Terraprobe

Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

PAVEMENT INVESTIGATION & DESIGN REPORT
CAWTHRA ROAD IMPROVEMENTS
SOUTH SERVICE ROAD TO EASTGATE PARKWAY
CITY OF MISSISSAUGA
REGIONAL MUNICIPALITY OF PEEL, ONTARIO

PREPARED FOR:

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File No. 1-18-0615
March 19, 2020

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1.0 INTRODUCTION

Terraprobe Inc. (Terraprobe) has been retained by IBI Group (IBI) to provide geotechnical engineering services in support of a Schedule 'B' Class Environmental Assessment Study for Cawthra Road between South Service Road and Eastgate Parkway in the City of Mississauga, Regional Municipality of Peel, Ontario. A site location plan is provided as Figure 1 and site photographs are presented in Figures 2 to 7.

The scope of work for the geotechnical engineering services of this project is outlined in Terraprobe's proposal titled *"Geotechnical Consulting Engineering Services, Cawthra Road Corridor and Intersection Improvements from QEW to Eastgate Parkway, City of Mississauga, Regional Municipality of Peel, Ontario"* dated June 29, 2018.

The purpose of this study was to assess the pavement condition and to explore the subsurface conditions by borehole drilling, falling weight deflectometer (FWD) testing, pavement coring and, laboratory testing on soil samples. The data obtained from this investigation was used to provide Borehole Location Plans, Borehole Logs, Pavement Core Logs, laboratory test results, a description of the subsurface conditions and pavement design recommendations.

2.0 SITE AND PROJECT DESCRIPTION

Cawthra Road is a north-south oriented, two-lane urban roadway under the jurisdiction of the Regional Municipality of Peel (Region of Peel) that serves an arterial function. The road is approximately 5.5 km long within the project limits. The south limit of this project is approximately 20 m south of South Service Road/Cawthra Road intersection, i.e. Sta. 9+960, and the north project limit is Cawthra Road/Eastgate Parkway intersection, i.e. Sta. 15+460 with chainage increasing from south to north.

The MTO interchange at the Queen Elizabeth Way is located within the south project limit and the Highway 403 is located at the north project limit. Grade separation structures exist at Dundas Street and also 125 m south of Dundas Street where the railway crosses above Cawthra Road.

3.0 INVESTIGATION PROCEDURES

3.1 Current Investigation

The field investigations were carried out during the period June 3 to 14, 2019 after obtaining utility clearances and permits. The work was performed in accordance with the lane closure times specified by the Region of Peel and City of Mississauga. Details of the field investigations are presented below.

- Drilling forty-one pavement boreholes through the existing lanes and shoulders of Cawthra Road each to a depth of approximately 1.5 m below ground surface;
- Drilling two 1.8 m deep boreholes at the proposed turning lane locations;
- Drilling sixteen 1.5 m deep pavement boreholes through the existing lanes of intersecting roads;
- Coring the Cawthra Road pavement at eighteen locations; and
- Manually excavating fifty-one shallow test pits in boulevard areas to estimate the topsoil thickness.

The borehole locations were marked in the field by Terraprobe's staff in relation to existing features shown on the drawings provided by IBI. The approximate borehole locations are shown on Figures 8 to 14.

The boreholes were drilled with a CME 55 truck-mounted drill rig and also portable drilling equipment supplied and operated by a specialist drilling contractor who was observed on a full-time basis by members of Terraprobe's technical staff.

In the boreholes drilled through the existing pavements, samples of the soil and granular material were collected from auger cuttings. In the boreholes drilled at the proposed turning lane locations, samples of the overburden soils were obtained by advancing a split spoon sampler with portable hand operated vibratory equipment. The ground water conditions in the open boreholes were observed during and immediately following the drilling operation.

The recovered soil samples were transferred to Terraprobe's Brampton laboratory for further examination and testing. Select soil samples were subjected to a laboratory testing programme consisting of natural moisture content and grain size distribution in accordance with ASTM Standards as appropriate. Fifteen soil samples and three asphalt cores were also submitted to SGS Laboratories for chemical testing. Falling Weight Deflectometer (FWD) testing was also performed on Cawthra Road between the project limits by Engtec Consulting Inc.

The results of the soil testing program, are presented on the Pavement Borehole Logs in Appendix A1 and on the figures in Appendix B. The pavement core data and photographs are provided in Appendix A1 and the results of the chemical tests are provided in Appendix C. The FWD test results and the report are included in Appendix D.

A visual pavement condition survey of Cawthra Road was completed in August 2019 and the Pavement Condition Evaluation Forms are included in Appendix E.

3.2 Previous Investigation

This site between Burnhamthorpe Road and Meadows Boulevard was previously investigated by Coffey Geotechnics in 2011, and the approximate locations of applicable boreholes from this study are shown on Terraprobe's Figures 12 and 13. Coffey's Borehole Location Plan and borehole logs are provided in Appendix A2.

4.0 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Borehole Logs in Appendix A. An overall description of the stratigraphy is given in the following paragraphs.

4.1 Pavement Structure

The average pavement structures of Cawthra Road are summarized in the following table.

Road	Station	Average Thickness (mm)			
		HMA	Concrete	Granular	Total
Cawthra Road	Sta. 9+960 to Sta. 12+750	105	200	300	605
	Sta. 12+750 to Sta. 14+280	175	-	405	580
	Sta. 14+280 to Sta. 15+080	140	-	460	600
	Sta. 15+080 to Sta. 15+460	300	-	375	675

Six samples of the granular base/subbase material were subjected to grain size distribution tests and the results are presented in Figure B1 in Appendix B. The results are compared to the Ontario Provincial Standards (OPSS) gradation specifications for Granular A and Granular B Type II. The natural water content of samples of the granular base/subbase range from 2% to 10% by weight.

The pavement structure of intersecting roads with Cawthra Road are summarized in the following table.

Road	**Location**	**Average Thickness (mm)**			
		HMA	**Concrete**	**Granular**	**Total**
Tedwyn Drive	East Bound Lane	150	-	250	400
Queensway East	East Leg, West Bound Lane West Leg, East Bound Turning Lane	90 220	130 -	260 490	480 710
Needham Lane	East Bound Lane	180	-	370	550
Silver Creek Boulevard	East Bound Lane	140	-	310	450
Santee Gate	East Bound Lane	130	-	270	400
Bloor Street	East Leg, East Bound Lane West Leg, West Bound Lane	200 230	- -	500 270	700 500
Schomberg Avenue	West Bound Lane	200	-	300	500
Hyacinthe Boulevard	West Bound Lane	180	-	420	600
Breckenridge Road	East Leg, East Bound Lane West Leg, West Bound Lane	140 180	- -	260 320	400 500
Runningbrook Drive	East Bound Lane	150	-	250	400
Hassall Road	East Bound Lane	140	-	310	450
Burnhamthorpe Road East	East Leg, East Bound Lane West Leg, West Bound Lane	250 240	- -	450 410	700 650

4.1.1 Pavement Condition

A visual pavement condition survey of Cawthra Road was completed in August 2019. The pavements were evaluated in accordance with the procedures outlined in the following manuals:

- Ministry of Transportation of Ontario (MTO) *Manual for Condition Rating of Flexible Pavements - Distress Manifestations (SP-024)*; and
- Ministry of Transportation Ontario, *Manual for Condition Rating of Rigid Pavements - Concrete Surface and Composite Distress Manifestations (SP-026),* September 1995

The Pavement Condition Evaluation Forms are included in Appendix E and, the observed pavement distresses and pavement condition of the evaluated pavement sections are summarized in the following table.

Section	Overall Condition	General Distresses
Cawthra Road Sta.9+960 to Sta. 10+830	PCR* = 95, RCR** = 9.5 Excellent	▪ Few very slight ravelling and coarse aggregate loss.
Cawthra Road Sta.10+830 to Sta.11+500	PCR* = 70, RCR** = 7.0 Good	▪ Frequent slight ravelling and coarse aggregate loss; ▪ Intermittent slight spalling; ▪ Intermittent moderate tenting/cupping; ▪ Intermittent moderate single and multiple longitudinal, meandering cracking; ▪ Intermittent moderate single transverse cracking; and ▪ Frequent moderate reflective transverse joints.
Cawthra Road Sta.11+500 to Sta. 12+750	PCR* = 80, RCR** = 8.0 Good to Excellent	▪ Few very slight ravelling and coarse aggregate loss; ▪ Few slight spalling; ▪ Few slight tenting/cupping; ▪ Few slight single and multiple longitudinal, meandering cracking; ▪ Few slight single transverse cracking; and ▪ Intermittent slight reflective transverse joints.
Cawthra Road Sta.12+750 to Sta.14+220	PCR* = 70, RCR** = 7.0 Good	▪ Throughout slight ravelling and coarse aggregate loss; ▪ Intermittent slight wheel track rutting; ▪ Intermittent slight distortion; ▪ Extensive slight single and multiple longitudinal wheel track cracking; ▪ Intermittent slight alligator longitudinal wheel track cracking; ▪ Throughout slight single and multiple centre line cracking; ▪ Few slight alligator centre line cracking; and ▪ Extensive slight half, full and multiple transverse cracking.
Cawthra Road Sta.14+220 to Sta.15+460	PCR = 90, RCR = 9.0 Excellent	▪ Intermittent very slight ravelling and coarse aggregate loss; ▪ Few very slight single and multiple longitudinal wheel track cracking; and ▪ Few very slight half, full and multiple transverse cracking.

* PCR = Pavement Condition Rating. ** RCR = Ride Condition Rating

4.2 Subgrade Soils

The pavement subgrade soils generally consist of a silty sand to sand, silty clay to clayey silt and sand and gravel to gravelly sand. Weathered shale was encountered at some borehole locations (auger refusal) and is interpreted to exist between Sta. 11+900 and Sta. 12+475.

The results of particle size analysis conducted on four samples of the silty sand to sand subgrade soils are shown in Figure B2 in Appendix B. The test results show a grain size distribution consisting of 8% to 18% gravel, 39% to 63% sand, 19% to 33% silt, and 4% to 18% clay size particles. The moisture content of samples of the silty sand to sand subgrade soils range from 7% to 13% by weight.

The results of particle size analysis conducted on two samples of the silty clay to clayey silt subgrade soils are shown in Figure B3 in Appendix B. The test results show a grain size distribution consisting of 1% and 2% gravel, 25% and 28% sand, 42% and 45% silt, and 28% and 29% clay size particles. The moisture content of two samples of the silty clay to clayey silt subgrade soils are 18% and 19% by weight.

The result of particle size analysis conducted on a sample of the sand and gravel to gravelly sand subgrade soil is shown in Figure B4 in Appendix B. The test result shows a grain size distribution consisting of 29%

gravel, 48% sand, 18% silt, and 5% clay size particles. The moisture content of a sample of the sand and gravel to gravelly sand subgrade soil is 5% by weight. Based on the particle size analysis:

- the silty sand to sand subgrade soils have a low frost susceptibility (LSFH) and their erodibility (K factor) ranges from 0.14 to 0.2;
- the silty clay to clayey silt subgrade soils have a low frost susceptibility (LSFH) and the erodibility (K factor) of the two tested samples are 0.33 and 0.37; and
- the sand and gravel to gravelly sand subgrade soil has a low frost susceptibility (LSFH) and the erodibility (K factor) of the tested sample is 0.05.

4.3 Topsoil

Topsoil layers ranging in thickness from 100 mm to 180 mm were encountered in the shallow test pits. Further details are provided in the Topsoil Thickness Sheets in Appendix A1. Topsoil thickness will vary between and beyond the test pit locations.

4.4 Ground Water

No free ground water was encountered in the boreholes. However, the ground water level can be expected to fluctuate seasonally and after severe weather events.

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 General

This section of the report presents an interpretation of the factual geotechnical data and provides pavement design recommendations. The discussions and recommendations are based on our understanding of the project, and our interpretation of the factual data obtained from the subsurface investigations.

Where comments are made on construction, they are provided to highlight those aspects that could affect the design of the project, and for which special provisions or operational constraints may be required in the Contract Documents. Those requiring information on the aspects of construction should make their own interpretation and assessment of the geotechnical information provided, as such interpretation may affect equipment selection, proposed construction methods, scheduling, and the like.

The pavement design recommendations provided herein are related to the following aspects of this project:

- Rehabilitating the Cawthra Road pavement between the project limits, Sta. 9+960± to Sta. 15+460±;
- Providing exclusive turning lanes at the Cawthra Road intersections with Eastgate Parkway, Rathburn Road, Bloor Street, Queensway East, North Service Road and South Service Road;
- Providing bus bays and bicycle tracks within the project limits; and
- An easterly shift of the Cawthra Road alignment from approximately 200 m north of Silver Creek Blvd. to Santee Gate, i.e. between Sta. 12+740 and Sta. 12+900.

5.2 Traffic Data

The 24-hour traffic count data and annual growth rate used for the pavement designs were provided by IBI and are based on Year 2017/2018 traffic data obtained from the Region of Peel. The ESAL values were derived using Average Annual Daily Truck Traffic (AADTT) obtained from the 24-hour traffic count data and also AADT data. The ESAL calculations for both analytical methodologies are provided in Tables F1/F1a to F5/F5a in Appendix F and these ESAL values are summarized in the following tables.

Traffic Volume and Pavement Design Parameters	**Location**		
	0.1 km North of Tedwyn Dr.	**0.2 km North of Queensway East**	**0.5 km North of Silver Creek Blvd.**
AADTT (2015)	4,212	2,666	3,409
Projected base year AADTT (2019)	4,354	2,756	3,524
Projected AADTT (2034)	4,928	3,119	3,989
Annual Growth Rate (2019 to 2034)	0.83%	0.83%	0.83%
Percent Commercial Vehicles	100%	100%	100%
Directional Split	50%	50%	50%
Cumulative Design ESALs (AADTT)	7,761,000	7,771,200	10,401,600
Cumulative Design ESALs (AADT)	6,768,000	7,968,000	8,467,200

Traffic Volume and Pavement Design Parameters	**Location**	
	0.2 km North of Bloor St.	**1.0 km North of Burnhamthorpe Rd.**
AADT (2015)	3,020	2,261
Projected base year AADT (2019)	3,122	2,337
Projected AADT (2039)	3,534	2,645
Annual Growth Rate (2019 to 2039)	0.83%	0.83%
Percent Commercial Vehicles	100%	100%
Directional Split	50%	50%
Cumulative Design ESALs (AADTT)	8,361,600	7,387,200
Cumulative Design ESALs (AADT)	7,838,400	7,017,600

5.3 Pavement Designs

The pavements were designed based on the traffic information provided by IBI and the data obtained from the field investigations. The following references and guidelines were used for the pavement designs.

- MTO's *"Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions, MI-183"*, March 19, 2008;
- American Association of State Highway and Transportation Officials, "*AASHTO Guide for Design of Pavement Structures"*, 1993;
- "*Procedures for Estimating Traffic Loads for Pavement Designs*," Hajek. J., 1995; and
- Canadian Portland Cement Association *"Thickness Design for Concrete Highway and Street Pavements"*, 1984.

The pavement design parameters are summarized in the following table.

Design Parameter		**Values**	
Design Period (years)		15	
Estimated Cumulative Design ESAL's		Sta. 0+960 to Sta. 12+750	7,968,000
		Sta. 12+750 to Sta. 14+220	10,401,600
		Sta. 14+220 to Sta. 15+460	7,387,200
Initial/Terminal Serviceability Index		$P_i = 4.5$	$P_t = 2.0$
Loss in Serviceability Index		2.5	
Desired Reliability (R %) and Standard Deviation (SD)		R = 85	SD = 0.44 (Flexible)
			SD = 0.34 (Rigid)
Flexible Pavement Design	Estimated Resilient Modulus of Subgrade Soil (MPa)	Sta. 0+960 to Sta. 12+750	35 to 50
		Sta. 12+750 to Sta. 14+220	35 to 38
		Sta. 14+220 to Sta. 15+460	30 to 40
	Layer Coefficients of Hot Mix Asphalt (HMA)	New HMA = 0.42 Existing HMA = 0.28	
	Layer Coefficient of Granular Materials	New Gran A = 0.14	New Gran B Type II = 0.12
		Existing Granular = 0.09 to 0.12	
	Drainage Coefficient of Granular Materials	m = 1 (new & existing granular base & subbase)	
Rigid Pavement Design	Modulus of Subgrade Reaction (k) (kPa/mm)	90	
	Mean PCC Modulus of Rupture (MPa)	4.7	
	Elastic Modulus of Concrete (MPa)	23,000	

5.3.1 Pavement Structure (New Construction - Widening)

Based on the estimated cumulative ESAL's and Region of Peel's Standard Drawing 5-1-1, the recommended pavement structure for new construction i.e. road widening and turning lanes, is provided in the following table.

Pavement Component/Parameter	**Component Thickness/Parameter Value (mm)**
DFC (Surface Course)	50
HDBC (Binder Course)	100*
Granular A Base Course	150
Granular B Type II Subbase Course	450
Total Thickness	750
Structural Number Provided	138
Design Structural Number	128 to 132

* 2x50 mm thick lifts

In the pavement widening areas we recommend the following construction methodology:

- Saw cut the pavement and remove the existing asphalt concrete;
- If and as required sub-excavate the existing granular material and subgrade soils to achieve the pavement design top of subgrade elevation;
- Place and compact the granular base and sub-base courses; and
- Apply tack coat to the existing pavement and pave the lower and upper binder courses followed with the surface course paving. Stagger HMA lifts 150 mm into the existing pavement to prevent reflective cracking at the construction joint.

5.3.2 Pavement Structure (Rehabilitation)

The structural capacities of the existing pavements were analyzed using AASHTO's pavement overlay design procedure. Designs were carried out for a service life extension of 15 years and both the rigid pavement and flexible pavements were found to be structurally deficient. The structural number deficiencies are tabulated below.

Section	Design ESALs	Required Design Structural Number (mm)	Existing Structural Number (mm)
Sta. 0+960 to Sta. 12+750	7,968,000	165	164
Sta. 12+750 to Sta. 14+220	10,401,600	121	90
Sta. 14+220 to Sta. 15+460	7,387,200	114	85

Various rehabilitation techniques were considered noting that raising the grade is not considered to be beneficial to the overall design. Therefore, the only feasible and practical rehabilitation strategies are:

- For the rigid pavement mill/remove the existing asphalt overlay (105 mm) and repave with 105 mm of new HMA;
- For the flexible pavements carry out full depth reconstruction or consider other rehabilitation techniques such as mill and overlay and/or full depth replacement. Full depth reconstruction is the only rehabilitation alternative that will provide a 15-year design life for the design traffic. The mill and overlay and full depth rehabilitation techniques will improve road performance but the service life extension for the design traffic will be less than 15 years. Tabulated below are the three rehabilitation alternatives for the flexible pavement and the calculated service life extensions.

Section	Service Life Extension (Year)		
	Full Depth Reconstruction	Full Depth Asphalt Replacement	Mill 100 mm and Overlay 100 mm
Sta. 12+750 to Sta. 14+220	15	10	5
Sta. 14+220 to Sta. 15+460	15	10	5

Since full depth reconstruction of the flexible pavement is a large expenditure, the preferred rehabilitation strategy i.e. mill 100 mm and overlay 100 mm (50 mm DFC surface course and 55 mm HDBC binder course) was considered after further consultations with the design team and client. Although the designs suggest that a service life extension of 5 years can be achieved with the 100 mm mill and overlay option, based on the Region's observations of the existing pavement performance (the existing pavement is over 10 years old and still performing acceptably) it is understood that this rehabilitation option could provide a service life extension of up to 10 years to reach its terminal serviceability limit. Preplacing the entire pavement envelope now will be very disruptive and will, in all likelihood still end in the pavement reaching its terminal serviceability over the next 10+ years.

The rigid pavement should be rehabilitated by full depth removal of the existing asphalt and repaving with 105 mm of asphalt consisting of 50 mm DFC surface course and 55 mm of HDBC binder course. This asphalt overlay will increase the structural number of the rigid pavement from 188 mm to 230 mm. Cracks in the concrete shall be routed and sealed in accordance with OPSD 508.020 prior to paving the HMA overlay.

Full depth composite (concrete) pavement repairs will be required where joint failures exist in the underlying concrete. Repairs shall be carried out in accordance with the Region of Peel Standard Drawing 5-2-2. Full depth repairs shall include:

- delineation (by sawing) and removal of the affected slab section(s) so as not to disturb or damage any adjacent slabs;
- appropriate disposal of the old concrete and steel reinforcement;
- treatment of any exposed steel and/or reinforcement against further corrosion;
- sub-excavation of undesirable and/or deleterious materials from the base’
- base preparation, Granular A base restoration;
- proper matching of transverse joints and proper separation along longitudinal joints to prevent crack propagation;
- installation of tie bars and dowels at 900 mm spacing and an insertion depth of 300 mm at mid depth the concrete slab;
- placing and curing of the Portland Cement Concrete; and
- joint resealing.

It should be noted that there are inherent risks associated with the rigid pavement rehabilitation most notably is the concrete pavement condition which can only be assessed after the asphalt is removed. If the concrete slabs are in poor condition, then large areas of concrete may require full depth concrete repairs which will result in increased construction costs.

5.4 Construction Features

5.4.1 Material Types

The following mix types as specified in the Region of Peel specifications and OPSS 1150 are considered suitable for this project.

DFC	Surface Course; and
HDBC	Binder Course.

Granular A material should be used for the base material and Granular B Type II is recommended as subbase material. The Granular A and the Granular B Type II material shall meet the OPSS.MUNI 1010 specifications and shall consist of crusher run limestone as specified in Region of Peel’s Standard Drawing 5-1-1.

5.4.1 Padding

HL3 HS is recommended as padding where grade adjustments require HMA thicknesses that are less than 50 mm. Padding shall be placed in lifts not exceeding 50 mm thick.

5.4.2 Asphalt Cement Grade

Performance graded asphalt cement PG 70-28 conforming to the Region of Peel specifications and OPSS MUNI 1101 is recommended for the surface course and upper binder courses. Performance graded asphalt cement PG 58-28 is recommended for all other mixes.

Asphalt cement used in the manufacture of hot mix asphalt surface and binder courses should not contain Vacuum Tower Asphalt Extenders (VTAE), Refined Engine Oil Bottoms (REOB) or Waste Engine Oil Residue (WEOR). Therefore, we recommend testing the Asphalt Cement properties and attributes in accordance with the test requirements outlined in OPSS Special Provision No, 111F09.

5.4.3 Tack Coat

A tack coat (SS1) should be applied to all construction joints prior to placing hot mix asphalt to create an adhesive bond. Prior to placing hot mix asphalt, SS1 tack coat must also be applied to all existing surfaces and between all new lifts.

5.4.4 Bus Bays

The road will carry transit buses and a rigid pavement is recommended for the bus bays. The bus bay pavement should be constructed in accordance with The Region of Peel Standard Drawing 5-2-10 *"Concrete Pavement for Acceleride Bus Bay"*.

5.4.5 Paved Shoulders

Paved shoulders are likely required in some areas. In these areas the paved shoulders shall be constructed by extending the top two lifts of hot mix asphalt on the main lanes over the granular shoulder material i.e. the 50 mm DFC surface course and the 50 mm HDBC upper binder course.

5.4.6 Subgrade Preparation

All topsoil, organics, soft/loose and otherwise disturbed soils shall be removed from the subgrade areas. The design subgrade is expected to consist of fine-grained soils or granular soils such as silty sand. The fine-grained soils (such as silty clays and clayey silts) will be weakened by construction traffic when wet, especially if site work is carried out during periods of wet weather. During these weather conditions, an adequate granular working surface would be required in order to minimize subgrade disturbance. Subgrade preparation and fill construction should not be done in the winter.

Immediately prior to placing the granular base course, the subgrade soils should be compacted and then proofrolled with a heavy rubber tired vehicle (such as a loaded gravel truck). The subgrade should be inspected for signs of rutting or displacement. Areas displaying signs of rutting or displacement should be recompacted and retested or, the material should be excavated and replaced with well-compacted and clean fill.

The fill may consist of either granular material or local inorganic soils provided that their moisture contents are within ±2% of optimum. Fill material shall be placed and compacted in accordance with OPSS MUNI 501 and the upper 300 mm thick layer of the subgrade soils shall be compacted to 98% of the material's Standard Proctor Maximum Dry Density (SPMDD).

5.4.7 Fill Materials

Only approved earth fill that complies with the OPSS.MUNI 212 specification for borrow material shall be used for construction. The placement of borrow material must be carefully monitored and properly compacted in accordance with OPSS.MUNI 501 to ensure adequate pavement support. Mixing of fill materials from different sources is not recommended due to the risks associated with differential settlement, drainage problems and frost heave.

Soils of low to medium frost susceptibility can be used as fill up to the proposed pavement design subgrade elevation. Soils with high frost susceptibility are not recommended for re-use within a zone extending to a maximum depth of 1.2 m below the proposed pavement design subgrade. These soils should be segregated and used elsewhere.

At the time of construction, the moisture content of the fill material shall be within ±2% of its Optimum Moisture Content (OMC). Reconditioning of the fill material to achieve optimum moisture content may be required prior to placement.

5.4.8 Drainage

Urban sections will require subdrains placed beneath the curb in accordance with the Region of Peel Standards 5-2-15A and 5-2-15B. Rural sections shall be constructed in accordance with OPSD 200.020. To provide positive surface water run-off as well as drainage across the pavement platform, the pavement surface should be sloped (normally 2%) and the pavement subgrade should be sloped at 3% towards the sides.

5.4.9 Pipe Culverts

Minor pipe culverts shall be installed in accordance with OPSD 802.010. Granular A material is recommended for embedment/bedding and cover to these pipes. Clean native soils can also be used as cover provided that these soils are placed below the design frost depth. Granular frost tapers will be required when the frost line is below the top of culvert.

5.4.10 Compaction of Base & Sub-Base Material

Asphalt concrete shall be placed and compacted in accordance with the Region of Peel Standards and OPSS 310. Granular base and subbase materials shall be placed in 150 mm lifts and compacted to 100% of the material's Standard Proctor Maximum Dry Density (SPMDD) at ±2% of its Optimum Moisture Content (OMC) in accordance with OPSS.MUNI 501.

5.4.11 Pavement Removals

Refer to the tabulated average pavement component thicknesses in Section 4.1 for the appropriate asphalt and granular thickness to use for estimating purposes.

5.4.12 Reuse of Existing Granular Material

The grain size analyses of three selected samples of the pavement base and subbase material indicates that the sampled material does not meet the OPSS.MUNI 1010 gradation requirements for Granular A and Granular B Type II material.

Therefore, granular material salvaged from under the existing pavement and shoulders is not recommended for re-use to construct the pavement base and subbase. This granular material can be used as non-structural fill elsewhere, provided that it is free of topsoil and other deleterious material.

5.4.13 Stripping

Assume an average topsoil thickness of 150 mm. Full depth removal of the topsoil and any other deleterious material is required prior to constructing the pavements in the widening areas.

5.4.14 Frost Penetration and Frost Susceptibility

For design purposes assume a frost penetration depth of 1.2 m. Based on MTO's *Pavement Design and Rehabilitation Manual, SDO 90-01,* the subgrade soils have a low susceptibility to frost heave (LSFH).

5.4.15 Soil Erodibility

Refer to the pavement borehole logs for the derived "K" factors. The soil erodibility of the subgrade soils is generally low to medium based on "K" factors of 0.05 to 0.37.

5.4.16 Excavations

All excavations shall be carried out in accordance with the guidelines outlined in the *"Occupational Health and Safety Act (OHSA) and Regulations for Construction Projects"*. Where workers must enter excavations extending deeper than 1.2 m, the trench walls must be suitably sloped and/or braced in accordance with the OHSA. Within the envisaged depths of temporary excavations, the OHSA soil classifications for this site are:

- Fill Soils – Type 3 soils;
- Silty Sand to Sand / Silty Clay to Clayey Silt / Sand and Gravel to Gravelly Sand – Type 3 soils.

The side slopes of temporary excavations may be formed no steeper than 1H:1V for Type 3 soils. Excavations should be undertaken in accordance with OPSS 902.

5.5 Soil Chemical Analysis

The testing carried out is intended to provide an overview of the soil quality and may not be adequate for the design of a soil management plan for construction because the actual quality of the excavated soils could vary between and beyond the boreholes. The actual acceptance criteria for surplus soil will vary with the receiving site and therefore additional sampling/testing will likely be required during construction to confirm disposal or re-use options. Debris or stained/odorous soils, that are encountered during excavation, should be segregated, and re-evaluated for disposal or re-use as fill and may require additional chemical analysis. If the excavated material is to be disposed of off-site, it is the contractor's responsibility to make arrangements and to identify a soil receiver that will accept excess soils.

Select soil samples from were submitted for analysis to investigate the high-risk APEC identified in Contamination Overview Study. A summary of the samples submitted for analysis is summarized below:

Borehole ID	Station/Location	Sample ID / Depth (m)	Soil Description	PCAs	APEC	Chemical Analysis		
						M&I	PHC	VOC
Borehole 1	10+030	AS 1 0.3 – 0.6	Granular Trace to some Silt	O1, 2, 3, 7, 8, 15 & 30	15	✓		
Borehole 7	10+700	AS 1 0.3 – 0.7	Granular Trace to some Silt	O1, 2, 3, 7, 8, 15 & 30	15	✓		
Borehole 15	11+340	AS 1 0.3 – 0.6	Granular Trace to some Silt	O1, 10, 28 & 30	4, 15	✓	✓	✓
Borehole 18	11+600	AS 1 0.3 – 0.6	Granular Trace to some Silt	O1, 10, 11, 28 & 30	6, 15	✓	✓	✓
Borehole 24	12+480	AS 1 0.3 – 0.6	Granular Trace to some Silt	O1, 28 & 30	10, 15	✓	✓	✓
Borehole 33	13+140	AS 1 0.2 – 0.5	Granular Trace Silt	O1 & 30	11, 15	✓		
Borehole 38	13+900	AS 1 0.2 – 0.5	Granular Trace to some Silt	1, 2, 3, 7, 8, 15 & 30	15	✓		
Borehole 40	14+220	AS 1 0.2 – 0.7	Granular Trace Silt	28 & 30	12, 15		✓	✓
Borehole 46	15+400	AS 1 0.0 – 0.8	Granular some Silt	1, 2, 3, 7, 8, 15 & 30	15	✓		
Borehole 53	Bloor Street, East Leg	AS 1 0.2 – 0.7	Granular Trace to some Silt	30	15	✓		
Borehole 62	Burnhamthorpe Rd. E. West Leg	AS 2 0.7 – 1.2	Gravelly Sand Trace to Some Silt	O1, 10, 28 & 30	12, 15		✓	✓

5.6 Applicable Standards

The results of the chemical analysis were compared to the Ministry of Environment, Conversation and Parks (MECP) Standards as found in the *“Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act”*, April 15, 2011. The Standards which the results were compared to, for coarse textured soils are:

- Table 1 Full Depth Background Site Condition Standards (Table 1);
- Table 2 Full Depth Generic Site Condition Standards in a Potable Ground Water Condition for Residential, Parkland and Intuitional Land Use (Table 2 RPI);
- Table 3 Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition for Residential, Parkland and Intuitional Land Use (Table 3 RPI); and
- Table 3 Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition for Industrial, Commercial and Community Land Use (Table 3 ICC).

The Standards were chosen for the following reasons:

- Table 1 – The results were compared to the Table 1 Standards in order to determine if the soil material was suitable for acceptance as clean fill meeting Table 1 at a potential receiving site;

- Table 2 RPI – The results were compared to the Table 2 RPI Standards in order to determine if the soil was suitable for acceptance as material meeting Table 2 at a potential receiving site;
- Table 3 RPI– The results were compared to the Table 3 RPI Standards in order to determine if the soil should be considered a waste; and
- Table 3 ICC – The results were compared to the Table 3 ICC as those are the applicable Site Condition Standards (SCS) for the site and to determine if the soil material should be considered a waste.

Table 3 ICC are the applicable SCS for the following reasons:

- The study area is in Commercial Land Use;
- Bedrock is presumed to be located at a depth greater than 2 m below ground surface;
- The site is located in an area that obtains its potable water from surface sources;
- The site is not located within 30 m of a surface water body; and
- The site is not located adjacent to an area of natural significance.

5.7 Sample Results

The results of the chemical analysis indicated the following:

Sample ID	Station/ Location	Table 1 RPI/ICC	Table 2 RPI	Table 3 RPI	Table 3 ICC
BH1 AS 1	10+030	Meets	Meets	Meets	Meets
BH 7 AS 1	10+700	Exceeds ▪ EC (ORP) ▪ SAR (ORP)	Exceeds ▪ EC (ORP) ▪ SAR (ORP)	Exceeds ▪ EC (ORP) ▪ SAR (ORP)	Meets
BH 15 AS 1	11+340	Exceeds ▪ Trichloroethylene (VOC) ▪ EC (ORP) ▪ SAR (ORP)	Exceeds ▪ Trichloroethylene (VOC) ▪ EC (ORP) ▪ SAR (ORP)	Exceeds ▪ Trichloroethylene (VOC) ▪ EC (ORP) ▪ SAR (ORP)	Exceeds ▪ EC (ORP) ▪ SAR (ORP)
BH 18 AS 1	11+600	Exceeds ▪ Hexane(n) (VOC) ▪ Trichloroethylene (VOC) ▪ EC (ORP) ▪ SAR (ORP)	Exceeds ▪ Trichloroethylene (VOC) ▪ EC (ORP) ▪ SAR (ORP)	Exceeds ▪ Trichloroethylene (VOC) ▪ EC (ORP) ▪ SAR (ORP)	Exceeds ▪ SAR (ORP)
BH 24 AS 1	12+480	Exceeds ▪ Trichloroethylene (VOC) ▪ EC (ORP) ▪ SAR (ORP)	Exceeds ▪ Trichloroethylene (VOC) ▪ EC (ORP) ▪ SAR (ORP)	Exceeds ▪ Trichloroethylene (VOC) ▪ EC (ORP) ▪ SAR (ORP)	Exceeds ▪ - SAR (ORP)
BH 33 AS 1	13+140	Exceeds ▪ EC (ORP) ▪ SAR (ORP)	Exceeds ▪ EC (ORP) ▪ SAR (ORP)	Exceeds ▪ EC (ORP) ▪ SAR (ORP)	Exceeds ▪ - EC (ORP) ▪ - SAR (ORP)
BH 38 AS 1	13+900	Exceeds ▪ EC (ORP) ▪ SAR (ORP)	Exceeds ▪ EC (ORP) ▪ SAR (ORP)	Exceeds ▪ EC (ORP) ▪ SAR (ORP)	Exceeds ▪ - SAR (ORP)
BH 40 AS 1	14+220	Exceeds ▪ Trichloroethylene (VOC) ▪ F4 (PHC) ▪ Gravimetric Heavy Hydrocarbons (PHC)	Exceeds ▪ Trichloroethylene (VOC)	Exceeds ▪ Trichloroethylene (VOC)	Meets

Sample ID	Station/ Location	Table 1 RPI/ICC	Table 2 RPI	Table 3 RPI	Table 3 ICC
BH 46 AS 1	15+400	Exceeds ▪ EC (ORP) ▪ SAR (ORP)	Exceeds ▪ EC (ORP) SAR (ORP)	Exceeds ▪ EC (ORP) SAR (ORP)	Meets
BH 53 AS 1	Bloor Street, East Leg	Exceeds ▪ EC (ORP) ▪ SAR (ORP)	Exceeds ▪ EC (ORP)	Exceeds ▪ EC (ORP)	Meets
BH 62 AS 2	Burnhamthorpe Rd. E. West Leg	Exceeds ▪ Trichloroethylene (VOC)	Exceeds ▪ Trichloroethylene (VOC)	Exceeds ▪ Trichloroethylene (VOC)	Meets

5.8 Asbestos

Three asphalt cores were tested for the presence of asbestos. Asbestos was not detected in any of the core samples.

6.0 LIMITATIONS AND RISK

6.1 Procedures

This investigation has been carried out using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by Terraprobe and other engineering practitioners, working under similar conditions and subject to the time, financial and physical constraints applicable to this project. The discussions and recommendations that have been presented are based on the factual data obtained.

It must be recognized that there are special risks whenever engineering or related disciplines are applied to identify subsurface conditions. Even a comprehensive sampling and testing programme implemented in accordance with the most stringent level of care may fail to detect certain conditions. Terraprobe has assumed for the purposes of providing design parameters and advice, that the conditions that exist between sampling points are similar to those found at the sample locations. The conditions that Terraprobe has interpreted to exist between sampling points can differ from those that actually exist.

It may not be possible to drill a sufficient number of boreholes or sample and report them in a way that would provide all the subsurface information that could affect construction costs, techniques, equipment, and scheduling.

6.2 Changes in Site and Scope

It must also be recognized that the passage of time, natural occurrences, and direct or indirect human intervention at or near the site have the potential to alter subsurface conditions. Ground water levels are particularly susceptible to seasonal fluctuations.

The discussion and recommendations are based on the factual data obtained from investigations made by Terraprobe and are intended for use by the owner and its retained designers in the design phase of the project. If there are changes to the project scope and development features the interpretations made of the subsurface information, the geotechnical design parameters and comments relating to constructability issues and quality control may not be relevant or complete for the revised project. Terraprobe should be retained to review the implications of such changes with respect to the contents of this report.

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REFERENCES

American Association of State Highway Officials, *AASHTO Guide for Design of Pavement Structures*, 1993.

Canadian Portland Cement Association "*Thickness Design for Concrete Highway and Street Pavements"*, 1984.

Ministry of the Environment, April 15, 2011. *Soil, Ground Water and Sediment Standards for Use under Part XV.1 of the Environmental Protection Act*, PIBS # 7382e01.

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Ministry of Transportation Ontario, *Manual for Condition Rating of Rigid Pavements - Concrete Surface and Composite Distress Manifestations (SP-026),* September 1995

Ontario Regulation 213/91, *Occupational Health and Safety Act (OHSA) and Regulations for Construction Projects*, April 11, 2012.

Ontario Provincial Standard Specifications (OPSS)

OPSS 310	Construction Specification for Hot Mix Asphalt.
OPSS 902	Construction Specification for Excavating and Backfilling Structures.
OPSS 1150	Material Specification for Hot Mix Asphalt.
OPSS.MUNI 212	Construction Specification for Borrow.
OPSS.MUNI 501	Construction Specification for Compacting.
OPSS.MUNI 1010	Material Specification for Aggregates Base, Subbase, Select Subgrade and Backfill Material.
OPSS.MUNI 1101	Material Specification for Performance Graded Asphalt Cement.

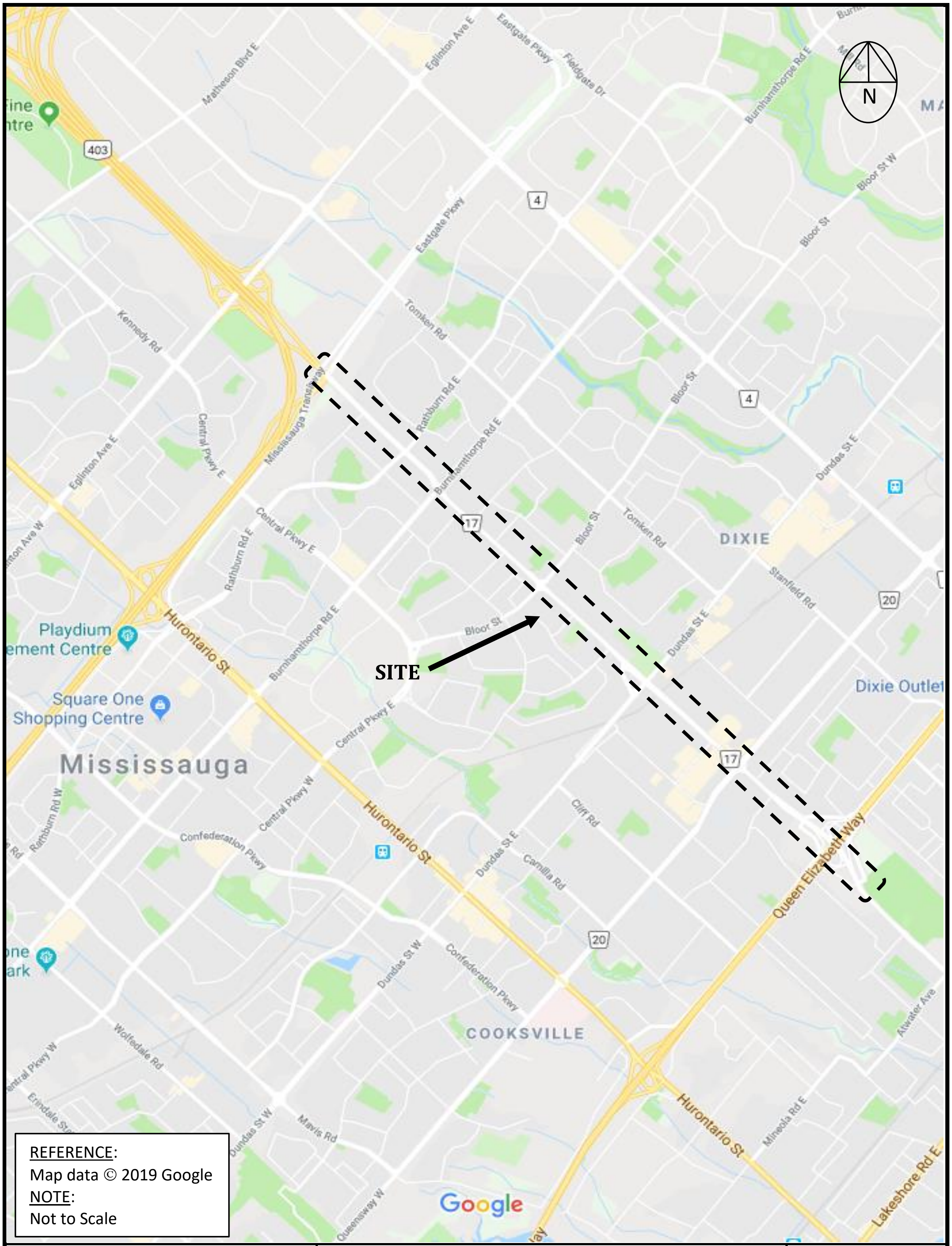
Ontario Provincial Standard Drawings (OPSD)

OPSD 100.060	Abbreviations, Geotechnical.
OPSD 200.020	Earth/Shale Grading, Divided Rural.
OPSD 508.020	Sealing or Resealing of Joints and Cracks in Concrete Pavement and Concrete Base.
OPSD 802.010	Flexible Pipe, Embedment and Backfill, Earth Excavation.

Region of Peel Standard Drawings

STD.DWG 5-2-2	Region of Peel Full Depth Composite (Concrete) Pavement Repair
STD.DWG 5-2-10	Region of Peel Concrete Pavement For Acceleride Bus Bay.
STD.DWG 5-2-15A	Region of Peel French Drain Trench Detail.
STD.DWG 5-2-15B	Region of Peel French Drain Trench with Subdrain Trench Details.

FIGURES



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Title:	SITE LOCATION PLAN CAWTHRA ROAD	Figure: 1
File No.:	1-18-0615	

SITE PHOTOGRAPHS	FIGURE 2

Photo 1: Cawthra Road at Sta. 10+040, Looking North

Photo 2: Cawthra Road at Sta. 10+040, Looking South

Project No. : 1-18-0615

Date : November, 2018

Terraprobe Inc.

Prepared by : SD

Checked by : RA

SITE PHOTOGRAPHS

FIGURE 3

Photo 3: Cawthra Road at Sta. 11+340, Looking North

Photo 4: Cawthra Road at Sta. 11+340, Looking South

Project No. : 1-18-0615

Date : November, 2018

Terraprobe Inc.

Prepared by : SD

Checked by : RA

SITE PHOTOGRAPHS

FIGURE 4

Photo 5: Cawthra Road at Sta. 12+100, Looking North

Photo 6: Cawthra Road at Sta. 12+100, Looking South

Project No. : 1-18-0615

Date : November, 2018

Terraprobe Inc.

Prepared by : SD

Checked by : RA

SITE PHOTOGRAPHS	FIGURE 5

Photo 7: Cawthra Road at Sta. 12+900, Looking North

Photo 8: Cawthra Road at Sta. 12+900, Looking South

Project No. :	1-18-0615	Terraprobe Inc.	Prepared by :	SD
Date :	November, 2018		Checked by :	RA

SITE PHOTOGRAPHS

FIGURE 6

Photo 9: Cawthra Road at Sta. 14+100, Looking North

Photo 10: Cawthra Road at Sta. 14+100, Looking South

Project No. :	1-18-0615	Prepared by :	SD
Date :	November, 2018	Checked by :	RA

Terraprobe Inc.

SITE PHOTOGRAPHS

FIGURE 7

Photo 11: Cawthra Road at Sta. 15+110, Looking North

Photo 12: Cawthra Road at Sta. 15+110, Looking South

Project No. : 1-18-0615

Date : November, 2018

Terraprobe Inc.

Prepared by : SD

Checked by : RA

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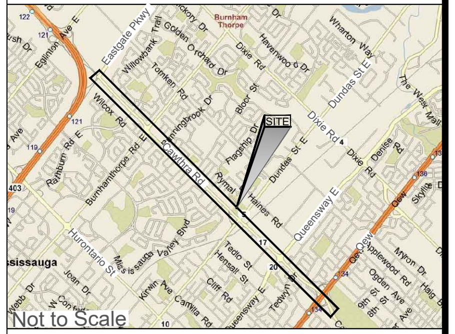

KEY PLAN

LEGEND

⊕	Pavement Borehole
▣	Test Pit

BH No.	ELEV. (m)	COORDINATES (UTM, NAD83, Zone 17)	
		NORTHING (m)	EASTING (m)

SCALE

10 5 0 5 10 15 20m

NOTE

This drawing is for subsurface information only. Surface details and features are for conceptual illustration. The subsurface conditions can be expected to vary between and beyond the borehole locations.

REFERENCE

Drawings provided in digital format by IBI Group received by email dated July 22, 2019.

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN SD	PROJECT No. 1–18–0615	DATE JULY 2019
DRAWN KC	CHK. RA	FIGURE No. 8

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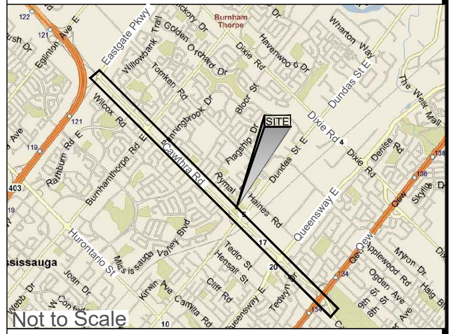

KEY PLAN

	LEGEND
⌖	Pavement Borehole
▚	Test Pit

BH No.	ELEV. (m)	COORDINATES (UTM, NAD83, Zone 17) NORTHING (m)	EASTING (m)

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DRAWN KC	CHK. RA	FIGURE No. 9

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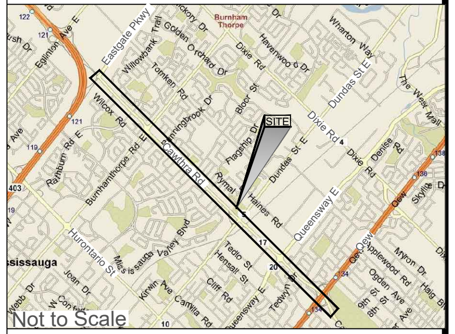

KEY PLAN

LEGEND

⊕ Pavement Borehole

▣ Test Pit

BH No.	ELEV. (m)	COORDINATES (UTM, NAD83, Zone 17)	
		NORTHING (m)	EASTING (m)

SCALE

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DESIGN SD	PROJECT No. 1-18-0615	DATE JULY 2019
DRAWN KC	CHK. RA	FIGURE No. 10

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KEY PLAN

	LEGEND
⊕	Pavement Borehole
◪	Test Pit

BH No.	ELEV. (m)	COORDINATES (UTM, NAD83, Zone 17)	
		NORTHING (m)	EASTING (m)

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DESIGN SD	PROJECT No. 1-18-0615	DATE JULY 2019
DRAWN KC	CHK. RA	FIGURE No. 11

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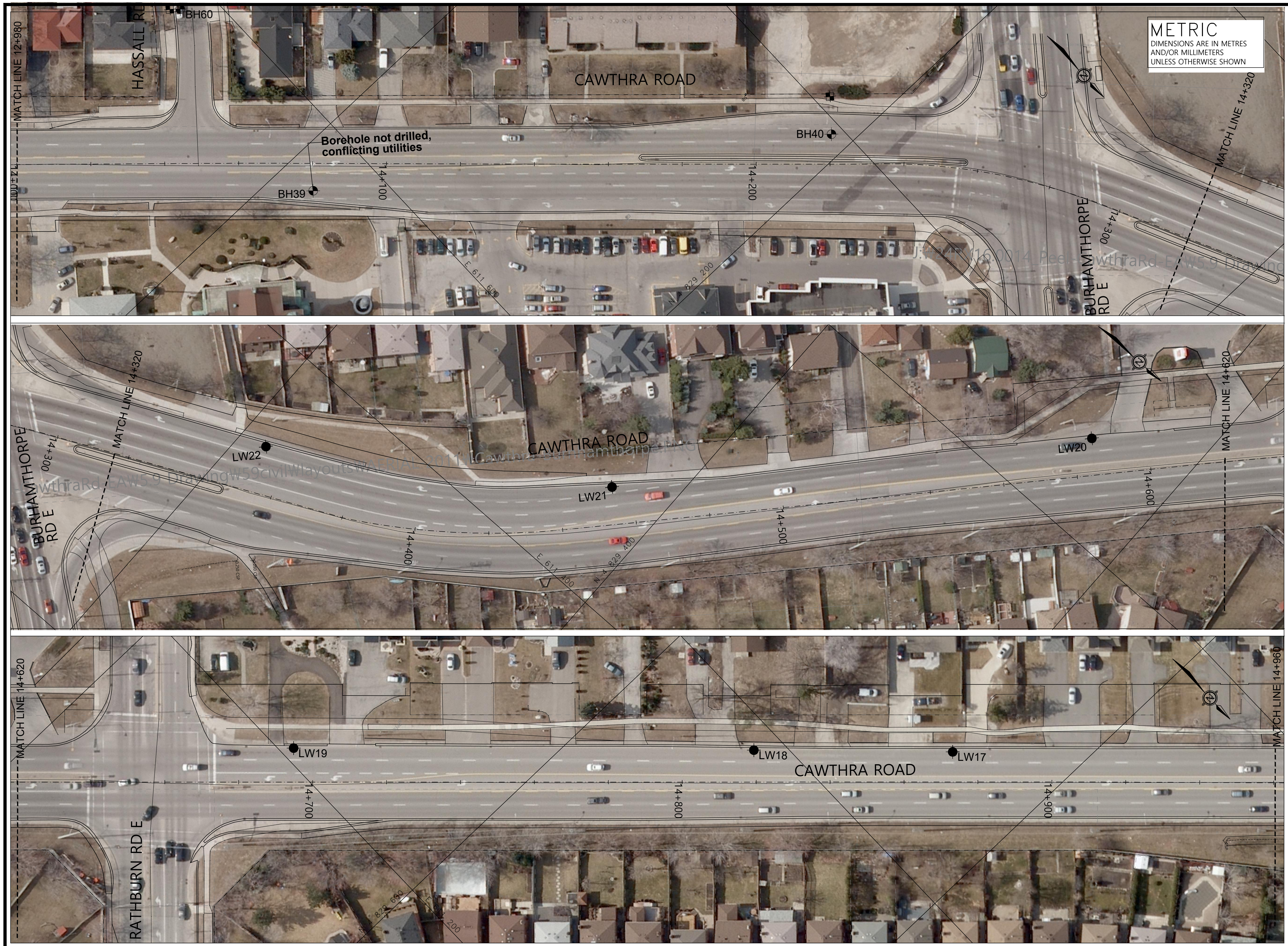

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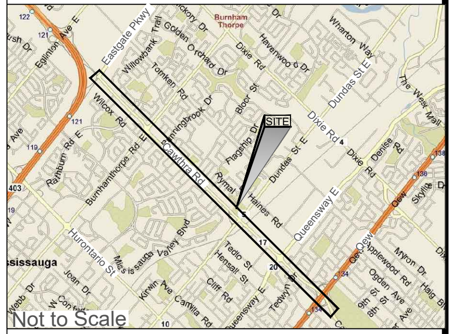

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KEY PLAN

LEGEND

⊕	Pavement Borehole
▚	Test Pit
●	Previous Borehole by Coffey, 2011

BH No.	ELEV. (m)	COORDINATES (UTM, NAD83, Zone 17)	
		NORTHING (m)	EASTING (m)

SCALE

10 5 0 5 10 15 20m

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DESIGN SD	PROJECT No. 1-18-0615	DATE JULY 2019
DRAWN KC	CHK. RA	FIGURE No. 12

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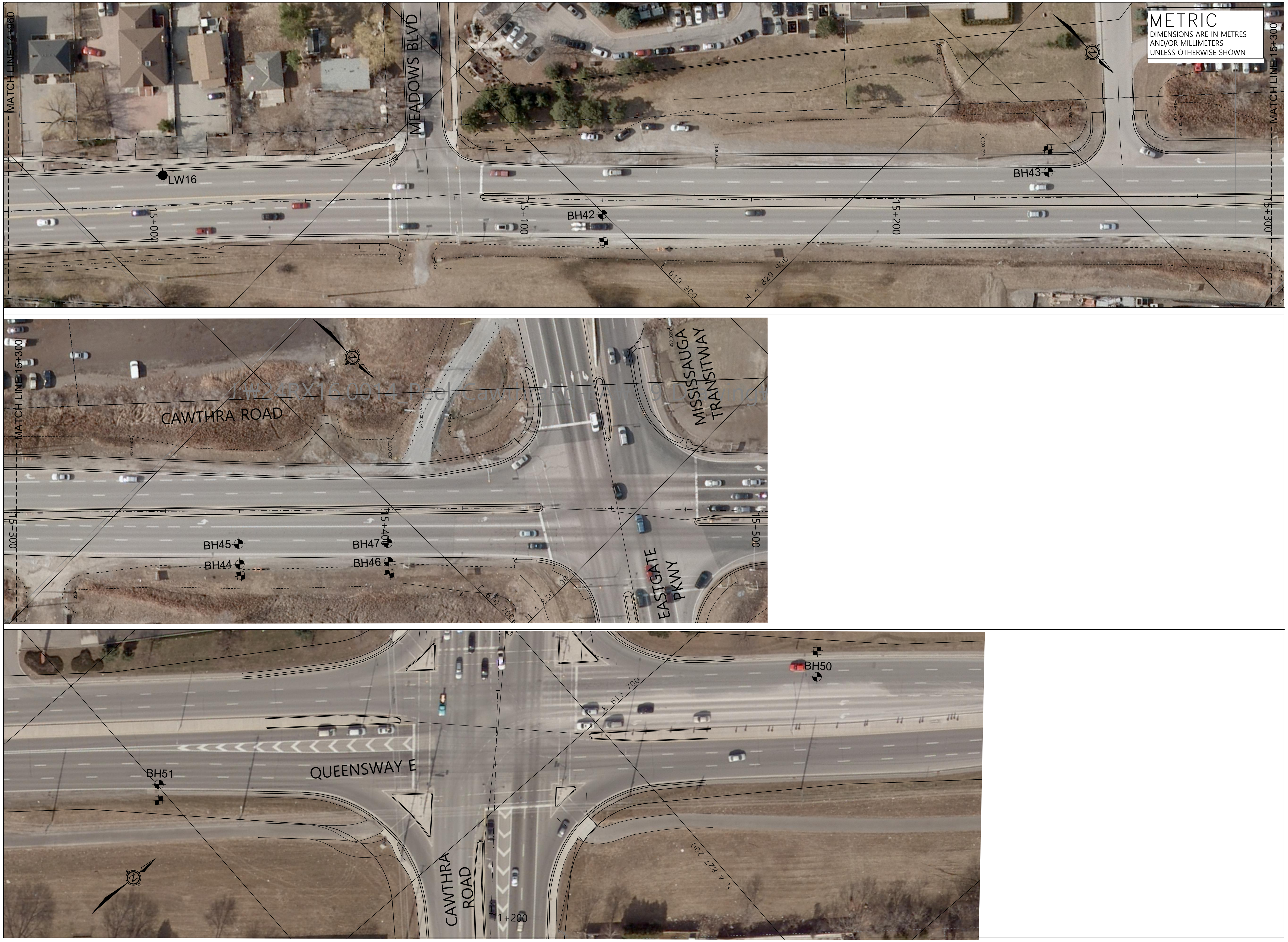

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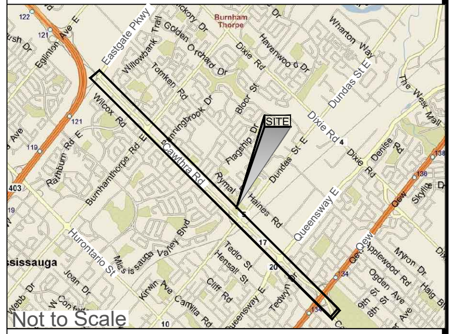

KEY PLAN

	LEGEND
⌖	Pavement Borehole
▚	Test Pit
●	Previous Borehole by Coffey, 2011

BH No.	ELEV. (m)	COORDINATES (UTM, NAD83, Zone 17)	
		NORTHING (m)	EASTING (m)

SCALE

10 5 0 5 10 15 20m

NOTE

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REFERENCE

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REVISIONS			
	DATE	BY	DESCRIPTION

DESIGN SD	PROJECT No. 1-18-0615	DATE JULY 2019
DRAWN KC	CHK. RA	FIGURE No. 13

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METRIC
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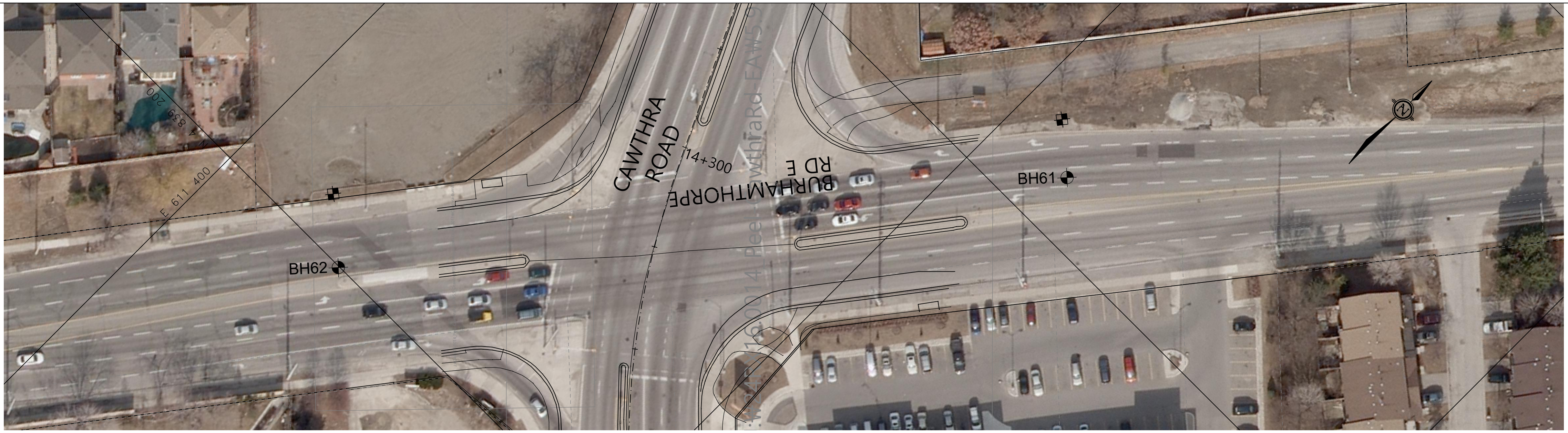

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KEY PLAN

LEGEND

⊕ Pavement Borehole

▣ Test Pit

BH No.	ELEV. (m)	COORDINATES (UTM, NAD83, Zone 17)	
		NORTHING (m)	EASTING (m)

SCALE

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DESIGN SD	PROJECT No. 1-18-0615	DATE JULY 2019
DRAWN KC	CHK. RA	FIGURE No. 14

Z:\1-Project Files\2018\1-18-0615 - Cawthra Road, Mississauga\1-Geotechnical - Cawthra Road Improvements\A. Dwgs, Logs\AutoCAD\1-18-0615 Figures.dwg,
Kamal

APPENDIX A

Borehole Logs & Core Data

APPENDIX A1

(Current Investigation)

Accep	acceptable
Agg	aggregate
Amor	amorphous
Asph	asphalt
BH	borehole
Bl	blue
Bld (y)	boulder (y)
Blds	boulders
Blk	black
Br	brown
BR	bedrock
BU	break up
CF	channel face
Cl (y)	clay (ey)
Co	coarse
Cob	cobbles
Comp	compact
Conc	concrete
Contam	contaminated
Cord	corduroy
Cr	crushed
D	dense
Decomp	decomposed
Dk	dark
D_R	relative density
E	earth
F	fine
FB	frost boil
FH	frost heave
Fib	fibrous
Fr Wat	free water
Gr (y)	gravel (ly)
Gran	granular
Grn	green

Gry	grey
H	heavy
Hi	highly
HM	hot mix
HP	high plasticity
Ip	plasticity index
L	loose
Liq	liquid
Lo	loam
Lt	light
Matl	material
Max	maximum
MDD	maximum dry density
Med	medium
Mod	moderate
Mott	mottled
MP	medium plasticity
Mrl	marl
Mul	mulch
MWD	maximum wet density
NFP	no further progress
NFP (blds)	no further progress (boulders)
Num	numerous
Ob	overburden
Occ	occasional
Ora	orange
Org	organic
Org M	organic matter
Pavt	pavement
Pedo	pedological
Pen Mac	penetration macadam
Poss	possible
PST	prime and surface treated
Psty	polystyrene

Quant	quantity
Reinf	reinforced
RF	rock fill
RSS	remoulded shear strength
Sa (y)	sand (y)
Sat	saturated
SH	shale
Sh Rk	shot rock
Si (y)	silt (y)
Sl (y)	slight (ly)
SP	slight plasticity
SSM	select subgrade material
St	sensitivity
Stn (y)	stone (y)
Stks	streaks
Surf	surface
Temp	temperature
TH	test hole
TP	test pit
Tps	topsoil
Tr	trace
Unreinf	unreinforced
USS	undisturbed shear strength
Varv	varved
VF	very fine
w	field moisture content
W	with
W_L	liquid limit
Wd (y)	wood (y)
Weath	weathered
Wopt	optimum moisture content
Wp	plastic limit
WT	water table
Yel	yellow

SUSCEPTIBILITY TO FROST HEAVING

HSFH – High
MSFH – Medium
LSFH – Low

ONTARIO PROVINCIAL STANDARD DRAWING

Nov 2006 | Rev 1

ABBREVIATIONS

GEOTECHNICAL

OPSD 100.060

PAVEMENT BOREHOLE LOGS

Cawthra Road, from Station 9+960 to Station 15+460

10+030 SB, L1 (BH1)

0 - 100	Asph
100 - 310	Conc
310 - 560	Br Gran, Tr to Some Si, Dry
560 - 1.50	Br Sa, Tr Si, Tr Gr, Moist

10+030 SB, OFF Rd. (BH2)

0 - 140	Tps
140 - 600	Br Si(y) Sa, Some Gr, Tr Cl, Moist*
600 - 1.20	Br Si(y) Sa, Tr Cl, Tr Gr, Moist
1.20 - 1.80	Gry Sa, Tr to Some Si, Moist

*Sample Depth = 140 - 600
Passing 4.75 mm = 89%
2.00 mm = 79%
425 µm = 61%
75 µm = 26%
5 µm = 5%
2 µm = 4%
w = 10%
Frost Susc. = LSFH
K factor = 0.14

10+100 NB, L1 (BH3)

0 - 100	Asph
100 - 305	Conc
305 - 620	Br Gran, Tr to Some Si, Dry
620 - 1.50	Gry Sa, Tr to Some Gr, Moist

10+520 SB, L1 (BH4)

0 - 110	Asph
110- 315	Conc
315 - 710	Br Gran,Tr to Some Si, Dry
710 - 1.50	Br Sa, Tr to Some Si, Tr Gr, Moist

10+560 NB, L1 (BH5)

0 - 100	Asph
100 - 280	Conc
280 - 690	Br Gran, Some Si, Dry*
690 - 1.50	Br Sa, Tr Gr, Moist

*Sample Depth = 280 - 690
Passing 26.5 mm = 100%
19 mm = 100%
13.2 mm = 88%
9.5 mm = 73%
4.75 mm = 48%
1.18 mm = 24%
300 µm = 16%
75 µm = 11%
w = 4%
Marginally Accep Gran A
Marginally Accep Gran B, Type II

10+560 NB, OFF Rd. (BH6)

0 - 150	Tps
150 - 600	Br Sa, Some Si, Some Gr, Tr Cl, Moist to Wet*
600 - 1.80	Br Sa, Tr to Some Si, Tr Gr, Moist

*Sample Depth = 150 - 600
Passing 4.75 mm = 82%
2.00 mm = 82%
425 µm = 77%
75 µm = 24%
5 µm = 7%
2 µm = 5%
w = 13%
Frost Susc. = LSFH
K factor = 0.16

10+700 NB, L1 (BH7)

0 - 90	Asph
90 - 290	Conc
290 - 740	Br Gran, Tr to Some Si, Dry
740 - 1.50	Br Si(y) Cl to Cl(y) Si, Tr to Some Sa, Tr Gr, Moist

10+700 SB, L2 (BH8)

0 - 95	Asph
95 - 285	Conc
285 - 570	Br Gran, Tr to Some Si, Dry
570 - 1.50	Br Si(y) Cl, and Sa, Tr Gr, Moist

10+780 NB, L1 (BH9)

0 - 90	Asph
90 - 300	Conc
300 - 590	Br Gran, Tr to Some Si,Dry
590 - 1.50	Br Si(y) Cl, Tr Sa, Tr Gr, Moist

10+860 NB, L1 (BH10)

0 - 100	Asph
100 - 345	Conc
345 - 670	Br Gran, Tr to Some Si, Dry
670 - 1.50	Br Sa, Tr to Some Si, Tr Gr, Moist

10+860 SB, L2 (BH11)

0 - 105	Asph
105 - 300	Conc
300 - 590	Br Gran, Tr to Some Si, Dry
590 - 1.50	Br Si(y) Cl, and Sa, Tr Gr, Moist

11+000 NB, L1 (BH12)

0 - 80	Asph
80 - 320	Conc
320 - 620	Br Gran, Tr to Some Si, Dry
620 - 1.50	Br Sa, Tr to Some Si, Tr Gr, Moist

PAVEMENT BOREHOLE LOGS

Cawthra Road, from Station 9+960 to Station 15+460

11+100 NB, L1 (BH13)

0 - 180	Asph
180 - 670	Br Gran, Tr to Some Si, Dry
670 - 1.50	Br Sa, Tr to Some Si, Tr Gr, Moist

11+100 SB, L2 (BH14)

0 - 90	Asph
90 - 290	Conc
290 - 635	Br Gran, Tr to Some Si, Dry
635 - 1.50	Br Sa, Tr to Some Si, Tr Gr, Moist

11+340 SB, L1 (BH15)

0 - 110	Asph
110 - 290	Conc
290 - 590	Br Gran, Tr to Some Si, Dry
590 - 1.10	Gry Si(y) Cl, and Sa, Tr Gr, Moist
1.10 - 1.20	Br Sa, Tr to Some Si, Moist

11+500 NB, L2 (BH16)

0 - 100	Asph
100 - 250	Conc
250 - 610	Br Gran, Tr to Some Si, Dry
610 - 1.20	Br Sa, Tr to Some Si, Tr Gr, Moist
1.20 - 1.50	Br Si(y) Cl to Cl(y) Si, Tr Sa, Tr Gr, Moist

11+500 SB, L1 (BH17)

0 - 90	Asph
90 - 300	Conc
300 - 590	Br Gran, Tr to Some Si, Dry
590 - 1.50	Br Sa, Tr to Some Si, Tr Gr, Tr Cl, Moist

11+600 NB, L2 (BH18)

0 - 80	Asph
80 - 260	Conc
260 - 595	Br Gran, Tr to Some Si, Dry
595 - 1.50	Br Sa, Tr to Some Si, Tr Gr, Moist

11+800 SB, L1 (BH19)

0 - 100	Asph
100 - 290	Conc
290 - 530	Br Gran, Some Si, Moist to Wet*
530 - 1.50	Br Si(y) Cl, Sa(y), Tr Gr, Wet**

*Sample Depth = 290 - 530
Passing 26.5 mm = 100%
19 mm = 100%
13.2 mm = 93%
9.5 mm = 88%
4.75 mm = 80%
1.18 mm = 67%
300 µm = 46%
75 µm = 19%
w = 10%
Not Accep Gran A
Not Accep Gran B, Type II

**Sample Depth = 530 - 1.50
Passing 4.75 mm = 99%
2.00 mm = 98%
425 µm = 83%
75 µm = 74%
5 µm = 43%
2 µm = 29%
w = 19%
Frost Susc. = LSFH
K factor = 0.37

12+000 NB, L1 (BH20)

0 - 115	Asph
115 - 320	Conc
320 - 600	Br Gran, Tr to Some Si, Dry
600 - 1.50	Gry Weath SH, Dry

12+200 NB, L1 (BH21)

0 - 125	Asph
125 - 175	Conc
175 - 540	Br Gran, Tr to Some Si, Dry
540 - 900	Gry Weath SH, Dry
900	NFP

12+200 SB, L1 (BH22)

0 - 80	Asph
80 - 340	Conc
340 - 610	Br Gran, Tr to Some Si, Dry
610 - 1.10	Br Si(y) Sa, Tr Cl, Tr Gr, Moist

12+470 NB, L2 (BH23)

0 - 85	Asph
85 - 195	Conc
195 - 590	Br Gran, Tr to Some Si, Dry
590 - 900	Br Si(y) Sa, Some Cl, Some Gr, Moist*
900	NFP

*Sample Depth = 590 - 900
Passing 4.75 mm = 85%
2.00 mm = 83%
425 µm = 69%
75 µm = 46%
5 µm = 19%
2 µm = 13%
w = 7%
Frost Susc. = LSFH
K factor = 0.20

12+480 SB, L1 (BH24)

0 - 130	Asph
130 - 330	Conc
330 - 640	Br Gran, Tr to Some Si, Dry
640 - 1.50	Br Sa, Tr to Some Si, Tr Gr, Moist

12+620 NB, L2 (BH26)

0 - 100	Asph
100 - 290	Conc
290 - 595	Br Gran, Tr to Some Si, Dry
595 - 1.50	Br Sa, Tr to Some Si, Tr Gr, Moist

12+700 NB, L2 (BH27)

0 - 135	Asph
135 - 335	Conc
335 - 640	Br Gran, Tr to Some Si, Dry
640 - 1.50	Br Sa, Tr Gr, Tr Si, Moist to Wet

12+700 SB, L2 (BH28)

0 - 125	Asph
125 - 325	Conc
325 - 600	Br Gran, Tr to Some Si, Dry
600 - 1.50	Br Sa, Tr to Some Si, Tr Gr, Moist

12+800 NB, L2 (BH29)

0 - 230	Asph
230 - 590	Br Gran, Tr to Some Si, Dry
590 - 1.50	Br Sa, Some Si to Si(y), Tr Gr, Moist

12+890 NB, L2 (BH30)

0 - 165	Asph
165 - 635	Br Gran, Tr to Some Si, Dry
635 - 1.20	Br Sa, Tr to Some Si, Tr Gr, Moist
1.20 - 1.50	Br Si(y) Cl to Cl(y) Si, Some Sa to Sa(y), Moist

12+890 SB, L2 (BH31)

0 - 165	Asph
165 - 535	Br Gran, Tr to Some Si, Dry
535 - 1.50	Br Si(y) Sa, Some Cl, Tr Gr, Moist*

*Sample Depth = 535 - 1.50
Passing 4.75 mm = 92%
2.00 mm = 87%
425 µm = 67%
75 µm = 44%
5 µm = 25%
2 µm = 18%
w = 10%
Frost Susc. = LSFH
K factor = 0.16

13+080 SB, L1 (BH32)

0 - 180	Asph
180 - 640	Br Gran, Tr to Some Si, Dry
640 - 1.50	Br Si(y) Cl, Sa(y), Tr Gr, Moist

13+140 NB, L2 (BH33)

0 - 180	Asph
180 - 540	Br Gran, Tr Si, Dry*
540 - 1.50	Gry Si(y) Cl, Tr to Some Sa, Tr Gr, Moist

*Sample Depth = 180 - 540
Passing 26.5 mm = 100%
19 mm = 98%
13.2 mm = 85%
9.5 mm = 71%
4.75 mm = 47%
1.18 mm = 29%
300 µm = 17%
75 µm = 9%
w = 2%
Marginally Accep Gran A
Marginally Accep Gran B, Type II

13+300 NB, L1 (BH35)

0 - 170	Asph
170 - 570	Br Gran, Tr to Some Si, Dry
540 - 1.50	Br Si(y) Cl, Tr to Some Sa, Tr Gr, Moist

13+510 SB, L1 (BH36)

0 - 170	Asph
170 - 590	Br Gran, Tr to Some Si, Dry
590 - 1.50	Gry Cl(y) Si, and Sa, Tr Gr, Moist

13+640 NB, L1 (BH37)

0 - 180	Asph
180 - 590	Br Gran, Tr to Some Si, Dry
590 - 1.50	Gry Cl(y) Si, and Sa, Tr Gr, Moist

13+900 SB, L1 (BH38)

0 - 190	Asph
190 - 530	Br Gran, Tr to Some Si, Dry
530 - 1.50	Br Si(y) Cl, Sa(y), Tr Gr, Wet*

*Sample Depth = 530 - 1.50
Passing 4.75 mm = 98%
2.00 mm = 97%
425 µm = 88%
75 µm = 70%
5 µm = 36%
2 µm = 28%
w = 18%
Frost Susc. = LSFH
K factor = 0.33

14+220 SB, L1 (BH40)

0 - 210	Asph
210 - 680	Br Gran, Tr Si, Dry to Moist*
680 - 900	Br Sa, Tr to Some Si, Some Gr, Moist

*Sample Depth = 210 - 680
Passing 26.5 mm = 100%
19 mm = 98%
13.2 mm = 85%
9.5 mm = 66%
4.75 mm = 44%
1.18 mm = 26%
300 µm = 14%
75 µm = 6%
w = 6%
Accep Gran A
Marginally Accep Gran B, Type II

15+120 NB, L2 (BH42)

0 - 180	Asph
180 - 560	Br Gran, Tr to Some Si, Moist
560 - 1.50	Br Gr(y) Sa, Tr to Some Si, Moist

15+240 SB, L1 (BH43)

0 - 280	Asph
280 - 620	Br Gran, Tr to Some Si, Moist
620 - 1.50	Gry Si(y) Cl, Tr to Some Sa, Tr Gr, Moist

15+360 NB, SH (BH44)

0 - 610	Br Gran, Tr to Some Si, Dry
610 - 900	Br Gr(y) Sa, Some Si, Tr Cl, Dry*
900 - 1.10	Br Sa(y) Si, Tr Gr, Moist

*Sample Depth = 610 - 900
Passing 4.75 mm = 71%
2.00 mm = 53%
425 µm = 34%
75 µm = 23%
5 µm = 7%
2 µm = 5%
w = 5%
Frost Susc. = LSFH
K factor = 0.05

15+360 NB, L1 (BH45)

0 - 300	Asph
300 - 710	Br Gran, Tr Si, Dry to Moist*
710 - 1.10	Br Si(y) Sa to Sa(y) Si, Tr to Some Gr, Wet
1.10 - 1.50	Br Si(y) Cl to Cl(y) Si, Some Sa, Tr Gr, Moist

*Sample Depth = 300 - 710
Passing 26.5 mm = 100%
19 mm = 100%
13.2 mm = 89%
9.5 mm = 65%
4.75 mm = 34%
1.18 mm = 15%
300 µm = 9%
75 µm = 6%
w = 5%
Accep Gran A
Marginally Accep Gran B, Type II

15+400 NB, SH (BH 46)

0 - 780	Br Gran, Some Si, Dry*
780 - 1.10	Gry Si(y) Cl, and Sa, Tr to Some Gr, Moist
1.10 - 1.50	Br Si(y) Cl, Sa(y), Tr Gr, Moist

*Sample Depth = 0 - 780
Passing 26.5 mm = 100%
19 mm = 98%
13.2 mm = 90%
9.5 mm = 74%
4.75 mm = 55%
1.18 mm = 33%
300 µm = 22%
75 µm = 15%
w = 4%
Not Accep Gran A
Not Accep Gran B, Type II

15+400 NB, L1 (BH 47)

0 - 320	Asph
320 - 745	Br Gran, Tr to Some Si, Dry
745 - 1.10	Gry Sa and Gr, Tr Si, Moist

PAVEMENT BOREHOLE LOGS

Intersecting Roads

Cawthra Road, From South Service Road to Eastgate Parkway, City of Mississauga — File No. 1-18-0615

Tedwyn Drive

BH48	**EBL**
0 - 150	Asph
150 - 400	Br Gran, Tr to Some Si, Dry
400 - 1.50	Br Sa, Tr to Some Si, Tr Gr, Moist

Queensway East

BH50	**East Leg-WB-L1**
0 - 90	Asph
90 - 320	Conc
320 - 580	Br Gran, Tr to Some Si, Dry
580 - 1.50	Br Sa, Tr to Some Si, Tr Gr, Moist

BH51	**West Leg-EB-Turning Lane**
0 - 220	Asph
220 - 710	Br Gran, Tr to Some Si, Dry
710 - 1.50	Br Sa, Tr to Some Si, Tr Gr, Moist

Needham Lane

BH66	**EBL**
0 - 180	Asph
180 - 550	Br Gran, Tr to Some Si, Moist
550 - 1.50	Gry Si(y) Sa, Tr to Some Cl, Tr Gr, Dry to Moist

Silver Creek Boulevard

BH25	**EBL**
0 - 140	Asph
140 - 450	Br Gran, Tr to Some Si, Moist
450 - 1.10	Gry Si(y) Cl, Tr to Some Sa, Moist
1.10 - 1.50	Br Si(y) Cl, Some Sa to Sa(y), Moist

Santee Gate

BH52	**EBL**
0 - 130	Asph
130 - 400	Br Gran, Tr to Some Si, Moist
400 - 1.50	Br Sa, Tr to Some Si, Moist

Bloor Street

BH53	**East Leg-EB-L2**
0 - 200	Asph
200 - 700	Br Gran, Tr to Some Si, Dry to Moist
700 - 1.50	Gry Si(y) Cl, Tr to Some Sa, Moist

BH54	**West Leg-WB-L1**
0 - 230	Asph
230 - 500	Grey Gran, Tr to Some Si, Moist
500 - 1.50	Gry Si(y) Sa, Some Cl to Cl(y), Dry

Schomberg Avenue

BH55	**WBL**
0 - 200	Asph
200 - 500	Br Gran, Tr to Some Si, Moist
500 - 1.50	Gry Si(y) Cl, Tr Sa, Moist

Hyacinthe Boulevard

BH56	**WBL**
0 - 180	Asph
180 - 600	Br Gran, Tr to Some Si, Moist
600 - 1.50	Gry Si(y) Cl, Tr Sa, Moist

Breckenridge Road

BH57	**East Leg-EBL**
0 - 140	Asph
140 - 400	Br Gran, Tr to Some Si, Moist
400 - 1.00	Gry Si(y) Cl, Tr Sa, Moist
1.00 - 1.50	Br Si(y) Cl, Tr Sa, Moist

BH58	**West Leg-WBL**
0 - 180	Asph
180 - 500	Br Gran, Tr to Some Si, Moist
500 - 1.40	Br Si(y) Cl, Tr Sa, Moist

Runningbrook Drive

BH59	**EBL**
0 - 150	Asph
150 - 400	Br Gran, Tr to Some Si, Moist
400 - 1.50	Br Si(y) Cl, Some Sa to Sa(y), Tr Gr, Moist

Hassall Road

BH60	**EBL**
0 - 140	Asph
140 - 450	Br Gran, Tr to Some Si, Moist
450 - 1.50	Br Si(y) Sa, Tr Cl,Tr to Some Gr, Moist

Burnhamthorpe Road East

BH61	**East Leg-WB-L2**
0 - 250	Asph
250 - 700	Br Gran, Tr to Some Si, Moist
700 - 1.50	Gry Si(y) Cl, Tr Sa, Moist

BH62	**West Leg-WB-L2**
0 - 240	Asph
240 - 650	Br Gran, Tr to Some Si, Moist
650 - 1.2	Br Gr(y) Sa, Tr to Some Si, Moist
1.20 - 1.50	Br Si(y) Cl, Some Sa to Sa(y),Tr Gr, Moist

PAVEMENT CORE PHOTOGRAPHS AND DATA

Station 10+030, SBL, L1

Lift Type	Thickness (mm)
DFC	50
HL8	50
Concrete	210
Total	310

Station 10+100, NBL, L1

Lift Type	Thickness (mm)
DFC	50
HL8	50
Concrete	205
Total	305

Station 10+520, SBL, L1

Lift Type	Thickness (mm)
DFC	50
HL8	60
Concrete	205
Total	315

Project No. : 1-18-0615

Date : July, 2019

Terraprobe Inc.

Prepared by : DP

Checked by : RA

PAVEMENT CORE PHOTOGRAPHS AND DATA

Station 10+560, NBL, L1

Lift Type	Thickness (mm)
DFC	40
HL8	60
Concrete	180
Total	280

Station 10+700, NBL, L1

Lift Type	Thickness (mm)
DFC	40
HL8	50
Concrete	200
Total	290

Station 10+780, NBL, L1

Lift Type	Thickness (mm)
DFC	50
HL8	40
Concrete	210
Total	300

Project No. : 1-18-0615

Date : July, 2019

Terraprobe Inc.

Prepared by : DP

Checked by : RA

PAVEMENT CORE PHOTOGRAPHS AND DATA

Station 11+100, NBL, L1

Lift Type	Thickness (mm)
DFC	60
HL3	50
HL8	70
Total	180

Station 11+340, SBL, L1

Lift Type	Thickness (mm)
DFC	60
HL8	50
Concrete	180
Total	290

Station 11+500, NBL, L2

Lift Type	Thickness (mm)
DFC	40
HL8	60
Concrete	150
Total	250

Project No. : 1-18-0615

Date : July, 2019

Terraprobe Inc.

Prepared by : DP

Checked by : RA

PAVEMENT CORE PHOTOGRAPHS AND DATA

Station 11+500, SBL, L1

Lift Type	Thickness (mm)
DFC	50
HL8	40
Concrete	210
Total	300

Station 11+600, NBL, L2

Lift Type	Thickness (mm)
DFC	50
HL8	30
Concrete	180
Total	260

Station 11+800, SBL, L1

Lift Type	Thickness (mm)
DFC	60
HL8	40
Concrete	190
Total	290

Project No. : 1-18-0615
Date : July, 2019

Terraprobe Inc.

Prepared by : DP
Checked by : RA

PAVEMENT CORE PHOTOGRAPHS AND DATA

Station 12+200, SBL, L1

Lift Type	Thickness (mm)
DFC	40
HL8	40
Concrete	260
Total	340

Station 12+620, NBL, L2

Lift Type	Thickness (mm)
DFC	40
HL8	60
Concrete	190
Total	290

Station 13+080, SBL, L1

Lift Type	Thickness (mm)
DFC	70
HL8	110
Total	180

Project No. : 1-18-0615
Date : July, 2019

Terraprobe Inc.

Prepared by : DP
Checked by : RA

PAVEMENT CORE PHOTOGRAPHS AND DATA

Station 14+220, SBL, L1

Lift Type	Thickness (mm)
DFC	50
HL8	120
HL8	40
Total	210

Station 15+120, NBL, L2

Lift Type	Thickness (mm)
DFC	50
HL8	130
Total	180

Station 15+360, NBL, L1

Lift Type	Thickness (mm)
DFC	40
HL8	160
HL8	100
Total	300

Project No. : 1-18-0615

Date : July, 2019

Terraprobe Inc.

Prepared by : DP

Checked by : RA

TOPSOIL THICKNESSES

Cawthra Road, From Station 9+960 to Station 15+460

Cawthra Road

Approximate Station No.	Location	Topsoil Thickness (mm)
10+030	West of Centre Line	140
10+100	East of Centre Line	150
10+520	West of Centre Line	125
10+560	East of Centre Line	150
10+700	East of Centre Line	140
10+700	West of Centre Line	125
10+780	East of Centre Line	125
10+860	East of Centre Line	115
10+860	West of Centre Line	150
11+000	East of Centre Line	125
11+100	East of Centre Line	115
11+100	West of Centre Line	150
11+340	West of Centre Line	125
11+500	East of Centre Line	140
11+500	West of Centre Line	125
11+600	East of Centre Line	140
11+800	West of Centre Line	140
12+200	West of Centre Line	140
12+470	East of Centre Line	150
12+480	West of Centre Line	125
12.+620	East of Centre Line	140
12+700	East of Centre Line	115
12+700	West of Centre Line	125
12+800	East of Centre Line	125
12+890	East of Centre Line	140
12+890	West of Centre Line	125
13+080	West of Centre Line	115
13+140	East of Centre Line	140
13+300	East of Centre Line	125
13+510	West of Centre Line	125
13+640	East of Centre Line	140
13+990	West of Centre Line	140
14+220	West of Centre Line	150
15+120	East of Centre Line	140
15+240	West of Centre Line	140
15+360	East of Centre Line	150
15+400	East of Centre Line	125

Intersecting Roads

Queensway East

BH No.	Location	Topsoil Thickness (mm)
50	North of Centre Line	140
51	South of Centre Line	140

Needham Lane

BH No.	Location	Topsoil Thickness (mm)
66	South of Centre Line	180

Santee Gate

BH No.	Location	Topsoil Thickness (mm)
52	South of Centre Line	120

Bloor Street

BH No.	Location	Topsoil Thickness (mm)
53	South of Centre Line	150
54	North of Centre Line	100

Schomberg Avenue

BH No.	Location	Topsoil Thickness (mm)
55	North of Centre Line	150

Hyacinthe Boulevard

BH No.	Location	Topsoil Thickness (mm)
56	North of Centre Line	120

Breckenridge Road

BH No.	Location	Topsoil Thickness (mm)
57	South of Centre Line	110
58	North of Centre Line	130

Runningbrook Drive

BH No.	Location	Topsoil Thickness (mm)
59	North of Centre Line	150

Hassall Road

BH No.	Location	Topsoil Thickness (mm)
60	South of Centre Line	170

TOPSOIL THICKNESSES

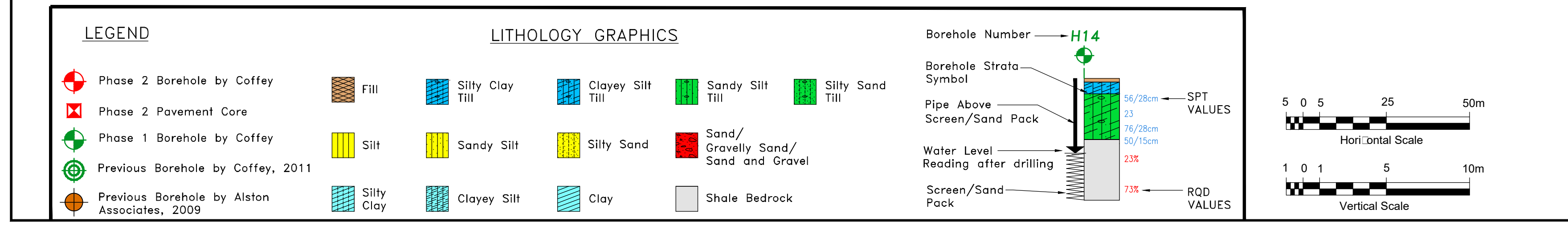
Cawthra Road, From Station 9+960 to Station 15+460

Burnhamthorpe Road East

BH No.	Location	Topsoil Thickness (mm)
61	North of Centre Line	120
62	North of Centre Line	150

APPENDIX A2

(Previous Investigation)



drawn	SH
approved	IL
date	AUGUST, 2013
scale	AS SHOWN

coffey

client MMM GROUP

project GEOTECHNICAL INVESTIGATION
HANLAN FEEDERMAIN NORTH SECTION

title PLAN AND PROFILE
CAWTHRA ROAD

project no GEOTMARK00231AA

drawing no 4

LOG OF BOREHOLE LW18

PROJECT: Local Watermain-Hanlan FM North
CLIENT: MMM Group
PROJECT LOCATION: Mississauga, Peel Region
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: Cawthra Rd, See DWG.5

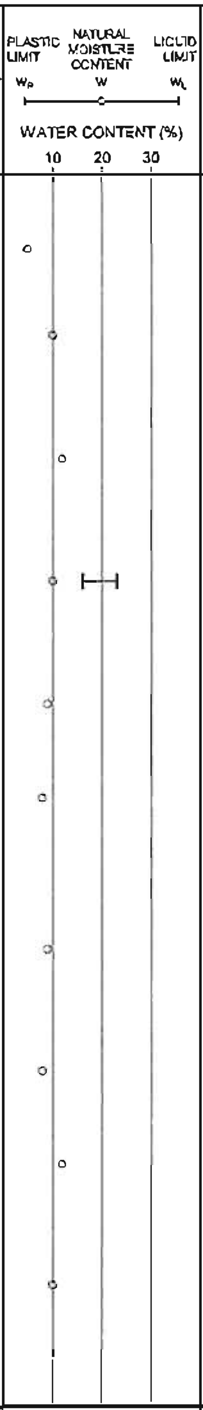
DRILLING DATA
Method: Solid Stem Augering
Diameter: 150mm
Date: May 27, 2011

REF. NO.: GEOTMARK00241AA
ENCL NO.: 16

(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	"N" BLOWS 0.3 m	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Ground Surface				
0.0	150mm **ASPHALT** 650mm**GRANULAR**				
	FILL clayey silt to silty clay, trace sand and gravel, brown, very stiff	1	SS	67	
		2	SS	27	2 39 40 19
	hard	3	SS	32	
2.3	**CLAYEY SILT** (Glacial Till) sandy, trace gravel, greyish brown, hard (CL-ML)	4	SS	60	6 31 43 20
					grinding from 2.7m to 3m
	grey	5	SS	84	
					auger grinding
		6	SS	50/ 00mm	
					hard auger grinding from 4.1m to 4.4m
4.8	**SHALE** grey	7	SS	60	
		8	SS	89/ 290mm	
	wet	9	SS	50/ 75mm	water encountered
		10	SS	50/ 25mm	
					Cave-In
		11	SS	50/ 15mm	
7.6	**END OF BOREHOLE**				

Date Water Level EL/Depth (m)
upon completion 4.8
17 June 2011 1.7

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100



UNIT WEIGHT γ (kN/m³)

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

coffey geotechnics

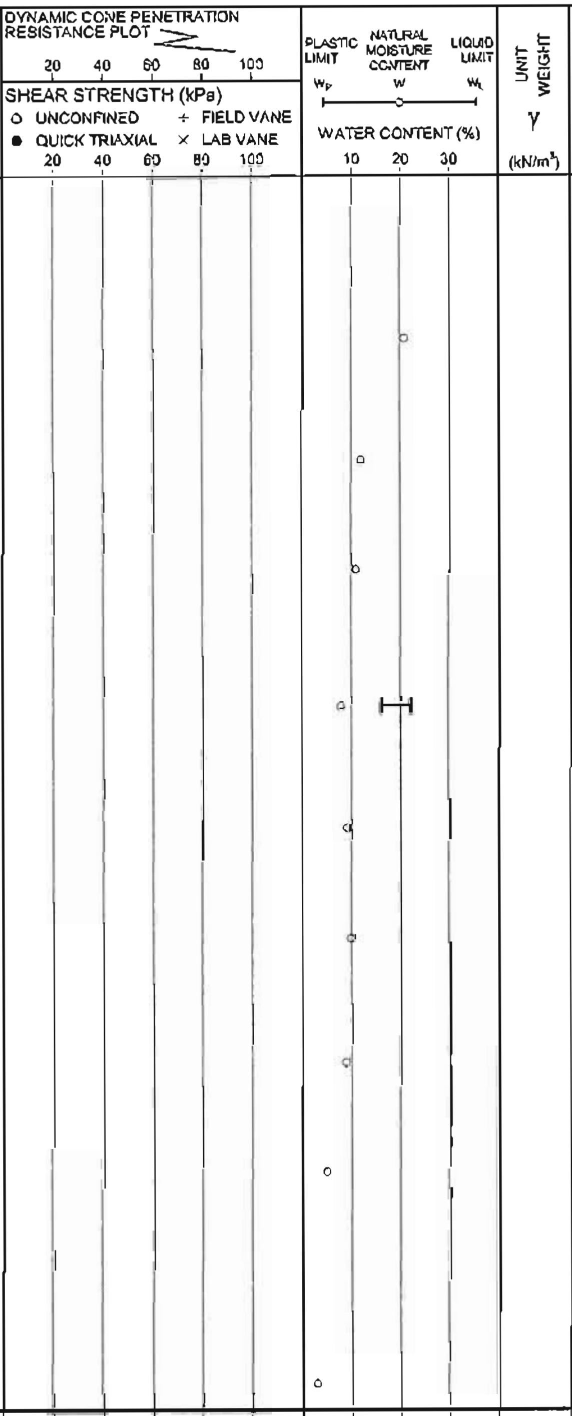
LOG OF BOREHOLE LW19

PROJECT: Local Watermain-Hanlan FM North
CLIENT: MMM Group
PROJECT LOCATION: Mississauga, Peel Region
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: Cawthra Rd and Rathburn Rd, See DWG.5

DRILLING DATA
Method: Solid Stem Augering
Diameter: 150mm
Date: May 30 2011

REF. NO.: GEOTMARK00241AA
ENCL NO.: 17

(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	"N" BLOWS 0.3 m	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Ground Surface				
0.0	**150mm ASPHALT** **450mmGRANULAR**	1		50/ 00mm	
	FILL silty clay, trace sand, grey/black, stiff, thinly laminated	2	SS	14	
		3	SS	36	PPT of 430 kPa
1.8	**CLAYEY SILT** (Glacial Till) sandy, some gravel,shale fragments, brown, hard (CL-ML)	4	SS	50/ 40mm	
	grey	5	SS	44	12 31 42 15 PPT >500 kPa
					auger grinding
		6	SS	74	
					auger grinding
4.6	**SHALE** grey	7	SS	50/ 40mm	
					auger grinding
		8	SS	50/ 25mm	
		9	SS	50/ 00mm	
					labored augering
		10	SS	50/ 15mm	labored augering from 7m to 7.6m Cave-in
		11	SS	50/ 25mm	
7.6	**END OF BOREHOLE** Date Water Level EL (m) upon completion dry				



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

coffey geotechnics

LOG OF BOREHOLE LW20

1 OF 1

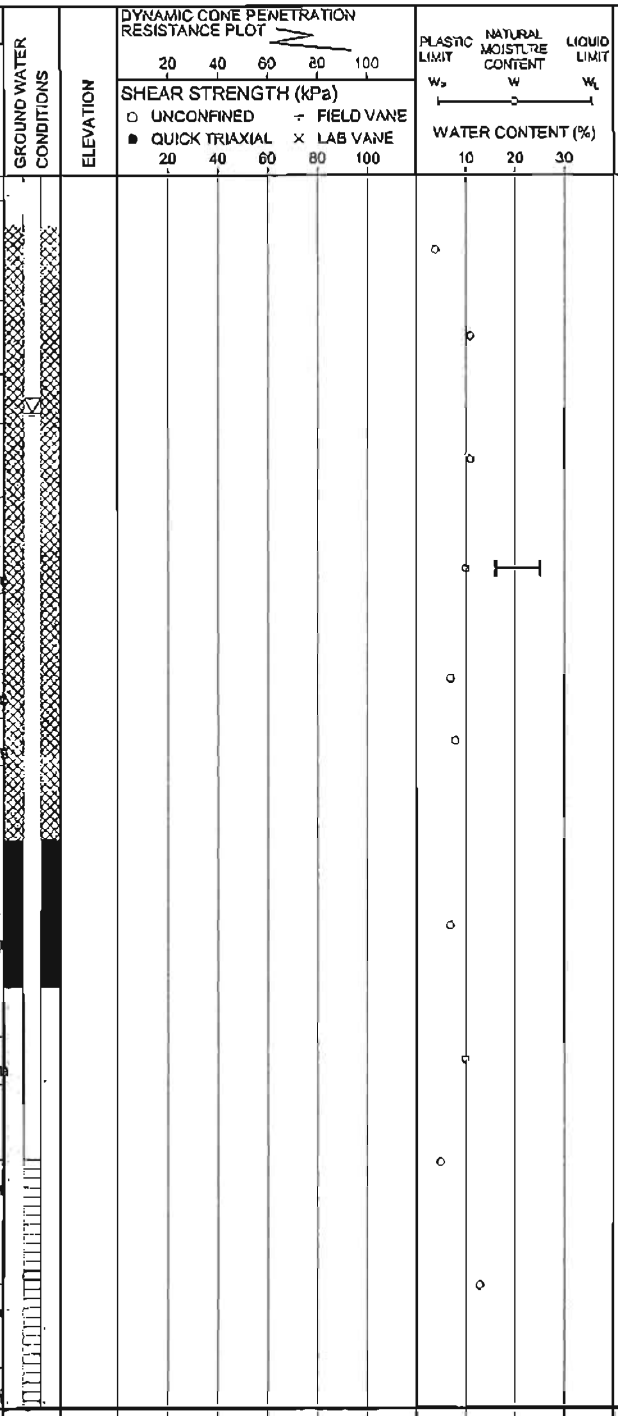
PROJECT: Local Watermain-Hanlan FM North
CLIENT: MMM Group
PROJECT LOCATION: Mississauga, Peel Region
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: Cawthra Rd, See DWG.5

DRILLING DATA
Method: Solid Stem Augering
Diameter: 150mm
Date: May 27, 2011

REF. NO.: GEOTMARK00241AA
ENCL NO.: 18

(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	"N" BLOWS 0.3 m	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Ground Surface				
0.0	150mm **ASPHALT** 550mm**GRANULAR** FILL clayey silt, trace sand and gravel, brown, very stiff to hard	1		77	
		2	SS	22	
		3	SS	36	
2.3	**SILTY CLAY** (Glacial Till) sandy, trace gravel, greyish brown, hard (CL)	4	SS	50/ 40mm	3 25 49 23
	grey	5	SS	50/ 25mm	
		6	SS	50/ 40mm	
					auger grinding from 4.3m to 4.6m
		7	SS	50/ 40mm	
		8	SS	50/ 40mm	
6.1	**SHALE** grey	9	SS	50/ 40mm	
		10	SS	50/ 15mm	
		11	SS	50/ 15mm	
7.8	**END OF BOREHOLE**				

Date Water Level EL./Depth(m)
upon completion 6.6
17 June 2011 1.5



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

coffey geotechnics

LOG OF BOREHOLE LW21

PROJECT: Local Watermain-Hanlan FM North
CLIENT: MMM Group
PROJECT LOCATION: Mississauga, Peel Region
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: Cawthra Rd, See DWG.5

DRILLING DATA
Method: Solid Stem Augering
Diameter: 150mm
Date: May 30, 2011

REF. NO.: GEOTMARK00241AA
ENCL NO.: 19

(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3 m	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Ground Surface				
0.0	188mm **ASPHALT** 600mm**GRANULAR**				
	FILL clayey silt, trace sand and gravel, brown, very stiff	1	SS	72	
		2	SS	23	
		3	SS	28	
2.3	**CLAYEY SILT to SILTY CLAY** (Glacial Till) some sand to sandy, trace gravel, shale and limestone fragments, grey, hard (CL-ML to CL)	4	SS	60	
		5	SS	50/ 25mm	
		6	SS	66	11 27 43 19
		7	SS	50/ 25mm	auger grinding from 4.7m to 5.2m
		8	SS	50/ 25mm	
6.1	SHALE grey	9	SS	50/ 25mm	spoon wet
	wet	10	SS	50/ 25mm	auger grinding from 7m to 7.6m
		11	SS	50/ 25mm	
7.6	END OF BOREHOLE Data Water Level EL/Depth(m) upon completion 3.8				

STRATA PLOT | GROUND WATER CONDITIONS | ELEVATION

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
SHEAR STRENGTH (kPa)
○ UNCONFINED + FIELD VANE
● 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

UNIT WEIGHT γ (kN/m³)

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

coffey geotechnics

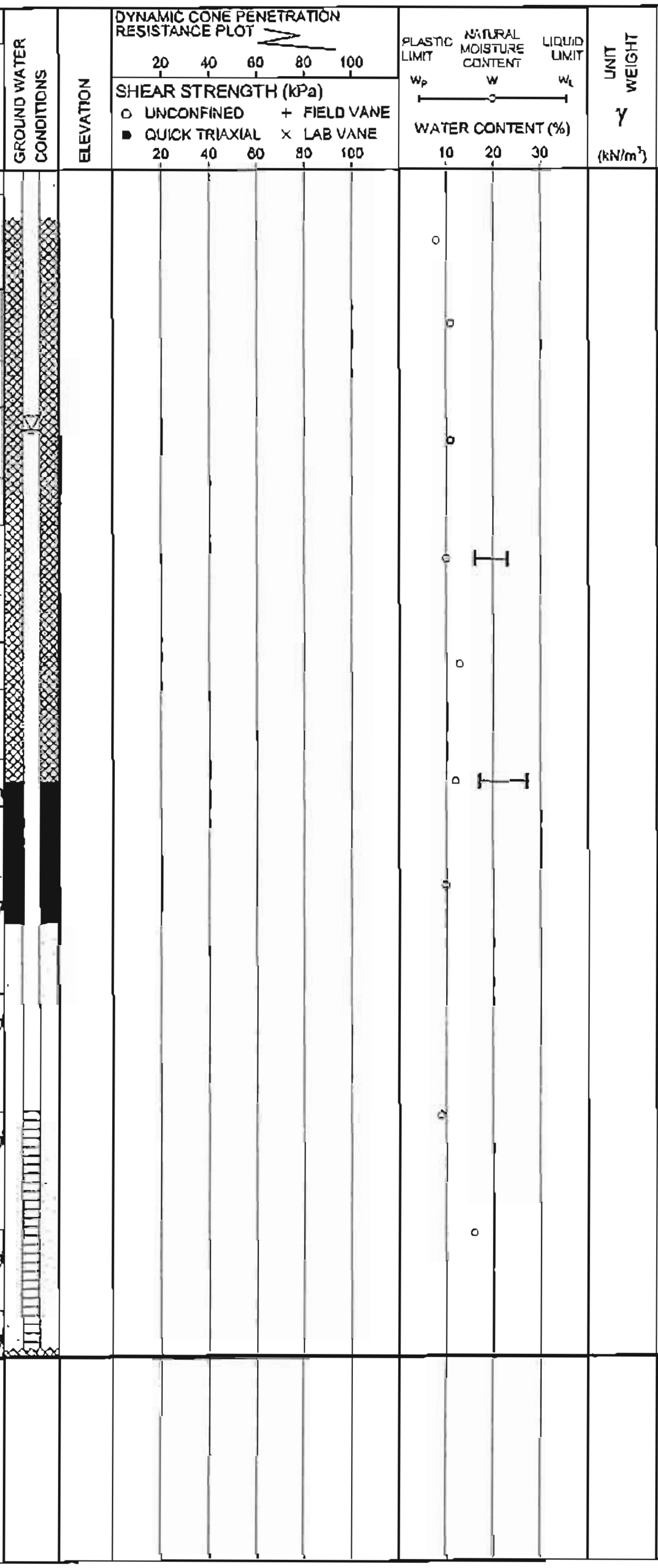
LOG OF BOREHOLE LW22

PROJECT: Local Watermain-Hanlan FM North
CLIENT: MMM Group
PROJECT LOCATION: Mississauga, Peel Region
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: Cawthra Rd, See DWG.5

DRILLING DATA
Method: Solid Stem Augering
Diameter: 150mm
Date: May 27, 2011

REF. NO.: GEOTMARK00241AA
ENCL NO.: 20

SOIL PROFILE		SAMPLES			REMARKS AND GRAIN SIZE DISTRIBUTION (%)			
(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS 0.3 m	GR	SA	SI	CL
	Ground Surface							
0.0	213mm ASPHALT 375mm**GRANULAR**							
	FILL clayey silt, trace sand and gravel, brown molted grey, very stiff to hard	1		20				
		2	SS	24				
		3	SS	33				
2.0	CLAYEY SILT (Glacial Till) trace sand and gravel, brown, hard, shale and limestone fragments	4	SS	66	2	26	48	24
	becoming silty clay, grey	5	SS	42				
		6	SS	50/ 25mm	4	17	49	30
		7	SS	50/ 125mm				
		8	SS	50/ 75mm				
		9	SS	50/ 50mm	spoon wet			
6.9	**SHALE** grey	10	SS	50/ 50mm				
		11	SS	50/ 50mm				
7.7	END OF BOREHOLE							



Date **Water Level**
EL/depth(m)
upon completion 6.6
17 June 2011 1.7

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

LOG OF BOREHOLE LW16

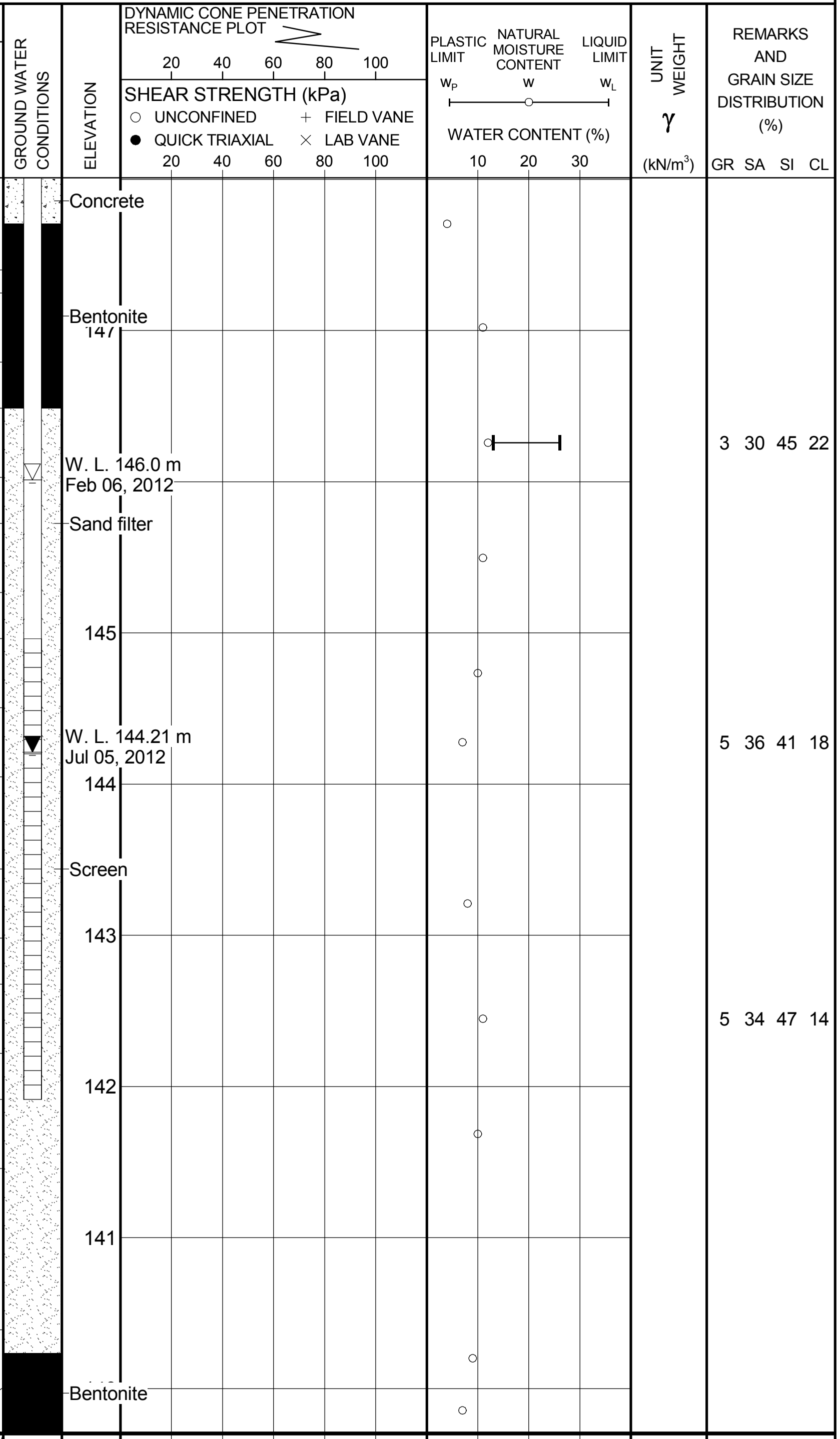
1 OF 1

PROJECT: Hanlan Feedermain North
CLIENT: MMM Group Limited
PROJECT LOCATION: City of Mississauga
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: N 4829762.5 E 610975.2

DRILLING DATA
Method: Hollow Stem Augering
Diameter: 200 mm
Date: 2011 10 28

REF. NO.: GEOTMARK00231AA
ENCL NO.:

SOIL PROFILE		SAMPLES			REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS 0.3 m	GR SA SI CL
148.0	Ground Surface				
147.9 0.1	~120 mm asphalt **FILL** crushed limestone	1	SS	50	
147.2 0.8	**SILTY CLAY TILL** sandy trace gravel brown very stiff	2	SS	25	
		3	SS	28	3 30 45 22
		4	SS	27	
145.1 2.9	**CLAYEY SILT TILL** sandy trace of gravel some cobbles brown to grey hard	5	SS	42	
		6	SS	105	5 36 41 18
		7	SS	37	
		8	SS	42	5 34 47 14
		9	SS	57	
140.4 7.6	**SHALE BEDROCK** grey	10	SS	97/ 225 mm	
		11	SS	52/ 150 mm	
139.7 8.3	**END OF BOREHOLE**				



50mm-diameter monitoring well installed to 6.1 m.

Water Level Date	Depth (m)
February 6, 2012	2.00
July 5, 2012	3.78

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

COFFEY SOIL LOG-2 GEOMARK00231AA HANLAN NORTH (REVISED ON AUG17, 2012).GPJ 31/7/13

LOG OF BOREHOLE LW17

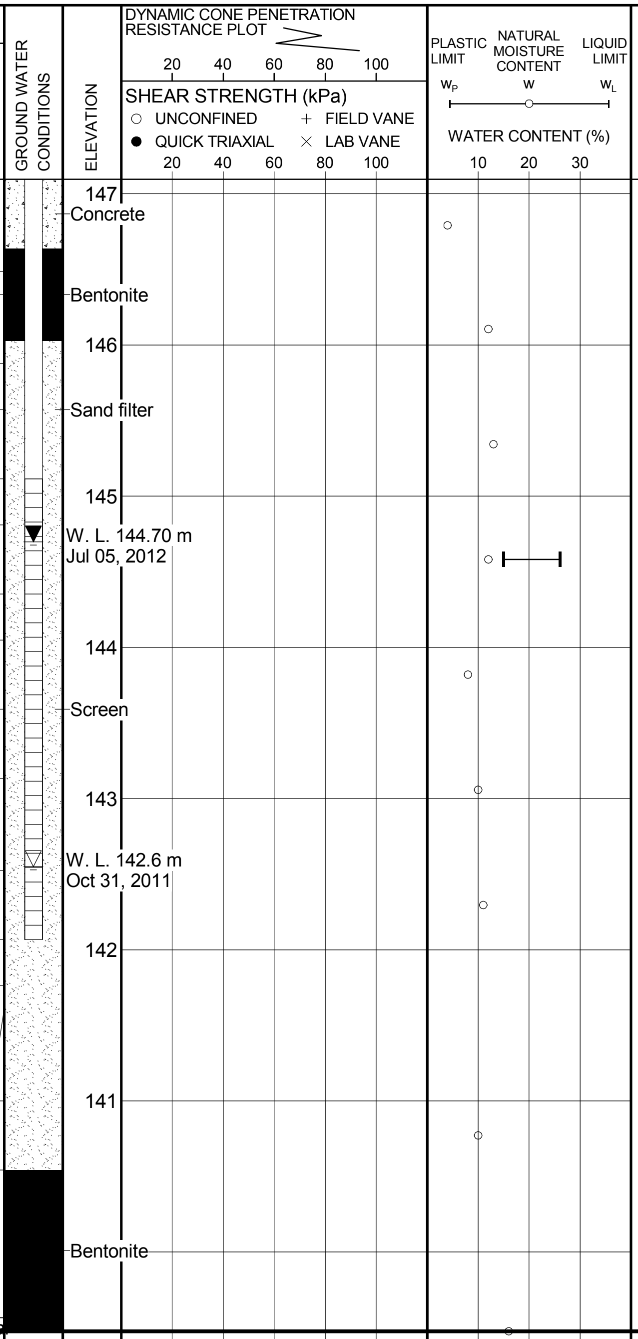
1 OF 1

PROJECT: Hanlan Feedermain North
CLIENT: MMM Group Limited
PROJECT LOCATION: City of Mississauga
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: N 4829673.6 E 611068.3

DRILLING DATA
Method: Hollow Stem Augering
Diameter: 200 mm
Date: 2011 10 31

REF. NO.: GEOTMARK00231AA
ENCL NO.:

(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3 m	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
147.1	Ground Surface				
147.0 0.0	~120 mm asphalt				
0.1	**FILL** crushed limestone	1	SS	45	
146.3 0.8	**CLAYEY SILT TILL** sandy trace to some gravel some cobbles brown / grey very stiff to hard	2	SS	17	
		3	SS	22	
		4	SS	25	10 33 40 17
		5	SS	71	
		6	SS	21	
	shale fragments	7	SS	22	9 38 35 18
	inferred cobble/ boulder				auger grinding
141.8 5.3	**SHALE BEDROCK** grey	8	SS	50/ 150 mm	spoon bouncing
		9	SS	42	
139.5		10	SS	Refusa	
7.6	**END OF BOREHOLE**				



UNIT WEIGHT γ (kN/m³)

Water lever at 4.5 m (not stabilized) upon completion.

50mm-diameter monitoring well installed to 5.0 m.

Water Level Date	Depth (m)
October 31, 2011	4.55
July 5, 2012	2.37

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

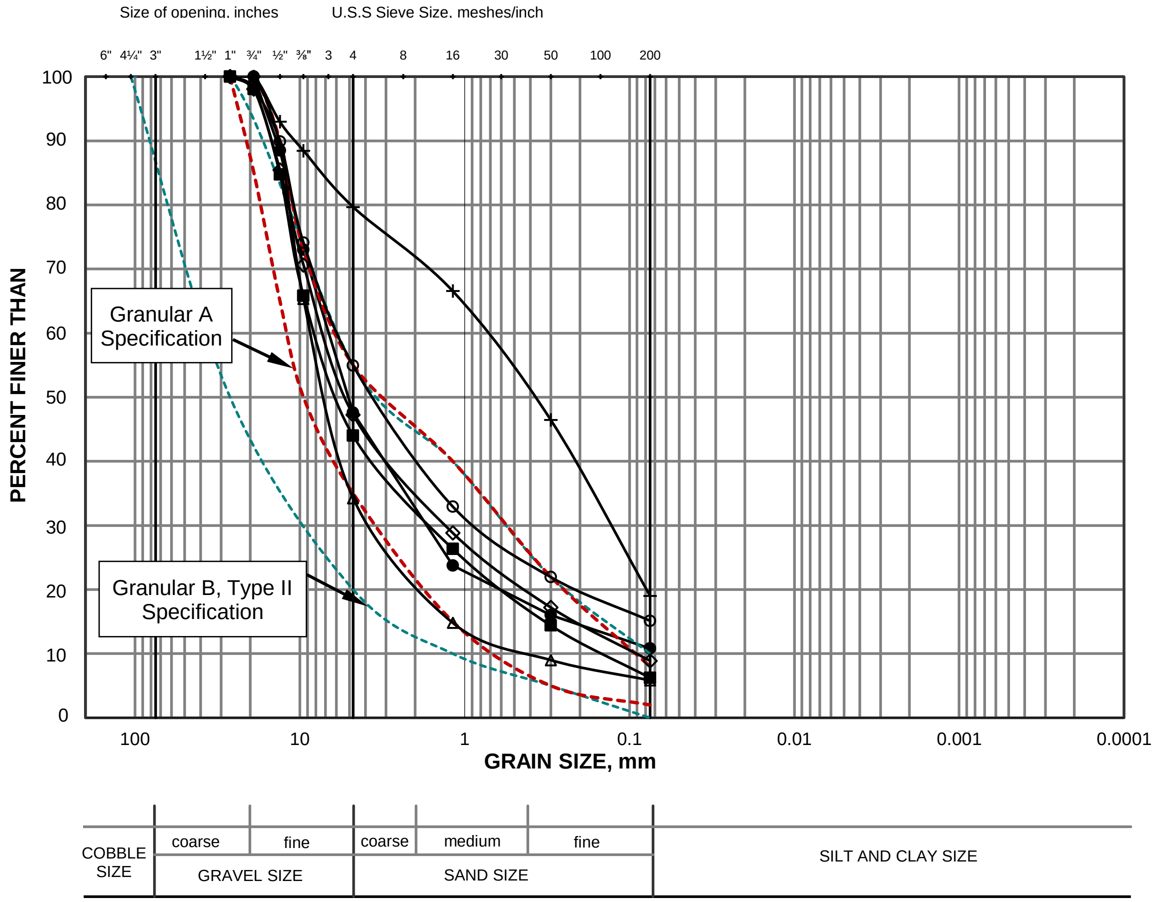
APPENDIX B

Laboratory Test Results

GRAIN SIZE DISTRIBUTION

FIGURE B1

GRANULAR BASE/SUBBASE



LEGEND

SYMBOL	BH No.	STATION	LOCATION	DEPTH (m)
●	BH 5	10+560	NB-L1	0.28 - 0.69
+	BH 19	11+800	SB-L1	0.29 - 0.53
◇	BH 33	13+140	NB-L2	0.18 - 0.54
■	BH 40	14+220	SB-L1	0.21 - 0.68
△	BH 45	15+360	NB-L1	0.30 - 0.71
○	BH 46	15+400	NB-SH	0.00 - 0.78

Project No: 1-18-0615
Date: July, 2019

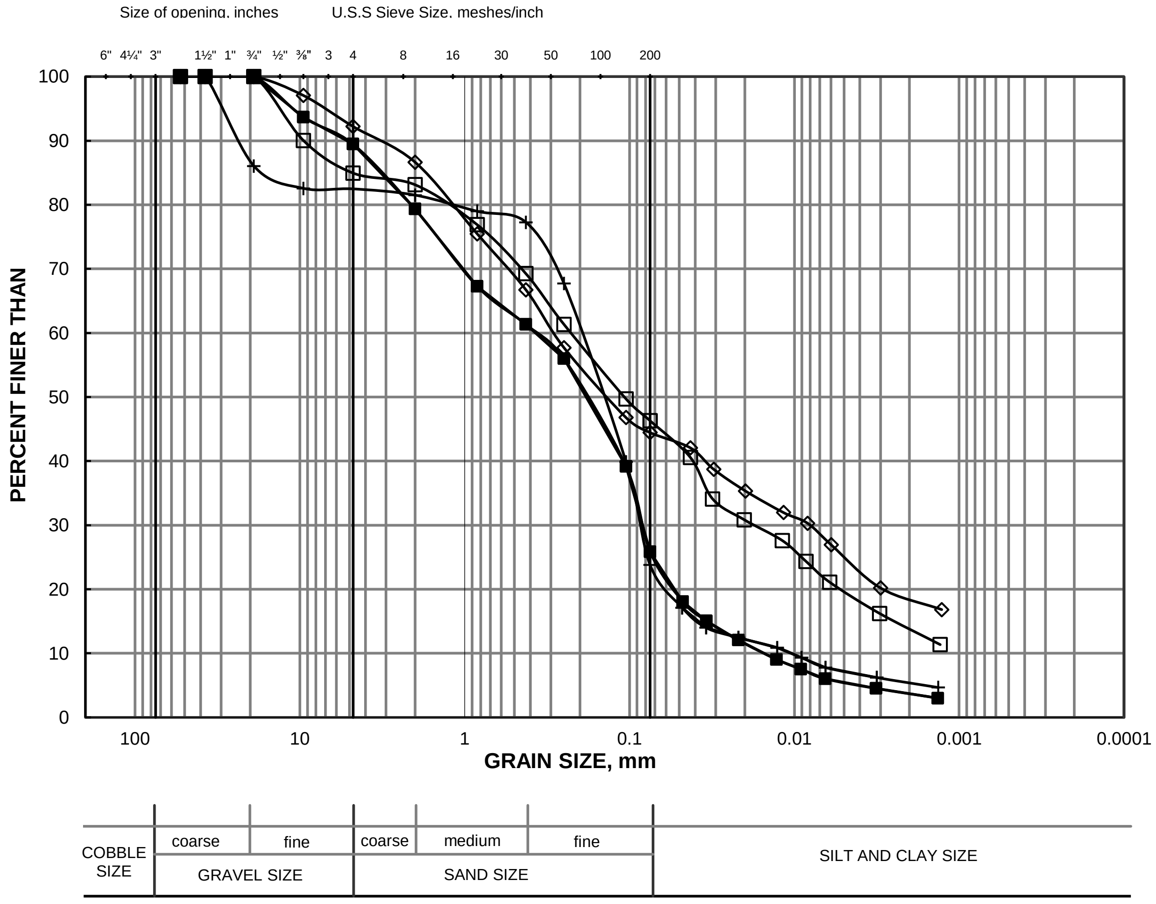
Terraprobe Inc.

Prepared by : MA
Checked by : SD

GRAIN SIZE DISTRIBUTION

FIGURE B2

SUBGRADE (Silty Sand to Sand)



LEGEND

SYMBOL	BH No.	STATION	LOCATION	DEPTH (m)
■	BH 2	10+030	SB-OFF Rd.	0.14 - 0.60
+	BH 6	10+560	NB-OFF Rd.	0.15 - 0.60
□	BH 23	12+470	NB-L2	0.59 - 0.90
◇	BH 31	12+890	SB-L2	0.54 - 1.50

Project No: 1-18-0615
Date: July, 2019

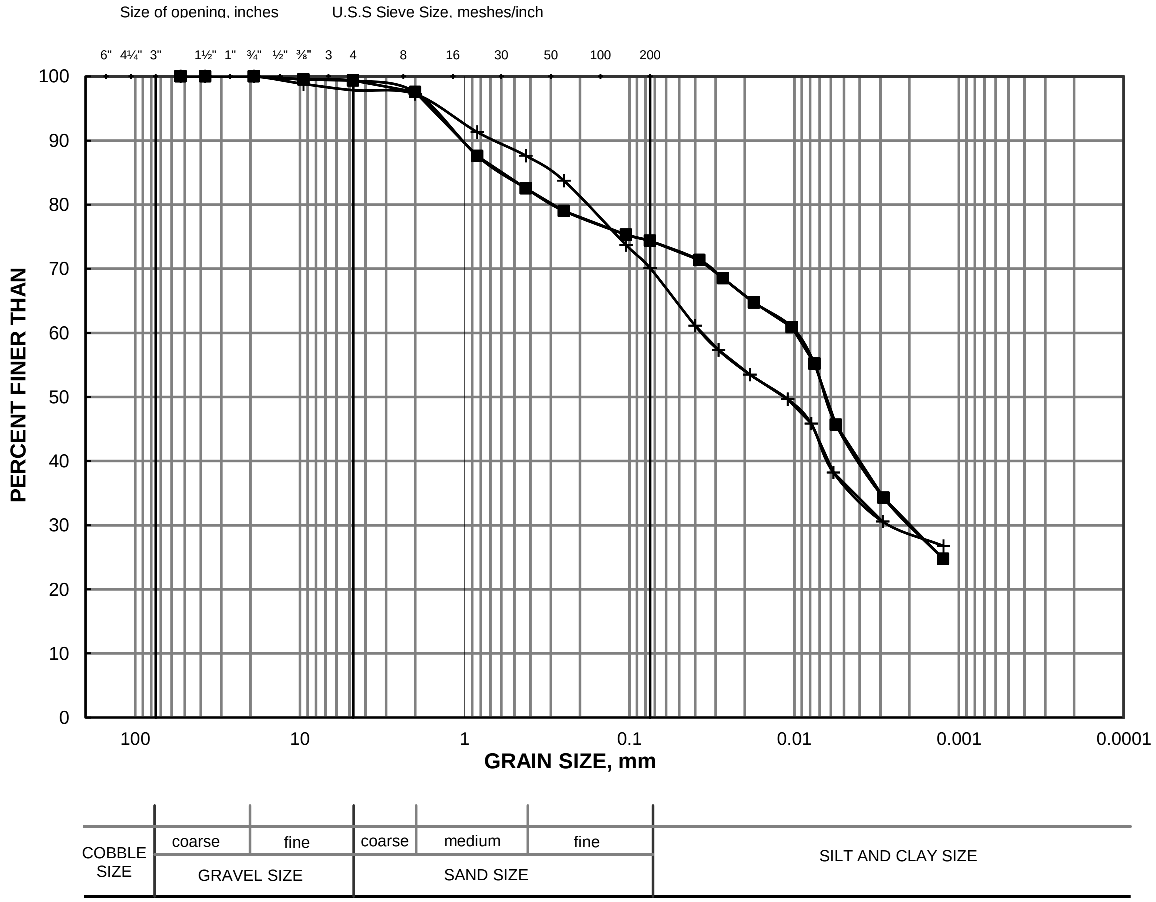
Terraprobe Inc.

Prepared by : MA
Checked by : SD

GRAIN SIZE DISTRIBUTION

FIGURE B3

SUBGRADE (Silty Clay to Clayey Silt)



LEGEND

SYMBOL	BH No.	STATION	LOCATION	DEPTH (m)
■	BH 19	11+800	SB-L1	0.53 - 1.50
+	BH 38	13+990	SB-L1	0.53 - 1.50

Project No: 1-18-0615
Date: July, 2019

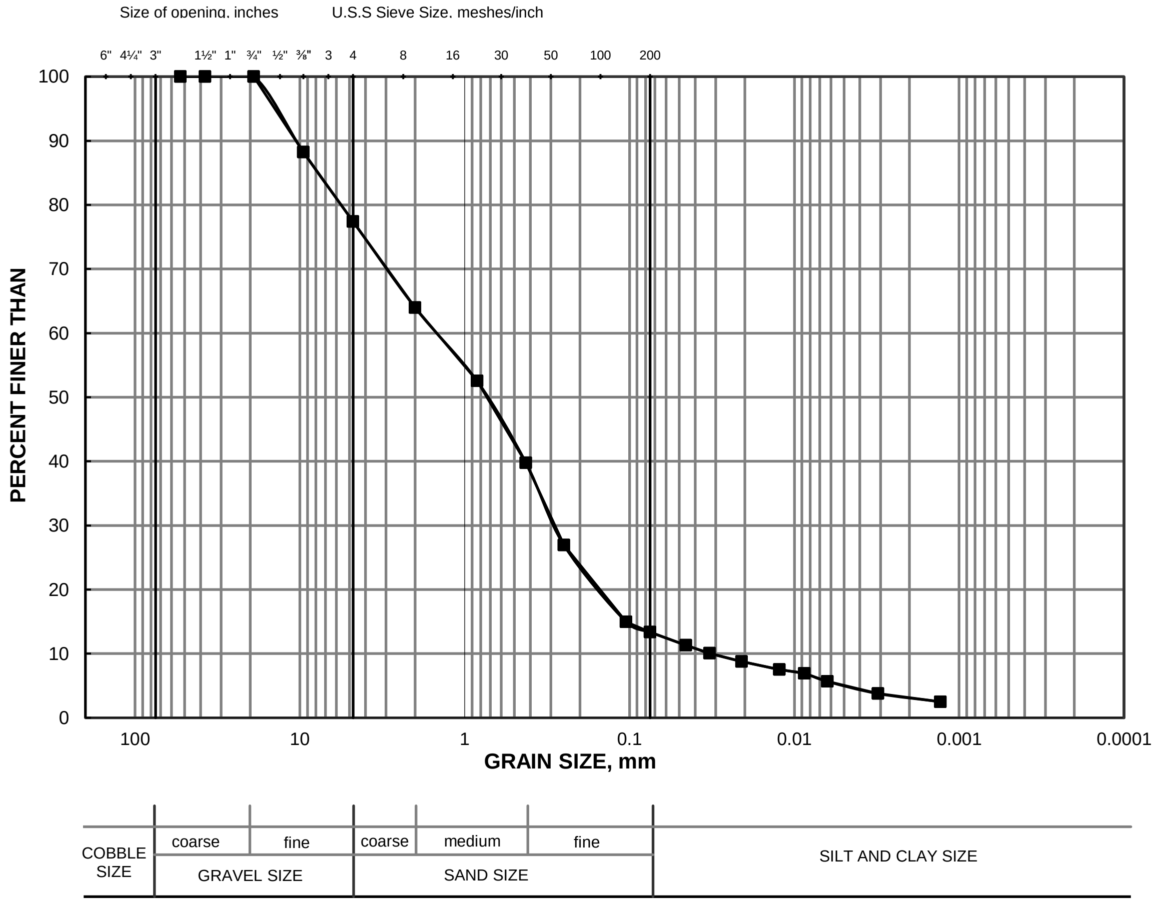
Terraprobe Inc.

Prepared by : MA
Checked by : SD

GRAIN SIZE DISTRIBUTION

FIGURE B4

SUBGRADE (Sand and Gravel to Gravelly Sand)



LEGEND

SYMBOL	BH No.	STATION	LOCATION	DEPTH (m)
■	BH 44	15+360	NB-SH	0.61 - 0.90

Project No: 1-18-0615
Date: July, 2019

Terraprobe Inc.

Prepared by : MA
Checked by : SD

APPENDIX C

Certificate of Chemical Analysis
(Soil Chemistry)

FINAL REPORT

CA14532-JUN19 R1

1-18-0615 C.awthra Rd - Mississauga

Prepared for

Terraprobe Inc

FINAL REPORT

CA14532-JUN19 R1

First Page

CLIENT DETAILS

Client	Terraprobe Inc
Address	11 Indell Lane Brampton, ON L6T 3Y3. Canada
Contact	Sepideh D_Monfared
Telephone	(905) 796-2650
Facsimile	(905) 796-2250
Email	smonfared@terraprobe.ca
Project	1-18-0615 C.awthra Rd - Mississauga
Order Number	
Samples	soil (4)

LABORATORY DETAILS

Project Specialist	Brad Moore Hon. B.Sc
Laboratory	SGS Canada Inc.
Address	185 Concession St., Lakefield ON, K0L 2H0
Telephone	705-652-2143
Facsimile	705-652-6365
Email	brad.moore@sgs.com
SGS Reference	CA14532-JUN19
Received	06/12/2019
Approved	06/17/2019
Report Number	CA14532-JUN19 R1
Date Reported	08/08/2019

COMMENTS

Temperature of Sample upon Receipt: 4 degrees C
Cooling Agent Present:YES
Custody Seal Present:NO

Chain of Custody Number:007156

SIGNATORIES

Brad Moore Hon. B.Sc

TABLE OF CONTENTS

PACKAGE: **REG153 - Hydrides** (SOIL)

L1 = REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED

L2 = REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED

Sample Number	8	9	10	11
Sample Name	Station 10+030, SBL, 295mm-560mm	Station 10+700, NBL, 285mm-740mm	Station 13+900, SBL, 190mm-530mm	Station 15+400, NBSH, 0mm-780mm
Sample Matrix	soil	soil	soil	soil
Sample Date	06/06/2019	06/06/2019	03/06/2019	03/06/2019

Hydrides

Parameter	**Units**	**RL**	**L1**	**L2**	**Result**	**Result**	**Result**	**Result**
Antimony	µg/g	0.8	1.3	40	< 0.8	< 0.8	< 0.8	< 0.8
Arsenic	µg/g	0.5	18	18	3.6	3.5	3.4	4.1
Selenium	µg/g	0.7	1.5	5.5	< 0.7	< 0.7	< 0.7	< 0.7

PACKAGE: **REG153 - Metals and Inorganics** (SOIL)

L1 = REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED

L2 = REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED

Sample Number	8	9	10	11
Sample Name	Station 10+030, SBL, 295mm-560mm	Station 10+700, NBL, 285mm-740mm	Station 13+900, SBL, 190mm-530mm	Station 15+400, NBSH, 0mm-780mm
Sample Matrix	soil	soil	soil	soil
Sample Date	06/06/2019	06/06/2019	03/06/2019	03/06/2019

Metals and Inorganics

Parameter	**Units**	**RL**	**L1**	**L2**	**Result**	**Result**	**Result**	**Result**
Moisture Content	%	-			3.8	7.1	2.8	5.5
Barium	µg/g	0.1	220	670	8.8	22	11	14
Beryllium	µg/g	0.02	2.5	8	0.09	0.15	0.08	0.11
Boron	µg/g	1	36	120	6	4	4	5
Cadmium	µg/g	0.02	1.2	1.9	0.26	0.21	0.54	0.37
Chromium	µg/g	0.5	70	160	4.2	7.2	2.9	12
Cobalt	µg/g	0.01	21	80	3.4	6.7	1.9	2.8
Copper	µg/g	0.1	92	230	11	15	7.2	28
Lead	µg/g	0.1	120	120	18	18	22	29
Molybdenum	µg/g	0.1	2	40	0.6	0.6	0.5	0.7

PACKAGE: **REG153 - Metals and Inorganics** (SOIL)

L1 = REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED

L2 = REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED

				Sample Number	8	9	10	11
				Sample Name	Station 10+030, SBL, 295mm-560mm	Station 10+700, NBL, 285mm-740mm	Station 13+900, SBL, 190mm-530mm	Station 15+400, NBSH, 0mm-780mm
				Sample Matrix	soil	soil	soil	soil
				Sample Date	06/06/2019	06/06/2019	03/06/2019	03/06/2019
Parameter	**Units**	**RL**	**L1**	**L2**	**Result**	**Result**	**Result**	**Result**
Metals and Inorganics (continued)								
Nickel	µg/g	0.5	82	270	5.9	7.7	5.1	7.1
Silver	µg/g	0.05	0.5	40	0.11	0.08	< 0.05	0.07
Thallium	µg/g	0.02	1	3.3	0.06	0.06	0.07	0.06
Uranium	µg/g	0.002	2.5	33	0.15	0.21	0.15	0.18
Vanadium	µg/g	3	86	86	5	10	6	6
Zinc	µg/g	0.7	290	340	120	86	150	140
Water Soluble Boron	µg/g	0.5		2	< 0.5	< 0.5	< 0.5	< 0.5

PACKAGE: **REG153 - Other (ORP)** (SOIL)

L1 = REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED

L2 = REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED

				Sample Number	8	9	10	11
				Sample Name	Station 10+030, SBL, 295mm-560mm	Station 10+700, NBL, 285mm-740mm	Station 13+900, SBL, 190mm-530mm	Station 15+400, NBSH, 0mm-780mm
				Sample Matrix	soil	soil	soil	soil
				Sample Date	06/06/2019	06/06/2019	03/06/2019	03/06/2019
Parameter	**Units**	**RL**	**L1**	**L2**	**Result**	**Result**	**Result**	**Result**
Other (ORP)								
Mercury	µg/g	0.05	0.27	3.9	< 0.05	< 0.05	< 0.05	< 0.05
Sodium Adsorption Ratio	---	0.2	2.4	12	2.4	**10.4**	**12.3**	**10.5**
SAR Calcium	mg/L	0.09			30.8	24.5	12.2	9.2
SAR Magnesium	mg/L	0.02			8.0	1.3	6.4	5.1
SAR Sodium	mg/L	0.15			57.7	199	210	154
Conductivity	mS/cm	0.002	0.57	1.4	0.56	**1.2**	**1.2**	**0.96**

PACKAGE: **REG153 - Other (ORP)** (SOIL)

L1 = REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED

L2 = REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED

				Sample Number	8	9	10	11
				Sample Name	Station 10+030, SBL, 295mm-560mm	Station 10+700, NBL, 285mm-740mm	Station 13+900, SBL, 190mm-530mm	Station 15+400, NBSH, 0mm-780mm
				Sample Matrix	soil	soil	soil	soil
				Sample Date	06/06/2019	06/06/2019	03/06/2019	03/06/2019
Parameter	**Units**	**RL**	**L1**	**L2**	**Result**	**Result**	**Result**	**Result**
Other (ORP) (continued)								
pH	pH Units	0.05			11.06	11.50	8.36	8.41
Chromium VI	µg/g	0.2	0.66	8	< 0.2	< 0.2	< 0.2	0.3
Free Cyanide	µg/g	0.05	0.051	0.051	< 0.05	< 0.05	< 0.05	< 0.05

EXCEEDANCE SUMMARY

Parameter	Method	Units	Result	REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED L1	REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED L2
Station 10+700, NBL, 285mm-740mm					
Conductivity	EPA 6010/SM 2510	mS/cm	1.2	0.57	
Sodium Adsorption Ratio	MOE 4696e01/EPA 6010	µg/g	10.4	2.4	
Station 13+900, SBL, 190mm-530mm					
Conductivity	EPA 6010/SM 2510	mS/cm	1.2	0.57	
Sodium Adsorption Ratio	MOE 4696e01/EPA 6010	µg/g	12.3	2.4	12
Station 15+400, NBSH, 0mm-780mm					
Conductivity	EPA 6010/SM 2510	mS/cm	0.96	0.57	
Sodium Adsorption Ratio	MOE 4696e01/EPA 6010	µg/g	10.5	2.4	

QC SUMMARY

Conductivity

Method: EPA 6010/SM 2510 I Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0265-JUN19	mS/cm	0.002	<0.002	0	10	99	90	110	NA		

Cyanide by SFA

Method: SM 4500 I Internal ref.: ME-CA-[ENV]SFA-LAK-AN-005

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Free Cyanide	SKA5039-JUN19	µg/g	0.05	<0.05	ND	20	95	80	120	105	75	125

Hexavalent Chromium by IC

Method: EPA218.6/EPA3060A I Internal ref.: ME-CA-[ENV]IC-LAK-AN-008

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chromium VI	DIO0224-JUN19	µg/g	0.2	<0.2	ND	20	89	80	120	97	75	125

QC SUMMARY

Mercury by CVAAS

Method: EPA 7471A/EPA 245 I Internal ref.: ME-CA-[ENV]SPE-LAK-AN-004

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Mercury	EMS0084-JUN19	µg/g	0.05	<0.05	ND	20	100	80	120	97	70	130

Metals in aqueous samples - ICP-OES

Method: MOE 4696e01/EPA 6010 I Internal ref.: ME-CA-[ENV]SPE-LAK-AN-003

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
SAR Calcium	ESG0044-JUN19	mg/L	0.09	<0.09	1	20	103	80	120	99	70	130
SAR Magnesium	ESG0044-JUN19	mg/L	0.02	<0.02	5	20	102	80	120	101	70	130
SAR Sodium	ESG0044-JUN19	mg/L	0.15	<0.15	2	20	98	80	120	104	70	130

FINAL REPORT

QC SUMMARY

Metals in Soil - Aqua-regia/ICP-MS

Method: EPA 3050/EPA 200.8 | Internal ref.: ME-CA-[ENV]SPE-LAK-AN-005

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Silver	EMS0084-JUN19	ug/g	0.05	<0.05	5	20	92	70	130	102	70	130
Arsenic	EMS0084-JUN19	µg/g	0.5	<0.5	5	20	101	70	130	91	70	130
Barium	EMS0084-JUN19	ug/g	0.1	<0.1	2	20	101	70	130	95	70	130
Beryllium	EMS0084-JUN19	µg/g	0.02	<0.02	6	20	101	70	130	103	70	130
Boron	EMS0084-JUN19	µg/g	1	<1	3	20	110	70	130	92	70	130
Cadmium	EMS0084-JUN19	µg/g	0.02	<0.02	ND	20	100	70	130	114	70	130
Cobalt	EMS0084-JUN19	µg/g	0.01	<0.01	ND	20	96	70	130	111	70	130
Chromium	EMS0084-JUN19	µg/g	0.5	<0.5	ND	20	97	70	130	111	70	130
Copper	EMS0084-JUN19	µg/g	0.1	<0.1	ND	20	96	70	130	104	70	130
Molybdenum	EMS0084-JUN19	µg/g	0.1	<0.1	ND	20	102	70	130	118	70	130
Nickel	EMS0084-JUN19	ug/g	0.5	<0.5	ND	20	99	70	130	113	70	130
Lead	EMS0084-JUN19	µg/g	0.1	<0.1	10	20	93	70	130	99	70	130
Antimony	EMS0084-JUN19	µg/g	0.8	<0.8	ND	20	102	70	130	111	70	130
Selenium	EMS0084-JUN19	µg/g	0.7	<0.7	ND	20	99	70	130	113	70	130
Thallium	EMS0084-JUN19	µg/g	0.02	<0.02	ND	20	93	70	130	99	70	130
Uranium	EMS0084-JUN19	µg/g	0.002	<0.002	6	20	100	70	130	105	70	130
Vanadium	EMS0084-JUN19	µg/g	3	<3	2	20	96	70	130	108	70	130
Zinc	EMS0084-JUN19	µg/g	0.7	<0.7	ND	20	99	70	130	103	70	130

QC SUMMARY

pH

Method: SM 4500 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	ARD0052-JUN19	pH Units	0.05		1	20	100	80	120			

Water Soluble Boron

Method: O.Reg. 153/04 | Internal ref.: ME-CA-[ENV] SPE-LAK-AN-003

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Water Soluble Boron	ESG0043-JUN19	µg/g	0.5	<0.5	ND	20	103	80	120	106	70	130

QC SUMMARY

Method Blank: a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

Duplicate: Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

LCS/Spike Blank: Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

Reference Material: a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

Multielement Scan Qualifier: as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

Duplicate Qualifier: for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Matrix Spike Qualifier: for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

LEGEND

FOOTNOTES

NSS	Insufficient sample for analysis.
RL	Reporting Limit.
↑	Reporting limit raised.
↓	Reporting limit lowered.
NA	The sample was not analysed for this analyte
ND	Non Detect

Samples analysed as received. Solid samples expressed on a dry weight basis. “Temperature Upon Receipt” is representative of the whole shipment and may not reflect the temperature of individual samples.

Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act” published by the Ministry and dated March 9, 2004 as amended.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated. This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at http://www.sgs.com/terms_and_conditions.htm. The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

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-- End of Analytical Report --

FINAL REPORT

CA14439-JUN19 R

1-18-0615-2 Missisaga

Prepared for

Terraprobe

FINAL REPORT

First Page

CLIENT DETAILS		LABORATORY DETAILS	
Client	Terraprobe	Project Specialist	Brad Moore Hon. B.Sc
		Laboratory	SGS Canada Inc.
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Contact	Mariam Al Gailani	Telephone	705-652-2143
Telephone	519-722-7134	Facsimile	705-652-6365
Facsimile	905-796-2250	Email	brad.moore@sgs.com
Email	malgailani@terraprobe.ca	SGS Reference	CA14439-JUN19
Project	1-18-0615-2 Missisaga	Received	06/10/2019
Order Number		Approved	06/14/2019
Samples	Soil (4)	Report Number	CA14439-JUN19 R
		Date Reported	06/14/2019

COMMENTS

Temperature of Sample upon Receipt: 8 degrees C
Cooling Agent Present:Yes
Custody Seal Present:No

Chain of Custody Number:007158

SIGNATORIES

Brad Moore Hon. B.Sc

TABLE OF CONTENTS

PACKAGE: **REG153 - Hydrides** (SOIL)

L1 = REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED

L2 = REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED

				Sample Number	10	11	12	13
				Sample Name	BH24/AS1	BH33//AS1	BH15/AS1	BH18/AS1
				Sample Matrix	Soil	Soil	Soil	Soil
				Sample Date	05/06/2019	05/06/2019	07/06/2019	07/06/2019
Parameter	**Units**	**RL**	**L1**	**L2**	**Result**	**Result**	**Result**	**Result**
Hydrides								
Antimony	µg/g	0.8	1.3	40	< 0.8	< 0.8	< 0.8	< 0.8
Arsenic	µg/g	0.5	18	18	2.5	5.9	2.0	1.9
Selenium	µg/g	0.7	1.5	5.5	< 0.7	< 0.7	< 0.7	< 0.7

PACKAGE: **REG153 - Metals and Inorganics** (SOIL)

L1 = REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED

L2 = REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED

				Sample Number	10	11	12	13
				Sample Name	BH24/AS1	BH33//AS1	BH15/AS1	BH18/AS1
				Sample Matrix	Soil	Soil	Soil	Soil
				Sample Date	05/06/2019	05/06/2019	07/06/2019	07/06/2019
Parameter	**Units**	**RL**	**L1**	**L2**	**Result**	**Result**	**Result**	**Result**
Metals and Inorganics								
Moisture Content	%	-			7.2	14.5	16.4	4.4
Barium	µg/g	0.1	220	670	22	58	52	23
Beryllium	µg/g	0.02	2.5	8	0.24	0.83	0.28	0.15
Boron	µg/g	1	36	120	4	13	4	4
Cadmium	µg/g	0.02	1.2	1.9	0.06	0.05	0.12	0.06
Chromium	µg/g	0.5	70	160	11	27	9.2	5.9
Cobalt	µg/g	0.01	21	80	4.9	16	2.6	3.2
Copper	µg/g	0.1	92	230	16	39	13	18
Lead	µg/g	0.1	120	120	8.9	5.4	9.4	5.5
Molybdenum	µg/g	0.1	2	40	0.3	0.2	0.3	0.2
Nickel	µg/g	0.5	82	270	11	35	5.9	6.5
Silver	µg/g	0.05	0.5	40	< 0.05	0.07	0.09	0.08
Thallium	µg/g	0.02	1	3.3	0.08	0.14	0.05	0.07

PACKAGE: **REG153 - Metals and Inorganics** (SOIL)

L1 = REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED

L2 = REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED

				Sample Number	10	11	12	13
				Sample Name	BH24/AS1	BH33//AS1	BH15/AS1	BH18/AS1
				Sample Matrix	Soil	Soil	Soil	Soil
				Sample Date	05/06/2019	05/06/2019	07/06/2019	07/06/2019
Parameter	**Units**	**RL**	**L1**	**L2**	**Result**	**Result**	**Result**	**Result**
Metals and Inorganics (continued)								
Uranium	µg/g	0.002	2.5	33	0.30	1.1	0.66	0.27
Vanadium	µg/g	3	86	86	15	33	14	11
Zinc	µg/g	0.7	290	340	36	73	23	23
Water Soluble Boron	µg/g	0.5		2	< 0.5	< 0.5	< 0.5	< 0.5

PACKAGE: **REG153 - Other (ORP)** (SOIL)

L1 = REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED

L2 = REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED

				Sample Number	10	11	12	13
				Sample Name	BH24/AS1	BH33//AS1	BH15/AS1	BH18/AS1
				Sample Matrix	Soil	Soil	Soil	Soil
				Sample Date	05/06/2019	05/06/2019	07/06/2019	07/06/2019
Parameter	**Units**	**RL**	**L1**	**L2**	**Result**	**Result**	**Result**	**Result**
Other (ORP)								
Mercury	µg/g	0.05	0.27	3.9	< 0.05	< 0.05	0.05	< 0.05
Sodium Adsorption Ratio	---	0.2	2.4	12	15.0	21.1	25.3	13.7
SAR Calcium	mg/L	0.09			7.9	48.4	25.1	5.8
SAR Magnesium	mg/L	0.02			0.29	43.4	7.0	1.8
SAR Sodium	mg/L	0.15			156	851	755	137
Conductivity	mS/cm	0.002	0.57	1.4	0.93	4.2	3.3	0.83
pH	pH Units	0.05			10.93	8.13	7.92	9.92
Chromium VI	µg/g	0.2	0.66	8	< 0.2	< 0.2	< 0.2	< 0.2
Free Cyanide	µg/g	0.05			< 0.05	< 0.05	< 0.05	< 0.05

FINAL REPORT

EXCEEDANCE SUMMARY

Parameter	Method	Units	Result	REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED L1	REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED L2
BH24/AS1					
Conductivity	EPA 6010/SM 2510	µg/g	0.93	0.57	
Sodium Adsorption Ratio	MOE 4696e01/EPA 6010	µg/g	15.0	2.4	12
BH33//AS1					
Conductivity	EPA 6010/SM 2510	µg/g	4.2	0.57	1.4
Sodium Adsorption Ratio	MOE 4696e01/EPA 6010	µg/g	21.1	2.4	12
BH15/AS1					
Conductivity	EPA 6010/SM 2510	µg/g	3.3	0.57	1.4
Sodium Adsorption Ratio	MOE 4696e01/EPA 6010	µg/g	25.3	2.4	12
BH18/AS1					
Conductivity	EPA 6010/SM 2510	µg/g	0.83	0.57	
Sodium Adsorption Ratio	MOE 4696e01/EPA 6010	µg/g	13.7	2.4	12

QC SUMMARY

Conductivity

Method: EPA 6010/SM 2510 I Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0200-JUN19	mS/cm	0.002	<0.002	0	10	99	90	110	NA		

Cyanide by SFA

Method: SM 4500 I Internal ref.: ME-CA-[ENV]SFA-LAK-AN-005

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Free Cyanide	SKA5027-JUN19	µg/g	0.05	<0.05	ND	20	100	80	120	108	75	125

Hexavalent Chromium by IC

Method: EPA218.6/EPA3060A I Internal ref.: ME-CA-[ENV]IC-LAK-AN-008

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chromium VI	DIO0180-JUN19	µg/g	0.2	<0.2	ND	20	110	80	120	94	75	125

QC SUMMARY

Mercury by CVAAS

Method: EPA 7471A/EPA 245 | Internal ref.: ME-CA-[ENV]SPE-LAK-AN-004

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Mercury	EMS0061-JUN19	µg/g	0.05	<0.05	13	20	99	80	120	99	70	130

Metals in aqueous samples - ICP-OES

Method: MOE 4696e01/EPA 6010 | Internal ref.: ME-CA-[ENV]SPE-LAK-AN-003

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
SAR Calcium	ESG0034-JUN19	mg/L	0.09	<0.09	0	20	99	80	120	104	70	130
SAR Magnesium	ESG0034-JUN19	mg/L	0.02	<0.02	1	20	99	80	120	107	70	130
SAR Sodium	ESG0034-JUN19	mg/L	0.15	<0.15	ND	20	100	80	120	110	70	130

FINAL REPORT

QC SUMMARY

Metals in Soil - Aqua-regia/ICP-MS

Method: EPA 3050/EPA 200.8 | Internal ref.: ME-CA-[ENV]SPE-LAK-AN-005

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Silver	EMS0061-JUN19	ug/g	0.05	<0.05	ND	20	98	70	130	102	70	130
Arsenic	EMS0061-JUN19	µg/g	0.5	<0.5	1	20	100	70	130	100	70	130
Barium	EMS0061-JUN19	ug/g	0.1	<0.1	1	20	107	70	130	104	70	130
Beryllium	EMS0061-JUN19	µg/g	0.02	<0.02	2	20	99	70	130	98	70	130
Boron	EMS0061-JUN19	µg/g	1	<1	3	20	107	70	130	105	70	130
Cadmium	EMS0061-JUN19	µg/g	0.02	<0.02	3	20	99	70	130	107	70	130
Cobalt	EMS0061-JUN19	µg/g	0.01	<0.01	4	20	103	70	130	112	70	130
Chromium	EMS0061-JUN19	µg/g	0.5	<0.5	6	20	107	70	130	118	70	130
Copper	EMS0061-JUN19	µg/g	0.1	<0.1	4	20	102	70	130	106	70	130
Molybdenum	EMS0061-JUN19	µg/g	0.1	<0.1	1	20	104	70	130	115	70	130
Nickel	EMS0061-JUN19	ug/g	0.5	<0.5	4	20	104	70	130	113	70	130
Lead	EMS0061-JUN19	ug/g	0.1	<0.1	3	20	103	70	130	108	70	130
Antimony	EMS0061-JUN19	µg/g	0.8	<0.8	ND	20	105	70	130	117	70	130
Selenium	EMS0061-JUN19	µg/g	0.7	<0.7	ND	20	100	70	130	102	70	130
Thallium	EMS0061-JUN19	µg/g	0.02	<0.02	11	20	101	70	130	107	70	130
Uranium	EMS0061-JUN19	µg/g	0.002	<0.002	0	20	104	70	130	105	70	130
Vanadium	EMS0061-JUN19	µg/g	3	<3	4	20	105	70	130	112	70	130
Zinc	EMS0061-JUN19	µg/g	0.7	<0.7	5	20	103	70	130	109	70	130

QC SUMMARY

pH

Method: SM 4500 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	ARD0039-JUN19	pH Units	0.05		1	20	100	80	120			

Water Soluble Boron

Method: O.Reg. 153/04 | Internal ref.: ME-CA-[ENV] SPE-LAK-AN-003

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Water Soluble Boron	ESG0037-JUN19	µg/g	0.5	<0.5	ND	20	100	80	120	105	70	130

QC SUMMARY

Method Blank: a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

Duplicate: Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

LCS/Spike Blank: Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

Reference Material: a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

Multielement Scan Qualifier: as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

Duplicate Qualifier: for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Matrix Spike Qualifier: for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

LEGEND

FOOTNOTES

NSS	Insufficient sample for analysis.
RL	Reporting Limit.
↑	Reporting limit raised.
↓	Reporting limit lowered.
NA	The sample was not analysed for this analyte
ND	Non Detect

Samples analysed as received. Solid samples expressed on a dry weight basis. “Temperature Upon Receipt” is representative of the whole shipment and may not reflect the temperature of individual samples.

Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act” published by the Ministry and dated March 9, 2004 as amended.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated. This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at http://www.sgs.com/terms_and_conditions.htm. The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

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-- End of Analytical Report --

FINAL REPORT

CA14604-JUN19 R

1-18-0615-2

Prepared for

Terraprobe

FINAL REPORT

First Page

CLIENT DETAILS		LABORATORY DETAILS	
Client	Terraprobe	Project Specialist	Rob Irwin B.Sc., C.Chem
		Laboratory	SGS Canada Inc.
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Telephone	519-722-7134	Facsimile	705-652-6365
Facsimile	905-796-2250	Email	rob.irwin@sgs.com
Email	malgailani@terraprobe.ca	SGS Reference	CA14604-JUN19
Project	1-18-0615-2	Received	06/14/2019
Order Number		Approved	06/20/2019
Samples	Soil (2)	Report Number	CA14604-JUN19 R
		Date Reported	06/20/2019

COMMENTS

CCME Method Compliance: Analyses were conducted using analytical procedures that comply with the Reference Method for the CWS for Petroleum Hydrocarbons in Soil and have been validated for use at the SGS laboratory, Lakefield, ON site.

Quality Compliance: Instrument performance / calibration quality criteria were met and extraction and analysis limits for holding times were met.
nC6 and nC10 response factors within 30% of response factor for toluene: YES
nC10, nC16 and nC34 response factors within 10% of the average response for the three compounds: YES
C50 response factors within 70% of nC10 + nC16 + nC34 average: YES
Linearity is within 15%: YES

F4G - gravimetric heavy hydrocarbons cannot be added to the C6 to C50 hydrocarbons.
The results for F4 and F4G are both reported and the greater of the two values is to be used in application to the CWS PHC.

Hydrocarbon results are expressed on a dry weight basis.

Temperature of Sample upon Receipt: 8 degrees C
Cooling Agent Present:Yes
Custody Seal Present:No

Chain of Custody Number:007160

SIGNATORIES

Rob Irwin B.Sc., C.Chem

CHARTERED
Robert Irwin
CHEMIST

TABLE OF CONTENTS

PACKAGE: **REG153 - BTEX** (SOIL)

L1 = REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED

L2 = REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED

				Sample Number	11
				Sample Name	BH62/AS2
				Sample Matrix	Soil
				Sample Date	13/06/2019
Parameter	**Units**	**RL**	**L1**	**L2**	**Result**
BTEX					
Benzene	µg/g	0.02	0.02	0.32	< 0.02
Ethylbenzene	µg/g	0.05	0.05	9.5	< 0.05
Toluene	µg/g	0.05	0.2	68	< 0.05
Xylene (total)	µg/g	0.05	0.05	26	< 0.05
m/p-xylene	µg/g	0.05			< 0.05
o-xylene	µg/g	0.05			< 0.05

PACKAGE: **REG153 - Hydrides** (SOIL)

L1 = REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED

L2 = REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED

				Sample Number	10	11
				Sample Name	BH53/AS1	BH62/AS2
				Sample Matrix	Soil	Soil
				Sample Date	13/06/2019	13/06/2019
Parameter	**Units**	**RL**	**L1**	**L2**	**Result**	**Result**
Hydrides						
Antimony	µg/g	0.8	1.3	40	< 0.8	< 0.8
Arsenic	µg/g	0.5	18	18	3.0	4.6
Selenium	µg/g	0.7	1.5	5.5	< 0.7	< 0.7

PACKAGE: **REG153 - Metals and Inorganics** (SOIL)

L1 = REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED

L2 = REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED

				Sample Number	10	11
				Sample Name	BH53/AS1	BH62/AS2
				Sample Matrix	Soil	Soil
				Sample Date	13/06/2019	13/06/2019
Parameter	**Units**	**RL**	**L1**	**L2**	**Result**	**Result**
Metals and Inorganics						
Moisture Content	%	-			5.2	9.8
Barium	µg/g	0.1	220	670	39	67
Beryllium	µg/g	0.02	2.5	8	0.16	0.51
Boron	µg/g	1	36	120	4	8
Cadmium	µg/g	0.02	1.2	1.9	0.07	0.09
Chromium	µg/g	0.5	70	160	6.4	18
Cobalt	µg/g	0.01	21	80	4.1	12
Copper	µg/g	0.1	92	230	20	32
Lead	µg/g	0.1	120	120	6.0	13
Molybdenum	µg/g	0.1	2	40	0.3	0.3
Nickel	µg/g	0.5	82	270	8.3	25
Silver	µg/g	0.05	0.5	40	0.06	0.15
Thallium	µg/g	0.02	1	3.3	0.07	0.14
Uranium	µg/g	0.002	2.5	33	0.29	0.52
Vanadium	µg/g	3	86	86	13	24
Zinc	µg/g	0.7	290	340	28	59
Water Soluble Boron	µg/g	0.5		2	< 0.5	

PACKAGE: **REG153 - Other (ORP)** (SOIL)

Sample Number	10
Sample Name	BH53/AS1
Sample Matrix	Soil
Sample Date	13/06/2019

L1 = REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED

L2 = REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED

Other (ORP)

Parameter	Units	RL	L1	L2	Result
Mercury	µg/g	0.05	0.27	3.9	< 0.05
Sodium Adsorption Ratio	---	0.2	2.4	12	9.0
SAR Calcium	mg/L	0.09			8.2
SAR Magnesium	mg/L	0.02			5.2
SAR Sodium	mg/L	0.15			147
Conductivity	mS/cm	0.002	0.57	1.4	0.89
pH	pH Units	0.05			8.03
Chromium VI	µg/g	0.2	0.66	8	< 0.2
Free Cyanide	µg/g	0.05			< 0.05

PACKAGE: **REG153 - PHCs** (SOIL)

L1 = REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED
L2 = REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED

Sample Number 11
Sample Name BH62/AS2
Sample Matrix Soil
Sample Date 13/06/2019

Parameter	Units	RL	L1	L2	Result
PHCs					
F1 (C6-C10)	µg/g	10	25	55	< 10
F1-BTEX (C6-C10)	µg/g	10			< 10
F2 (C10-C16)	µg/g	10	10	230	< 10
F3 (C16-C34)	µg/g	50	240	1700	< 50
F4 (C34-C50)	µg/g	50	120	3300	< 50
Chromatogram returned to baseline at nC50	Yes / No	-			YES

PACKAGE: **REG153 - THMs (VOC)** (SOIL)

L1 = REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED
L2 = REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED

Sample Number 11
Sample Name BH62/AS2
Sample Matrix Soil
Sample Date 13/06/2019

Parameter	Units	RL	L1	L2	Result
THMs (VOC)					
Bromodichloromethane	µg/g	0.05	0.05	18	< 0.05
Bromoform	µg/g	0.05	0.05	0.61	< 0.05
Dibromochloromethane	µg/g	0.05	0.05	13	< 0.05

PACKAGE: **REG153 - VOC Surrogates** (SOIL)

L1 = REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED

L2 = REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED

Sample Number: 11
Sample Name: BH62/AS2
Sample Matrix: Soil
Sample Date: 13/06/2019

Parameter	Units	RL	L1	L2	Result
VOC Surrogates					
Surr 1,2-Dichloroethane-d4	Surr Rec %	-			102
Surr 4-Bromofluorobenzene	Surr Rec %	-			92
Surr 2-Bromo-1-Chloropropane	Surr Rec %	-			90

PACKAGE: **REG153 - VOCs** (SOIL)

L1 = REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED

L2 = REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED

Sample Number: 11
Sample Name: BH62/AS2
Sample Matrix: Soil
Sample Date: 13/06/2019

Parameter	Units	RL	L1	L2	Result
VOCs					
Acetone	µg/g	0.5	0.5	16	< 0.5
Bromomethane	µg/g	0.05	0.05	0.05	< 0.05
Carbon tetrachloride	µg/g	0.05	0.05	0.21	< 0.05
Chlorobenzene	µg/g	0.05	0.05	2.4	< 0.05
Chloroform	µg/g	0.05	0.05	0.47	< 0.05
1,2-Dichlorobenzene	µg/g	0.05	0.05	6.8	< 0.05
1,3-Dichlorobenzene	µg/g	0.05	0.05	9.6	< 0.05
1,4-Dichlorobenzene	µg/g	0.05	0.05	0.2	< 0.05
Dichlorodifluoromethane	µg/g	0.05	0.05	16	< 0.05
1,1-Dichloroethane	µg/g	0.05	0.05	17	< 0.05
1,2-Dichloroethane	µg/g	0.05	0.05	0.05	< 0.05
1,1-Dichloroethylene	µg/g	0.05	0.05	0.064	< 0.05
trans-1,2-Dichloroethylene	µg/g	0.05	0.05	1.3	< 0.05

PACKAGE: **REG153 - VOCs** (SOIL)

L1 = REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED

L2 = REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED

Sample Number 11
Sample Name BH62/AS2
Sample Matrix Soil
Sample Date 13/06/2019

VOCs (continued)

Parameter	Units	RL	L1	L2	Result
cis-1,2-Dichloroethylene	µg/g	0.05	0.05	55	< 0.05
1,2-Dichloropropane	µg/g	0.05	0.05	0.16	< 0.05
cis-1,3-dichloropropene	µg/g	0.03			< 0.03
trans-1,3-dichloropropene	µg/g	0.03			< 0.03
1,3-dichloropropene (total)	µg/g	0.05	0.05	0.18	< 0.05
Ethylenedibromide	µg/g	0.05	0.05	0.05	< 0.05
n-Hexane	µg/g	0.05	0.05	46	0.05
Methyl ethyl ketone	µg/g	0.5	0.5	70	< 0.5
Methyl isobutyl ketone	µg/g	0.5	0.5	31	< 0.5
Methyl-t-butyl Ether	µg/g	0.05	0.05	11	< 0.05
Methylene Chloride	µg/g	0.05	0.05	1.6	< 0.05
Styrene	µg/g	0.05	0.05	34	< 0.05
Tetrachloroethylene	µg/g	0.05	0.05	4.5	< 0.05
1,1,1,2-Tetrachloroethane	µg/g	0.05	0.05	0.087	< 0.05
1,1,2,2-Tetrachloroethane	µg/g	0.05	0.05	0.05	< 0.05
1,1,1-Trichloroethane	µg/g	0.05	0.05	6.1	< 0.05
1,1,2-Trichloroethane	µg/g	0.05	0.05	0.05	< 0.05
Trichloroethylene	µg/g	0.05	0.05	0.91	**0.24**
Trichlorofluoromethane	µg/g	0.05	0.25	4	< 0.05
Vinyl Chloride	µg/g	0.02	0.02	0.032	< 0.02

EXCEEDANCE SUMMARY

Parameter	Method	Units	Result	REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED L1	REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED L2
BH53/AS1					
Conductivity	EPA 6010/SM 2510	µg/g	0.89	0.57	
Sodium Adsorption Ratio	MOE 4696e01/EPA 6010	µg/g	9.0	2.4	
BH62/AS2					
Trichloroethylene	EPA 5035A/5030B/8260C	µg/g	0.24	0.05	

QC SUMMARY

Conductivity

Method: EPA 6010/SM 2510 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0277-JUN19	mS/cm	0.002	<0.002	0	10	99	90	110	NA		

Cyanide by SFA

Method: SM 4500 | Internal ref.: ME-CA-[ENV]SFA-LAK-AN-005

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Free Cyanide	SKA5050-JUN19	µg/g	0.05	<0.05	ND	20	99	80	120	90	75	125

Hexavalent Chromium by IC

Method: EPA218.6/EPA3060A | Internal ref.: ME-CA-[ENV]IC-LAK-AN-008

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chromium VI	DIO0287-JUN19	µg/g	0.2	<0.2	ND	20	111	80	120	108	75	125

QC SUMMARY

Mercury by CVAAS

Method: EPA 7471A/EPA 245 I Internal ref.: ME-CA-[ENV]SPE-LAK-AN-004

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Mercury	EMS0101-JUN19	µg/g	0.05	<0.05	ND	20	100	80	120	98	70	130

Metals in aqueous samples - ICP-OES

Method: MOE 4696e01/EPA 6010 I Internal ref.: ME-CA-[ENV]SPE-LAK-AN-003

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
SAR Calcium	ESG0047-JUN19	mg/L	0.09	<0.09	1	20	98	80	120	101	70	130
SAR Magnesium	ESG0047-JUN19	mg/L	0.02	<0.02	ND	20	97	80	120	103	70	130
SAR Sodium	ESG0047-JUN19	mg/L	0.15	<0.15	ND	20	96	80	120	100	70	130

FINAL REPORT

QC SUMMARY

Metals in Soil - Aqua-regia/ICP-MS

Method: EPA 3050/EPA 200.8 | Internal ref.: ME-CA-[ENV]SPE-LAK-AN-005

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Silver	EMS0101-JUN19	ug/g	0.05	<0.05	ND	20	94	70	130	98	70	130
Arsenic	EMS0101-JUN19	μg/g	0.5	<0.5	2	20	100	70	130	108	70	130
Barium	EMS0101-JUN19	ug/g	0.1	<0.1	7	20	103	70	130	98	70	130
Beryllium	EMS0101-JUN19	μg/g	0.02	<0.02	0	20	96	70	130	93	70	130
Boron	EMS0101-JUN19	μg/g	1	<1	ND	20	104	70	130	97	70	130
Cadmium	EMS0101-JUN19	μg/g	0.02	<0.02	6	20	99	70	130	109	70	130
Cobalt	EMS0101-JUN19	μg/g	0.01	<0.01	0	20	102	70	130	111	70	130
Chromium	EMS0101-JUN19	μg/g	0.5	<0.5	3	20	101	70	130	111	70	130
Copper	EMS0101-JUN19	μg/g	0.1	<0.1	2	20	103	70	130	106	70	130
Molybdenum	EMS0101-JUN19	μg/g	0.1	<0.1	1	20	94	70	130	107	70	130
Nickel	EMS0101-JUN19	ug/g	0.5	<0.5	2	20	103	70	130	111	70	130
Lead	EMS0101-JUN19	ug/g	0.1	<0.1	6	20	99	70	130	99	70	130
Antimony	EMS0101-JUN19	μg/g	0.8	<0.8	ND	20	99	70	130	113	70	130
Selenium	EMS0101-JUN19	μg/g	0.7	<0.7	ND	20	98	70	130	89	70	130
Thallium	EMS0101-JUN19	μg/g	0.02	<0.02	ND	20	99	70	130	105	70	130
Uranium	EMS0101-JUN19	μg/g	0.002	<0.002	6	20	95	70	130	94	70	130
Vanadium	EMS0101-JUN19	μg/g	3	<3	1	20	105	70	130	114	70	130
Zinc	EMS0101-JUN19	μg/g	0.7	<0.7	2	20	105	70	130	111	70	130

QC SUMMARY

Petroleum Hydrocarbons (F1)

Method: CCME Tier 1 | Internal ref.: ME-CA-[ENV]GC-LAK-AN-010

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
F1 (C6-C10)	GCM0310-JUN19	µg/g	10	<10	ND	30	106	80	120	108	60	140

Petroleum Hydrocarbons (F2-F4)

Method: CCME Tier 1 | Internal ref.: ME-CA-[ENV]GC-LAK-AN-010

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
F2 (C10-C16)	GCM0316-JUN19	µg/g	10	<10	ND	30	102	80	120	107	60	140
F3 (C16-C34)	GCM0316-JUN19	µg/g	50	<50	ND	30	102	80	120	107	60	140
F4 (C34-C50)	GCM0316-JUN19	µg/g	50	<50	ND	30	102	80	120	107	60	140

QC SUMMARY

pH

Method: SM 4500 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	ARD0058-JUN19	pH Units	0.05		0	20	100	80	120			

QC SUMMARY

Volatile Organics

Method: EPA 5035A/5030B/8260C | Internal ref.: ME-CA-[ENV]GC-LAK-AN-004

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
1,1,1,2-Tetrachloroethane	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	92	60	130	88	50	140
1,1,1-Trichloroethane	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	85	60	130	81	50	140
1,1,2,2-Tetrachloroethane	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	93	60	130	84	50	140
1,1,2-Trichloroethane	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	91	60	130	86	50	140
1,1-Dichloroethane	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	83	60	130	78	50	140
1,1-Dichloroethylene	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	86	60	130	81	50	140
1,2-Dichlorobenzene	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	92	60	130	87	50	140
1,2-Dichloroethane	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	89	60	130	85	50	140
1,2-Dichloropropane	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	90	60	130	85	50	140
1,3-Dichlorobenzene	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	92	60	130	88	50	140
1,4-Dichlorobenzene	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	92	60	130	87	50	140
Acetone	GCM0309-JUN19	µg/g	0.5	< 0.5	ND	50	91	50	140	80	50	140
Benzene	GCM0309-JUN19	µg/g	0.02	< 0.02	ND	50	89	60	130	86	50	140
Bromodichloromethane	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	90	60	130	86	50	140
Bromoform	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	90	60	130	85	50	140
Bromomethane	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	77	50	140	76	50	140
Carbon tetrachloride	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	88	60	130	85	50	140
Chlorobenzene	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	90	60	130	87	50	140
Chloroform	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	90	60	130	87	50	140
cis-1,2-Dichloroethylene	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	89	60	130	85	50	140

QC SUMMARY

Volatile Organics (continued)

Method: EPA 5035A/5030B/8260C | Internal ref.: ME-CA-[ENV]GC-LAK-AN-004

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
cis-1,3-dichloropropene	GCM0309-JUN19	µg/g	0.03	< 0.03	ND	50	91	60	130	81	50	140
Dibromochloromethane	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	91	60	130	87	50	140
Dichlorodifluoromethane	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	66	50	140	61	50	140
Ethylbenzene	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	90	60	130	87	50	140
Ethylenedibromide	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	92	60	130	87	50	140
n-Hexane	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	91	60	130	77	50	140
m/p-xylene	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	90	60	130	86	50	140
Methyl ethyl ketone	GCM0309-JUN19	µg/g	0.5	< 0.5	ND	50	94	50	140	82	50	140
Methyl isobutyl ketone	GCM0309-JUN19	µg/g	0.5	< 0.5	ND	50	96	50	140	88	50	140
Methyl-t-butyl Ether	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	94	60	130	90	50	140
Methylene Chloride	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	87	60	130	83	50	140
o-xylene	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	91	60	130	88	50	140
Styrene	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	91	60	130	88	50	140
Tetrachloroethylene	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	89	60	130	83	50	140
Toluene	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	90	60	130	87	50	140
trans-1,2-Dichloroethylene	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	83	60	130	79	50	140
trans-1,3-dichloropropene	GCM0309-JUN19	µg/g	0.03	< 0.03	ND	50	90	60	130	81	50	140
Trichloroethylene	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	89	60	130	86	50	140
Trichlorofluoromethane	GCM0309-JUN19	µg/g	0.05	< 0.05	ND	50	84	50	140	74	50	140
Vinyl Chloride	GCM0309-JUN19	µg/g	0.02	< 0.02	ND	50	79	50	140	82	50	140

QC SUMMARY

Water Soluble Boron

Method: O.Reg. 153/04 | Internal ref.: ME-CA-[ENV] SPE-LAK-AN-003

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Water Soluble Boron	ESG0050-JUN19	µg/g	0.5	<0.5	ND	20	101	80	120	99	70	130

Method Blank: a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

Duplicate: Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

LCS/Spike Blank: Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

Reference Material: a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

Multielement Scan Qualifier: as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

Duplicate Qualifier: for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Matrix Spike Qualifier: for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

LEGEND

FOOTNOTES

NSS	Insufficient sample for analysis.
RL	Reporting Limit.
↑	Reporting limit raised.
↓	Reporting limit lowered.
NA	The sample was not analysed for this analyte
ND	Non Detect

Samples analysed as received. Solid samples expressed on a dry weight basis. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act" published by the Ministry and dated March 9, 2004 as amended.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated. This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at http://www.sgs.com/terms_and_conditions.htm. The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

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-- End of Analytical Report --

FINAL REPORT

CA14440-JUN19 R

1-18-0615-2, Mississauga

Prepared for

Terraprobe

FINAL REPORT

First Page

CLIENT DETAILS

Client	Terraprobe
Address	11 Indell Lane Brampton, Ontario L6T 3Y3. Canada
Contact	Mariam Al Gailani
Telephone	519-722-7134
Facsimile	905-796-2250
Email	malgailani@terraprobe.ca
Project	1-18-0615-2, Mississauga
Order Number	
Samples	Soil (4)

LABORATORY DETAILS

Project Specialist	Brad Moore Hon. B.Sc
Laboratory	SGS Canada Inc.
Address	185 Concession St., Lakefield ON, K0L 2H0
Telephone	705-652-2143
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SGS Reference	CA14440-JUN19
Received	06/10/2019
Approved	06/14/2019
Report Number	CA14440-JUN19 R
Date Reported	06/14/2019

COMMENTS

CCME Method Compliance: Analyses were conducted using analytical procedures that comply with the Reference Method for the CWS for Petroleum Hydrocarbons in Soil and have been validated for use at the SGS laboratory, Lakefield, ON site.

Quality Compliance: Instrument performance / calibration quality criteria were met and extraction and analysis limits for holding times were met.
nC6 and nC10 response factors within 30% of response factor for toluene: YES
nC10, nC16 and nC34 response factors within 10% of the average response for the three compounds: YES
C50 response factors within 70% of nC10 + nC16 + nC34 average: YES
Linearity is within 15%: YES

F4G - gravimetric heavy hydrocarbons cannot be added to the C6 to C50 hydrocarbons.
The results for F4 and F4G are both reported and the greater of the two values is to be used in application to the CWS PHC.

Hydrocarbon results are expressed on a dry weight basis.

Temperature of Sample upon Receipt: 7 degrees C
Cooling Agent Present:Yes
Custody Seal Present:No

Chain of Custody Number:007159

SIGNATORIES

Brad Moore Hon. B.Sc

TABLE OF CONTENTS

PACKAGE: **REG153 - BTEX** (SOIL)

L1 = REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED

L2 = REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED

				Sample Number	10	11	12	13
				Sample Name	BH40/AS1	BH24/AS1	BH15/AS1	BH18/AS1
				Sample Matrix	Soil	Soil	Soil	Soil
				Sample Date	04/06/2019	05/06/2019	07/06/2019	07/06/2019
Parameter	**Units**	**RL**	**L1**	**L2**	**Result**	**Result**	**Result**	**Result**
BTEX								
Benzene	µg/g	0.02	0.02	0.32	< 0.02	< 0.02	< 0.02	< 0.02
Ethylbenzene	µg/g	0.05	0.05	9.5	< 0.05	< 0.05	< 0.05	< 0.05
Toluene	µg/g	0.05	0.2	68	< 0.05	< 0.05	< 0.05	< 0.05
Xylene (total)	µg/g	0.05	0.05	26	< 0.05	< 0.05	< 0.05	< 0.05
m/p-xylene	µg/g	0.05			< 0.05	< 0.05	< 0.05	< 0.05
o-xylene	µg/g	0.05			< 0.05	< 0.05	< 0.05	< 0.05

PACKAGE: **REG153 - Metals and Inorganics** (SOIL)

L1 = REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED

L2 = REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED

				Sample Number	10	11	12	13
				Sample Name	BH40/AS1	BH24/AS1	BH15/AS1	BH18/AS1
				Sample Matrix	Soil	Soil	Soil	Soil
				Sample Date	04/06/2019	05/06/2019	07/06/2019	07/06/2019
Parameter	**Units**	**RL**	**L1**	**L2**	**Result**	**Result**	**Result**	**Result**
Metals and Inorganics								
Moisture Content	%	-			6.0	8.4	16.5	3.4

PACKAGE: **REG153 - PHCs** (SOIL)

L1 = REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED

L2 = REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED

				Sample Number	10	11	12	13
				Sample Name	BH40/AS1	BH24/AS1	BH15/AS1	BH18/AS1
				Sample Matrix	Soil	Soil	Soil	Soil
				Sample Date	04/06/2019	05/06/2019	07/06/2019	07/06/2019
Parameter	**Units**	**RL**	**L1**	**L2**	**Result**	**Result**	**Result**	**Result**
PHCs								
F1 (C6-C10)	µg/g	10	25	55	< 10	< 10	< 10	< 10
F1-BTEX (C6-C10)	µg/g	10			< 10	< 10	< 10	< 10
F2 (C10-C16)	µg/g	10	10	230	< 10	< 10	< 10	< 10
F3 (C16-C34)	µg/g	50	240	1700	189	< 50	56	< 50
F4 (C34-C50)	µg/g	50	120	3300	401	< 50	< 50	78
F4G-sg (GHH)	µg/g	200	120	3300	1120			
Chromatogram returned to baseline at nC50	Yes / No	-			NO	YES	YES	YES

PACKAGE: **REG153 - THMs (VOC)** (SOIL)

L1 = REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED

L2 = REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED

				Sample Number	10	11	12	13
				Sample Name	BH40/AS1	BH24/AS1	BH15/AS1	BH18/AS1
				Sample Matrix	Soil	Soil	Soil	Soil
				Sample Date	04/06/2019	05/06/2019	07/06/2019	07/06/2019
Parameter	**Units**	**RL**	**L1**	**L2**	**Result**	**Result**	**Result**	**Result**
THMs (VOC)								
Bromodichloromethane	µg/g	0.05	0.05	18	< 0.05	< 0.05	< 0.05	< 0.05
Bromoform	µg/g	0.05	0.05	0.61	< 0.05	< 0.05	< 0.05	< 0.05
Dibromochloromethane	µg/g	0.05	0.05	13	< 0.05	< 0.05	< 0.05	< 0.05

PACKAGE: **REG153 - VOC Surrogates** (SOIL)

L1 = REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED

L2 = REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED

				Sample Number	10	11	12	13
				Sample Name	BH40/AS1	BH24/AS1	BH15/AS1	BH18/AS1
				Sample Matrix	Soil	Soil	Soil	Soil
				Sample Date	04/06/2019	05/06/2019	07/06/2019	07/06/2019
Parameter	**Units**	**RL**	**L1**	**L2**	**Result**	**Result**	**Result**	**Result**
VOC Surrogates								
Surr 1,2-Dichloroethane-d4	Surr Rec %	-			102	100	100	102
Surr 4-Bromofluorobenzene	Surr Rec %	-			90	90	89	89
Surr 2-Bromo-1-Chloropropane	Surr Rec %	-			87	92	86	87

PACKAGE: **REG153 - VOCs** (SOIL)

L1 = REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED

L2 = REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED

				Sample Number	10	11	12	13
				Sample Name	BH40/AS1	BH24/AS1	BH15/AS1	BH18/AS1
				Sample Matrix	Soil	Soil	Soil	Soil
				Sample Date	04/06/2019	05/06/2019	07/06/2019	07/06/2019
Parameter	**Units**	**RL**	**L1**	**L2**	**Result**	**Result**	**Result**	**Result**
VOCs								
Acetone	μg/g	0.5	0.5	16	< 0.5	< 0.5	< 0.5	< 0.5
Bromomethane	μg/g	0.05	0.05	0.05	< 0.05	< 0.05	< 0.05	< 0.05
Carbon tetrachloride	μg/g	0.05	0.05	0.21	< 0.05	< 0.05	< 0.05	< 0.05
Chlorobenzene	μg/g	0.05	0.05	2.4	< 0.05	< 0.05	< 0.05	< 0.05
Chloroform	μg/g	0.05	0.05	0.47	< 0.05	< 0.05	< 0.05	< 0.05
1,2-Dichlorobenzene	μg/g	0.05	0.05	6.8	< 0.05	< 0.05	< 0.05	< 0.05
1,3-Dichlorobenzene	μg/g	0.05	0.05	9.6	< 0.05	< 0.05	< 0.05	< 0.05
1,4-Dichlorobenzene	μg/g	0.05	0.05	0.2	< 0.05	< 0.05	< 0.05	< 0.05
Dichlorodifluoromethane	μg/g	0.05	0.05	16	< 0.05	< 0.05	< 0.05	< 0.05
1,1-Dichloroethane	μg/g	0.05	0.05	17	< 0.05	< 0.05	< 0.05	< 0.05
1,2-Dichloroethane	μg/g	0.05	0.05	0.05	< 0.05	< 0.05	< 0.05	< 0.05
1,1-Dichloroethylene	μg/g	0.05	0.05	0.064	< 0.05	< 0.05	< 0.05	< 0.05
trans-1,2-Dichloroethylene	μg/g	0.05	0.05	1.3	< 0.05	< 0.05	< 0.05	< 0.05

FINAL REPORT

CA14440-JUN19 R

Client: Terraprobe

Project: 1-18-0615-2, Mississauga

Project Manager: Mariam Al Gailani

Samplers: Mariam Al Gailani

PACKAGE: **REG153 - VOCs** (SOIL)

L1 = REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED

L2 = REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED

				Sample Number	10	11	12	13
				Sample Name	BH40/AS1	BH24/AS1	BH15/AS1	BH18/AS1
				Sample Matrix	Soil	Soil	Soil	Soil
				Sample Date	04/06/2019	05/06/2019	07/06/2019	07/06/2019
Parameter	**Units**	**RL**	**L1**	**L2**	**Result**	**Result**	**Result**	**Result**
VOCs (continued)								
cis-1,2-Dichloroethylene	µg/g	0.05	0.05	55	< 0.05	< 0.05	< 0.05	< 0.05
1,2-Dichloropropane	µg/g	0.05	0.05	0.16	< 0.05	< 0.05	< 0.05	< 0.05
cis-1,3-dichloropropene	µg/g	0.03			< 0.03	< 0.03	< 0.03	< 0.03
trans-1,3-dichloropropene	µg/g	0.03			< 0.03	< 0.03	< 0.03	< 0.03
1,3-dichloropropene (total)	µg/g	0.05	0.05	0.18	< 0.05	< 0.05	< 0.05	< 0.05
Ethylenedibromide	µg/g	0.05	0.05	0.05	< 0.05	< 0.05	< 0.05	< 0.05
n-Hexane	µg/g	0.05	0.05	46	< 0.05	< 0.05	< 0.05	**0.08**
Methyl ethyl ketone	µg/g	0.5	0.5	70	< 0.5	< 0.5	< 0.5	< 0.5
Methyl isobutyl ketone	µg/g	0.5	0.5	31	< 0.5	< 0.5	< 0.5	< 0.5
Methyl-t-butyl Ether	µg/g	0.05	0.05	11	< 0.05	< 0.05	< 0.05	< 0.05
Methylene Chloride	µg/g	0.05	0.05	1.6	< 0.05	< 0.05	< 0.05	< 0.05
Styrene	µg/g	0.05	0.05	34	< 0.05	< 0.05	< 0.05	< 0.05
Tetrachloroethylene	µg/g	0.05	0.05	4.5	< 0.05	< 0.05	< 0.05	< 0.05
1,1,1,2-Tetrachloroethane	µg/g	0.05	0.05	0.087	< 0.05	< 0.05	< 0.05	< 0.05
1,1,2,2-Tetrachloroethane	µg/g	0.05	0.05	0.05	< 0.05	< 0.05	< 0.05	< 0.05
1,1,1-Trichloroethane	µg/g	0.05	0.05	6.1	< 0.05	< 0.05	< 0.05	< 0.05
1,1,2-Trichloroethane	µg/g	0.05	0.05	0.05	< 0.05	< 0.05	< 0.05	< 0.05
Trichloroethylene	µg/g	0.05	0.05	0.91	**0.17**	**0.17**	**0.16**	**0.58**
Trichlorofluoromethane	µg/g	0.05	0.25	4	< 0.05	< 0.05	< 0.05	< 0.05
Vinyl Chloride	µg/g	0.02	0.02	0.032	< 0.02	< 0.02	< 0.02	< 0.02

EXCEEDANCE SUMMARY

Parameter	Method	Units	Result	REG153 / SOIL / COARSE - TABLE 1 - Residential/Parkland/Industrial - UNDEFINED L1	REG153 / SOIL / COARSE - TABLE 3 - Industrial/Commercial - UNDEFINED L2

BH40/AS1

F4 (C34 to C50)	CCME Tier 1	µg/g	401	120	
Gravimetric Heavy Hydrocarbons	CCME Tier 1	µg/g	1120	120	
Trichloroethylene	EPA 5035A/5030B/8260C	µg/g	0.17	0.05	

BH24/AS1

Trichloroethylene	EPA 5035A/5030B/8260C	µg/g	0.17	0.05	

BH15/AS1

Trichloroethylene	EPA 5035A/5030B/8260C	µg/g	0.16	0.05	

BH18/AS1

n-Hexane	EPA 5035A/5030B/8260C	µg/g	0.08	0.05	
Trichloroethylene	EPA 5035A/5030B/8260C	µg/g	0.58	0.05	

QC SUMMARY

Petroleum Hydrocarbons (F1)

Method: CCME Tier 1 | Internal ref.: ME-CA-[ENV]GC-LAK-AN-010

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
F1 (C6-C10)	GCM0196-JUN19	µg/g	10	<10	ND	30	93	80	120	106	60	140

Petroleum Hydrocarbons (F2-F4)

Method: CCME Tier 1 | Internal ref.: ME-CA-[ENV]GC-LAK-AN-010

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
F2 (C10-C16)	GCM0203-JUN19	µg/g	10	<10	ND	30	114	80	120	111	60	140
F3 (C16-C34)	GCM0203-JUN19	µg/g	50	<50	ND	30	114	80	120	111	60	140
F4 (C34-C50)	GCM0203-JUN19	µg/g	50	<50	ND	30	114	80	120	111	60	140

QC SUMMARY

Petroleum Hydrocarbons (F4G)

Method: CCME Tier 1 I Internal ref.: ME-CA-[ENV]GC-LAK-AN-010

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
F4G-sg (GHH)	GCM0272-JUN19	µg/g	200	<200	NA	30	101	80	120	NA	60	140

FINAL REPORT

QC SUMMARY

Volatile Organics

Method: EPA 5035A/5030B/8260C | Internal ref.: ME-CA-[ENV]GC-LAK-AN-004

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%) Low	High	Spike Recovery (%)	Recovery Limits (%) Low	High
1,1,1,2-Tetrachloroethane	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	83	60	130	88	50	140
1,1,1-Trichloroethane	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	79	60	130	84	50	140
1,1,2,2-Tetrachloroethane	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	80	60	130	86	50	140
1,1,2-Trichloroethane	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	80	60	130	87	50	140
1,1-Dichloroethane	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	77	60	130	82	50	140
1,1-Dichloroethylene	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	80	60	130	86	50	140
1,2-Dichlorobenzene	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	83	60	130	88	50	140
1,2-Dichloroethane	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	80	60	130	87	50	140
1,2-Dichloropropane	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	82	60	130	89	50	140
1,3-Dichlorobenzene	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	83	60	130	89	50	140
1,4-Dichlorobenzene	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	84	60	130	88	50	140
Acetone	GCM0195-JUN19	µg/g	0.5	< 0.5	ND	50	79	50	140	86	50	140
Benzene	GCM0195-JUN19	µg/g	0.02	< 0.02	ND	50	83	60	130	90	50	140
Bromodichloromethane	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	82	60	130	88	50	140
Bromoform	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	78	60	130	82	50	140
Bromomethane	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	83	50	140	79	50	140
Carbon tetrachloride	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	83	60	130	87	50	140
Chlorobenzene	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	83	60	130	90	50	140
Chloroform	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	83	60	130	89	50	140
cis-1,2-Dichloroethylene	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	83	60	130	89	50	140

FINAL REPORT

QC SUMMARY

Volatile Organics (continued)

Method: EPA 5035A/5030B/8260C | Internal ref.: ME-CA-[ENV]GC-LAK-AN-004

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
cis-1,3-dichloropropene	GCM0195-JUN19	µg/g	0.03	< 0.03	ND	50	81	60	130	81	50	140
Dibromochloromethane	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	80	60	130	85	50	140
Dichlorodifluoromethane	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	62	50	140	60	50	140
Ethylbenzene	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	84	60	130	90	50	140
Ethylenedibromide	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	81	60	130	87	50	140
n-Hexane	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	83	60	130	76	50	140
m/p-xylene	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	83	60	130	88	50	140
Methyl ethyl ketone	GCM0195-JUN19	µg/g	0.5	< 0.5	ND	50	80	50	140	84	50	140
Methyl isobutyl ketone	GCM0195-JUN19	µg/g	0.5	< 0.5	ND	50	80	50	140	84	50	140
Methyl-t-butyl Ether	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	84	60	130	86	50	140
Methylene Chloride	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	80	60	130	86	50	140
o-xylene	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	84	60	130	90	50	140
Styrene	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	83	60	130	90	50	140
Tetrachloroethylene	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	82	60	130	87	50	140
Toluene	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	83	60	130	88	50	140
trans-1,2-Dichloroethylene	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	78	60	130	83	50	140
trans-1,3-dichloropropene	GCM0195-JUN19	µg/g	0.03	< 0.03	ND	50	77	60	130	76	50	140
Trichloroethylene	GCM0195-JUN19	µg/g	0.05	< 0.05	5	50	83	60	130	67	50	140
Trichlorofluoromethane	GCM0195-JUN19	µg/g	0.05	< 0.05	ND	50	78	50	140	83	50	140
Vinyl Chloride	GCM0195-JUN19	µg/g	0.02	< 0.02	ND	50	75	50	140	79	50	140

QC SUMMARY

Method Blank: a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

Duplicate: Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

LCS/Spike Blank: Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

Reference Material: a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

Multielement Scan Qualifier: as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

Duplicate Qualifier: for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Matrix Spike Qualifier: for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

LEGEND

FOOTNOTES

NSS	Insufficient sample for analysis.
RL	Reporting Limit.
↑	Reporting limit raised.
↓	Reporting limit lowered.
NA	The sample was not analysed for this analyte
ND	Non Detect

Samples analysed as received. Solid samples expressed on a dry weight basis. “Temperature Upon Receipt” is representative of the whole shipment and may not reflect the temperature of individual samples.

Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act” published by the Ministry and dated March 9, 2004 as amended.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated. This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at http://www.sgs.com/terms_and_conditions.htm. The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

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-- End of Analytical Report --

CERTIFICATE OF ANALYSIS

Company: SGS Lakefield Research Ltd.
Contact: Mr. Brad Moore
Client Address: 185 Concession Street, PO Box 4300, Lakefield, ON
Client Reference: CA60010-MAR20
Sampling Date:

Report Date: 17-Mar-20
Analysis Date: 17-Mar-20
Received Date: 16-Mar-20
LEX Project Number: 08200471
Number of Analyses: 3

Analysis Requested Bulk Asbestos by PLM

Analysis was performed in accordance with the method EPA/600/R-93/116, Method for the Determination of Asbestos in Bulk Building Materials adopted in Designated Substance - Asbestos on Construction Projects and in Buildings and Repair Operations - made under the Occupational Health and Safety Act Ontario Regulation 278/05. LEX Scientific Inc. is accredited by the National Voluntary Laboratory Accreditation Program (NVLAP 101949) by the National Institute of Standards and Technology for analysis of bulk materials for asbestos.

German Leal, B.Sc.
Laboratory Manager

		Fibrous Asbestos Content %		**Other Materials Content %**	
Client Sample:	STA 11+600 NBL, L2	**Asbestos Detected?**	**No**		
LEX Sample:	01	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Asphalt	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Black/Grey	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Bottom Layer (50-80)	**Other Amphiboles:**	None Detected	**Non-Fibrous:**	100
		Comments:	N/A		

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst

		Fibrous Asbestos Content %		Other Materials Content %	
Client Sample:	STA 13+080 SBL, L1	**Asbestos Detected?**	**No**		
LEX Sample:	02	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Asphalt	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Black/Grey	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Middle Layer (70-180)	**Other Amphiboles:**	None Detected	**Non-Fibrous:**	100
		Comments:	N/A		
Client Sample:	STA 15+360 NBL, L1	**Asbestos Detected?**	**No**		
LEX Sample:	03	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Asphalt	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Black/Grey	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Middle Layer (40-200)	**Other Amphiboles:**	None Detected	**Non-Fibrous:**	100
		Comments:	N/A		

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst

APPENDIX D

Falling Weight Deflectometer Testing Results

Falling Weight Deflectometer Testing – Cawthra Road from South Service Road to Eastgate Parkway, Mississauga, Ontario

Prepared For:

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Project Number:

ET19-1111A

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Date Submitted:
August 6, 2019

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Appendix A:	Normalized FWD Deflection Data and Effective Structural Number
Appendix B:	Backcalculated Pavement Layer Moduli
Appendix C:	Calibration Certificate – FWD Machine

Property and Confidentiality

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Test results mentioned herein are only valid for the road referenced in this report. The factual data, interpretations and any recommendations contained in this report pertain to a specific project, as described in the report and are not applicable to any other project or location.

Executive Summary

Engtec Consulting Inc. (Engtec) conducted Falling Weight Deflectometer (FWD) testing on Cawthra Road from South Service Road to Eastgate Parkway, Mississauga, Ontario. The road has two (2) lanes in each travel direction and the approximate length of the road is about 5.435km. This project was undertaken at the request of Ms. Sepideh D-Monfared, Project Manager, Terraprobe Inc.

The non-destructive testing/evaluation on this project consisted of the following elements:

- In-situ FWD testing at approximately 100m intervals on each travel direction, as requested by the Project Manager;
- Recording ambient air and asphalt surface temperatures during the field testing;
- Deflection Normalization to 40kN load and 25°C temperature for deflection basin assessment;
- In-Situ Subgrade Resilient Modulus assessment using back-calculation procedures; and
- Backcalculation of asphalt, concrete and granular layer moduli and effective structural number.

1 Introduction

Engtec Consulting Inc. (Engtec) was retained by Terraprobe Inc. to undertake Falling Weight Deflectometer (FWD) testing on Cawthra Road from South Service Road to Eastgate Parkway, Mississauga, Ontario. The road has two (2) lanes in each travel direction and the length is approximately 5.435km. The pavement sections tested and evaluated under this project are listed in Table 1 below.

Table 1: Tested Pavement Sections and Lengths.

Sec. #	Section	Station	Length, m
1	Northbound Driving Lane (NBDL)	10+000 – 15+435	5435.0
2	Northbound Passing Lane (NBPL)		
3	Southbound Driving Lane (SBDL)		
4	Southbound Passing Lane (SBPL)		

The project employed the use of Engtec's Falling Weight Deflectometer (FWD) to perform field testing at approximately 100m intervals in each travel direction. For this project, the dynamic load applied using the FWD was kept between 30kN to 85kN (standard for major road pavements) range, as per standard industry practices and MTO protocols outlined in the Publication 053 by Materials and Research Office (MERO-053). The deflection profile recorded by the FWD equipment was then normalized to 40kN at 25°C temperature, as per the industry protocols outlined in the above-mentioned references.

The average pavement structure of the pavement sections was provided by the Terraprobe Inc. to Engtec and was used for detailed data analysis on this project. The data analysis protocol adopted for this project included the backcalculation of the in-situ Subgrade Resilient Modulus (M_R), Granular, Concrete and Asphalt Layer Moduli. In addition, industry standardized analysis that included Normalized Deflection analysis consisting of determination/assessment of center plate deflection (d_0), deflection ration (d_0/d_{200}) and areas of deflection basin (A) were also determined.

2 Project Methodology

Engtec undertook FWD testing on the subject pavement sections in the night of June 20th, 2019 in order to backcalculate the pavement layer moduli. The objective of this testing was to provide the structural assessment for different pavement layers for each pavement section. Compilation of data collected from the field investigation and the backcalculation results are presented in this report for information purposes.

To achieve this objective, Engtec has performed the following tasks:

1. In-situ FWD testing at approximately 100m intervals on each travel direction;
2. Recording ambient air and asphalt surface temperatures during the field testing;
3. Deflection Normalization to 40kN load and 25°C temperature for deflection basin assessment;
4. In-Situ Subgrade Resilient Modulus assessment using backcalculation procedures; and

5. Backcalculation of Concrete, Asphalt and Granular Layer Moduli.

3 Evaluated Roadway

A total of one hundred seventeen (117) FWD test points were conducted in the field on the various pavement sections. The pavement sections and the number of FWD tests for each section are summarized in Table 2 below.

Terraprobe conducted a borehole (BH) investigation on the roads and provided Engtec with the summary of average pavement layer thicknesses. Based on the pavement average layer thicknesses and structure composition, the road was divided into four section for the analysis purpose. Table 2 shows the average of the pavement layer thicknesses for each pavement sections. It should be noted that the average pavement layer thicknesses for each pavement section used in the analysis are based upon the borehole information provided to Engtec.

Table 2: Number of FWD Tests and Layer Thicknesses from the Boreholes (BHs) for each Pavement Section

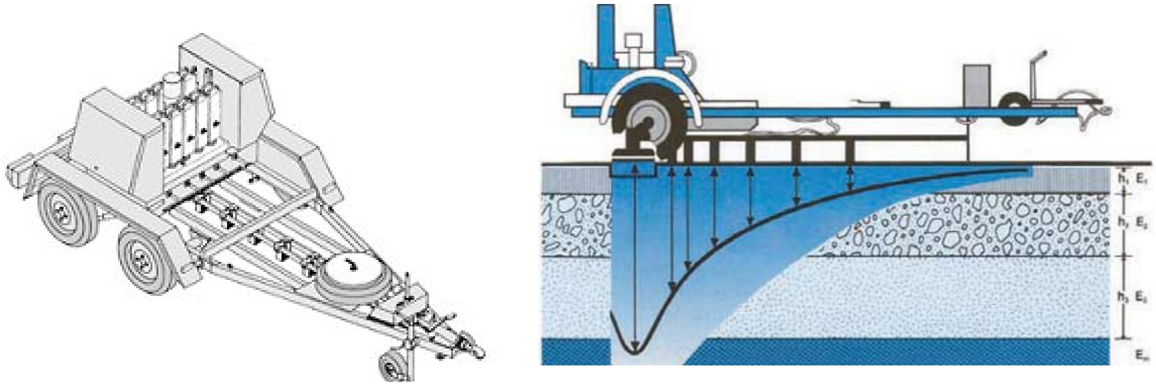
Sec. #	Pavement Section	Station	No. of FWD Tests	Average Thicknesses, mm			
				Asphalt	Concrete	Granular	Total
1	South Service Rd. to 200m North of Silver Creek Blvd (All Lanes)	10+000 to 12+750	61	105	200	300	605
2	200 m North of Silver Creek to Burnhamthorpe Rd (All Lanes)	12+750 To 14+300	32	175	–	405	580
3	Burnhamthorpe Rd to Meadows Blvd (All Lanes)	14+300 To 15+100	16	140	–	460	600
4	Meadows Blvd to Eastgate Parkway (All Lanes)	15+100 to 15+400	8	300	–	375	675

4 Falling Weight Deflectometer (FWD) Testing and Analysis

A program of FWD load/deflection testing was completed in the night of June 20th, 2019 by Engtec to assess the structural condition of Cawthra Road from South Service Road to Eastgate Parkway. The testing device used by Engtec is a Dynatest 8082 Heavy Weight Deflectometer calibrated in May 1st, 2018 by Dynatest North America.

At each test location, six (6) load levels (ranging between 30kN to 85kN), were used to determine the deflection response of the existing pavement structure. For the reader's information, the 40kN load level simulates the wheel load of a standard heavy truck (80kN single axle load). The FWD data was analyzed using the FWD Area computer analysis program for backcalculation of subgrade M_R and deflection normalization works accordingly. The asphalt and granular layers moduli were backcalculated using ELMOD 6 Software developed by Dynatest.

The measured FWD dynamic deflections were normalized to represent the equivalent deflections for a design wheel load of 40kN and asphalt concrete temperature of 25°C. The Strategic Highways Research Program (SHRP) specifies the locations of the sensors, and the minimum number of loading drops that are to be applied to a pavement section, so that the standard deviation and variance in the backcalculated results can be ascertained. The sensor spacing was set as per standard protocols as 0mm, 200mm, 300mm, 450mm, 600mm, 900mm, 1200mm, 1500mm and 1800mm (which are in accordance with the SHRP specifications and MERO-019 requirements) [1,2].



a. FWD Device **b. FWD Mechanics**

c - Falling Weight Deflectometer Testing (Load Cells and Geophones)

Figure 1: Falling Weight Deflectometer Device, Mechanics and Testing

The FWD applies an impact load to the pavement surface, and measures the surface deformation (deflection basin), using seven geophones. This data is recorded by the data acquisition system, and then used to backcalculate the material properties of individual layers, if the thicknesses of the pavement layers are known. This process can also be performed vice-versa in order to determine the layer thicknesses, if the material properties are known.

It is also important to determine the surface, sub-surface and ambient air temperatures at the time of the testing, because it is critical to conduct the backcalculation for flexible pavement with hot-mix asphalt surface which has high thermal susceptibility. For the project specified testing plan, the ambient air temperatures and the pavement surface temperatures were detected on site using the thermal gun attached to the data acquisition system. These temperatures are further used to calculate the asphalt layer temperature for any analysis contained in this report.

Once the FWD data for various pavement sections was obtained, a normalized deflection and deflection ratio coupled with the area of deflection basin analysis was performed.

4.1 Normalization of Deflection Data

The data collected from the pavement sections using the FWD is stored in Microsoft® Access and ASCII file format. Normalization of the FWD data to 40kN applied load at 25°C temperature was performed using FWD Area Software to estimate the structural capacity of the existing pavement. The deflection basin profile and individual deflections approximate the existing condition of the pavement that is being tested using the FWD machine. The criteria that are widely used in the industry and employed in this study are as follows:

- d_0: Centre Plate Deflection (primarily measures the subgrade strength and the pavement stiffness);
- d_0/d_{200}: Ratio of Centre Plate Deflection to Sensor Deflection at 200mm from the Centre Plate. The ratio of d_0/d_{200} indicates the strength of the subgrade relative to the overlying pavement structure, as d_0/d_{200} increases, the horizontal tensile forces in the pavement structure layer(s) increases. For given asphalt layer conditions, d_0/d_{200} is a measure of asphalt strain and the potential for material fracture of cracking to occur.
- Normalized Area: Area of the Deflection Basin (overall ability of the pavement to effectively distribute vehicular loading).

The details of this analysis are attached in Appendix A Tables 1-A through 4-A. Summary of the results presented in Appendix A for normalized deflection are shown in Table 3.

4.2 Backcalculation Analysis

Once the deflection profile was obtained for each drop, the backcalculated of independent pavement layer moduli were estimated using the ELMOD 6 software developed by Dynatest and accepted in the industry as a standard. The backcalculation under ELMOD 6, was undertaken using the average layer thicknesses. The thicknesses of the pavement were measured from boreholes conducted by Terraprobe Inc. Since the asphalt, concrete and granular layer thicknesses varied, the backcalculation was conducted based on the overall average pavement layer thicknesses for each pavement section shown in Table 2. Table 4 shows the average backcalculated pavement layer moduli for all pavement sections. Detailed backcalculation for each pavement section are attached in Appendix B, Tables 1-B through 4-B.

The pavement subgrade resilient modulus (M_R) of the existing pavement section was also backcalculated from the FWD deflection data and corrected according to the AASHTO 1993 pavement Design Guide procedure. The AASHTO correction factor used to calculate the resilient Modulus (M_r) is 0.3. The backcalculated average subgrade resilient modulus (M_r) values for all pavement sections are shown in Table 4.

4.3 Effective Structure Number SN_{eff}

The FWD data was used to calculate the Effective Structure Number (SN_{eff}) of the existing pavement structure based on the Effective Modulus (E_p) of all pavement layers above the subgrade layer. Table 3 shows the summary of SN_{eff} for all pavement sections. Detail calculations of the SN_{eff} is presented in Appendix A, Tables 1-A through 4-A.

Table 3: Normalized deflection, deflection basin area, and effective structural number for tested pavement sections.

Sec. #	Pavement Section	Station	d_{0adj} (mm)	d_0/d_{200}	A (mm)	SN_{eff} (mm)
1	South Service Rd. to 200 m North of Silver Creek Blvd	10+000 to 12+750	0.10	1.11	778	431*
2	200 m North of Silver Creek to Burnhamthorpe Rd	12+750 To 14+300	0.26	1.17	608	206
3	Burnhamthorpe Rd to Meadows Blvd	14+300 To 15+100	0.22	1.20	606	213
4	Meadows Blvd to Eastgate Parkway	15+100 to 15+435	0.18	1.20	643	266

Note: * This high SN_{eff} is due to the effect of 200 mm of concrete in this pavement section.

Table 4: Average Backcalculated Layer Moduli for Tested Pavement Sections.

Sec. #	Pavement Section	Station	Layer Thickness, mm			Backcalculated Layer Moduli, MPa				Corrected Subgrade Resilient Modulus (M_r), MPa
			Asphalt	Concrete	Granular	Asphalt	Concrete	Granular	Subgrade	
1	South Service Rd. to 200 m North of Silver Creek Blvd	10+000 to 12+750	105	200	300	9875	23036	226	282	85
2	200 m North of Silver Creek to Burnhamthorpe Rd	12+750 To 14+300	175	-	405	6413	-	258	126	38
3	Burnhamthorpe Rd to Meadows Blvd	14+300 To 15+100	140	-	460	8893	-	306	129	39
4	Meadows Blvd to Eastgate Parkway	15+100 to 15+435	300	-	375	3298	-	249	149	45

5 Closure

This report summarizes Engtec Consulting Inc. efforts to analyze the FWD data, undertake backcalculation of pavement layer moduli and estimate the Effective Structure number SN_{eff} for Cawthra Road from South Service Road to Eastgate Parkway, Mississauga, Ontario.

We trust that this report is satisfactory for your purposes. Should you have any questions, please contact the undersigned.

Yours truly,

Bhutta

Hassan, Salama, Ph.D., P. Eng.
Pavement Engineer
Engtec Consulting Inc.

Salman Bhutta, Ph.D., P. Eng.
Principal
Engtec Consulting Inc.

6 References

1. “Manual for FWD Testing in the Long-Term Pavement Performance Program,” SHRP-P-661, PCS Law Engineering and Braun Intertec Pavement, Inc., National Research Council, Washington, DC, 1993.
2. MTO, Pavements and Foundations Section, “Falling Weight Deflectometer (FWD) Testing Guideline,” MERO-019, 2005
3. Anderson, P. D., “Cost-Effective Structural Rehabilitation of Pavements Using NDT Deflection Methods,” 1989.
4. Horak, E. and Emery, S. “Falling Weight Deflectometer Bowl Parameters as Analysis Tool for Pavement Structural Evaluations,” Australian Road Research Board, ARRB, 2016
5. Pierce, L. M., “Development of a Computer Program for the Determination of the Area Value and Subgrade Resilient Modulus Using Dynatest FWD,” Report/Software by Washington State Department of Transportation, May 1999.
6. Zhang, Z., Claros, G., Manuel, L., and Damnjanovic, I.,” Development of Structural Condition Index to Support Pavement Maintenance and Rehabilitation Decisions at Network Level,” Transportation Research Record No. 1827, pp. 10 – 17, 200
7. MTO, “Adaptation and Verification Of AASHTO Pavement Design Guide For Ontario Conditions,” Final Report, March 2008

Appendix A:

Normalized FWD Deflection Data and Effective Structural Number

Table 1-A: FWD Data Analysis - Cawthra Road from South Service Rd. to 200 m North of Silver Creek Blvd - All Lanes in both Directions (St 10+000 to 12+750).

Station	Direction	d_{0adj} (mm)	d_0/d_{200}	A (mm)	SN_{eff} (mm)
10.000	NBDL	0.075	1.10	808	491
10.000	SBDL	0.102	1.08	785	394
10.015	SBPL	0.089	1.07	810	482
10.025	NBPL	0.094	1.09	793	450
10.025	SBDL	0.092	1.10	781	440
10.050	NBDL	0.091	1.09	787	445
10.100	SBPL	0.105	1.07	777	427
10.125	NBPL	0.119	1.03	814	489
10.125	SBDL	0.076	1.11	798	428
10.225	SBPL	0.132	1.16	685	311
10.230	NBPL	0.076	1.14	796	450
10.250	NBDL	0.095	1.06	814	506
10.395	SBDL	0.103	1.09	762	422
10.400	NBPL	0.096	1.08	792	440
10.425	SBPL	0.087	1.08	803	489
10.450	NBDL	0.102	1.08	776	423
10.525	SBDL	0.084	1.12	773	407
10.550	NBPL	0.078	1.10	807	493
10.623	SBPL	0.097	1.06	803	426
10.650	NBDL	0.083	1.11	793	416
10.725	SBDL	0.081	1.09	801	452
10.750	NBPL	0.099	1.11	786	413
10.825	SBPL	0.097	1.14	742	392
10.851	NBDL	0.100	1.14	755	415
10.925	SBDL	0.075	1.07	828	487
10.950	NBPL	0.094	1.06	813	478
11.025	SBPL	0.088	1.08	809	500
11.050	NBDL	0.192	1.17	612	252
11.125	SBDL	0.082	1.08	807	485
11.150	NBPL	0.076	1.09	819	446
11.225	SBPL	0.090	1.08	799	472
11.283	NBDL	0.128	1.05	774	444

Table 1-A (Cont): FWD Data Analysis - Cawthra Road from South Service Rd. to 200 m North of Silver Creek Blvd - All Lanes in both Directions (St 10+000 to 12+750).

Station	Direction	d_{0adj} (mm)	d_0/d_{200}	A (mm)	SN_{eff} (mm)
11.325	SBDL	0.144	1.11	707	372
11.350	NBPL	0.098	1.07	793	448
11.425	SBPL	0.078	1.10	817	492
11.450	NBDL	0.129	1.17	688	341
11.524	SBDL	0.103	1.13	759	400
11.550	NBPL	0.074	1.15	794	457
11.625	SBPL	0.106	1.09	780	435
11.665	NBDL	0.068	1.13	813	517
11.725	SBDL	0.086	1.09	774	422
11.750	NBPL	0.090	1.08	809	468
11.825	SBPL	0.114	1.11	757	453
11.850	NBDL	0.054	1.12	869	533
11.925	SBDL	0.104	1.25	686	324
11.950	NBPL	0.068	1.20	781	373
12.025	SBPL	0.071	1.18	782	431
12.053	NBDL	0.101	1.11	750	378
12.125	SBDL	0.093	1.17	747	370
12.150	NBPL	0.061	1.25	793	392
12.226	SBPL	0.102	1.17	754	432
12.250	NBDL	0.071	1.11	818	426
12.325	SBDL	0.094	1.11	762	402
12.350	NBPL	0.076	1.10	814	461
12.424	SBPL	0.075	1.13	806	485
12.455	NBDL	0.101	1.10	775	418
12.525	SBDL	0.097	1.10	773	470
12.550	NBPL	0.106	1.10	765	435
12.625	SBPL	0.096	1.09	786	440
12.650	NBDL	0.145	1.12	713	378
12.725	SBDL	0.183	1.12	661	271
Mean		0.10	1.11	778	431
Standard Deviation		0.03	0.04	44	55
C.O.V (%)		26.03	3.87	6	13
Maximum		0.19	1.25	869	533
Minimum		0.05	1.03	612	252

Notes:

Station 10+000 is the South Side of the North Pedestrian Crossing at the Intersection of Cawthra Rd and S. Service Rd.

Table 2-A: FWD Data Analysis - Cawthra Road from 200 m North of Silver Creek to Burnhamthorpe Rd - All Lanes in both Directions (St 12+750 To 14+300).

Station	Direction	d_{0adj} (mm)	d_0/d_{200}	A (mm)	SN_{eff} (mm)
12.725	SBDL	0.183	1.12	661	269
12.751	NBPL	0.201	1.27	565	164
12.825	SBPL	0.191	1.22	594	217
12.850	NBDL	0.239	1.16	593	212
12.925	SBDL	0.267	1.14	608	216
12.950	NBPL	0.227	1.21	582	198
13.024	SBPL	0.178	1.17	641	239
13.050	NBDL	0.424	1.18	550	141
13.125	SBDL	0.444	1.14	571	146
13.150	NBPL	0.308	1.14	585	155
13.225	SBPL	0.104	1.12	744	378
13.251	NBDL	0.198	1.25	583	219
13.325	SBDL	0.204	1.12	647	246
13.350	NBPL	0.238	1.19	602	183
13.422	SBPL	0.197	1.15	643	213
13.450	NBDL	0.398	1.17	558	145
13.525	SBDL	0.320	1.15	594	160
13.550	NBPL	0.234	1.24	579	204
13.625	SBPL	0.203	1.12	650	232
13.650	NBDL	0.351	1.15	567	167
13.725	SBDL	0.439	1.17	553	144
13.750	NBPL	0.206	1.17	624	235
13.823	SBPL	0.217	1.16	619	222
13.850	NBDL	0.358	1.24	534	146
13.925	SBDL	0.348	1.14	591	156
13.950	NBPL	0.174	1.26	603	229
14.025	SBPL	0.188	1.11	668	274
14.050	NBDL	0.347	1.12	589	176
14.125	SBDL	0.292	1.16	576	178
14.151	NBPL	0.145	1.13	702	299
14.225	SBPL	0.193	1.14	649	232
14.250	NBDL	0.211	1.17	626	196
Mean		0.26	1.17	608	206
Standard Deviation		0.09	0.05	46	52
C.O.V (%)		35.02	3.87	8	25
Maximum		0.44	1.27	744	378
Minimum		0.10	1.11	534	141

Notes:

Station 10+000 is the South Side of the North Pedestrian Crossing at the Intersection of Cawthra Rd and S. Service Rd.

Table 3-A: FWD Data Analysis - Cawthra Road from Burnhamthorpe Rd to Meadows Blvd - All Lanes in both Directions (St 14+300 To 15+100).

Station	Direction	d_{0adj} (mm)	d_0/d_{200}	A (mm)	SN_{eff} (mm)
14.325	SBDL	0.257	1.20	584	192
14.350	NBPL	0.095	1.15	737	370
14.425	SBPL	0.226	1.21	596	182
14.450	NBDL	0.082	1.27	683	349
14.525	SBDL	0.192	1.18	616	244
14.550	NBPL	0.246	1.21	587	172
14.625	SBPL	0.387	1.19	566	135
14.651	NBDL	0.253	1.26	572	155
14.725	SBDL	0.238	1.14	617	227
14.750	NBPL	0.199	1.19	611	211
14.825	SBPL	0.191	1.20	607	212
14.850	NBDL	0.222	1.20	594	190
14.925	SBDL	0.233	1.15	604	223
14.950	NBPL	0.198	1.25	584	195
15.025	SBPL	0.201	1.24	581	184
15.050	NBDL	0.281	1.23	554	164
Mean		0.22	1.20	606	213
Standard Deviation		0.07	0.04	45	64
C.O.V (%)		31.86	3.26	8	30
Maximum		0.39	1.27	737	370
Minimum		0.08	1.14	554	135

Notes:

Station 10+000 is the South Side of the North Pedestrian Crossing at the Intersection of Cawthra Rd and S. Service Rd.

Table 4-A: FWD Data Analysis - Cawthra Road from Meadows Blvd to Eastgate Parkway - All Lanes in both Directions (St 15+100 to 15+400).

Station	Direction	d_{0adj} (mm)	d_0/d_{200}	A (mm)	SN_{eff} (mm)
15.125	SBDL	0.278	1.24	545	181
15.150	NBPL	0.129	1.23	648	295
15.224	SBPL	0.091	1.15	735	359
15.250	NBDL	0.308	1.19	559	182
15.325	SBDL	0.174	1.19	625	248
15.350	NBPL	0.183	1.14	657	258
15.4	SBPL	0.170	1.12	706	258
15.435	NBDL	0.083	1.35	665	349
Mean		0.18	1.20	643	266
Standard Deviation		0.08	0.07	66	67
C.O.V (%)		45.81	6.15	10	25
Maximum		0.31	1.35	735	359
Minimum		0.08	1.12	545	181

Notes:
Station 10+000 is the South Side of the North Pedestrian Crossing at the Intersection of Cawthra Rd and S. Service Rd.

Appendix B:

Backcalculated Pavement Layer Moduli

Table 1-B: Backcalculated Layer Moduli - Cawthra Road from South Service Rd. to 200 m North of Silver Creek Blvd - All Lanes in both Directions (St 10+000 to 12+750).

Station	Location	Layer Thickness, mm			Backcalculated Layer Moduli, MPa				Corrected Subgrade Resilient Modulus (M_r), MPa
		Asphalt	Concrete	Granular	Asphalt	Concrete	Granular	Subgrade	
10.000	NBDL	105	200	300	17531	27225	306	332	100
10.000	SBDL	105	200	300	10096	20572	141	198	59
10.015	SBPL	105	200	300	7873	33275	203	268	80
10.025	NBPL	105	200	300	13029	18093	293	264	79
10.025	SBDL	105	200	300	10794	25353	218	245	73
10.050	NBDL	105	200	300	10877	20632	332	282	84
10.100	SBPL	105	200	300	12957	12185	306	245	74
10.125	NBPL	105	200	300	14967	26093	192	147	44
10.125	SBDL	105	200	300	14451	22275	225	352	106
10.225	SBPL	105	200	300	3690	8678	171	346	104
10.230	NBPL	105	200	300	14525	22275	275	400	120
10.250	NBDL	105	200	300	13639	38250	146	213	64
10.395	SBDL	105	200	300	9239	18020	234	279	84
10.400	NBPL	105	200	300	10658	18043	198	295	88
10.425	SBPL	105	200	300	11347	29872	203	280	84
10.450	NBDL	105	200	300	9542	16691	203	284	85
10.525	SBDL	105	200	300	10176	23389	212	331	99
10.550	NBPL	105	200	300	14320	27225	303	328	98
10.623	SBPL	105	200	300	8845	15879	226	290	87
10.650	NBDL	105	200	300	9562	18819	223	414	124
10.725	SBDL	105	200	300	13382	28300	164	297	89
10.750	NBPL	105	200	300	7911	17130	216	298	89
10.825	SBPL	105	200	300	5277	14249	366	339	102
10.851	NBDL	105	200	300	5628	24750	192	303	91
10.925	SBDL	105	200	300	29513	22550	238	280	84
10.950	NBPL	105	200	300	16452	25338	171	252	76
11.025	SBPL	105	200	300	14022	27627	321	245	73
11.050	NBDL	105	200	300	4808	2441	207	269	81
11.125	SBDL	105	200	300	26006	24503	203	317	95
11.150	NBPL	105	200	300	10183	25338	214	330	99
11.225	SBPL	105	200	300	14897	22352	234	274	82
11.283	NBDL	105	200	300	15267	17954	172	164	49

Table 1-B (Cont): Backcalculated Layer Moduli - Cawthra Road from South Service Rd. to 200 m North of Silver Creek Blvd - All Lanes in both Directions (St 10+000 to 12+750).

Station	Location	Layer Thickness, mm			Backcalculated Layer Moduli, MPa				Corrected Subgrade Resilient Modulus (M_r), MPa
		Asphalt	Concrete	Granular	Asphalt	Concrete	Granular	Subgrade	
11.325	SBDL	105	200	300	4601	15288	138	216	65
11.350	NBPL	105	200	300	9970	18311	288	257	77
11.425	SBPL	105	200	300	14738	25217	310	317	95
11.450	NBDL	105	200	300	4991	8678	360	274	82
11.524	SBDL	105	200	300	8226	25781	160	192	58
11.550	NBPL	105	200	300	6071	34939	180	450	135
11.625	SBPL	105	200	300	10054	17864	242	236	71
11.665	NBDL	105	200	300	7544	62178	205	364	109
11.725	SBDL	105	200	300	10071	24503	203	299	90
11.750	NBPL	105	200	300	10391	24819	256	268	81
11.825	SBPL	105	200	300	4940	34589	190	194	58
11.850	NBDL	105	200	300	51473	24131	279	524	157
11.925	SBDL	105	200	300	2584	24750	236	257	77
11.950	NBPL	105	200	300	5925	19847	245	733	220
12.025	SBPL	105	200	300	5454	38520	235	389	117
12.053	NBDL	105	200	300	7374	13884	215	357	107
12.125	SBDL	105	200	300	5117	24746	219	245	74
12.150	NBPL	105	200	300	6445	31464	250	590	177
12.226	SBPL	105	200	300	3957	29494	256	253	76
12.250	NBDL	105	200	300	12309	21718	310	375	113
12.325	SBDL	105	200	300	8686	22868	195	252	76
12.350	NBPL	105	200	300	8085	25728	285	385	116
12.424	SBPL	105	200	300	7612	39393	178	377	113
12.455	NBDL	105	200	300	9860	17569	193	284	85
12.525	SBDL	105	200	300	11127	26549	324	238	72
12.550	NBPL	105	200	300	7995	19045	268	242	73
12.625	SBPL	105	200	300	10426	18822	190	299	90
12.650	NBDL	105	200	300	4535	14249	240	184	55
12.725	SBDL	105	200	300	3469	7573	143	135	41
Average					9875	23036	226	282	85
Maximum					17531	39393	332	450	135
Minimum					2584	7573	138	135	41

Notes:

Station 10+000 is the South Side of the North Pedestrian Crossing at the Intersection of Cawthra Rd and S. Service Rd.

🟨 Highlighted Cells are outliers and excluded from the summary statistics.

Table 2-B: Backcalculated Layer Moduli - Cawthra Road from 200 m North of Silver Creek to Burnhamthorpe Rd - All Lanes in both Directions (St 12+750 To 14+300).

Station	Location	Layer Thickness, mm		Backcalculated Layer Moduli, MPa			Corrected Subgrade Resilient Modulus (M_r), MPa
		Asphalt	Granular	Asphalt	Granular	Subgrade	
12.725	SBDL	175	405	12033	489	95	29
12.751	NBPL	175	405	3539	295	256	77
12.825	SBPL	175	405	5151	345	239	72
12.850	NBDL	175	405	5764	238	166	50
12.925	SBDL	175	405	6225	362	69	21
12.950	NBPL	175	405	4501	322	152	46
13.024	SBPL	175	405	8817	319	173	52
13.050	NBDL	175	405	3420	125	59	18
13.125	SBDL	175	405	6506	164	18	5
13.150	NBPL	175	405	4845	160	86	26
13.225	SBPL	175	405	41804	238	332	100
13.251	NBDL	175	405	4645	444	210	63
13.325	SBDL	175	405	10200	524	65	20
13.350	NBPL	175	405	5796	236	118	35
13.422	SBPL	175	405	9165	218	149	45
13.450	NBDL	175	405	4083	118	66	20
13.525	SBDL	175	405	5576	269	38	11
13.550	NBPL	175	405	4308	361	143	43
13.625	SBPL	175	405	9573	216	147	44
13.650	NBDL	175	405	4241	150	85	26
13.725	SBDL	175	405	3082	225	32	10
13.750	NBPL	175	405	7490	295	158	47
13.823	SBPL	175	405	7551	248	145	43
13.850	NBDL	175	405	2910	198	83	25
13.925	SBDL	175	405	5905	166	46	14
13.950	NBPL	175	405	5535	482	222	67
14.025	SBPL	175	405	12107	255	160	48
14.050	NBDL	175	405	5328	127	80	24
14.125	SBDL	175	405	3886	393	61	18
14.151	NBPL	175	405	16449	316	210	63
14.225	SBPL	175	405	10375	236	146	44
14.250	NBDL	175	405	9204	197	135	41
Average				6413	258	126	38
Maximum				16449	482	256	77
Minimum				2910	118	18	5

Notes:

Station 10+000 is the South Side of the North Pedestrian Crossing at the Intersection of Cawthra Rd and S. Service Rd.

🟨 Highlighted Cells are outliers and excluded from the summary statistics.

Table 3-B: Backcalculated Layer Moduli - Cawthra Road from Burnhamthorpe Rd to Meadows Blvd - All Lanes in both Directions (St 14+300 To 15+100).

Station	Location	Layer Thickness, mm		Backcalculated Layer Moduli, MPa			Corrected Subgrade Resilient Modulus (M_{r}), MPa
		Asphalt	Granular	Asphalt	Granular	Subgrade	
14.325	SBDL	140	460	8829	333	90	27
14.350	NBPL	140	460	36373	841	282	85
14.425	SBPL	140	460	8965	276	134	40
14.450	NBDL	140	460	12349	1869	456	137
14.525	SBDL	140	460	10931	481	144	43
14.550	NBPL	140	460	7804	248	120	36
14.625	SBPL	140	460	6184	127	61	18
14.651	NBDL	140	460	7296	260	108	32
14.725	SBDL	140	460	14343	268	98	30
14.750	NBPL	140	460	10198	311	167	50
14.825	SBPL	140	460	10295	334	178	53
14.850	NBDL	140	460	9878	276	141	42
14.925	SBDL	140	460	10087	367	110	33
14.950	NBPL	140	460	7356	386	169	51
15.025	SBPL	140	460	6492	363	163	49
15.050	NBDL	140	460	5841	254	115	35
Average				8893	306	129	39
Maximum				14343	481	178	53
Minimum				5841	127	61	18

Notes:

Station 10+000 is the South Side of the North Pedestrian Crossing at the Intersection of Cawthra Rd and S. Service Rd.

🟨 Highlighted Cells are outliers and excluded from the summary statistics.

Table 4-B: Backcalculated Layer Moduli - Cawthra Road from Meadows Blvd to Eastgate Parkway - All Lanes in both Directions (St 15+100 to 15+400).

Station	Location	Layer Thickness, mm		Backcalculated Layer Moduli, MPa			Corrected Subgrade Resilient Modulus ($M_{r)}$, MPa
		Asphalt	Granular	Asphalt	Granular	Subgrade	
15.125	SBDL	300	375	1540	272	97	29
15.150	NBPL	300	375	4392	377	283	85
15.224	SBPL	300	375	8282	323	375	113
15.250	NBDL	300	375	1653	123	114	34
15.325	SBDL	300	375	3495	444	108	32
15.350	NBPL	300	375	3785	169	150	45
15.400	SBPL	300	375	4924	112	141	42
15.435	NBDL	300	375	5393	1085	559	168
Average				3298	249	149	45
Maximum				4924	444	283	85
Minimum				1540	112	97	29

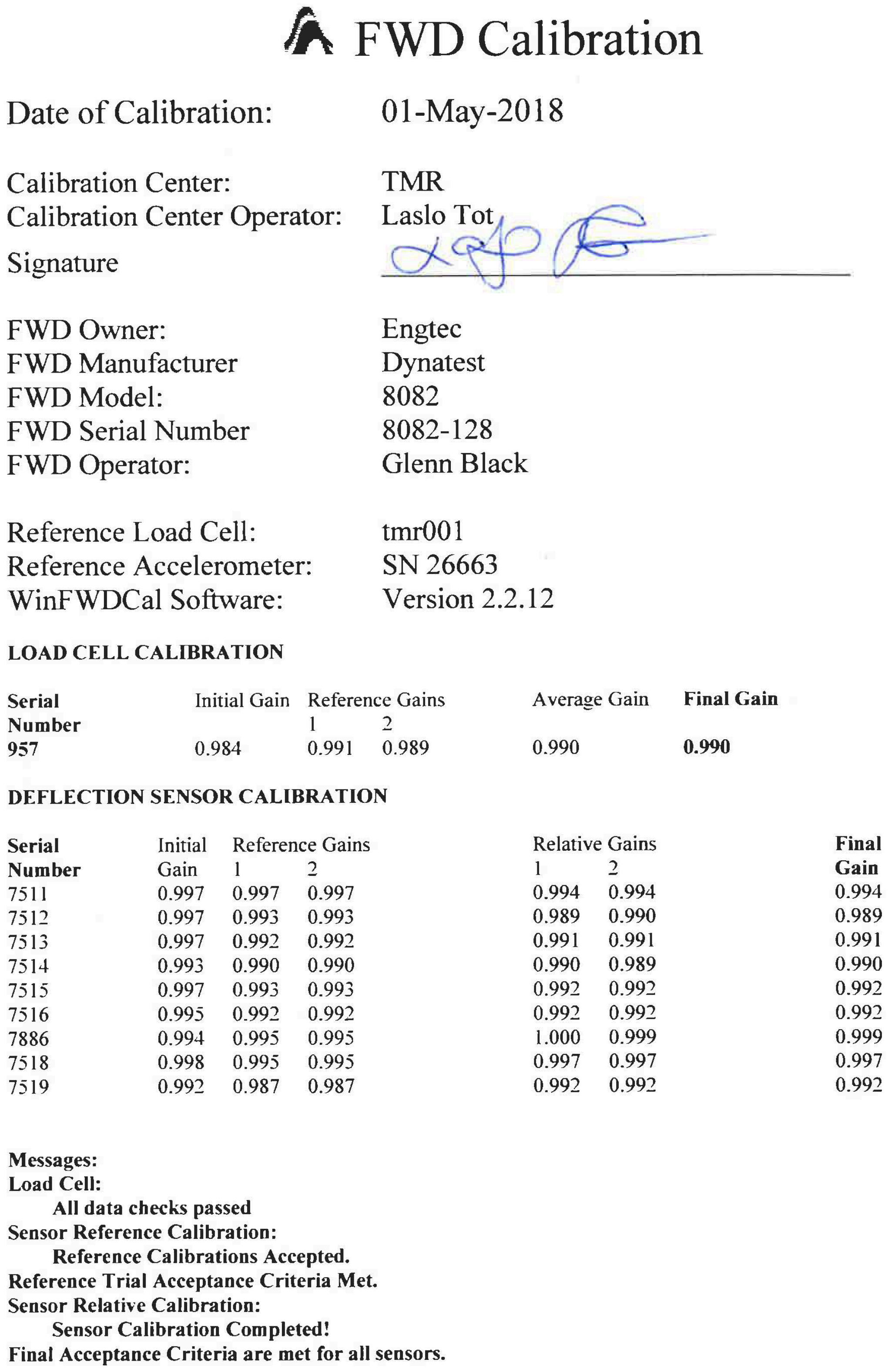
Notes:

Station 10+000 is the South Side of the North Pedestrian Crossing at the Intersection of Cawthra Rd and S. Service Rd.

🟨 Highlighted Cells are outliers and excluded from the summary statistics.

Appendix C:

Calibration Certificate – FWD Machine



FWD Calibration

Date of Calibration: 01-May-2018

Calibration Center: TMR
Calibration Center Operator: Laslo Tot
Signature

FWD Owner: Engtec
FWD Manufacturer Dynatest
FWD Model: 8082
FWD Serial Number 8082-128
FWD Operator: Glenn Black

Reference Load Cell: tmr001
Reference Accelerometer: SN 26663
WinFWDCal Software: Version 2.2.12

LOAD CELL CALIBRATION

Serial Number	Initial Gain	Reference Gains 1	2	Average Gain	**Final Gain**
957	0.984	0.991	0.989	0.990	**0.990**

DEFLECTION SENSOR CALIBRATION

Serial Number	Initial Gain	Reference Gains 1	2	Relative Gains 1	2	**Final Gain**
7511	0.997	0.997	0.997	0.994	0.994	0.994
7512	0.997	0.993	0.993	0.989	0.990	0.989
7513	0.997	0.992	0.992	0.991	0.991	0.991
7514	0.993	0.990	0.990	0.990	0.989	0.990
7515	0.997	0.993	0.993	0.992	0.992	0.992
7516	0.995	0.992	0.992	0.992	0.992	0.992
7886	0.994	0.995	0.995	1.000	0.999	0.999
7518	0.998	0.995	0.995	0.997	0.997	0.997
7519	0.992	0.987	0.987	0.992	0.992	0.992

Messages:
Load Cell:
All data checks passed
Sensor Reference Calibration:
Reference Calibrations Accepted.
Reference Trial Acceptance Criteria Met.
Sensor Relative Calibration:
Sensor Calibration Completed!
Final Acceptance Criteria are met for all sensors.

APPENDIX E

Flexible Pavement Condition Evaluation Forms

Ministry of Transportation
Ontario

Composite Pavement Condition Evaluation Form

Location: Cawthra Road

District ☐☐ **Highway** ☐☐☐☐

From: Station 9+960 **To:** Station 10+830

LHRS ☐☐☐☐☐ (begins) ☐☐☐☐ (offset) km **Section Length** 870 m

Traffic Direction B — B - both directions; N - northbound; S - southbound; E - eastbound; W - westbound

Survey Date 19 (year) 08 (month) **PCR** 95 **RCR** 9.5

Facility A — A - all lanes; C - collector; E - express; O - others (additional lanes)

Contract No. ☐☐ - ☐☐☐ **WP No.** ☐☐☐☐☐☐☐☐☐

Class A — F - freeway; A - arterial; C - collector; L - local; S - secondary

Ride Condition Rating (at 80 km/hr)

10	Excellent (smooth)
8	Good (comfortable)
6	Fair (uncomfortable)
4	Poor (v. rough/bumpy)
2	Very Poor, (dangerous, at 80 km/hr)
0	

			Severity of Distress					Density of Distress Extent of Occurrence %				
			Very Slight	Slight	Moderate	Severe	Very Severe	Few <10	Intermittent 10-20	Frequent 20-50	Extensive 50-80	Throughout 80-100
PAVEMENT			1	2	3	4	5	1	2	3	4	5
Surface Defects	Ravelling & C. Agg. Loss	1	✓					✓				
	Flushing	2										
	Spalling	3										
Surface Deformations	Tenting/Cupping	4										
	Wheel Track Rutting	5										
	Distortion & Settlement	6										
	Joint Failures	7										
CRACKING	Longitudinal, Meandering - Single and Midlane	8										
	Centre Line - Single	9										
	Centre Line - Multiple	10										
	Diag./Corner/Edge Cres. - Single & Multiple	11										
	Transverse - Single	12										
	Transverse - Multiple	13										
	Map - Single & Multiple	14										
Transverse Joints	Sawed	15										
	Reflective	16										

Shoulders				Left						Right					
Surface	Width	ONE?	Distress	Severity			Density Occurrence, %			Severity			Density Occurrence, %		
				Light	Med	Sever	<10	10-30	>30	Light	Med	Sever	<10	10-30	>30
				2	3	4	2	3	4	2	3	4	2	3	4
Concrete	Fully		Cracking												
	Partially Paved		Pave Edge/Curb Seperation												
			Distortion												
Hot-mix	Fully		Cracking												
	Partially Paved		Pave Edge/Curb Seperation												
			Distortion												
Surface Treated	Fully		Cracking												
	Partially Paved		Pave Edge/Curb Seperation												
			Break-Up												
Primed	Fully		Break-Up												
	Partially														
Gravel															

Maintenance Treatment		EXTENT OF OCCURRENCE, %				
		<10	10-20	20-50	50-80	>80
		1	2	3	4	5
Pavement	Manual Patching, Hot or Cold Mix					
	Machine Patching, Partial/Fill Width					
	Microsurfacing					
	Grooving					
	Rout and Seal Cracks or Joints					
	Concrete Joint / Slab Replacement					
Shoulders	Manual Patching, Hot or Cold Mix					
	Machine Patching, Partial or Fill Width					
	Spray Patching / Chip Seal					
	Sealing Cracks or Joints					

Distress Comments: (items not covered above)

Other Comments: (e.g., subsections, additional contracts)

Evaluated by: Rehman Abdul. P.Eng.

Ministry of Transportation
Ontario

Composite Pavement Condition Evaluation Form

Location: Cawthra Road

From: Station 10+830 **To:** Station 11+500

LHRS ☐☐☐☐☐ begins ☐☐☐☐ offset km **Section Length** 670 m

Survey Date 19 year 08 month **PCR** 70 **RCR** 7.0

Contract No. ☐☐ - ☐☐☐ **WP No.** ☐☐☐☐☐☐☐☐☐

District ☐☐ **Highway** ☐☐☐☐

Traffic Direction B — B - both directions; N - northbound; S - southbound; E - eastbound; W - westbound

Facility A — A - all lanes; C - collector; E - express; O - others (additional lanes)

Class A — F - freeway; A - arterial; C - collector; L - local; S - secondary

Ride Condition Rating (at 80 km/hr)	10 Excellent (smooth) 8 Good (comfortable) 6 Fair (uncomfortable) 4 Poor (v. rough/bumpy) 2 Very Poor, (dangerous, at 80 km/hr) 0		Severity of Distress					Density of Distress Extent of Occurrence %				
			Very Slight	Slight	Moderate	Severe	Very Severe	Few <10	Intermittent 10-20	Frequent 20-50	Extensive 50-80	Throughout 80-100
PAVEMENT			1	2	3	4	5	1	2	3	4	5
Surface Defects	Ravelling & C. Agg. Loss	1		✓						✓		
	Flushing	2										
	Spalling	3		✓					✓			
Surface Deformations	Tenting/Cupping	4			✓				✓			
	Wheel Track Rutting	5										
	Distortion & Settlement	6										
	Joint Failures	7										
CRACKING	Longitudinal, Meandering - Single and Midlane	8			✓				✓			
	Centre Line - Single	9										
	Centre Line - Multiple	10										
	Diag./Corner/Edge Cres. - Single & Multiple	11										
	Transverse - Single	12			✓				✓			
	Transverse - Multiple	13										
	Map - Single & Multiple	14										
Transverse Joints	Sawed	15										
	Reflective	16			✓					✓		

Distress Comments: (items not covered above)

Shoulders				**Left**						**Right**					
Surface	**Width**	**ONE?**	**Distress**	Severity			Density Occurrence, %			Severity			Density Occurrence, %		
				Light	Med	Sever	<10	10-30	>30	Light	Med	Sever	<10	10-30	>30
				2	3	4	2	3	4	2	3	4	2	3	4
Concrete	Fully		Cracking												
	Partially Paved		Pave Edge/Curb Seperation												
			Distortion												
Hot-mix	Fully		Cracking												
	Partially Paved		Pave Edge/Curb Seperation												
			Distortion												
Surface Treated	Fully		Cracking												
	Partially Paved		Pave Edge/Curb Seperation												
			Break-Up												
Primed	Fully		Break-Up												
	Partially														
Gravel															

Maintenance Treatment		EXTENT OF OCCURRENCE, %									
		<10		10-20		20-50		50-80		>80	
		1		2		3		4		5	
Pavement	Manual Patching, Hot or Cold Mix			✓	✓						
	Machine Patching, Partial/Fill Width										
	Microsurfacing										
	Grooving										
	Rout and Seal Cracks or Joints										
	Concrete Joint / Slab Replacement										
Shoulders	Manual Patching, Hot or Cold Mix										
	Machine Patching, Partial or Fill Width										
	Spray Patching / Chip Seal										
	Sealing Cracks or Joints										

Other Comments: (e.g., subsections, additional contracts)

Evaluated by: Rehman Abdul. P.Eng.

Ministry of Transportation
Ontario

Composite Pavement Condition Evaluation Form

Location: Cawthra Road

From: Station 11+500 **To:** Station 12+750

LHRS ☐☐☐☐☐ begins ☐☐☐☐ offset km **Section Length** 1 2 5 0 m

Survey Date 1 9 year 0 8 month **PCR** 8 0 **RCR** 8 . 0

Contract No. ☐☐ - ☐☐☐ **WP No.** ☐☐☐☐☐☐☐☐☐

District ☐☐ **Highway** ☐☐☐☐

Traffic Direction B — B - both directions; N - northbound; S - southbound; E - eastbound; W - westbound

Facility A — A - all lanes; C - collector; E - express; O - others (additional lanes)

Class A — F - freeway; A - arterial; C - collector; L - local; S - secondary

Ride Condition Rating (at 80 km/hr)

10 Excellent (smooth)
8 Good (comfortable)
6 Fair (uncomfortable)
4 Poor (v. rough/bumpy)
2 Very Poor, (dangerous, at 80 km/hr)
0

			Severity of Distress					Density of Distress Extent of Occurrence %				
			Very Slight	Slight	Moderate	Severe	Very Severe	Few <10	Intermittent 10-20	Frequent 20-50	Extensive 50-80	Throughout 80-100
PAVEMENT			1	2	3	4	5	1	2	3	4	5
Surface Defects	Ravelling & C. Agg. Loss	1	✓					✓				
	Flushing	2										
	Spalling	3		✓				✓				
Surface Deformations	Tenting/Cupping	4		✓				✓				
	Wheel Track Rutting	5										
	Distortion & Settlement	6										
	Joint Failures	7										
CRACKING	Longitudinal, Meandering - Single and Midlane	8		✓				✓				
	Centre Line - Single	9										
	Centre Line - Multiple	10										
	Diag./Corner/Edge Cres. - Single & Multiple	11										
	Transverse - Single	12		✓					✓			
	Transverse - Multiple	13										
	Map - Single & Multiple	14										
Transverse Joints	Sawed	15										
	Reflective	16		✓					✓			

Shoulders				**Left**						**Right**					
Surface	**Width**	**ONE?**	**Distress**	Severity			Density Occurrence, %			Severity			Density Occurrence, %		
				Light 2	Med 3	Sever 4	<10 2	10-30 3	>30 4	Light 2	Med 3	Sever 4	<10 2	10-30 3	>30 4
Concrete	Fully		Cracking												
	Partially Paved		Pave Edge/Curb Seperation												
			Distortion												
Hot-mix	Fully		Cracking												
	Partially Paved		Pave Edge/Curb Seperation												
			Distortion												
Surface Treated	Fully		Cracking												
	Partially Paved		Pave Edge/Curb Seperation												
			Break-Up												
Primed	Fully		Break-Up												
	Partially														
Gravel															

Maintenance Treatment		EXTENT OF OCCURRENCE, %				
		<10	10-20	20-50	50-80	>80
		1	2	3	4	5
Pavement	Manual Patching, Hot or Cold Mix					
	Machine Patching, Partial/Fill Width		✓			
	Microsurfacing					
	Grooving					
	Rout and Seal Cracks or Joints					
	Concrete Joint / Slab Replacement					
Shoulders	Manual Patching, Hot or Cold Mix					
	Machine Patching, Partial or Fill Width					
	Spray Patching / Chip Seal					
	Sealing Cracks or Joints					

Distress Comments: (items not covered above)

Other Comments: (e.g., subsections, additional contracts)

Evaluated by: Rehman Abdul. P.Eng.

Ministry of Transportation
Ontario

Flexible Pavement Condition Evaluation Form

Location: Cawthra Road

From: Station 12+750 **To:** Station 14+220

LHRS ☐☐☐☐☐ begins ☐☐☐☐ offset km

Section Length 1 4 7 0 m

Survey Date 1 9 year 0 8 month

PCR 7 0

RCR 7 . 0

Contract No. ☐☐ - ☐☐☐

WP No. ☐☐☐☐☐☐☐☐☐

District ☐☐

Highway ☐☐☐☐

Traffic Direction B
B - both directions; N - northbound; S - southbound; E - eastbound; W - westbound

Facility A
A - all lanes; C - collector; E - express; O - others (additional lanes)

Class A
F - freeway; A - arterial; C - collector; L - local; S - secondary

Ride Condition Rating (at 80 km/hr)

10	
8	Excellent (smooth)
6	Good (comfortable)
4	Fair (uncomfortable)
2	Poor (v. rough/bumpy)
0	Very Poor, (dangerous, at 80 km/hr)

	PAVEMENT		Severity of Distress: Very Slight 1	Slight 2	Moderate 3	Severe 4	Very Severe 5	Density of Distress, Extent of Occurrence %: Few <10 1	Intermittent 10-20 2	Frequent 20-50 3	Extensive 50-80 4	Throughout 80-100 5
Surface Defects	Ravelling & C. Agg. Loss	1		✓								✓
	Flushing	2										
Surface Deformations	Rippling and Shoving	3										
	Wheel Track Rutting	4		✓					✓			
	Distortion	5		✓					✓			
CRACKING – Longitudinal Wheel Track	Single and Multiple	6		✓							✓	
	Alligator	7		✓					✓			
CRACKING – Centre Line	Single and Multiple	8		✓								✓
	Alligator	9		✓				✓				
CRACKING – Pavement Edge	Single and Multiple	10										
	Alligator	11										
CRACKING – Transverse	Half, Full and Multiple	12		✓							✓	
	Alligator	13										
CRACKING	Longitudinal Meander and Midlane	14										
CRACKING	Random / Map	15										

Shoulders			Severity of Distress				Density of Distress Extent of Occurrence, %			
			Right		Left		Right		Left	
Dominant Type		Distress	Mod. 1	Sev. 2	Mod. 1	Sev. 2	10-30 1	>30 2	10-30 1	>30 2
Paved Full		Cracking								
		Pavement Edge/ Curb Separation								
Paved Partial		Distortion								
Surface Treated		Breakup/Separtion								
		Edge Break								
Primed		Breakup/Separtion								
Gravel										

Maintenance Treatment		EXTENT OF OCCURRENCE, % <10 1	10-20 2	20-50 3	50-80 4	>80 5
Pavement	Manual Patching	✓				
	Machine Patching	✓				
	Spray Patching					
	Rout and Seal Cracks					
	Chip Seal					
Shoulders	Manual Patching					
	Machine Patching					
	Rout and Seal Cracks					
	Chip Seal					

Distress Comments: (items not covered above)

Other Comments: (e.g., subsections, additional contracts)

Evaluated by: Rehman Abdul. P.Eng.

Flexible Pavement Condition Evaluation Form

Ministry of Transportation
Ontario

Location: Cawthra Road

From: Station 14+220 **To:** Station 15+460

LHRS ☐☐☐☐☐ begins ☐☐☐☐ offset km

Section Length 1 2 4 0 m

Survey Date 1 9 year 0 8 month

PCR 9 0

RCR 9 . 0

Contract No. ☐☐ - ☐☐☐

WP No. ☐☐☐☐☐☐☐☐☐

District ☐☐

Highway ☐☐☐☐

Traffic Direction B
B - both directions; N - northbound; S - southbound;
E - eastbound; W - westbound

Facility A
A - all lanes; C - collector; E - express;
O - others (additional lanes)

Class A
F - freeway; A - arterial; C - collector; L - local;
S - secondary

Ride Condition Rating (at 80 km/hr)

10	
8	Excellent (smooth)
6	Good (comfortable)
4	Fair (uncomfortable)
2	Poor (v. rough/bumpy)
0	Very Poor, (dangerous, at 80 km/hr)

				Severity of Distress					Density of Distress Extent of Occurrence %				
				Very Slight	Slight	Moderate	Severe	Very Severe	Few <10	Intermittent 10-20	Frequent 20-50	Extensive 50-80	Throughout 80-100
PAVEMENT				1	2	3	4	5	1	2	3	4	5
Surface Defects		Ravelling & C. Agg. Loss	1	✓						✓			
		Flushing	2										
Surface Deformations		Rippling and Shoving	3										
		Wheel Track Rutting	4										
		Distortion	5										
CRACKING	Longitudinal Wheel Track	Single and Multiple	6	✓					✓				
		Alligator	7										
	Centre Line	Single and Multiple	8										
		Alligator	9										
	Pavement Edge	Single and Multiple	10										
		Alligator	11										
	Transverse	Half, Full and Multiple	12	✓					✓				
		Alligator	13										
	Longitudinal Meander and Midlane		14										
	Random / Map		15										

Shoulders			Severity of Distress				Density of Distress Extent of Occurrence, %			
			Right		Left		Right		Left	
Dominant Type		Distress	Mod. 1	Sev. 2	Mod. 1	Sev. 2	10-30 1	>30 2	10-30 1	>30 2
Paved Full		Cracking								
		Pavement Edge/ Curb Separation								
Paved Partial		Distortion								
Surface Treated		Breakup/Separtion								
		Edge Break								
Primed		Breakup/Separtion								
Gravel										

Maintenance Treatment		EXTENT OF OCCURRENCE, %				
		<10	10-20	20-50	50-80	>80
		1	2	3	4	5
Pavement	Manual Patching					
	Machine Patching					
	Spray Patching					
	Rout and Seal Cracks					
	Chip Seal					
Shoulders	Manual Patching					
	Machine Patching					
	Rout and Seal Cracks					
	Chip Seal					

Distress Comments: (items not covered above)

Other Comments: (e.g., subsections, additional contracts)

Evaluated by: Rehman Abdul. P.Eng.

APPENDIX F

Pavement Design Data

Table F1
Cawthra Road
0.1 Km North of Tedwyn Drive
Regional Municipality Of Peel
Equivalent Single Axle Load Calculations (Commercial Vehicle Data)

Description - Cawthra Road (0.1 Km North of Tedwyn Drive)

Traffic Data Year	**2018**	**2019**	**2034**
Design Year		**2019**	
Analysis Period	1	15	
1a) Average Annual Daily Truck Traffic (AADTT)	1,976	1,992	2,255
Annual Growth Rate (%)	0.83%	0.83%	
1b) Truck fraction of total traffic		100.0%	
Number of lanes in one direction		2	
1c) Directional Factor		0.5	
1d) Lane distribution Factor		0.8	
Daily Truck Volume		**797**	

2) Breakdown of Truck Portions (10 Classes)

	2019 to 2034
FHWA Vehicle Class 4	9.3%
FHWA Vehicle Class 5	28.9%
FHWA Vehicle Class 6	13.7%
FHWA Vehicle Class 7	18.1%
FHWA Vehicle Class 8	10.2%
FHWA Vehicle Class 9	5.8%
FHWA Vehicle Class 10	3.8%
FHWA Vehicle Class 11	0.4%
FHWA Vehicle Class 12	0.2%
FHWA Vehicle Class 13	9.7%

3) Truck Factors (10 Classes)

FHWA Vehicle Class 4	2.0
FHWA Vehicle Class 5	0.3
FHWA Vehicle Class 6	0.9
FHWA Vehicle Class 7	4.0
FHWA Vehicle Class 8	1.1
FHWA Vehicle Class 9	1.6
FHWA Vehicle Class 10	4.0
FHWA Vehicle Class 11	1.0
FHWA Vehicle Class 12	4.3
FHWA Vehicle Class 13	5.6

4) Total Daily ESALs in Design Lane	**1617**

5) Total Base Year ESALs	**2019**
Number of Days of Truck Traffic	300
Total Base Year ESALs	**485,100**

6) Cumulative ESALs for Design Period

Design Period	15
Annual Growth Rate (%)	0.83%
Geometric Growth Factor	16.0
Cumulative ESALs for the Design Period	**7,761,600**

File. No. 1-18-0186

Table F1a
Cawthra Road
0.1 Km North of Tedwyn Drive
Regional Municipality Of Peel
Equivalent Single Axle Load Calculations (AADT DATA)

Description - Cawthra Road (0.1 Km North of Tedwyn Drive)				
Traffic Data Year		**2018**	**2019**	**2034**
Design Year			**2019**	
Analysis Period		1	15	
1a) Average Annual Daily Traffic (AADT)		32,969	33,243	37,631
Annual Growth Rate (%)		0.83%	0.83%	
1b) Truck fraction of total traffic			5.5%	
Number of lanes in one direction			2	
1c) Directional Factor			0.5	
1d) Lane distribution Factor			0.8	
	Daily Truck Volume		**732**	
Road Classification			**Urban Principal Arterial**	
2) Breakdown of Truck Proportions				
	Class 1		30.0%	
	Class 2		10.0%	
	Class 3		45.0%	
	Class 4		15.0%	
3) Daily Truck Volumes (4 Classes)			**2019 to 2034**	
	Class 1		220	
	Class 2		73	
	Class 3		329	
	Class 4		110	
4) Truck Factors (4 Classes)				
	Class 1		0.5	
	Class 2		2.3	
	Class 3		1.6	
	Class 4		5.5	
5) Daily ESALs per Truck Class (4 Classes)				
	Class 1		110	
	Class 2		168	
	Class 3		527	
	Class 4		604	
6) Total Daily ESALs in Design Lane			**1410**	
7) Total Base Year ESALs			**2019**	
Number of Days of Truck Traffic			300	
	Total Base Year ESALs		**423,000**	
8) Cumulative ESALs for Design Period				
Design Period			15	
Annual Growth Rate (%)			0.83%	
Geometric Growth Factor			16.0	
			6,768,000	
	Cumulative ESALs for the Design Period		**6,768,000**	

Note: ESAL Calculations are based on "Procedures for Estimating Traffic Loads for Pavement Design",Hajek, J., 1995, and "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions" (MI-83), 2008.

File. No. 1-18-0615

Table F2
Cawthra Road
0.2 Km North of Queensway East
Regional Municipality Of Peel
Equivalent Single Axle Load Calculations (Commercial Vehicle Data)

Description - Cawthra Road (0.2 Km North of Queensway East)				
Traffic Data Year		**2018**	**2019**	**2039**
Design Year			**2019**	
Analysis Period		1	15	
1a) Average Annual Daily Truck Traffic (AADTT)		2,329	2,348	2,658
Annual Growth Rate (%)		0.83%	0.83%	
1b) Truck fraction of total traffic			100.0%	
Number of lanes in one direction			2	
1c) Directional Factor			0.5	
1d) Lane distribution Factor			0.8	
	Daily Truck Volume		**940**	
2) Breakdown of Truck Portions (10 Classes)			**2019 to 2034**	
	FHWA Vehicle Class 4		10.5%	
	FHWA Vehicle Class 5		32.7%	
	FHWA Vehicle Class 6		13.8%	
	FHWA Vehicle Class 7		21.3%	
	FHWA Vehicle Class 8		13.5%	
	FHWA Vehicle Class 9		3.4%	
	FHWA Vehicle Class 10		1.5%	
	FHWA Vehicle Class 11		0.2%	
	FHWA Vehicle Class 12		0.0%	
	FHWA Vehicle Class 13		3.1%	
3) Truck Factors (10 Classes)				
	FHWA Vehicle Class 4		2.0	
	FHWA Vehicle Class 5		0.3	
	FHWA Vehicle Class 6		0.9	
	FHWA Vehicle Class 7		4.0	
	FHWA Vehicle Class 8		1.1	
	FHWA Vehicle Class 9		1.6	
	FHWA Vehicle Class 10		4.0	
	FHWA Vehicle Class 11		1.0	
	FHWA Vehicle Class 12		4.3	
	FHWA Vehicle Class 13		5.6	
4) Total Daily ESALs in Design Lane			**1619**	
5) Total Base Year ESALs			**2019**	
Number of Days of Truck Traffic			300	
	Total Base Year ESALs		**485,700**	
6) Cumulative ESALs for Design Period				
Design Period			15	
Annual Growth Rate (%)			0.83%	
Geometric Growth Factor			16.0	
	Cumulative ESALs for the Design Period		**7,771,200**	

Table F2a
Cawthra Road
0.2 Km North of Queensway East
Regional Municipality Of Peel
Equivalent Single Axle Load Calculations (AADT DATA)

Description - Cawthra Road (0.2 Km North of Queensway East)				
Traffic Data Year		**2018**	**2019**	**2034**
Design Year			**2019**	
Analysis Period		1	15	
1a) Average Annual Daily Traffic (AADT)		35,583	35,878	40,614
Annual Growth Rate (%)		0.83%	0.83%	
1b) Truck fraction of total traffic			6.0%	
Number of lanes in one direction			2	
1c) Directional Factor			0.5	
1d) Lane distribution Factor			0.8	
	Daily Truck Volume		**862**	
Road Classification			**Urban Principal Arterial**	
2) Breakdown of Truck Proportions				
	Class 1		30.0%	
	Class 2		10.0%	
	Class 3		45.0%	
	Class 4		15.0%	
3) Daily Truck Volumes (4 Classes)			**2019 to 2034**	
	Class 1		259	
	Class 2		86	
	Class 3		388	
	Class 4		129	
4) Truck Factors (4 Classes)				
	Class 1		0.5	
	Class 2		2.3	
	Class 3		1.6	
	Class 4		5.5	
5) Daily ESALs per Truck Class (4 Classes)				
	Class 1		129	
	Class 2		198	
	Class 3		621	
	Class 4		711	
6) Total Daily ESALs in Design Lane			**1660**	
7) Total Base Year ESALs			**2019**	
Number of Days of Truck Traffic			300	
	Total Base Year ESALs		**498,000**	
8) Cumulative ESALs for Design Period				
Design Period			15	
Annual Growth Rate (%)			0.83%	
Geometric Growth Factor			16.0	
			7,968,000	
	Cumulative ESALs for the Design Period		**7,968,000**	

Note: ESAL Calculations are based on "Procedures for Estimating Traffic Loads for Pavement Design",Hajek, J., 1995, and "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions" (MI-83), 2008.

Table F3
Cawthra Road
0.5 Km North of Silver Creek Boulevard
Regional Municipality Of Peel
Equivalent Single Axle Load Calculations (Commercial Vehicle Data)

Description - Cawthra Road (0.5 Km North of Silver Creek Boulevard)				
Traffic Data Year		**2018**	**2019**	**2034**
Design Year			**2019**	
Analysis Period		1	15	
1a) Average Annual Daily Truck Traffic (AADTT)		2,493	2,514	2,845
Annual Growth Rate (%)		0.83%	0.83%	
1b) Truck fraction of total traffic			100.0%	
Number of lanes in one direction			2	
1c) Directional Factor			0.5	
1d) Lane distribution Factor			0.8	
	Daily Truck Volume		**1006**	
2) Breakdown of Truck Portions (10 Classes)			**2019 to 2034**	
	FHWA Vehicle Class 4		8.4%	
	FHWA Vehicle Class 5		23.7%	
	FHWA Vehicle Class 6		13.7%	
	FHWA Vehicle Class 7		26.4%	
	FHWA Vehicle Class 8		14.2%	
	FHWA Vehicle Class 9		3.8%	
	FHWA Vehicle Class 10		2.1%	
	FHWA Vehicle Class 11		0.1%	
	FHWA Vehicle Class 12		0.0%	
	FHWA Vehicle Class 13		7.8%	
3) Truck Factors (10 Classes)				
	FHWA Vehicle Class 4		2.0	
	FHWA Vehicle Class 5		0.3	
	FHWA Vehicle Class 6		0.9	
	FHWA Vehicle Class 7		4.0	
	FHWA Vehicle Class 8		1.1	
	FHWA Vehicle Class 9		1.6	
	FHWA Vehicle Class 10		4.0	
	FHWA Vehicle Class 11		1.0	
	FHWA Vehicle Class 12		4.3	
	FHWA Vehicle Class 13		5.6	
4) Total Daily ESALs in Design Lane			**2167**	
5) Total Base Year ESALs			**2019**	
Number of Days of Truck Traffic			300	
	Total Base Year ESALs		**650,100**	
6) Cumulative ESALs for Design Period				
Design Period			15	
Annual Growth Rate (%)			0.83%	
Geometric Growth Factor			16.0	
	Cumulative ESALs for the Design Period		**10,401,600**	

Table F3a
Cawthra Road
0.5 Km North of Silver Creek Boulevard
Regional Municipality Of Peel
Equivalent Single Axle Load Calculations (AADT DATA)

Description - Cawthra Road (0.5 Km North of Silver Creek Boulevard)

Traffic Data Year		**2018**	**2019**	**2034**
Design Year			**2019**	
Analysis Period		1	15	
1a) Average Annual Daily Traffic (AADT)		37,226	37,535	42,490
Annual Growth Rate (%)		0.83%	0.83%	
1b) Truck fraction of total traffic			6.1%	
Number of lanes in one direction			2	
1c) Directional Factor			0.5	
1d) Lane distribution Factor			0.8	
	Daily Truck Volume		**916**	
Road Classification			**Urban Principal Arterial**	
2) Breakdown of Truck Proportions				
	Class 1		30.0%	
	Class 2		10.0%	
	Class 3		45.0%	
	Class 4		15.0%	
3) Daily Truck Volumes (4 Classes)			**2019 to 2034**	
	Class 1		275	
	Class 2		92	
	Class 3		412	
	Class 4		137	
4) Truck Factors (4 Classes)				
	Class 1		0.5	
	Class 2		2.3	
	Class 3		1.6	
	Class 4		5.5	
5) Daily ESALs per Truck Class (4 Classes)				
	Class 1		137	
	Class 2		211	
	Class 3		660	
	Class 4		756	
6) Total Daily ESALs in Design Lane			**1764**	
7) Total Base Year ESALs			**2019**	
Number of Days of Truck Traffic			300	
	Total Base Year ESALs		**529,200**	
8) Cumulative ESALs for Design Period				
Design Period			15	
Annual Growth Rate (%)			0.83%	
Geometric Growth Factor			16.0	
			8,467,200	
	Cumulative ESALs for the Design Period		**8,467,200**	

Note: ESAL Calculations are based on "Procedures for Estimating Traffic Loads for Pavement Design",Hajek, J., 1995, and "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions" (MI-83), 2008.

Table F4
Cawthra Road
0.2 Km North of Bloor Street
Regional Municipality Of Peel
Equivalent Single Axle Load Calculations (Commercial Vehicle Data)

Description - Cawthra Road (0.2 Km North of Bloor Street)			
Traffic Data Year	**2018**	**2019**	**2034**
Design Year		**2019**	
Analysis Period	1	15	
1a) Average Annual Daily Truck Traffic (AADTT)	2,306	2,325	2,632
Annual Growth Rate (%)	0.83%	0.83%	
1b) Truck fraction of total traffic		100.0%	
Number of lanes in one direction		2	
1c) Directional Factor		0.5	
1d) Lane distribution Factor		0.8	
Daily Truck Volume		**931**	

2) Breakdown of Truck Portions (10 Classes)		**2019 to 2034**
	FHWA Vehicle Class 4	7.3%
	FHWA Vehicle Class 5	30.5%
	FHWA Vehicle Class 6	12.0%
	FHWA Vehicle Class 7	24.6%
	FHWA Vehicle Class 8	15.4%
	FHWA Vehicle Class 9	3.9%
	FHWA Vehicle Class 10	1.9%
	FHWA Vehicle Class 11	0.3%
	FHWA Vehicle Class 12	0.0%
	FHWA Vehicle Class 13	4.1%
3) Truck Factors (10 Classes)		
	FHWA Vehicle Class 4	2.0
	FHWA Vehicle Class 5	0.3
	FHWA Vehicle Class 6	0.9
	FHWA Vehicle Class 7	4.0
	FHWA Vehicle Class 8	1.1
	FHWA Vehicle Class 9	1.6
	FHWA Vehicle Class 10	4.0
	FHWA Vehicle Class 11	1.0
	FHWA Vehicle Class 12	4.3
	FHWA Vehicle Class 13	5.6
4) Total Daily ESALs in Design Lane		**1742**
5) Total Base Year ESALs		**2019**
Number of Days of Truck Traffic		300
	Total Base Year ESALs	**522,600**
6) Cumulative ESALs for Design Period		
Design Period		15
Annual Growth Rate (%)		0.83%
Geometric Growth Factor		16.0
	Cumulative ESALs for the Design Period	**8,361,600**

Table F4a
Cawthra Road
0.2 Km North of Bloor Street
Regional Municipality Of Peel
Equivalent Single Axle Load Calculations (AADT DATA)

Description - Cawthra Road (0.2 Km North of Bloor Street)

Traffic Data Year		**2018**	**2019**	**2034**
Design Year			**2019**	
Analysis Period		1	15	
1a) Average Annual Daily Traffic (AADT)		33,911	34,192	38,706
Annual Growth Rate (%)		0.83%	0.83%	
1b) Truck fraction of total traffic			6.2%	
Number of lanes in one direction			2	
1c) Directional Factor			0.5	
1d) Lane distribution Factor			0.8	
	Daily Truck Volume		**848**	
Road Classification			**Urban Principal Arterial**	
2) Breakdown of Truck Proportions				
	Class 1		30.0%	
	Class 2		10.0%	
	Class 3		45.0%	
	Class 4		15.0%	
3) Daily Truck Volumes (4 Classes)			**2019 to 2034**	
	Class 1		254	
	Class 2		85	
	Class 3		382	
	Class 4		127	
4) Truck Factors (4 Classes)				
	Class 1		0.5	
	Class 2		2.3	
	Class 3		1.6	
	Class 4		5.5	
5) Daily ESALs per Truck Class (4 Classes)				
	Class 1		127	
	Class 2		195	
	Class 3		611	
	Class 4		700	
6) Total Daily ESALs in Design Lane			**1633**	
7) Total Base Year ESALs			**2019**	
Number of Days of Truck Traffic			300	
	Total Base Year ESALs		**489,900**	
8) Cumulative ESALs for Design Period				
Design Period			15	
Annual Growth Rate (%)			0.83%	
Geometric Growth Factor			16.0	
			7,838,400	
	Cumulative ESALs for the Design Period		**7,838,400**	

Note: ESAL Calculations are based on "Procedures for Estimating Traffic Loads for Pavement Design",Hajek, J., 1995, and "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions" (MI-83), 2008.

Table F5
Cawthra Road
1.0 Km North of Burnhamthorpe Road
Regional Municipality Of Peel
Equivalent Single Axle Load Calculations (Commercial Vehicle Data)

Description - Cawthra Road (1.0 Km North of Burnhamthorpe Road)

Traffic Data Year	**2017**	**2019**	**2034**
Design Year		**2019**	
Analysis Period	2	15	
1a) Average Annual Daily Truck Traffic (AADTT)	2,028	2,062	2,334
Annual Growth Rate (%)	0.83%	0.83%	
1b) Truck fraction of total traffic		100.0%	
Number of lanes in one direction		2	
1c) Directional Factor		0.5	
1d) Lane distribution Factor		0.8	
Daily Truck Volume		**825**	

2) Breakdown of Truck Portions (10 Classes)

	2019 to 2034
FHWA Vehicle Class 4	8.0%
FHWA Vehicle Class 5	30.5%
FHWA Vehicle Class 6	12.5%
FHWA Vehicle Class 7	23.0%
FHWA Vehicle Class 8	14.5%
FHWA Vehicle Class 9	4.7%
FHWA Vehicle Class 10	1.5%
FHWA Vehicle Class 11	0.1%
FHWA Vehicle Class 12	0.0%
FHWA Vehicle Class 13	5.0%

3) Truck Factors (10 Classes)

FHWA Vehicle Class 4	2.0
FHWA Vehicle Class 5	0.3
FHWA Vehicle Class 6	0.9
FHWA Vehicle Class 7	4.0
FHWA Vehicle Class 8	1.1
FHWA Vehicle Class 9	1.6
FHWA Vehicle Class 10	4.0
FHWA Vehicle Class 11	1.0
FHWA Vehicle Class 12	4.3
FHWA Vehicle Class 13	5.6

4) Total Daily ESALs in Design Lane	**1539**

5) Total Base Year ESALs	**2019**
Number of Days of Truck Traffic	300
Total Base Year ESALs	**461,700**

6) Cumulative ESALs for Design Period

Design Period	15
Annual Growth Rate (%)	0.83%
Geometric Growth Factor	16.0
Cumulative ESALs for the Design Period	**7,387,200**

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Table F5a
Cawthra Road
1.0 Km North of Burnhamthorpe Road
Regional Municipality Of Peel
Equivalent Single Axle Load Calculations (AADT DATA)

Description - Cawthra Road (1.0 Km North of Burnhamthorpe Road)				
Traffic Data Year		**2017**	**2019**	**2034**
Design Year			**2019**	
Analysis Period		2	15	
1a) Average Annual Daily Traffic (AADT)		30,085	30,586	34,624
Annual Growth Rate (%)		0.83%	0.83%	
1b) Truck fraction of total traffic			6.2%	
Number of lanes in one direction			2	
1c) Directional Factor			0.5	
1d) Lane distribution Factor			0.8	
	Daily Truck Volume		**759**	
Road Classification			**Urban Principal Arterial**	
2) Breakdown of Truck Proportions				
	Class 1		30.0%	
	Class 2		10.0%	
	Class 3		45.0%	
	Class 4		15.0%	
3) Daily Truck Volumes (4 Classes)			**2019 to 2034**	
	Class 1		228	
	Class 2		76	
	Class 3		342	
	Class 4		114	
4) Truck Factors (4 Classes)				
	Class 1		0.5	
	Class 2		2.3	
	Class 3		1.6	
	Class 4		5.5	
5) Daily ESALs per Truck Class (4 Classes)				
	Class 1		114	
	Class 2		175	
	Class 3		546	
	Class 4		626	
6) Total Daily ESALs in Design Lane			**1462**	
7) Total Base Year ESALs			**2019**	
Number of Days of Truck Traffic			300	
	Total Base Year ESALs		**438,600**	
8) Cumulative ESALs for Design Period				
Design Period			15	
Annual Growth Rate (%)			0.83%	
Geometric Growth Factor			16.0	
			7,017,600	
	Cumulative ESALs for the Design Period		**7,017,600**	

Note: ESAL Calculations are based on "Procedures for Estimating Traffic Loads for Pavement Design",Hajek, J., 1995, and "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions" (MI-83), 2008.

Table F6

1993 AASHTO FLEXIBLE PAVEMENT DESIGN

File No.: 1-18-0615

Project Name: Cawthra Road - Sta. 9+960 to Sta. 12+750

Design Structural Number for Future Traffic

Design ESALs:	7,968,000
Initial Serviceability:	4.5
Terminal Serviceability:	2.5
Level of Reliability (%):	85
Overall Standard Deviation:	0.44
Subgrade Resilient Modulus (MPa):	35
Design Structural Number:	128

Effective Structural Number of Existing Pavement

Pavement Components	Thickness (mm)	Structural Coefficient	Drainage Coefficient	Structural Number
HMA			1.0	0
Base Course			0.9	0
Subbase Course			0.9	0
Total	0			0

The existing pavement is structurally inadequate.

New Pavement Structural Design

Pavement Components	Thickness (mm)	Structural Coefficient	Drainage Coefficient	Structural Number
HMA	150	0.42	1.0	63
Base Course	150	0.14	1.0	21
Subbase Course	450	0.12	1.0	54
Total	750			138

The designed pavement is structurally adequate.

Table F7

1993 AASHTO FLEXIBLE PAVEMENT DESIGN

File No.: 1-18-0615

Project Name: Cawthra Road - Sta. 12+750 to Sta. 14+220

Design Structural Number for Future Traffic

Design ESALs:	10,401,600
Initial Serviceability:	4.5
Terminal Serviceability:	2.5
Level of Reliability (%):	85
Overall Standard Deviation:	0.44
Subgrade Resilient Modulus (MPa):	35
Design Structural Number:	132

Effective Structural Number of Existing Pavement

Pavement Components	Thickness (mm)	Structural Coefficient	Drainage Coefficient	Structural Number
HMA			1.0	0
Base Course			0.9	0
Subbase Course			0.9	0
Total	0			0

The existing pavement is structurally inadequate.

New Pavement Structural Design

Pavement Components	Thickness (mm)	Structural Coefficient	Drainage Coefficient	Structural Number
HMA	150	0.42	1.0	63
Base Course	150	0.14	1.0	21
Subbase Course	450	0.12	1.0	54
Total	750			138

The designed pavement is structurally adequate.

Table F8

1993 AASHTO FLEXIBLE PAVEMENT DESIGN

File No.:	1-18-0615
Project Name:	Cawthra Road - Sta. 14+220 to Sta. 15+460

Design Structural Number for Future Traffic

Design ESALs:	7,387,200
Initial Serviceability:	4.5
Terminal Serviceability:	2.5
Level of Reliability (%):	85
Overall Standard Deviation:	0.44
Subgrade Resilient Modulus (MPa):	30
Design Structural Number:	132

Effective Structural Number of Existing Pavement

Pavement Components	Thickness (mm)	Structural Coefficient	Drainage Coefficient	Structural Number
HMA			1.0	0
Base Course			0.9	0
Subbase Course			0.9	0
Total	0			0

The existing pavement is structurally inadequate.

New Pavement Structural Design

Pavement Components	Thickness (mm)	Structural Coefficient	Drainage Coefficient	Structural Number
HMA	150	0.42	1.0	63
Base Course	150	0.14	1.0	21
Subbase Course	450	0.12	1.0	54
Total	750			138

The designed pavement is structurally adequate.

Table F9

1993 AASHTO FLEXIBLE PAVEMENT DESIGN

File No.:	1-18-0615
Project Name:	Cawthra Road - Sta. 12+750 to Sta. 14+220

Design Structural Number for Future Traffic

Design ESALs:	10,401,600
Initial Serviceability:	4.5
Terminal Serviceability:	2.0
Level of Reliability (%):	85
Overall Standard Deviation:	0.44
Subgrade Resilient Modulus (MPa):	38
Design Structural Number:	121

Effective Structural Number of Existing Pavement

Pavement Components	Thickness (mm)	Structural Coefficient	Drainage Coefficient	Structural Number
HMA	175	0.28	1.0	49
Base Course	150	0.12	1.0	18
Subbase Course	255	0.09	1.0	23
Total	580			90

The existing pavement is structurally inadequate.

Full Depth Asphalt Replacement

Pavement Components	Thickness (mm)	Structural Coefficient	Drainage Coefficient	Structural Number
New HMA	175	0.42	1.0	74
Base Course	150	0.12	1.0	18
Subbase Course	255	0.09	1.0	23
Total	580			115

The designed pavement is structurally inadequate.

Table F10

1993 AASHTO FLEXIBLE PAVEMENT DESIGN

File No.: 1-18-0615

Project Name: Cawthra Road - Sta. 12+750 to Sta. 14+220

Design Structural Number for Future Traffic

Design ESALs:	10,401,600
Initial Serviceability:	4.5
Terminal Serviceability:	2.0
Level of Reliability (%):	85
Overall Standard Deviation:	0.44
Subgrade Resilient Modulus (MPa):	38
Design Structural Number:	121

Effective Structural Number of Existing Pavement

Pavement Components	Thickness (mm)	Structural Coefficient	Drainage Coefficient	Structural Number
HMA	175	0.28	1.0	49
Base Course	150	0.12	1.0	18
Subbase Course	255	0.09	1.0	23
Total	580			90

The existing pavement is structurally inadequate.

Mill and HMA Overlay Design

Mill (mm): **90**

HMA Overlay (mm): **90**

Pavement Components	Thickness (mm)	Structural Coefficient	Drainage Coefficient	Structural Number
New HMA	90	0.42	1.0	38
Remaining AC	85	0.28	1.0	24
Base Course	150	0.12	1.0	18
Subbase Course	255	0.09	1.0	23
Total	580			103

The designed pavement is structurally inadequate.

Table F11

1993 AASHTO FLEXIBLE PAVEMENT DESIGN

File No.: 1-18-0615

Project Name: Cawthra Road - Sta. 14+220 to Sta. 15+460

Design Structural Number for Future Traffic

Design ESALs:	7,387,200
Initial Serviceability:	4.5
Terminal Serviceability:	2.0
Level of Reliability (%):	85
Overall Standard Deviation:	0.44
Subgrade Resilient Modulus (MPa):	40
Design Structural Number:	114

Effective Structural Number of Existing Pavement

Pavement Components	Thickness (mm)	Structural Coefficient	Drainage Coefficient	Structural Number
HMA	140	0.28	1.0	39
Base Course	150	0.12	1.0	18
Subbase Course	310	0.09	1.0	28
Total	600			85

The existing pavement is structurally inadequate.

Full Depth Asphalt Replacement

Mill (mm): **HMA Overlay (mm):**

Pavement Components	Thickness (mm)	Structural Coefficient	Drainage Coefficient	Structural Number
New HMA	140	0.42	1.0	59
Base Course	150	0.12	1.0	18
Subbase Course	310	0.09	1.0	28
Total	600			105

The designed pavement is structurally inadequate.

Table F12
1993 AASHTO FLEXIBLE PAVEMENT DESIGN

File No.:	1-18-0615
Project Name:	Cawthra Road - Sta. 14+220 to Sta. 15+460

Design Structural Number for Future Traffic

Design ESALs:	7,387,200
Initial Serviceability:	4.5
Terminal Serviceability:	2.0
Level of Reliability (%):	85
Overall Standard Deviation:	0.44
Subgrade Resilient Modulus (MPa):	40
Design Structural Number:	114

Effective Structural Number of Existing Pavement

Pavement Components	Thickness (mm)	Structural Coefficient	Drainage Coefficient	Structural Number
HMA	140	0.28	1.0	39
Base Course	150	0.12	1.0	18
Subbase Course	310	0.09	1.0	28
Total	600			85

The existing pavement is structurally inadequate.

Mill and HMA Overlay Design

Mill (mm): **100** **HMA Overlay (mm):** **100**

Pavement Components	Thickness (mm)	Structural Coefficient	Drainage Coefficient	Structural Number
New HMA	100	0.42	1.0	42
Remaining AC	40	0.28	1.0	11
Base Course	150	0.12	1.0	18
Subbase Course	310	0.09	1.0	28
Total	600			100

The designed pavement is structurally inadequate.