be applied to the binder course or milled asphalt surface before paving, as per OPSS.PROV 308.

5.11 RECYCLING AND RE-USE OF MATERIAL

Asphalt removed from the roadway should be considered (pending testing and approval) for RAP (Reclaimed Asphalt Pavement).

Granular materials removed from the roadway may be considered acceptable for re-use as Granular B Type I in particular areas (see table 4-5). All such materials shall be removed and stockpiled on-site for reuse, except in locations where the subbase was determined to be unsuitable (table 4-5) and shall be replaced with new materials according to OPSS 1010.

5.12 PAVEMENT TRANSITIONS

All longitudinal and transverse joints should meet the requirements of OPSS 313. All longitudinal joints should be staggered between asphalt lifts. Staggering of the longitudinal joints should be constructed by offsetting the paving edge of the surface and binder course by a minimum of 150 mm. Transitions in between existing and new granular base and/or subbase where required should be completed at a minimum 10H: 1V taper.

5.13 DRAINAGE IMPROVEMENTS

The structural performance of pavements is dependent on the provision of sufficient subsurface and surface drainage. According to our findings, the project roadway overall surface and subsurface drainage is generally adequate, although few areas were noted to have flat pavement grades and shallow ditches, which may obstruct the proper drainage of the pavement structure on the project roadway. The current subsurface materials are of fair to poor quality and the subgrade soils are water-sensitive, poor subsurface drainage contributes to frost-heave/settlement and pavement distress.

Water can be drained at regular intervals (about every 50 metres, where feasible) from the granular beneath the new active transportation facility into the nearby road's subdrain, which then channels water into the newly built subdrains beside the Multi-Use Path. Consider the presence of impervious silty clay subgrade in BH1 and BH5, which must be delineated during the detailed design phase (i.e. further investigation).

The surface of the completed pavement should be provided with a minimum centre-to-edge cross fall of 2 percent and the subgrade surface under the pavement should also be provided with a minimum centre-to-edge cross fall of 2 percent.

5.14 TESTING AND INSPECTIONS

It is recommended that geotechnical testing and inspections be carried out during construction operations to confirm construction is in accordance with the project specifications and design assumptions. Testing and inspections should include road subgrade proof-rolling inspections where applicable, compaction testing, monitoring of asphalt/concrete placement, etc.

6 LIMITATIONS

The comments given in this report are intended for the guidance of design engineers. It should be noted that the pavement design recommendations are based on the advancement of fourteen (14) boreholes, 7 coreholes and 6 hand augers. The number of boreholes required to determine the localized underground conditions between boreholes affecting construction costs, techniques, sequencing, equipment, scheduling, etc., may be greater than has been carried out for current purposes. Contractors bidding on or undertaking the work shall, in this light, decide on their own investigations, as well as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them. Prior to construction of the pavement structure, it is recommended that a qualified geotechnical engineer or experienced engineering technician should inspect the condition of the exposed granular base.

Some of the traffic data, including truck distribution and growth rate were estimated. The estimated values should be confirmed, and designs should be re-evaluated by a qualified Pavement Engineer.

Information in this report shall not be used by third parties without WSP's permission.

We trust that the information contained in this report is satisfactory. Should you have any questions, please do not hesitate to contact us.

APPENDIX

A

SITE PHOTOS

Figure A.1 25th Side Road, northbound lane, facing north. Showing frequent medium to high severity edge cracking associated with medium severity transverse construction joint cracking along asphalt patch, slight wheel-path flushing. [CS, August 2021]

Figure A.2 25th Side Road, southbound, facing north. Showing medium to high severity alligator cracking and potholing, frequent slight wheel-path flushing, medium severity ravelling and coarse aggregate loss. [CS, August 2021]

Figure A.3: 25th Side Road, southbound, facing north. Showing frequent medium to high severity edge cracking associated with medium to high severity ravelling and coarse aggregate loss. Medium wheel-path flushing. [CS, August 2021]

Figure A.4: 25th Side Road, northbound, facing north. Showing low to medium severity longitudinal/Transverse cracking. Low severity raveling and coarse aggregate loss. [CS, August 2021]

Figure A.5: 25th Side Road, northbound, facing north. Showing medium to high severity edge cracking associated with medium severity alligator cracking. [CS, August 2021]

Figure A.6: 25th Side Road, off shoulder, facing west. Showing low to medium severity edge cracking, slight wheel path rutting, medium severity patching, low to medium severity construction joint cracking. [CS, August 2021]

Figure A.7: 25th Side Road, northbound, facing north. Showing low severity edge cracking. [CS, August 2021]

Figure A.8: 25th Side Road, northbound, facing west. Showing medium severity ravelling and coarse aggregate loss, slight wheel-path rutting and low severity longitudinal and transverse cracking. [CS, August 2021]

Figure A.9: 25th Side Road, northbound, facing south. Showing frequent low to medium pavement edge cracking associated with medium to high severity ravelling and coarse aggregate loss. Medium wheel-path flushing, slight wheel path rutting. [CS, August 2021]

Figure A.10: 25th Side Road, east off- shoulder, facing west. Showing frequent medium to high edge cracking associated with medium severity transverse construction joint cracking along asphalt patch. Medium severity patching and medium to high severity alligator cracking. [CS, August 2021]

Figure A.11: 25th Side Road, southbound, facing east. Showing medium to high severity edge cracking, medium severity alligator cracking, medium severity ravelling and coarse aggregate loss. [CS, August 2021]

APPENDIX

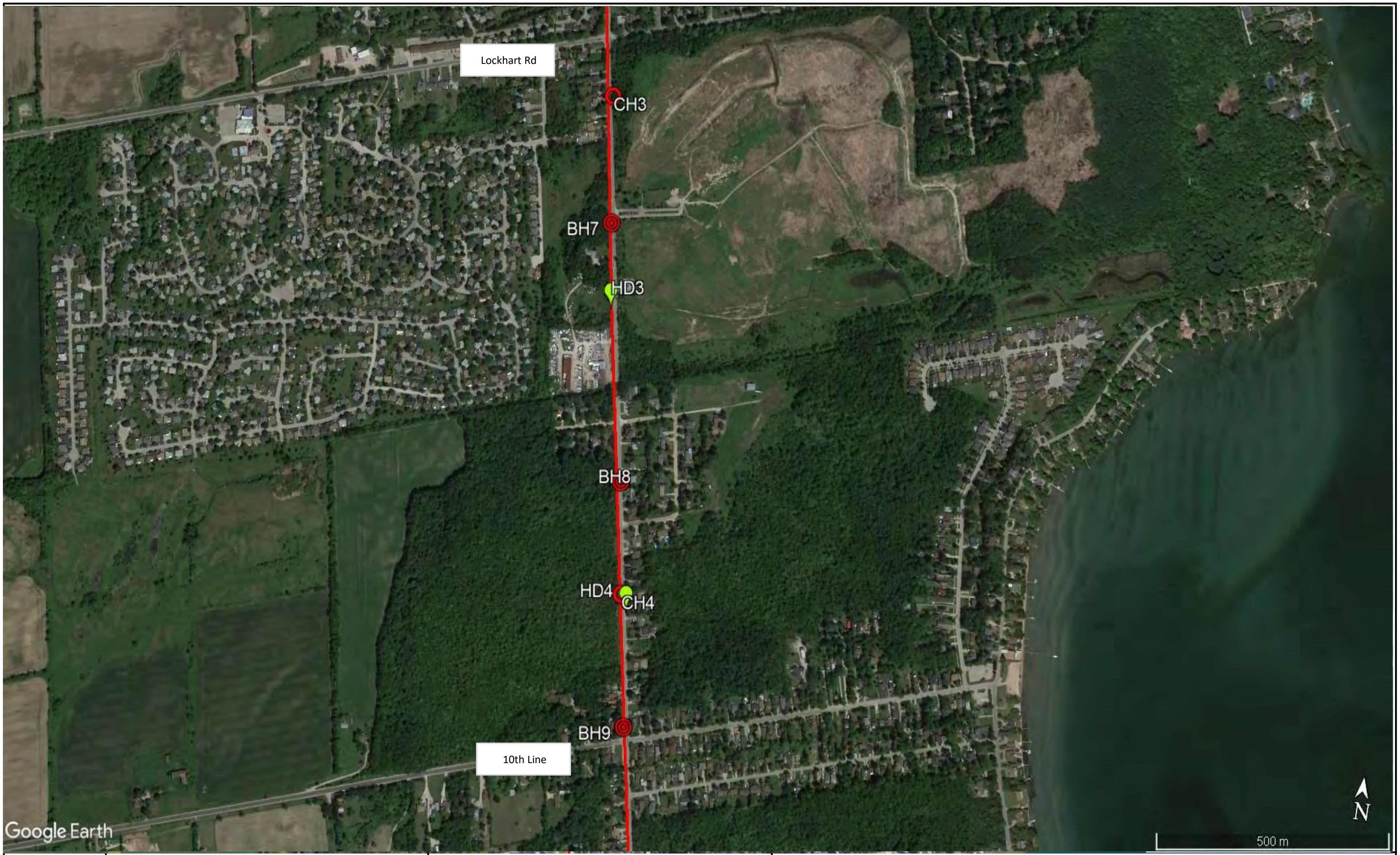
B

BOREHOLE LOCATION PLAN

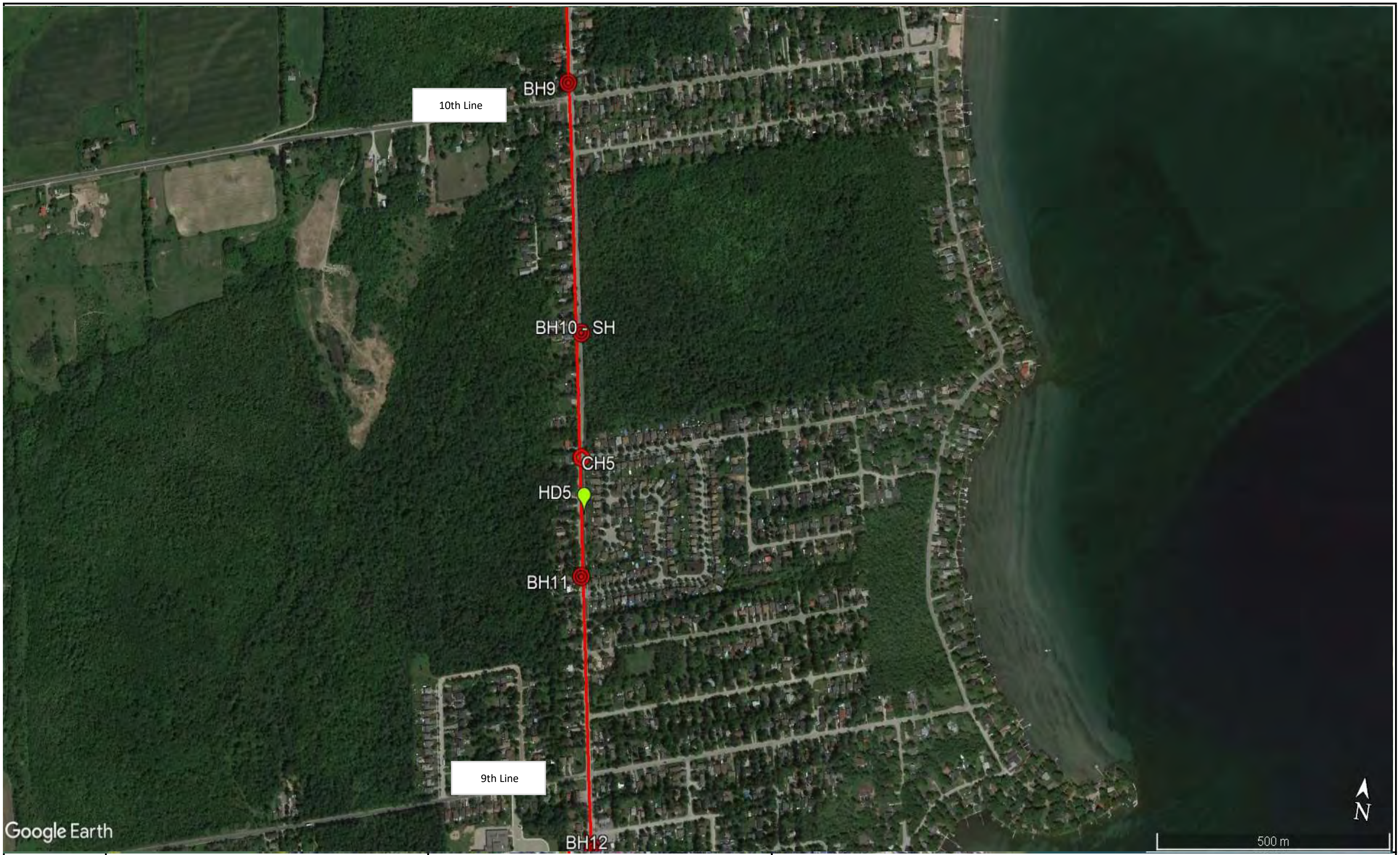
Client:	Town of Innisfil			Drawing No:	1
Drawn:	SH	Approved:	MQ	Title:	Project Limits
Date:	19-Oct-21	Scale:	N.T.S	Project:	Innisfil 25th Side Road
Original Size:	Letter	HD - Hand Dig BH - Borehole BH-SH - Shoulder Borehole CH - Corehole			

Client:	Town of Innisfil			Drawing No:	2
Drawn:	SH	Approved:	MQ	Title:	Borehole/Corehole - Layout Plan
Date:	19-Oct-21	Scale:	N.T.S	Project:	Innisfil 25th Side Road
Original Size:	Letter	HD - Hand Dig BH - Borehole BH-SH - Shoulder Borehole CH - Corehole		wsp	

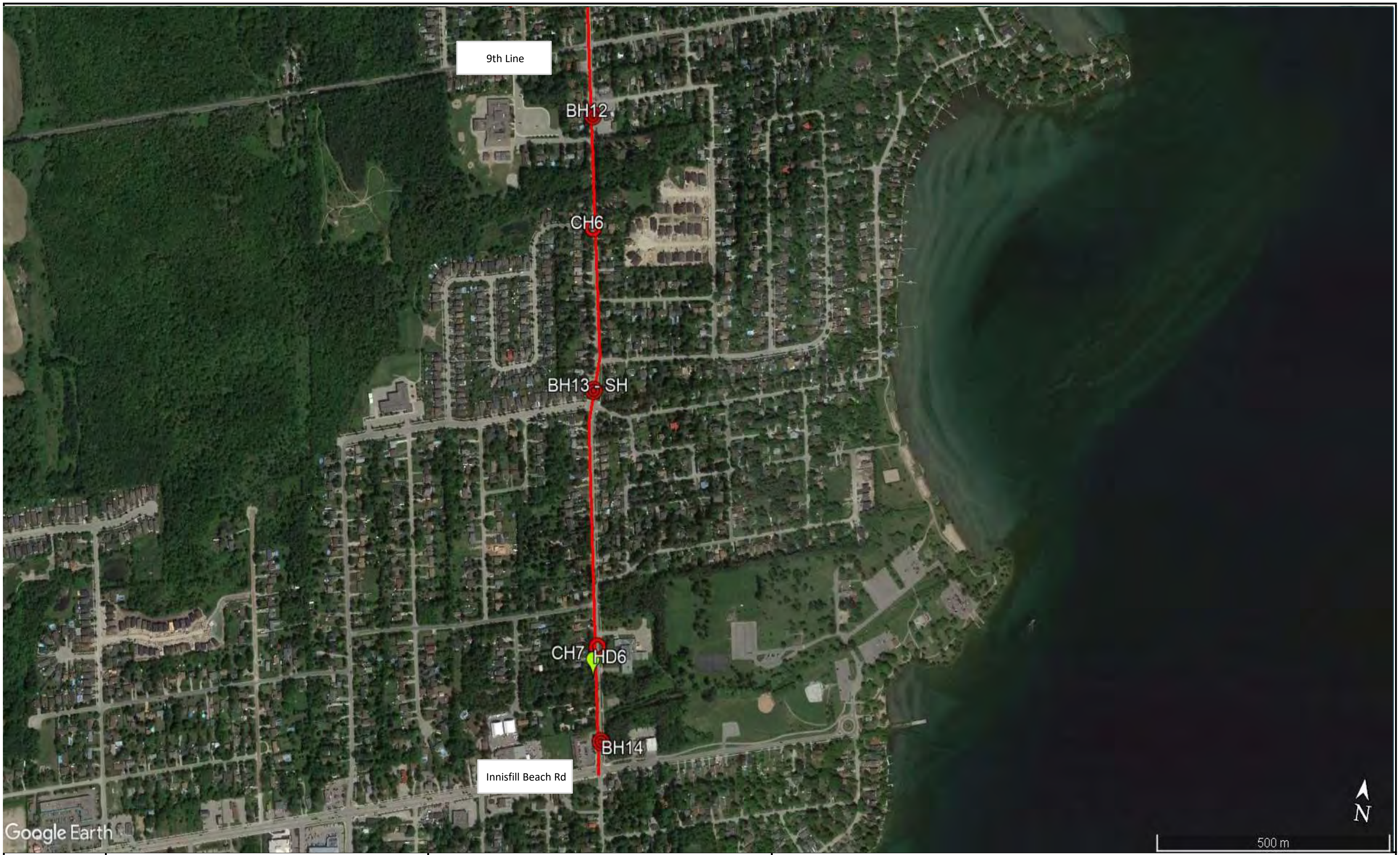
Client:	Town of Innisfil		Drawing No:	3
Drawn: SH	Approved: MQ	Title:	Borehole/Corehole - Layout Plan	
Date: 19-Oct-21	Scale: N.T.S	Project:	Innisfil 25th Side Road	
Original Size: Letter	HD - Hand Dig BH - Borehole BH-SH - Shoulder Borehole CH - Corehole			



Client:	Town of Innisfil			Drawing No:	4
Drawn:	SH	Approved:	MQ	Title:	Borehole/Corehole - Layout Plan
Date:	19-Oct-21	Scale:	N.T.S	Project:	Innisfil 25th Side Road
Original Size:	Letter	HD - Hand Dig BH - Borehole BH-SH - Shoulder Borehole CH - Corehole			



Client:	Town of Innisfil			Drawing No:	5
Drawn:	SH	Approved:	MQ	Title:	Borehole/Corehole - Layout Plan
Date:	19-Oct-21	Scale:	N.T.S	Project:	Innisfil 25th Side Road
Original Size:	Letter	HD - Hand Dig BH - Borehole BH-SH - Shoulder Borehole CH - Corehole			



Client:	Town of Innisfil			Drawing No:	6
Drawn:	SH	Approved:	MQ	Title:	Borehole/Corehole - Layout Plan
Date:	19-Oct-21	Scale:	N.T.S	Project:	Innisfil 25th Side Road
Original Size:	Letter	HD - Hand Dig BH - Borehole BH-SH - Shoulder Borehole CH - Corehole			wsp

APPENDIX

C

BOREHOLE LOGS

LOG OF BOREHOLE BH 1

1 OF 1

PROJECT: Innisfil 25th Side Road
CLIENT: Town of Innisfil
PROJECT LOCATION: Innisfil, ON

Method: SOLID STEM AUGER
Date: 2021-09-16
ENCL.NO: 1
REF.NO: 211-06027-00

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH (kPa): ○ UNCONFINED; + FIELD VANE & Sensitivity; ● QUICK TRIAXIAL; × LAB VANE: 20 40 60 80 100
PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L; WATER CONTENT (%): 10 20 30

SOIL PROFILE (m) ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION / SHEAR STRENGTH (kPa)	WATER CONTENT (%)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m^3)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
	Ground Surface														
0.00	**ASPHALT (100mm)**	■													
0.07	**GRANULAR BASE (180mm)** sand and gravel, trace fines brown, moist	▩	1	AS					○						
0.25	**GRANULAR SUBBASE (270mm)** gravelly sand, trace fines, brown, moist	▩	2	AS											
0.52	**SILTY CLAY** some sand, trace gravel, brownish grey, moist, firm	▨													
		▨	3	SS	4				○			1	19	41	39
1.50	**END OF BOREHOLE** Notes: 1) Borehole open and dry upon completion														

1

WSP-SOIL-ROCK-APRIL-05-2017 (1).GLB
WSP SOIL LOG 2DIG 211-06027-00.GPJ 21-10-20

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
$+^3$, $\times^3$: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

LOG OF BOREHOLE BH 2

PROJECT: Innisfil 25th Side Road
CLIENT: Town of Innisfil
PROJECT LOCATION: Innisfil, ON

Method: SOLID STEM AUGER
Date: 2021-09-16
ENCL.NO: 2
REF.NO: 211-06027-00

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT w LIQUID LIMIT W_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m^3)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION Ground Surface	STRATA PLOT	NUMBER	TYPE	"N" BLOWS / 0.3 m							
0.00	**ASPHALT (170mm)**	■										
0.17	**GRANULAR BASE (180mm)** gravelly sand, trace fines, brown, moist	▨	1	AS								39 56 (5)
0.35	**GRANULAR SUBBASE (320mm)** sand, some gravel, trace fines, brown, moist	▨	2	AS								
0.67	**SAND** trace gravel, trace silt, brown, moist, compact	⁘										
			3	SS	20				○			
1.50	**END OF BOREHOLE** Notes: 1) Borehole open and dry upon completion											

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

LOG OF BOREHOLE BH 3

PROJECT: Innisfil 25th Side Road
CLIENT: Town of Innisfil
PROJECT LOCATION: Innisfil, ON

Method: SOLID STEM AUGER
Date: 2021-09-16
ENCL.NO: 3
REF.NO: 211-06027-00

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT w LIQUID LIMIT W_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)			
(m) ELEV DEPTH	DESCRIPTION Ground Surface	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3 m							GR	SA	SI	CL
0.00	**ASPHALT (150mm)**	■													
0.15	**GRANULAR BASE (200mm)** sand and gravel, trace fines, brown, moist	▨	1	AS					○						
0.35	**GRANULAR SUBBASE (300mm)** gravelly sand, trace fines, brown, moist	▨	2	AS											
0.55	**SAND** some gravel, trace silt, trace clay, brown, moist, compact	⁙	3	SS	20							15	76	7	2
1.50	**END OF BOREHOLE** Notes: 1) Borehole open and dry upon completion														

WSP-SOIL-ROCK-APRIL-05-2017 (1).GLB
WSP SOIL LOG 2DIG 211-06027-00.GPJ 21-10-20

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity

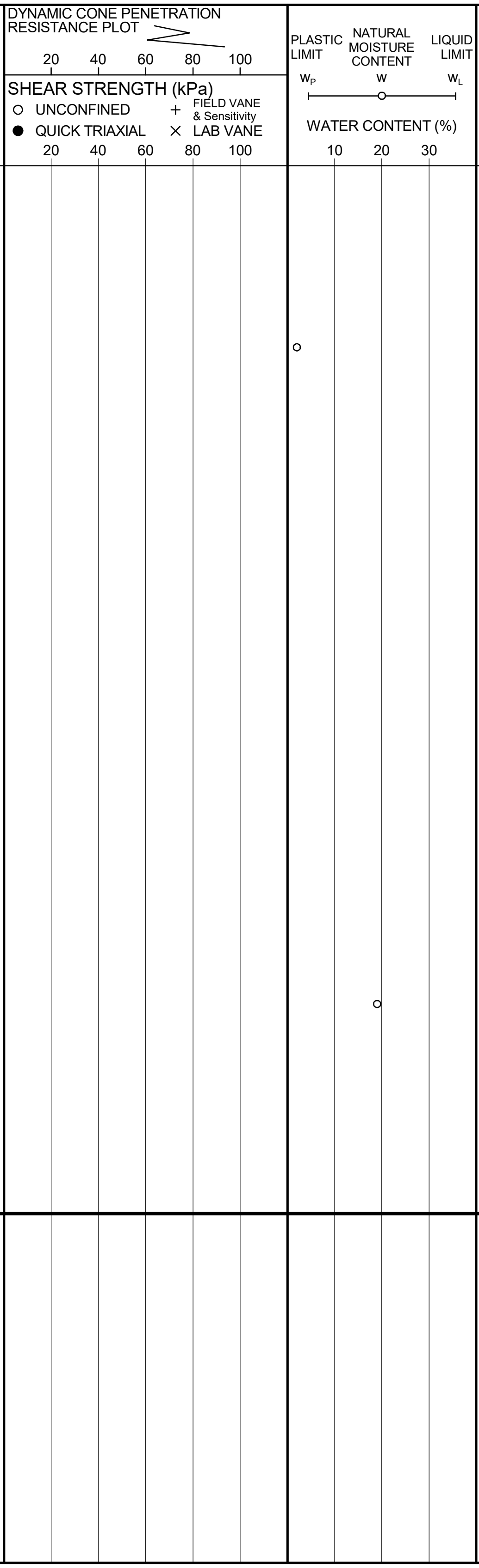
○ ε=3% Strain at Failure

LOG OF BOREHOLE BH 4

PROJECT: Innisfil 25th Side Road
CLIENT: Town of Innisfil
PROJECT LOCATION: Innisfil, ON

Method: SOLID STEM AUGER
Date: 2021-09-16
ENCL.NO: 4
REF.NO: 211-06027-00

SOIL PROFILE			SAMPLES							
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS / 0.3 m	GROUND WATER CONDITIONS	ELEVATION	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Ground Surface									
0.00	**ASPHALT (160mm)**	■								
0.16	**GRANULAR BASE (200mm)** sand and gravel, trace fines, brown, moist	▩	1	AS						
0.36	**GRANULAR SUBBASE (300mm)** sand and gravel, trace fines, brown, moist	▩	2	AS						54 42 (4)
0.66	**SAND** trace gravel, trace silt, brown, moist to wet, loose	⁘								
		⁘	3	SS	6					
1.50	**END OF BOREHOLE** Notes: 1) Borehole open and wet upon completion									



GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES + ^{3}, × ^{3}: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

LOG OF BOREHOLE BH 5

1 OF 1

PROJECT: Innisfil 25th Side Road
CLIENT: Town of Innisfil
PROJECT LOCATION: Innisfil, ON

Method: SOLID STEM AUGER
Date: 2021-09-16
ENCL.NO: 5
REF.NO: 211-06027-00

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)			
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3 m							GR	SA	SI	CL
	Ground Surface														
0.00	**ASPHALT (160mm)**	■													
0.16	**GRANULAR BASE (360mm)** sand and gravel, brown, moist	▨	1	AS					○						
0.36	**GRANULAR SUBBASE (300mm)** gravelly sand, trace fines, brown, moist	▨	2	AS											
0.66	**SILTY CLAY** some sand, brownish grey, moist, firm	▨													
1		▨	3	SS	7				○				13	50	37
1.50	**END OF BOREHOLE** Notes: 1) Borehole open and dry upon completion														

WSP-SOIL-ROCK-APRIL-05-2017 (1).GLB
WSP SOIL LOG 2DIG 211-06027-00.GPJ 21-10-20

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES $+^{3}, \times^{3}$: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

wsp

LOG OF BOREHOLE BH 6

1 OF 1

PROJECT: Innisfil 25th Side Road
CLIENT: Town of Innisfil
PROJECT LOCATION: Innisfil, ON

Method: SOLID STEM AUGER
Date: 2021-09-16
ENCL.NO: 6
REF.NO: 211-06027-00

SOIL PROFILE (m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	TYPE	"N" BLOWS / 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L / WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Ground Surface											
0.00	**ASPHALT (130mm)**	■										
0.13	**GRANULAR BASE (180mm)** gravelly sand, trace fines, brown, moist	▨	1	AS					○			30 62 (8)
0.31	**GRANULAR SUBBASE (300mm)** sand and gravel, brown, moist	▨	2	AS								
0.61	**SAND** some gravel, trace silt, brown, moist, loose	⁘										
1			3	SS	8				○			
1.50	**END OF BOREHOLE** Notes: 1) Borehole open and dry upon completion											

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES + 3 , × 3 : Numbers refer to Sensitivity ○ ε=3% Strain at Failure

LOG OF BOREHOLE BH 7

PROJECT: Innisfil 25th Side Road
CLIENT: Town of Innisfil
PROJECT LOCATION: Innisfil, ON

Method: SOLID STEM AUGER
Date: 2021-09-16
ENCL.NO: 7
REF.NO: 211-06027-00

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)			
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3 m							GR	SA	SI	CL
	Ground Surface														
0.00	**ASPHALT (125 mm)**														
0.13	**GRANULAR BASE (200mm)** gravelly sand, dark brown, moist		1	AS											
0.40	**GRANULAR SUBBASE (400mm)** sand and gravel, trace silt, brown, moist		2	AS											
0.65	**SAND** some silt, trace clay, brown, moist, loose														
1			3	SS	6								69	20	11
1.52	**END OF BOREHOLE** Notes: 1) Borehole open and wet upon completion														

WSP-SOIL-ROCK-APRIL-05-2017 (1).GLB
WSP SOIL LOG 2DIG 211-06027-00.GPJ 21-10-20

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

LOG OF BOREHOLE BH 8

PROJECT: Innisfil 25th Side Road
CLIENT: Town of Innisfil
PROJECT LOCATION: Innisfil, ON

Method: SOLID STEM AUGER
Date: 2021-09-16
ENCL.NO: 8
REF.NO: 211-06027-00

SOIL PROFILE			SAMPLES					DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30			REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION Ground Surface	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	GR SA SI CL
0.00	**ASPHALT (130mm)**	■										
0.13	**GRANULAR BASE (180mm)** sand and gravel, brown, moist	▨	1	AS					○			
0.31	**GRANULAR SUBBASE (300mm)** sand, some gravel, brown, moist	▨	2	AS								
0.61	**SAND** some gravel, trace silt, brown, moist, loose	⋯										
1			3	SS	7				○			
1.50	**END OF BOREHOLE** Notes: 1) Borehole open and dry upon completion											

WSP-SOIL-ROCK-APRIL-05-2017 (1).GLB
WSP SOIL LOG 2DIG 211-06027-00.GPJ 21-10-20

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

LOG OF BOREHOLE BH 9

PROJECT: Innisfil 25th Side Road
CLIENT: Town of Innisfil
PROJECT LOCATION: Innisfil, ON

Method: SOLID STEM AUGER
Date: 2021-09-16
ENCL.NO: 9
REF.NO: 211-06027-00

(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION (Ground Surface)	STRATA PLOT	SAMPLES NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m^3)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
0.00	**ASPHALT (180mm)**														
0.18	**GRANULAR BASE (190mm)** sand and gravel, trace fines, brown, moist		1	AS								42	54	(4)	
0.32	**GRANULAR SUBBASE (300mm)** sand and gravel, trace fines, brown, moist		2	AS											
0.62	**SAND** some silt, some clay, some gravel, grey, moist, loose														
			3	SS	5				○						
1.50	**END OF BOREHOLE** Notes: 1) Borehole open and dry upon completion														

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

LOG OF BOREHOLE BH 10

PROJECT: Innisfil 25th Side Road
CLIENT: Town of Innisfil
PROJECT LOCATION: Innisfil, ON

Method: SOLID STEM AUGER
Date: 2021-09-16
ENCL.NO: 10
REF.NO: 211-06027-00

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV / DEPTH	DESCRIPTION Ground Surface	STRATA PLOT	NUMBER	TYPE	"N" BLOWS / 0.3 m							
0.00	**GRANULAR BASE (170mm)** sand and gravel, brown, moist	☒	1	AS					○			
0.17	**GRANULAR SUBBASE (300mm)** gravelly sand, brown, moist	☒	2	AS								
0.47	**SAND** some silt, some gravel, grey, moist, compact	⁘										
			3	SS	13				○			
1.50	**END OF BOREHOLE** Notes: 1) Borehole open and dry upon completion											

WSP-SOIL-ROCK-APRIL-05-2017 (1).GLB
WSP SOIL LOG 2DIG 211-06027-00.GPJ 21-10-20

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
$+^3, \times^3$: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

LOG OF BOREHOLE BH 11

PROJECT: Innisfil 25th Side Road
CLIENT: Town of Innisfil
PROJECT LOCATION: Innisfil, ON

Method: SOLID STEM AUGER
Date: 2021-09-16
ENCL.NO: 11
REF.NO: 211-06027-00

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT w LIQUID LIMIT W_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m^3)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION Ground Surface	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3 m							
0.00	**ASPHALT (100mm)**	■										
0.1	**GRANULAR BASE (180mm)** sand, some gravel, brown, moist	▨	1	AS					○			
0.28	**GRANULAR SUBBASE (300mm)** gravelly sand, brown, moist	▨	2	AS								
0.5	**SAND** trace gravel, grey, wet, compact	⁙										
1			3	SS	16				○			
1.50	**END OF BOREHOLE** Notes: 1) Borehole open and dry upon completion											

WSP-SOIL-ROCK-APRIL-05-2017 (1).GLB
WSP SOIL LOG 2DIG 211-06027-00.GPJ 21-10-20

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

LOG OF BOREHOLE BH12

PROJECT: Innisfil 25th Side Road
CLIENT: Town of Innisfil
PROJECT LOCATION: Innisfil, ON

Method: SOLID STEM AUGER
Date: 2021-09-16
ENCL.NO: 12
REF.NO: 211-06027-00

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)			
(m) ELEV DEPTH	DESCRIPTION Ground Surface	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3 m							GR	SA	SI	CL
0.00	**ASPHALT (120mm)**	■													
0.12	**GRANULAR BASE (170mm)** sand and gravel, brown, moist	☒	1	AS					○						
0.29	**GRANULAR SUBBASE (300mm)** sand with gravel, brown, moist	☒	2	AS											
0.62	**SAND** some gravel, trace silt, brown, moist, loose	⁘													
			3	SS	9				○			6	86	5	3
1.50	**END OF BOREHOLE** Notes: 1) Borehole open and dry upon completion														

GROUNDWATER ELEVATIONS
Measurement 1st ∇ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
$+^3, \times^3$: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

wsp

LOG OF BOREHOLE BH 13

1 OF 1

PROJECT: Innisfil 25th Side Road
CLIENT: Town of Innisfil
PROJECT LOCATION: Innisfil, ON

Method: SOLID STEM AUGER
Date: 2021-09-16
ENCL.NO: 13
REF.NO: 211-06027-00

SOIL PROFILE			SAMPLES									
(m) ELEV DEPTH	DESCRIPTION Ground Surface	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m^3)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.00	**GRANULAR BASE (180mm)** sand and gravel, brown, moist		1	AS								
0.18	**GRANULAR SUBBASE (300mm)** Sand with gravel, some fines		2	AS								27 58 (21)
0.48	**SAND** some gravel, grey, moist, compact		3	SS	14							
1.50	**END OF BOREHOLE** Notes: 1) Borehole open and dry upon completion											

WSP-SOIL-ROCK-APRIL-05-2017 (1).GLB
WSP SOIL LOG 2DIG 211-06027-00.GPJ 21-10-20

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

LOG OF BOREHOLE BH 14

1 OF 1

PROJECT: Innisfil 25th Side Road
CLIENT: Town of Innisfil
PROJECT LOCATION: Innisfil, ON

Method: SOLID STEM AUGER
Date: 2021-09-16
ENCL.NO: 14
REF.NO: 211-06027-00

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH (kPa): ○ UNCONFINED; ● QUICK TRIAXIAL; + FIELD VANE & Sensitivity; × LAB VANE: 20 40 60 80 100
PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L; WATER CONTENT (%): 10 20 30

SOIL PROFILE (m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION / SHEAR STRENGTH (kPa)	WATER CONTENT (%)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	GR	SA	SI	CL
	Ground Surface														
0.00	**ASPHALT (100mm)**	■													
0.1	**GRANULAR BASE (180mm)** sand and gravel, brown, moist	▨	1	AS					○						
0.28	**GRANULAR SUBBASE (250mm)** sand, some gravel, brown, moist	▨	2	AS											
0.5	**SAND** trace gravel, trace silt, trace clay, brown, moist, dense	░													
1		░	3	SS	24				○			5	82	9	4
1.50	**END OF BOREHOLE** Notes: 1) Borehole open and dry upon completion														

WSP-SOIL-ROCK-APRIL-05-2017 (1).GLB
WSP SOIL LOG 2DIG 211-06027-00.GPJ 21-10-20

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

LOG OF BOREHOLE HD1

PROJECT: Innisfil 25th Side Road
CLIENT: Town of Innisfil
PROJECT LOCATION: Innisfil, ON

Method: MANUAL AUGER
Date: 2021-09-16
ENCL.NO: 15
REF.NO: 211-06027-00

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m^3)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION Ground Surface	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m							
0.00	**TOPSOIL (300mm)**	⁘	1	AS					○			
0.30	**FILL** sand and gravel, brown, moist	▨	2	AS					○			
0.50	**END OF BOREHOLE** Notes: 1) Borehole open and dry upon completion											

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

LOG OF BOREHOLE HD2

PROJECT: Innisfil 25th Side Road
CLIENT: Town of Innisfil
PROJECT LOCATION: Innisfil, ON

Method: MANUAL AUGER
Date: 2021-09-16
ENCL.NO: 16
REF.NO: 211-06027-00

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT W_L / WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS / 0.3 m							
	Ground Surface											
0.00	**TOPSOIL (150mm)**		1	AS					○			
0.15	**FILL** sand, trace organics, brown, moist	⊠	2	AS					○			
0.60	**END OF BOREHOLE** Notes: 1) Borehole open and dry upon completion											

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

LOG OF BOREHOLE HD3

PROJECT: Innisfil 25th Side Road
CLIENT: Town of Innisfil
PROJECT LOCATION: Innisfil, ON

Method: MANUAL AUGER
Date: 2021-09-16
ENCL.NO: 17
REF.NO: 211-06027-00

SOIL PROFILE			SAMPLES					DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION					
	Ground Surface											
0.00	**TOPSOIL (100mm)**		1	AS					○			
0.10	**SAND** some silt, some clay, some rootlets, brown, wet		2	AS					68 ○			
						∇	0.6 m					
0.70	**END OF BOREHOLE** Notes: 1) Borehole open and wet upon completion 2) water level at 0.6m below ground surface											

GROUNDWATER ELEVATIONS

Measurement 1st ∇ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

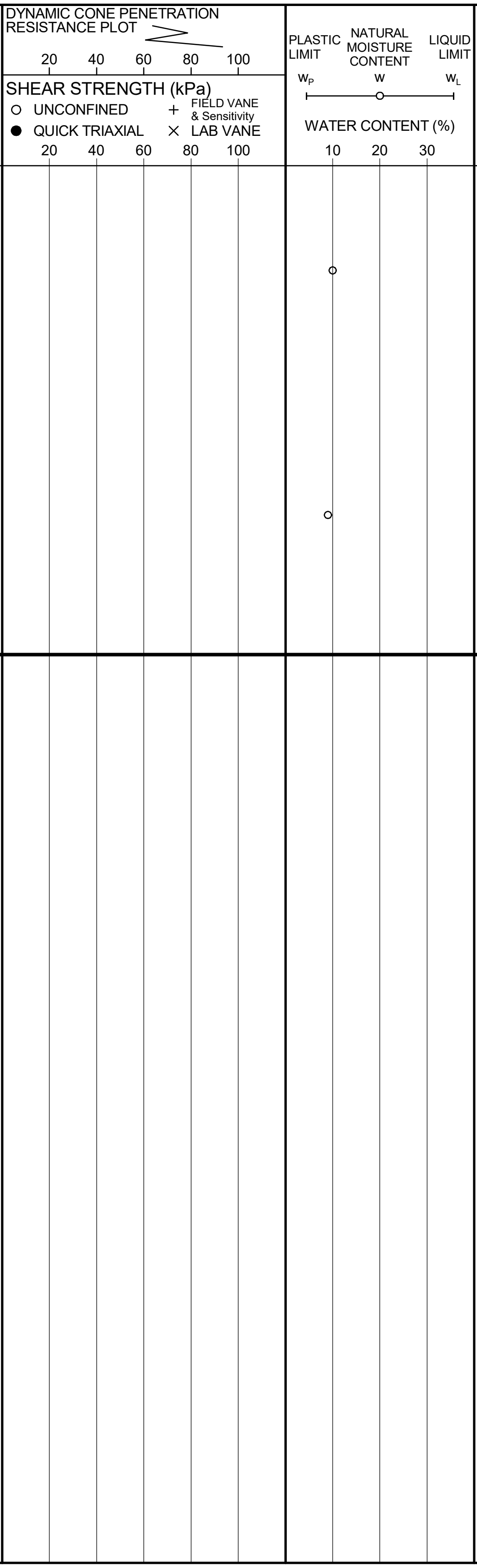
LOG OF BOREHOLE HD4

1 OF 1

PROJECT: Innisfil 25th Side Road
CLIENT: Town of Innisfil
PROJECT LOCATION: Innisfil, ON

Method: MANUAL AUGER
Date: 2021-09-16
ENCL.NO: 18
REF.NO: 211-06027-00

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)			
(m) ELEV DEPTH	DESCRIPTION Ground Surface	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m							GR	SA	SI	CL
0.00	**TOPSOIL (300mm)**	⁙	1	AS											
0.30	**FILL** gravelly sand, trace fines, brown, moist	▨	2	AS								24	67		(9)
0.70	**END OF BOREHOLE** Notes: 1) Borehole open and dry upon completion														



WSP-SOIL-ROCK-APRIL-05-2017 (1).GLB
WSP SOIL LOG 2DIG 211-06027-00.GPJ 21-10-20

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

wsp

LOG OF BOREHOLE HD5

PROJECT: Innisfil 25th Side Road
CLIENT: Town of Innisfil
PROJECT LOCATION: Innisfil, ON

Method: MANUAL AUGER
Date: 2021-09-16
ENCL.NO: 19
REF.NO: 211-06027-00

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m^3)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION Ground Surface	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3 m							
0.00	**TOPSOIL (400mm)**		1	AS					○			
0.40	**SAND** some organics, brown, moist		2	AS					○			
0.70	**END OF BOREHOLE** Notes: 1) Borehole open and dry upon completion											

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

LOG OF BOREHOLE HD6

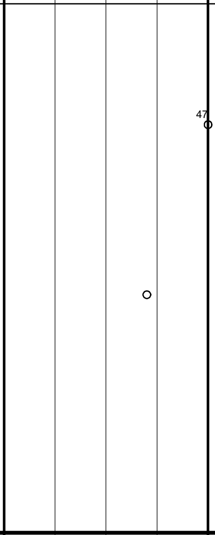
PROJECT: Innisfil 25th Side Road
CLIENT: Town of Innisfil
PROJECT LOCATION: Innisfil, ON

Method: MANUAL AUGER
Date: 2021-09-16
ENCL.NO: 20
REF.NO: 211-06027-00

SOIL PROFILE (m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH (kPa)	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Ground Surface											
0.00	**TOPSOIL (100mm)**											
0.10	**SAND** trace organics, brown, moist to wet		1	AS								
			2	AS								
0.70	**END OF BOREHOLE** Notes: 1) Borehole open and dry upon completion											

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH (kPa): ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100



WATER CONTENT (%): 10 20 30

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES $+^3$, $\times^3$: Numbers refer to Sensitivity

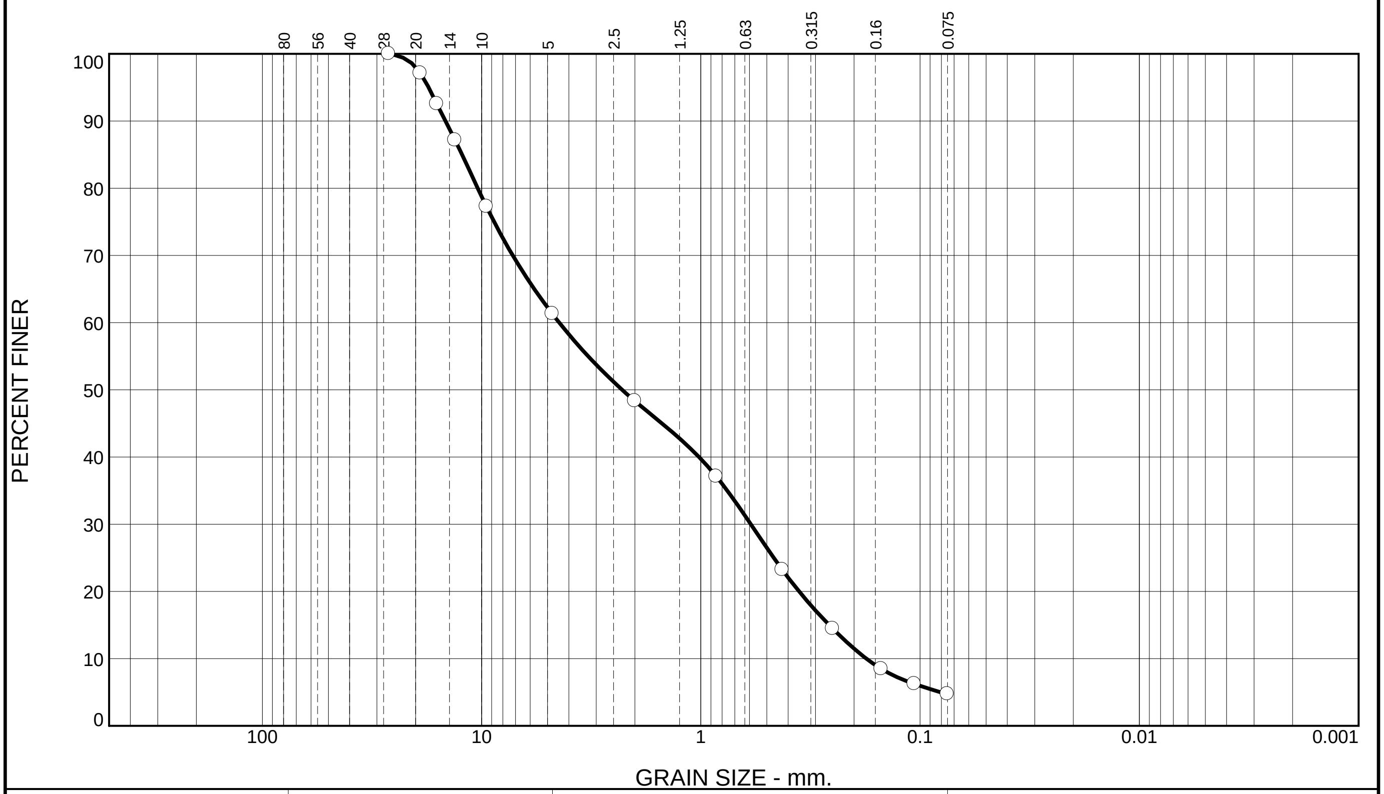
○ ε=3% Strain at Failure

APPENDIX

D

LABORATORY RESULTS

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	3	36	13	25	18	5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
26.50	100		
19.00	97		
16.00	93		
13.20	87		
9.50	77		
4.75	61		
2.00	48		
0.85	37		
0.425	23		
0.250	14		
0.150	8		
0.106	6		
0.075	4.7		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 14.6194 D_{85}= 12.2743 D_{60}= 4.4235
D_{50}= 2.2854 D_{30}= 0.5917 D_{15}= 0.2598
D_{10}= 0.1760 C_u= 25.14 C_c= 0.45

Classification

USCS= SP AASHTO=

Remarks

Source of Sample: Site Drilling
Sample Number: BH2_AS1

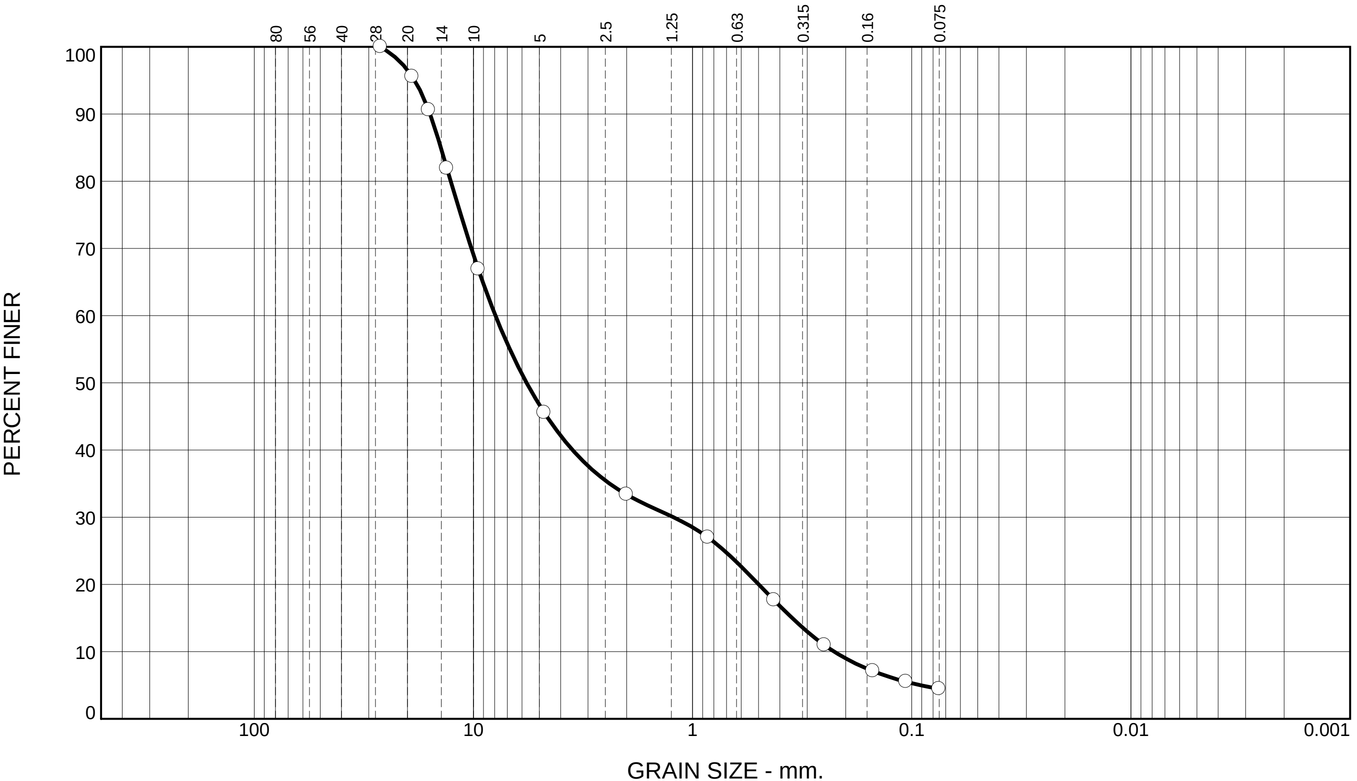
Date: Oct. 18, 2021

Client: Town of Innisfil
Project: 25th Side Road

Project No: 211-06027-00 **Figure** R1772-S-1

Tested By: Bonnie Wang **Checked By:** Bruce Shan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	4	50	13	15	14	4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
26.50	100		
19.00	96		
16.00	91		
13.20	82		
9.50	67		
4.75	46		
2.00	33		
0.85	27		
0.425	18		
0.250	11		
0.150	7		
0.106	5		
0.075	4.4		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 15.7633 D_{85}= 14.0760 D_{60}= 7.9360
D_{50}= 5.7202 D_{30}= 1.2234 D_{15}= 0.3512
D_{10}= 0.2262 C_u= 35.09 C_c= 0.83

Classification

USCS= GP AASHTO=

Remarks

Source of Sample: Site Drilling
Sample Number: BH4_AS2

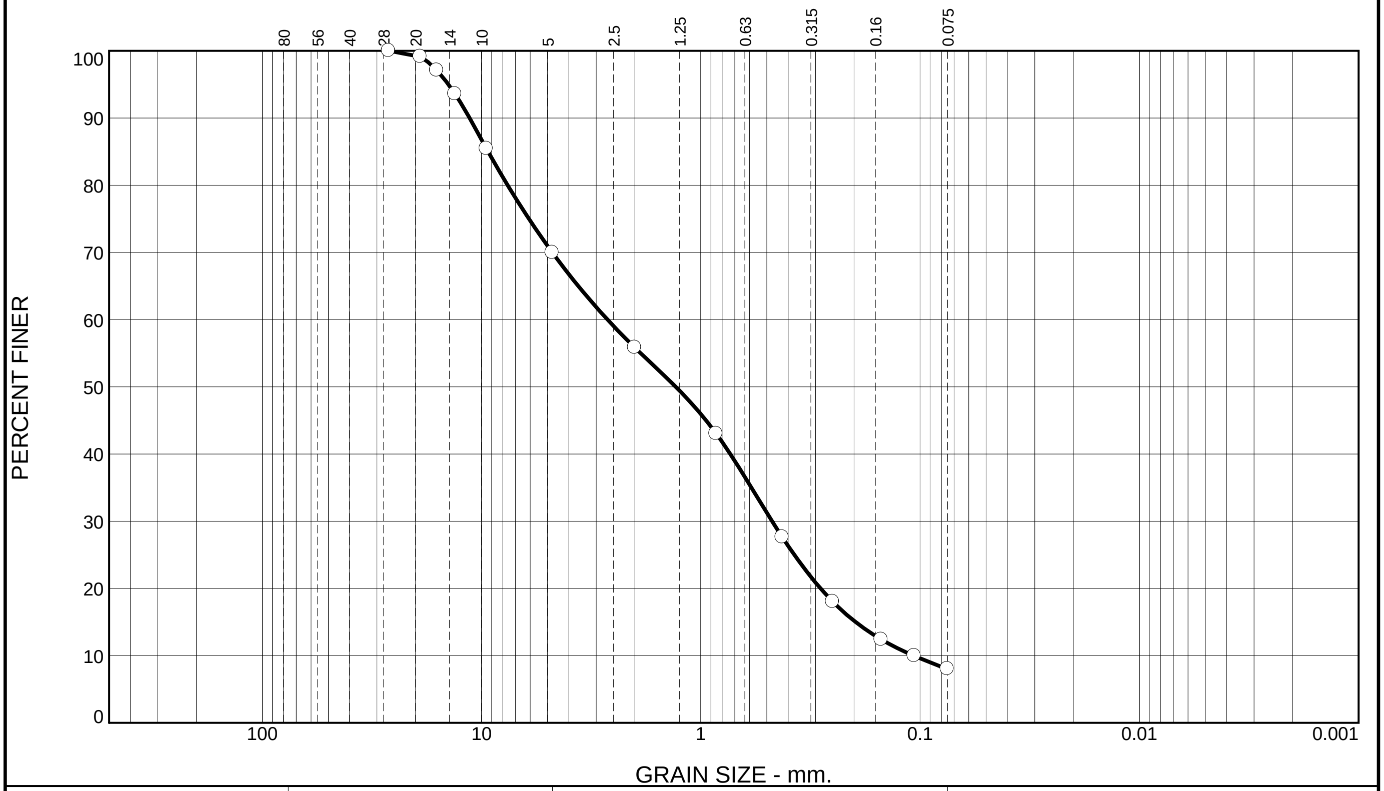
Date: Oct. 18, 2021

Client: Town of Innisfil
Project: 25th Side Road

Project No: 211-06027-00 **Figure** R1772-S-2

Tested By: Bonnie Wang **Checked By:** Bruce Shan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	1	29	14	28	20	8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
26.50	100		
19.00	99		
16.00	97		
13.20	94		
9.50	85		
4.75	70		
2.00	56		
0.85	43		
0.425	28		
0.250	18		
0.150	12		
0.106	10		
0.075	8.0		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 11.3475	D_{85}= 9.3398	D_{60}= 2.6653
D_{50}= 1.3019	D_{30}= 0.4733	D_{15}= 0.1969
D_{10}= 0.1070	C_u= 24.91	C_c= 0.79

Classification

USCS= AASHTO=

Remarks

Source of Sample: Site Drilling
Sample Number: BH6_AS1

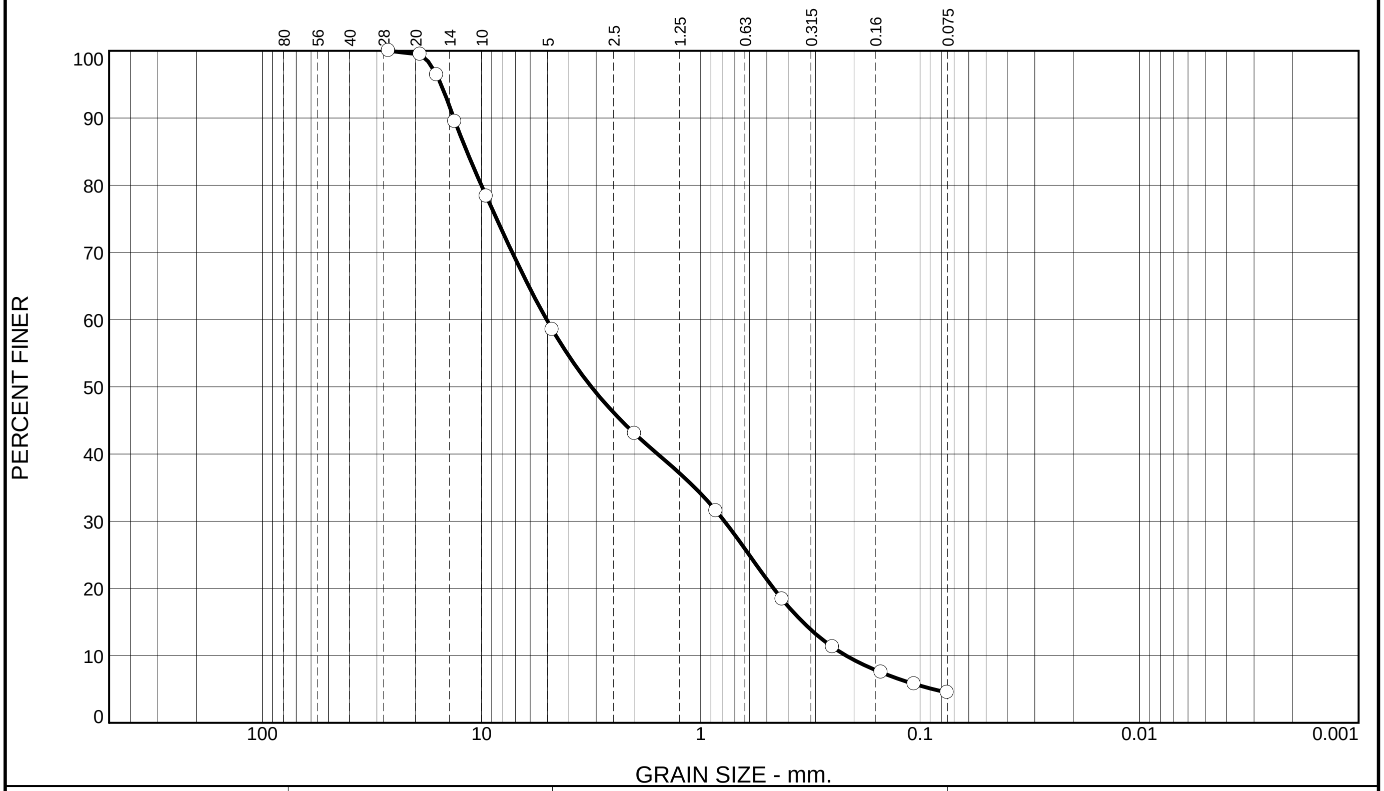
Date: Oct. 18, 2021

Client: Town of Innisfil
Project: 25th Side Road

Project No: 211-06027-00 **Figure** R1772-S-3

Tested By: Bonnie Wang **Checked By:** Bruce Shan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	1	41	15	25	14	4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
26.50	100		
19.00	99		
16.00	96		
13.20	89		
9.50	78		
4.75	58		
2.00	43		
0.85	32		
0.425	18		
0.250	11		
0.150	7		
0.106	6		
0.075	4.5		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 13.3895 D_{85}= 11.6723 D_{60}= 5.0510
D_{50}= 3.1584 D_{30}= 0.7803 D_{15}= 0.3428
D_{10}= 0.2175 C_u= 23.22 C_c= 0.55

Classification

USCS= SP AASHTO=

Remarks

Source of Sample: Site Drilling
Sample Number: BH9_AS1

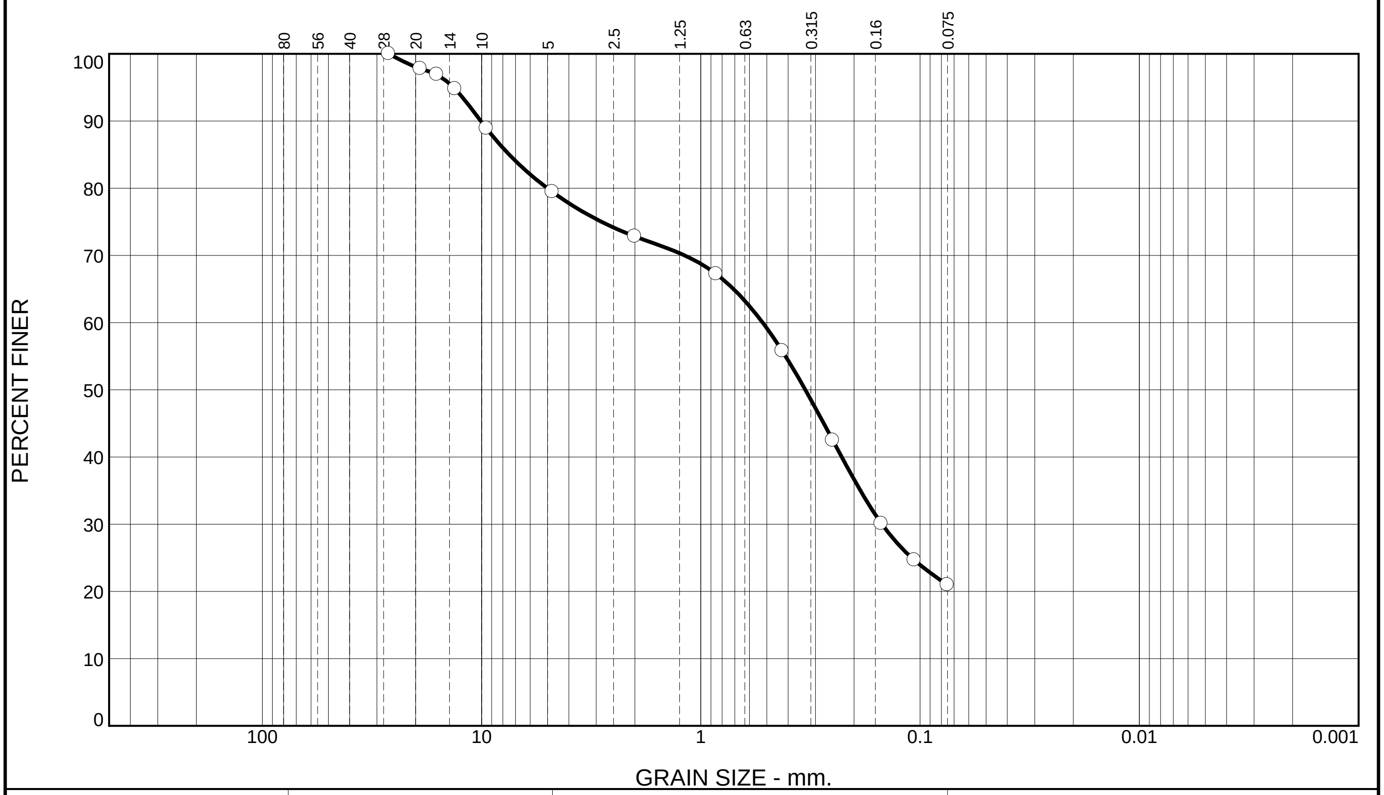
Date: Oct. 18, 2021

Client: Town of Innisfil
Project: 25th Side Road

Project No: 211-06027-00 **Figure** R1772-S-4

Tested By: Bonnie Wang **Checked By:** Bruce Shan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	2	19	6	17	35	21	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
26.50	100		
19.00	98		
16.00	97		
13.20	95		
9.50	89		
4.75	79		
2.00	73		
0.85	67		
0.425	56		
0.250	42		
0.150	30		
0.106	25		
0.075	21		

* (no specification provided)

Soil Description

Atterberg Limits

PL=
LL=
PI=

Coefficients

D_{90}= 10.0903
D_{85}= 7.4831
D_{60}= 0.5224
D_{50}= 0.3337
D_{30}= 0.1493
D_{15}=
D_{10}=
C_u=
C_c=

Classification

USCS=
AASHTO=

Remarks

Source of Sample: Site Drilling
Sample Number: BH13_AS2

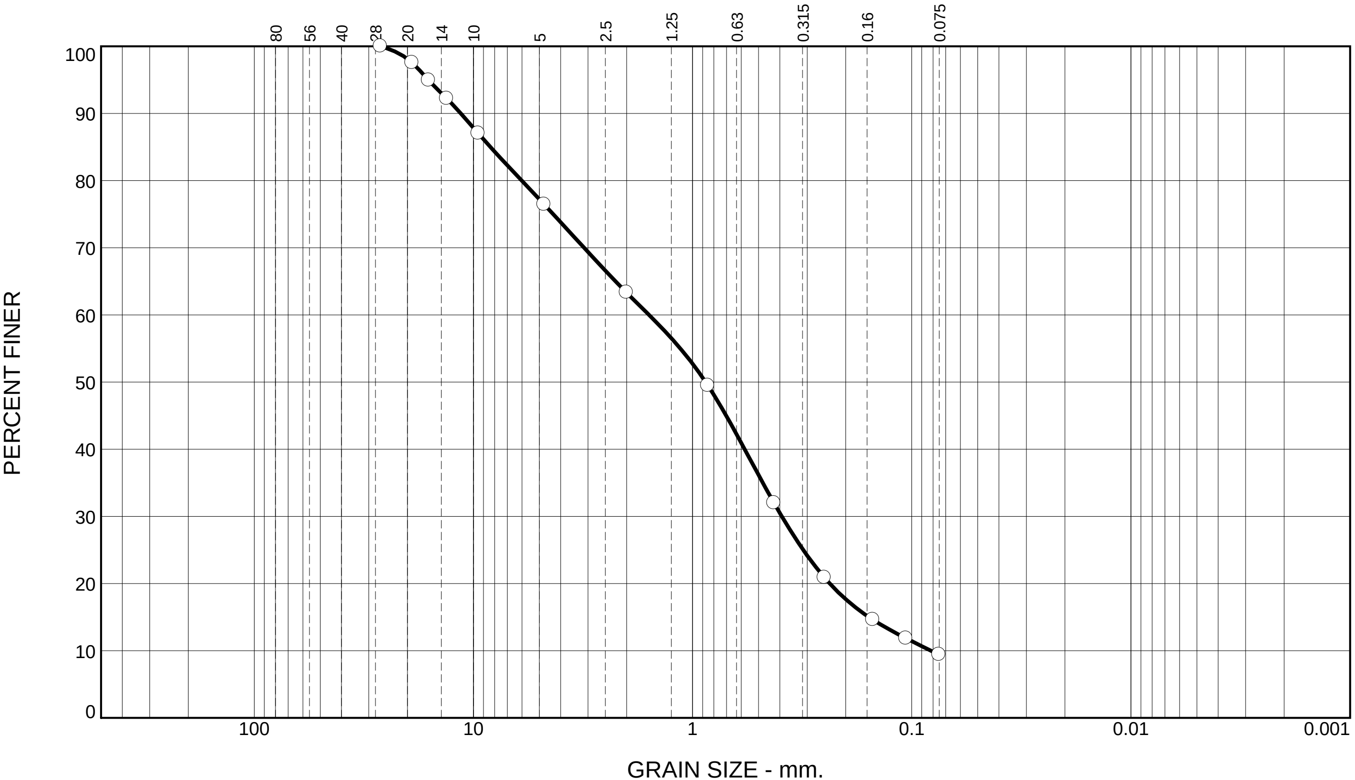
Date: Oct. 18, 2021

Client: Town of Innisfil
Project: 25th Side Road

Project No: 211-06027-00
Figure R1772-S-5

Tested By: Bonnie Wang
Checked By: Bruce Shan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	2	22	13	31	23	9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
26.50	100		
19.00	98		
16.00	95		
13.20	92		
9.50	87		
4.75	76		
2.00	63		
0.85	49		
0.425	32		
0.250	21		
0.150	15		
0.106	12		
0.075	9.4		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 11.4289	D_{85}= 8.3651	D_{60}= 1.5813
D_{50}= 0.8717	D_{30}= 0.3916	D_{15}= 0.1568
D_{10}= 0.0817	C_u= 19.35	C_c= 1.19

Classification

USCS= AASHTO=

Remarks

Source of Sample: Site Drilling
Sample Number: HD4_AS2

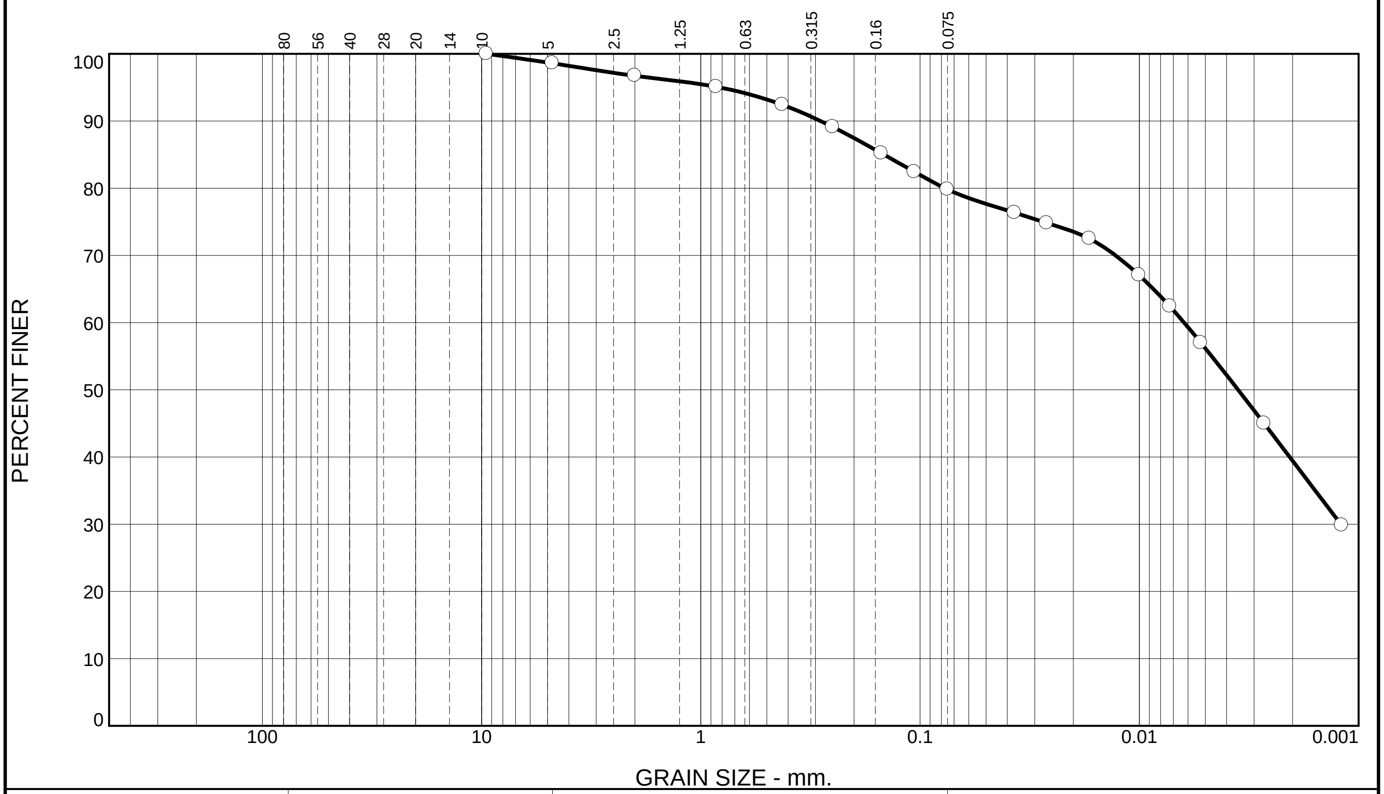
Date: Oct. 18, 2021

Client: Town of Innisfil
Project: 25th Side Road

Project No: 211-06027-00 **Figure** R1772-S-6

Tested By: Bonnie Wang **Checked By:** Bruce Shan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	1	2	5	12	41	39

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
9.50	100		
4.75	99		
2.00	97		
0.85	95		
0.425	92		
0.250	89		
0.150	85		
0.106	82		
0.075	80		
0.0371 mm.	76		
0.0264 mm.	75		
0.0169 mm.	72		
0.0100 mm.	67		
0.0072 mm.	62		
0.0052 mm.	57		
0.0027 mm.	45		
0.0012 mm.	30		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.2846 D_{85}= 0.1464 D_{60}= 0.0062
D_{50}= 0.0035 D_{30}= 0.0012 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Source of Sample: Site Drilling
Sample Number: BH1_SS3

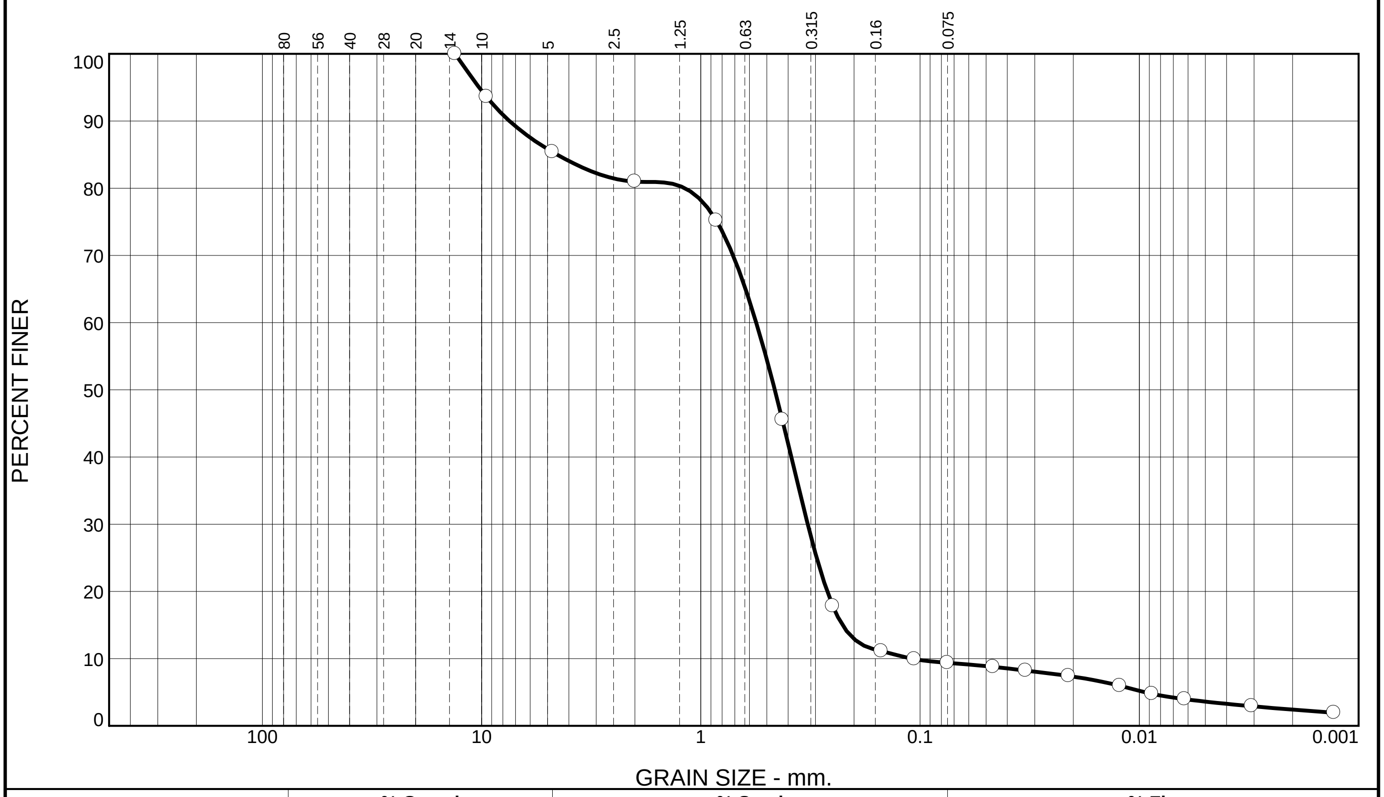
Date: Oct. 13, 2021

Client: Town of Innisfil
Project: 25th Side Road

Project No: 211-06027-00 **Figure** R1772-H-1

Tested By: Bonnie Wang **Checked By:** Bruce Shan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	15	4	35	37	7	2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
13.20	100		
9.50	94		
4.75	85		
2.00	81		
0.85	75		
0.425	46		
0.250	18		
0.150	11		
0.106	10		
0.075	9.4		
0.0464 mm.	8.8		
0.0330 mm.	8.2		
0.0210 mm.	7.4		
0.0123 mm.	6.0		
0.0088 mm.	4.8		
0.0062 mm.	4.0		
0.0031 mm.	2.9		
0.0013 mm.	1.9		

* (no specification provided)

Soil Description

Atterberg Limits

PL=
LL=
PI=

Coefficients

D_{90}= 7.4629
D_{85}= 4.5239
D_{60}= 0.5591
D_{50}= 0.4599
D_{30}= 0.3255
D_{15}= 0.2260
D_{10}= 0.1089
C_u= 5.14
C_c= 1.74

Classification

USCS=
AASHTO=

Remarks

Source of Sample: Site Drilling
Sample Number: BH3_SS3

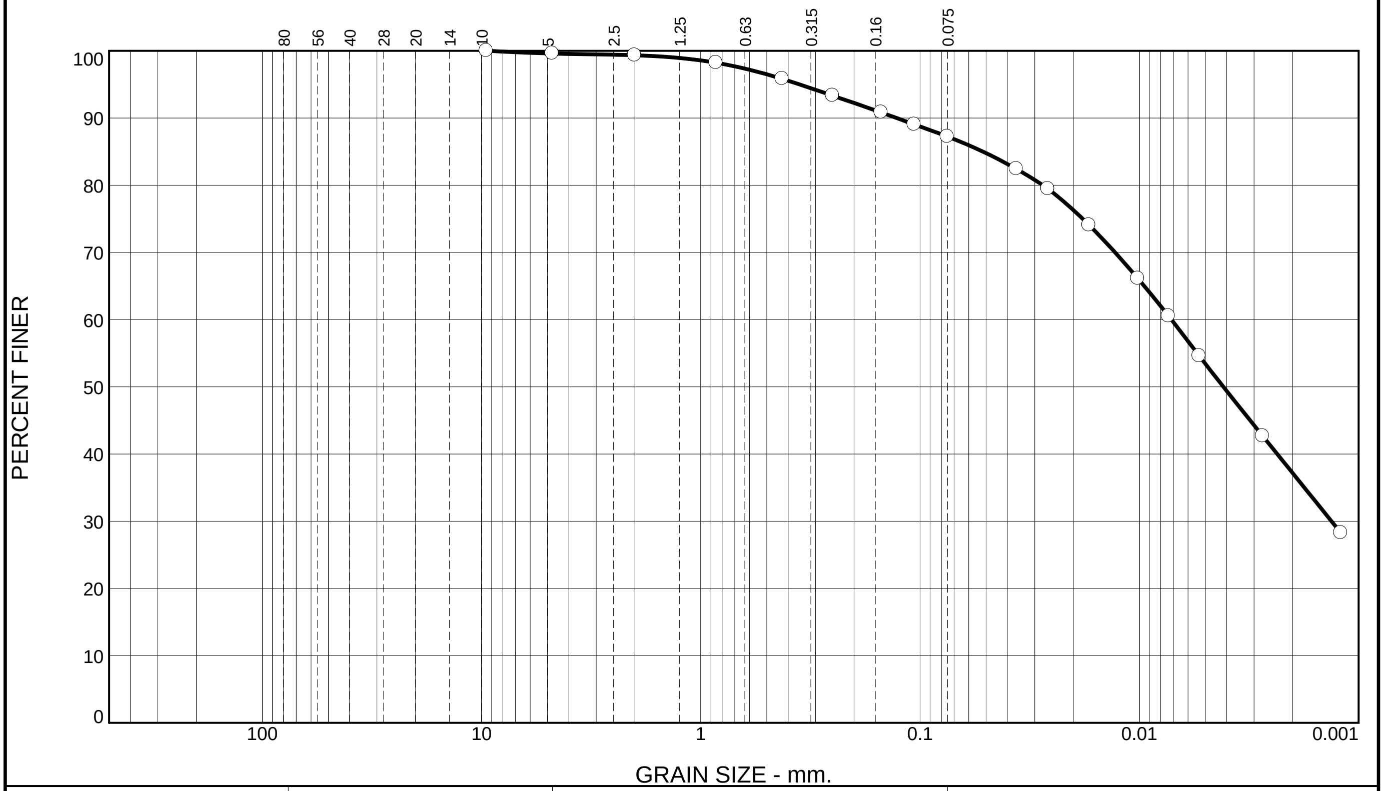
Date: Oct. 13, 2021

Client: Town of Innisfil
Project: 25th Side Road

Project No: 211-06027-00
Figure R1772-H-2

Tested By: Bonnie Wang **Checked By:** Bruce Shan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	1	3	9	50	37

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
9.50	100		
4.75	100		
2.00	99		
0.85	98		
0.425	96		
0.250	93		
0.150	91		
0.106	89		
0.075	87		
0.0363 mm.	82		
0.0261 mm.	79		
0.0169 mm.	74		
0.0101 mm.	66		
0.0074 mm.	61		
0.0053 mm.	55		
0.0027 mm.	43		
0.0012 mm.	28		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.1281 D_{85}= 0.0518 D_{60}= 0.0071
D_{50}= 0.0041 D_{30}= 0.0013 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Source of Sample: Site Drilling
Sample Number: BH5_SS3

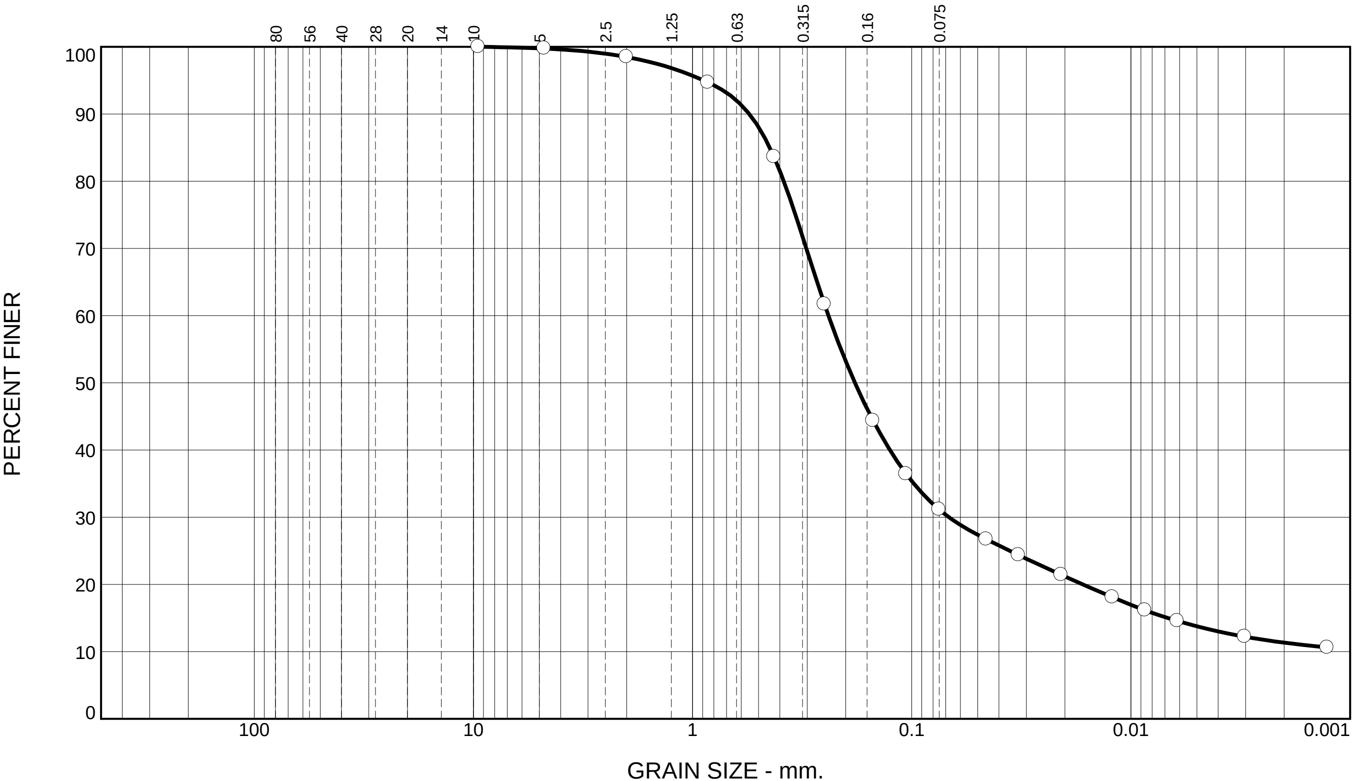
Date: Oct. 13, 2021

Client: Town of Innisfil
Project: 25th Side Road

Project No: 211-06027-00 **Figure** R1772-H-3

Tested By: Bonnie Wang **Checked By:** Bruce Shan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	2	14	53	20	11

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
9.50	100		
4.75	100		
2.00	98		
0.85	95		
0.425	84		
0.250	62		
0.150	44		
0.106	36		
0.075	31		
0.0457 mm.	27		
0.0326 mm.	24		
0.0208 mm.	21		
0.0121 mm.	18		
0.0086 mm.	16		
0.0061 mm.	15		
0.0030 mm.	12		
0.0013 mm.	11		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.5513 D_{85}= 0.4444 D_{60}= 0.2399
D_{50}= 0.1817 D_{30}= 0.0677 D_{15}= 0.0068
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Source of Sample: Site Drilling
Sample Number: BH7_SS3

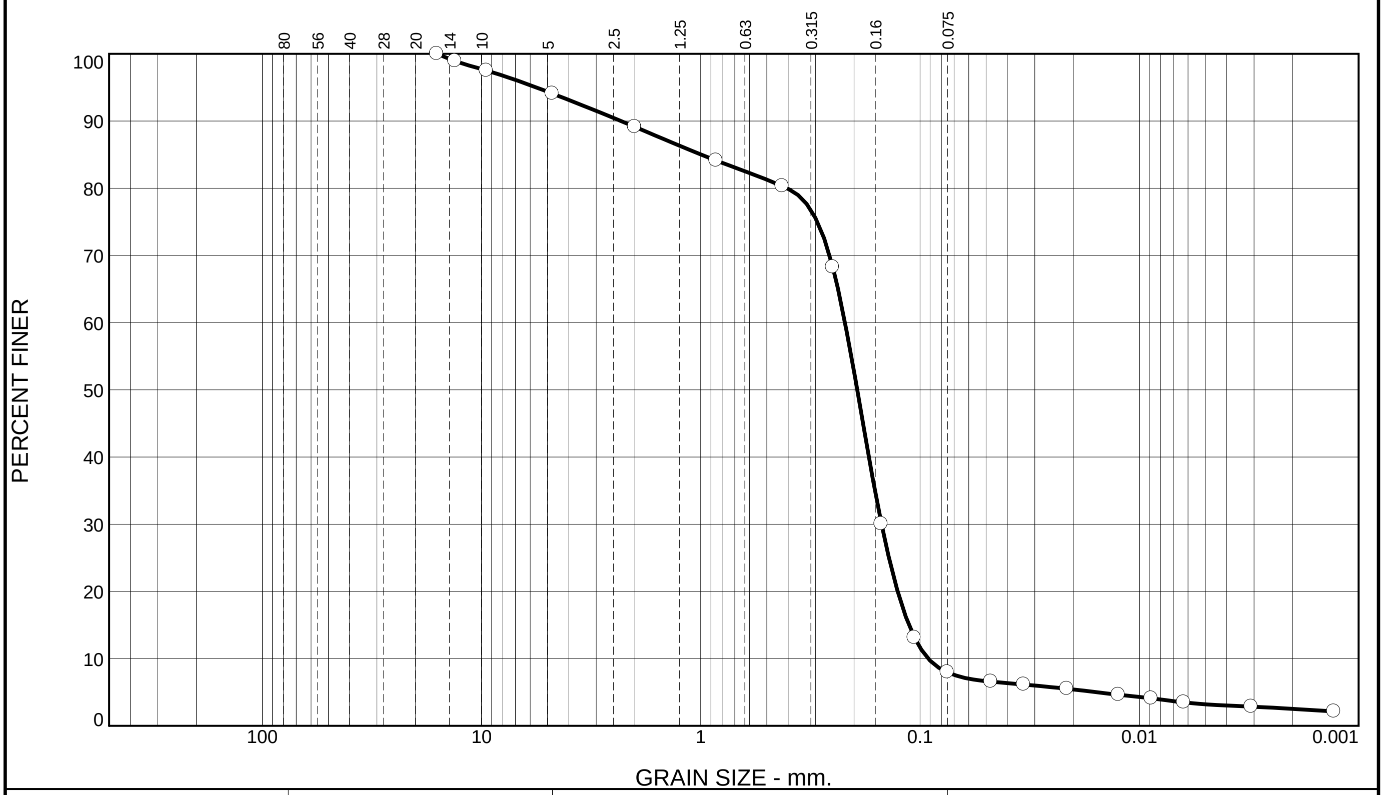
Date: Oct. 13, 2021

Client: Town of Innisfil
Project: 25th Side Road

Project No: 211-06027-00 **Figure** R1772-H-4

Tested By: Bonnie Wang **Checked By:** Bruce Shan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	6	5	9	72	5	3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
16.00	100		
13.20	99		
9.50	98		
4.75	94		
2.00	89		
0.85	84		
0.425	80		
0.250	68		
0.150	30		
0.106	13		
0.075	8.0		
0.0475 mm.	6.6		
0.0337 mm.	6.1		
0.0214 mm.	5.5		
0.0124 mm.	4.6		
0.0088 mm.	4.1		
0.0063 mm.	3.5		
0.0031 mm.	2.9		
0.0013 mm.	2.1		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 2.3177 D_{85}= 0.9972 D_{60}= 0.2200
D_{50}= 0.1935 D_{30}= 0.1499 D_{15}= 0.1124
D_{10}= 0.0919 C_u= 2.39 C_c= 1.11

Classification

USCS= AASHTO=

Remarks

Source of Sample: Site Drilling
Sample Number: BH12_SS3

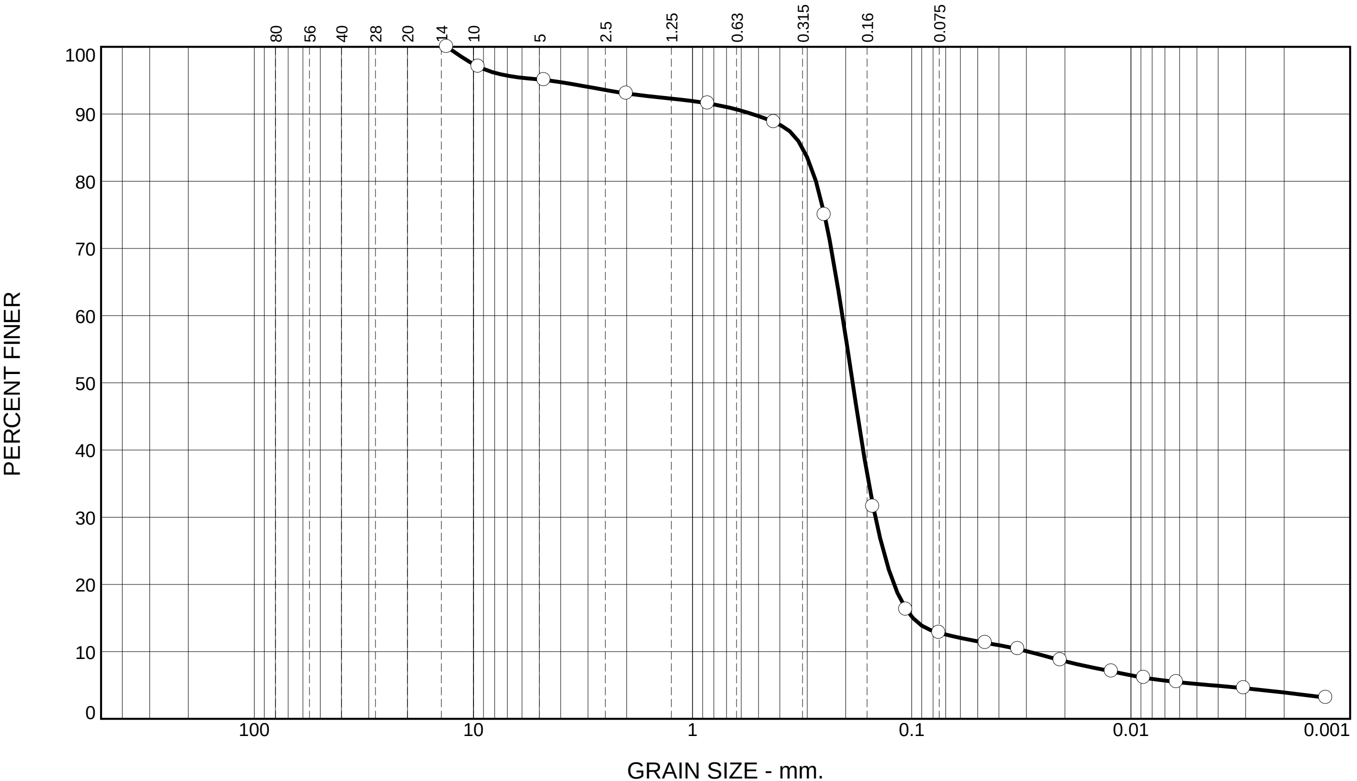
Date: Oct. 13, 2021

Client: Town of Innisfil
Project: 25th Side Road

Project No: 211-06027-00 **Figure** R1772-H-5

Tested By: Bonnie Wang **Checked By:** Bruce Shan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	5	2	4	76	9	4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
13.20	100		
9.50	97		
4.75	95		
2.00	93		
0.85	92		
0.425	89		
0.250	75		
0.150	32		
0.106	16		
0.075	13		
0.0460 mm.	11		
0.0327 mm.	10		
0.0209 mm.	8.7		
0.0122 mm.	7.0		
0.0087 mm.	6.1		
0.0062 mm.	5.5		
0.0030 mm.	4.6		
0.0013 mm.	3.1		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.5350 D_{85}= 0.3154 D_{60}= 0.2072
D_{50}= 0.1861 D_{30}= 0.1466 D_{15}= 0.0989
D_{10}= 0.0293 C_u= 7.07 C_c= 3.54

Classification

USCS= AASHTO=

Remarks

Source of Sample: Site Drilling
Sample Number: BH14_SS3

Date: Oct. 13, 2021

Client: Town of Innisfil
Project: 25th Side Road

Project No: 211-06027-00 **Figure** R1772-H-6

Tested By: Bonnie Wang **Checked By:** Bruce Shan

APPENDIX

E

PAVEMENT DESIGN

Accumulated ESALS	1012894
Subgrade Modulus (PSI)	4351.14
Reliability (%)	85
Initial Serviceability	4.2
Terminal Serviceability	2
Standard Deviation	0.49

Modulus Converter	
Mpa	30
PSI	4351.14

Required SN (imperial)	3.914557	Required SN (Metric)	99.4

ESAL Calculator	
Input	Value
AADT	4079
% Trucks	4
Truck Factor	1.4
Directional Distribution	1
Lane Distribution	0.5
Design Period	20
Growth Rate	2
Calculated ESALS	1012894

Mill & Overlay (60mm)

Layer Mapper				
Layer ID	Layer Coeff	Drainage Coeff	Thickness (mm)	SN
1	0.42	1	60	25.2
2	0.25	1	65	16.25
3	0.11	1	200	22
4	0.08	1	290	23.2
5				
6				
7				
			Total SN	86.65

Partial Depth Reconstruction (preferred)

Layer Mapper				
Layer ID	Layer Coeff	Drainage Coeff	Thickness (mm)	SN
1	0.42	1	120	50.4
2	0.14	1	150	21
3	0.08	1	345	27.6
			Total SN	99

Full Depth Reconstruction - Town of Innisfil

Layer Mapper				
Layer ID	Layer Coeff	Drainage Coeff	Thickness (mm)	SN
1	0.42	1	100	42
2	0.14	1	150	21
3	0.09	1	400	36
			Total SN	99

Full Depth Reconstruction - MTO

Layer Mapper				
Layer ID	Layer Coeff	Drainage Coeff	Thickness (mm)	SN
1	0.42	1	130	54.6
2	0.14	1	150	21
3	0.09	1	450	40.5
			Total SN	116.1

APPENDIX

F

LIFECYCLE COST ANALYSIS

LIFE CYCLE COST ANALYSIS SUMMARY

25th Side Road

30 Year Design Period

Ranking	Alternative		Initial Construction	Life Cycle Cost	Cost Difference
1	Rehab	Option 1- One Lift 60mm Mill and Overlay	$1,144,482	$2,829,371	$1,684,889
2	Rehab	Option 2- Partial Depth Reconstruction	$2,266,624	$2,880,270	$613,646
3	Rehab	Option 3- Full Depth Reconstruction (Town of Innisfil)	$2,714,190	$3,600,834	$886,644
4	Rehab	Option 4- Full Depth Reconstruction- MTO Manual	$3,071,571	$4,209,039	$1,137,468

Life Cycle Cost Analysis for Option 1
One Lift Mill and Pave on Flexible Pavement
8-10 Year Design Life
25th Side Road

One Lift 60mm Mill and Overlay
Estimated LCCA for 2-lane Section

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities/km		Pay Item Price ($)	Cost ($)	Present Worth ($)
1	*Initial Construction Cost*					*$1,144,482*
5	Rout and Seal Cracks[2]	1,730	m	$9.00	$15,570.00	$12,200
	Mill (60 mm) and 60-mm Patch[3]	2,422	m^2	$4.00	$9,688.00	$7,591
8	Mill 100mm	48,440	m^2	$6.00	$290,640.00	$196,717
	Pave 50mm SP 19.0 B[5]	5,958	t	$81.00	$482,607.72	$326,648
	Pave 50mm SP 12.5 B[4]	6,128	t	$126.00	$772,085.16	$522,578
	Rout and Seal Cracks	1,730	m	$9.00	$15,570.00	$10,538
	Application of Tack Coat 2 Layers	96,880	m^2	$0.50	$48,440.00	$32,786
13	Rout and Seal Cracks[2]	1,730	m	$9.00	$15,570.00	$8,257
	Mill (50 mm) and 50-mm Patch[3]	2,422	m^2	$4.00	$9,688.00	$5,138
18	Rout and Seal Cracks[2]	1,730	m	$9.00	$15,570.00	$6,470
	Mill (50 mm) and 50-mm Patch[3]	2,422	m^2	$4.00	$9,688.00	$4,026
20	Mill 100mm	48,440	m^2	$6.00	$290,640.00	$109,539
	Pave 50mm SP 19.0 B[5]	5,958	t	$81.00	$482,607.72	$181,890
	Pave 50mm SP 12.5 B[4]	6,128	t	$126.00	$772,085.16	$290,991
	Rout and Seal Cracks	1,730	m	$9.00	$15,570.00	$5,868
	Application of Tack Coat 2 Layers	96,880	m^2	$0.50	$48,440.00	$18,257
25	Rout and Seal Cracks[2]	1,730	m	$9.00	$15,570.00	$4,598
	Mill (50 mm) and 50-mm Patch[3]	2,422	m^2	$4.00	$9,688.00	$2,861
30	Salvage Value	2	years	-$134,111.91	-$268,223.81	-$62,061
					Total Life Cycle Cost Analysis Worth	**$2,829,371**

Notes:
1. Discount rate of 5.0 % has been assumed.
2. Length of route and crack sealing based on an estimated 25% of the total length of the project road.
3. Area for mill and patch treatment based on an estimated 5% of the total area of the project road.
4. Conversion Factor for SuperPave 12.5: 2.53 t/m^3.
5. Conversion Factor for SuperPave 19.0: 2.46 t/m^3.

Life Cycle Cost Analysis for Option 2
Full Depth Asphalt Replacement - Flexible Pavement
15 Year Design Life
25th Side Road

Partial Depth Reconstruction
Estimated LCCA for 2-lane section

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities/km		Pay Item Price ($)	Cost ($)	Present Worth ($)
1	*Initial Construction Cost*					*$2,266,624*
7	Rout and Seal Cracks[2]	1,730	m	$9.00	$15,570.00	$11,065
	Mill (50 mm) and 50-mm Patch[3]	2,422	m^2	$4.00	$9,688.00	$6,885
12	Rout and Seal Cracks[2]	1,730	m	$9.00	$15,570.00	$8,670
	Mill (50 mm) and 50-mm Patch[3]	2,422	m^2	$4.00	$9,688.00	$5,395
18	Rout and Seal Cracks[2]	1,730	m	$9.00	$15,570.00	$6,470
	Mill (50 mm) and 50-mm Patch[3]	2,422	m^2	$4.00	$9,688.00	$4,026
20	Full Depth Asphalt Removal	48,440	m^2	$6.00	$290,640.00	$109,539
	Pave 70mm SP 19.0 B[3]	7,150	t	$81.00	$579,129.26	$218,268
	Pave 50mm SP 12.5 B[4]	6,128	t	$126.00	$772,085.16	$290,991
	Application of Tack Coat 1 Layer	48,440	m^2	$0.50	$24,220.00	$9,128
25	Rout and Seal Cracks[2]	1,730	m	$9.00	$15,570.00	$4,598
	Mill (60 mm) and 60-mm Patch[3]	2,422	m^2	$4.00	$9,688.00	$2,861
30	Salvage Value	2	years	-$138,839.54	-$277,679.07	-$64,249
					Total Life Cycle Cost Analysis Worth	**$2,880,270**

Notes:
1. Discount rate of 5.0 % has been assumed.
2. Length of route and crack sealing based on an estimated 25% of the total length of the project road.
3. Area for mill and patch treatment based on an estimated 5% of the total area of the project road.
4. Conversion Factor for SuperPave 12.5: 2.53 t/m^3.
5. Conversion Factor for SuperPave 19.0: 2.46 t/m^3.

Life Cycle Cost Analysis for Option 3
Full Depth Reconstruction - Flexible Pavement
20 Year Design Life
25th Side Road

Reconstruction
Estimated LCCA for 2-lane section

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities/km		Pay Item Price ($)	Cost ($)	Present Worth ($)
1	*Initial Construction Cost*					*$2,714,190*
5	Rout and Seal Cracks^2	1,730	m	$9.00	$15,570.00	$12,200
	Mill (50 mm) and 50-mm Patch^3	2,422	m^2	$4.00	$9,688.00	$7,591
10	Rout and Seal Cracks^2	1,730	m	$9.00	$15,570.00	$9,559
	Mill (50 mm) and 50-mm Patch^3	2,422	m^2	$4.00	$9,688.00	$5,948
15	Rout and Seal Cracks^2	1,730	m	$9.00	$15,570.00	$7,489
	Mill (50 mm) and 50-mm Patch^3	2,422	m^2	$4.00	$9,688.00	$4,660
20	Full Depth Asphalt Removal	48,440	m^2	$6.00	$290,640.00	$109,539
	Pave 50mm SP 19.0 B^3	5,958	t	$81.00	$482,607.72	$482,608
	Pave 50mm SP 12.5 B^4	6,128	t	$126.00	$772,085.16	$290,991
	Application of Tack Coat 1 Layer	48,440	m^2	$0.50	$24,220.00	$9,128
25	Rout and Seal Cracks^2	1,730	m	$9.00	$15,570.00	$4,598
	Mill (50 mm) and 50-mm Patch^3	2,422	m^2	$4.00	$9,688.00	$2,861
30	Salvage Value	2	years	-$130,796.07	-$261,592.15	-$60,527
					Total Life Cycle Cost Analysis Worth	**$3,600,834**

Notes:
- **1.** Discount rate of 5.0 % has been assumed.
- **2.** Length of route and crack sealing based on an estimated 25% of the total length of the project road.
- **3.** Area for mill and patch treatment based on an estimated 5% of the total area of the project road.
- **4.** Conversion Factor for SuperPave 12.5: 2.53 t/m^3.
- **5.** Conversion Factor for SuperPave 19.0: 2.46 t/m^3.

Life Cycle Cost Analysis for Option 4
Full Depth Reconstruction - Flexible Pavement
20 Year Design Life
25th Side Road

Reconstruction (MTO Manual)
Estimated LCCA for 2-lane section

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities/km		Pay Item Price ($)	Cost ($)	Present Worth ($)
1	*Initial Construction Cost*					*$3,071,571*
5	Rout and Seal Cracks[2]	1,730	m	$9.00	$15,570.00	$12,200
	Mill (50 mm) and 50-mm Patch[3]	2,422	m^2	$4.00	$9,688.00	$7,591
10	Rout and Seal Cracks[2]	1,730	m	$9.00	$15,570.00	$9,559
	Mill (50 mm) and 50-mm Patch[3]	2,422	m^2	$4.00	$9,688.00	$5,948
15	Rout and Seal Cracks[2]	1,730	m	$9.00	$15,570.00	$7,489
	Mill (50 mm) and 50-mm Patch[3]	2,422	m^2	$4.00	$9,688.00	$4,660
20	Full Depth Asphalt Removal	48,440	m^2	$6.00	$290,640.00	$109,539
	Pave 80mm SP 19.0 B[3]	9,533	t	$81.00	$772,172.35	$772,172
	Pave 50mm SP 12.5 B[4]	6,128	t	$126.00	$772,085.16	$290,991
	Application of Tack Coat 1 Layer	48,440	m^2	$0.50	$24,220.00	$9,128
25	Rout and Seal Cracks[2]	1,730	m	$9.00	$15,570.00	$4,598
	Mill (50 mm) and 50-mm Patch[3]	2,422	m^2	$4.00	$9,688.00	$2,861
30	Salvage Value	3	years	-$143,009.04	-$429,027.12	-$99,267
					Total Life Cycle Cost Analysis Worth	**$4,209,039**

Notes:
1. Discount rate of 5.0 % has been assumed.
2. Length of route and crack sealing based on an estimated 25% of the total length of the project road.
3. Area for mill and patch treatment based on an estimated 5% of the total area of the project road.
4. Conversion Factor for SuperPave 12.5: 2.53 t/m^3.
5. Conversion Factor for SuperPave 19.0: 2.46 t/m^3.

APPENDIX

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LIMITATIONS OF REPORT

LIMITATIONS OF REPORT AND GENERAL COMMENTS

WSP Canada 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 accorded the privilege of making this review, WSP Canada Inc. will assume no responsibility for interpretation of the recommendations in the report.

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

This report is intended solely for the Client named. The material in it reflects our best judgment in light of the information available to WSP Canada Inc. at the time of preparation. Unless otherwise agreed in writing by WSP, it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. No portion of this report may be used as a separate entity, it is written to be read in its entirety.

The conclusions and recommendations given in this report are based on information determined at the test hole locations. The information contained herein in no way reflects on the environment aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation.

The design recommendations given in this 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.

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. WSP Canada 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 accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time.