



Terraprobe

*Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing*

**GEOTECHNICAL INVESTIGATION & DESIGN REPORT
BLOOMINGTON ROAD WIDENING & RAMP REALIGNMENTS
HIGHWAY 404/BLOOMINGTON ROAD INTERCHANGE
REGIONAL MUNICIPALITY OF YORK, ONTARIO
GEOCRE No.: 30M14-448**

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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 detailed engineering design for Bloomington Road widening, and ramp realignments of the Highway 404 and Bloomington Road interchange in the Regional Municipality of York, Ontario. A site location plan is provided as Figure 1 and site photographs are presented in Figures 2 and 3.

The scope of work for the geotechnical engineering services of this project is outlined in Terraprobe's proposal titled *"Proposal for Geotechnical Engineering Services Bloomington Road Widening, Ramp Realignment at Highway 404 and Bloomington Road Interchange, The Regional Municipality of York"* dated November 03, 2015.

The purpose of this investigation was to explore the subsurface conditions at the site by borehole drilling and pavement coring, in-situ testing and; laboratory testing on soil samples. The data obtained from this investigation was used to provide Borehole Location Plans, Borehole Logs, laboratory test results, a description of the subsurface conditions and geotechnical design recommendations.

2.0 PROJECT AND SITE DESCRIPTION

Bloomington Road is an east-west oriented arterial roadway, consisting mainly of two through lanes in each direction. The roadway is approximately 825 m long within the project limits and passes below the CN railway tracks and Highway 404. Bloomington Road also crosses a marsh (on both sides of the road) that exists between the west project limit easterly to about Sta. 9+635.

The Regional Municipality of York carried out improvements to Bloomington Road under Contract No. 11-105. The work included road improvements with a focus of minimizing impacts to the marsh as well as replacing existing culverts. Provisions for erosion and sedimentation controls adjacent to the marsh were also implemented.

3.0 INVESTIGATION PROCEDURES

A visual pavement condition evaluation was carried out in March 2016 and the site investigation and field testing were carried out on March 14 and 15, 2016. Details of the field investigation are presented below.

- Drilling eighteen pavement boreholes through the existing shoulders and lanes of Bloomington Road in both directions to a depth of approximately 1.5 m below ground surface;
- Asphalt concrete coring at two borehole locations on the main lanes of Bloomington Road;
- Drilling three boreholes adjacent to Bloomington Road at locations of the proposed GO Station access roads to depths of approximately 2.4 m below ground surface;
- Manually excavating seven shallow test pits to estimate topsoil thickness in the road widening areas;
- Manually probing the wetland area on the south side of Bloomington Road at three locations to estimate the thickness of soft/weak and organic deposits; and
- Drilling one foundation borehole (BH1) to a depth of 9.6 m below ground surface in the vicinity of the concrete culvert at Sta. 9+525.

The borehole and test pit locations were marked in the field by Terraprobe's field staff in relation to existing features shown on the base plan provided by IBI and Borehole 1 was surveyed for coordinates and geodetic



elevation with a Trimble R10 Receiver connected to the Global Navigation Satellite System. The approximate borehole, probe and test pit locations are shown in Figure 4.

Utility clearances and permits were obtained by Terraprobe prior to drilling and a member of Terraprobe's technical staff observed and recorded the borehole drilling and sampling operations on a full-time basis.

The boreholes were drilled with either a CME 55 truck-mounted drill rig or a track mounted power probe supplied and operated by specialist drilling contractors. Borehole 1 was extended through the overburden soils using hollow stem augering techniques and soil samples were obtained at intervals of depth ranging from 0.75 m to 1.5 m, using a 50 mm outer diameter (O.D.) split-spoon sampler in conjunction with the Standard Penetration Test (SPT) procedures as specified in ASTM Method D1586¹. The ground water condition was observed during and immediately following the drilling operation and a standpipe piezometer consisting of a 50 mm diameter PVC pipe with a slotted screen, was installed and enclosed in sand in Borehole 1 to permit longer term ground water level monitoring.

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. The results of the soil testing program, are presented on the Borehole Logs in Appendix A and on the figures in Appendix B. The pavement core data and photographs are provided in Appendix A and the visual pavement condition survey data is included in Appendix C.

Five soil samples were also submitted to Agat Laboratories for soil chemical testing to assess soil disposal options for excess soils generated during construction. The results of the soil chemical tests are provided in Appendix D.

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. An overall description of the subsurface conditions is provided in the following paragraphs under two sections viz. Pavement Structure (Bloomington Road) and Culvert at Sta. 9+525.

The stratigraphic boundaries shown on the Borehole Logs are inferred from non-continuous soil sampling as well as observations during drilling and, therefore represent transitions between soil types rather than exact planes of geological change. The subsurface conditions will vary between and beyond the borehole locations.

4.1 Pavement Structure

The average pavement structure of Bloomington road is summarized below.

Road	Station	Average Thickness (mm)		
		HMA	Granular	Total
Bloomington Road	East Limit to West Limit	165	640	805

The granular material comprising the base/subbase course of the road generally consists of an upper gravelly sand material averaging 165 mm in thickness that is further underlain by a sand subbase. On

¹ ASTM D1586 – Standard Test Method for Standard Penetration Tests and Split Barrel Sampling of Soils.



contract drawings the base and subbase courses are identified as Granular A and Granular C materials respectively.

Two 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 I. The natural water content of two samples of the granular base/subbase are 3% and 4%.

4.1.1 Topsoil and Wetland Deposits

At the test pit locations, the measured topsoil thicknesses generally ranged 100 mm to 260 mm. Topsoil thickness may vary between and beyond the test pit locations. The wetland area on the south side of Bloomington Road was manually probed to estimate the depth of soft/weak soils and organic deposits. These deposits were found to be approximately 725 mm to 915 mm thick.

4.1.2 Subgrade Soils

The subgrade soil encountered at this site generally consists of sand to sand and silt with trace gravel. The moisture contents of two samples of the subgrade soil samples are 5% and 9% by weight. The results of particle size analysis conducted on two samples of the sand to sand and silt subgrade soils are shown in Figure B2 in Appendix B.

Based on the particle size analysis the sand to sand and silt soils have a low frost susceptibility (LSFH) and their erodibility (K factor) varies from 0.09 to 0.22

4.2 Culvert at Sta. 9+525

4.2.1 Flexible Pavement

Borehole 1 was drilled through the shoulder of the Bloomington Road. This borehole encountered a flexible pavement consisting of 180 mm thick asphaltic concrete underlain by a 1220 mm thick layer of granular base that extends to elevation 299.7 m. The natural water content (by weight) of a sample of the granular fill is 5%.

4.2.2 Fill – Gravel

A layer of gravel fill material was encountered below the flexible pavement in Borehole 1 and the thickness, depth and base elevation of the gravel fill is summarized in the following table.

Gravel Fill Borehole Data

Borehole No.	Fill Thickness (m)	Fill Depth (m)	Fill Base Elevation (m)
BH1	0.7	2.1	299.0

A Standard Penetration test performed in the gravel fill measured a SPT N-value of 20 blows for 0.3 m of penetration indicating a compact relative density.



4.2.3 Peat

The gravel fill is underlain by a layer of fibrous peat. Summarized below is the thickness, depth and base elevation of the peat.

Peat Borehole Data

Borehole No.	Peat Thickness (m)	Peat Depth (m)	Peat Base Elevation (m)
BH1	1.9	4.0	297.1

The natural water content of the peat is 499%.

4.2.4 Silty Sand to Sand

Silty sand and sand layers were encountered in Borehole 1 and the locations, thicknesses, depths and base elevations of the silty sand and sand are summarized in the following table.

Silty Sand and Sand Borehole Data

Borehole No.	Silty Sand and Sand Thickness (m)	Silty Sand and Sand Depth (m)	Silty Sand and Sand Base Elevation (m)
BH1	1.6	5.6	295.5
BH1	2.5	9.6*	291.5

* Borehole termination depth.

Standard Penetration tests performed in the silty sand and sand deposits measured SPT N-values ranging from 14 to 41 blows for 0.3 m of penetration indicating a compact to dense relative density. The natural water contents of a sample of the silty sand and a sample of the sand deposits are 16% and 24% by weight.

A grain size distribution plot of a sample of the silty sand deposit is depicted on Figure B3 in Appendix B. The results show a grain size distribution consisting of 4% gravel, 60% sand, 32% silt and, 4% clay sized particles.

4.2.5 Silty Clay

The silty sand and sand layers are divided by a silty clay deposit in Borehole 1. Summarized below is the location, thickness, depth and base elevation of the silty clay deposit.

Silty Clay Borehole Data

Borehole No.	Silty Clay Thickness (m)	Silty Clay Depth (m)	Silty Clay Base Elevation (m)
BH1	1.5	7.1	294.0

A Standard Penetration test carried out in the silty clay deposit measured a SPT N-value of 7 blows for 0.3 m of penetration suggesting a firm consistency. The natural water content of a sample of the silty clay deposit is 26% by weight.

The grain size distribution curve of a sample of the silty clay layer is shown in Figure B4 in Appendix B. These results show a grain size distribution consisting of 0% gravel, 4% sand, 52% silt and, 44% clay sized particles.



4.3 Ground Water Level

Borehole 1 was instrumented with a 50 mm diameter standpipe piezometer. The water level readings measured on separate visits made after the completion of drilling are presented below.

Borehole No.	Date	Water Levels	
		Depth (m)	Elevation (m)
1	April 12, 2016	1.8	299.3
	April 22, 2016	1.8	299.3

The readings taken in the piezometer are considered to be stabilised water levels. However, the ground water level can be expected to fluctuate seasonally and after severe weather events. The ground water level will also be controlled by the free water level in the wetland.

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 General

This section of the report presents an interpretation of the factual geotechnical data and provides geotechnical 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 future GO Station proposed at the southwest quadrant of the Highway 404/Bloomington Road East Interchange will require widening Bloomington Road as well as interchange ramp realignments. Geotechnical recommendations are provided in this report for the following design features:

- At Sta. 9+525 - Removing 4.9 m of the existing twin 1.8 m x 1.2 m concrete culverts measuring 34.5 m in length on the south side of Bloomington Road and; extending with twin 9.7 m x 1.8 m x 1.2 m concrete box culverts. The existing and proposed fill height on the culverts is 1.0 m±; and
- Pavement designs for Bloomington road widening and the future GO Station access roads.

5.2 Pavements

5.2.1 Pavement Condition

A visual pavement condition survey of Bloomington Road was completed in March 2016 in accordance with the procedures outlined in the Ministry of Transportation of Ontario (MTO) *Manual for Condition Rating of Flexible Pavements - Distress Manifestations (SP-024)*. The Pavement Condition Evaluation Forms are included in Appendix C and, the observed pavement distresses and pavement condition of the evaluated pavement sections are summarized in the following table.



Section	Overall Condition	General Distresses
Bloomington Road Sta. 9+460 to Sta. 9+800	PCR = 90, RCR = 9.0 Good	<ul style="list-style-type: none"> Frequent slight ravelling and coarse aggregate loss.
Bloomington Road Sta. 9+800 to Sta. 9+880	PCR = 40, Fair	<ul style="list-style-type: none"> Throughout moderate ravelling and coarse aggregate loss; Intermittent slight distortion; Frequent slight single and multiple longitudinal wheel track cracking; Throughout moderate single and multiple centre line cracking; Throughout slight single and multiple pavement edge cracking; Extensive moderate half, full and multiple transverse cracking; Throughout slight longitudinal meander and midlane cracking; Extensive slight random/map cracking.
Bloomington Road Sta. 9+880 to Sta. 10+275	PCR = 85, RCR = 8.5 Good	<ul style="list-style-type: none"> Frequent slight ravelling and coarse aggregate loss. Frequent very slight half, full and multiple transverse cracking.

5.2.2 Traffic Data

It is understood that Bloomington Road will be selectively widened within the project limits to accommodate access in and egress out of the proposed GO Station. The traffic data provided by IBI, interpreted data and derived Equivalent Single Axle Loads (ESALs) are tabulated below:

Parameters	Bloomington Road	Access Roads
AADT (2013)	15,200	
Projected AADT (2017)	19,960	4,300
Projected AADT (2021)	22,550	5,700
Projected AADT (2026)	26,840	8,400
Projected AADT (2031)	29,590	-
Projected AADT (2037)	33,375	19,705
Annual Growth Rate (2013 – 2017)	7%	-
Annual Growth Rate (2017 – 2021)	3.1%	7.3%
Annual Growth Rate (2021 – 2026)	3.5%	8.1%
Annual Growth Rate (2026 – 2037)	2%	8.1%
Percent Commercial Vehicles	10%	7% buses
Design ESAL (2016 – 2031)	13,432,300	4,963,100

5.2.3 Pavement Designs

The pavements were designed based on the traffic information provided by IBI and the data obtained from the field investigations. Pavement designs were carried out for new construction (widening) as well as rehabilitation. 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; and
- American Association of State Highway and Transportation Officials, "AASHTO Guide for Design of Pavement Structures", 1993.

The pavement design parameters are summarized in the following table.

AASHTO Pavement Design Parameters

Design Parameter	Values	
Initial/Terminal Serviceability Index	$P_i = 4.4$ to 4.2	$P_t = 2.2$
Loss in Serviceability Index	2.2 to 2.0	
Desired Reliability (R %) and Standard Deviation (SD)	$R = 85$	$SD = 0.45$
Estimated Resilient Modulus of Subgrade Soil (MPa)	30 to 40	
Layer Coefficients of Hot Mix Asphalt (HMA)	New HMA = 0.42	Existing HMA = 0.35
Layer Coefficient of Granular Materials	Gran. A = 0.14 Existing Gran. A = 0.12	Gran. B Type I = 0.09 Existing Gran. C = 0.09
Drainage Coefficient of Granular Materials	New Granular = 1.0	Existing Granular = 1.0

5.2.4 Pavement Structures (New Construction – Widening)

For the derived design traffic (ESAL's), the recommended pavement structures for new construction (widening and new alignment) are:

Pavement Component/Parameter	Bloomington Road (mm)	Access Roads (mm)
HMA Surface Course Superpave 12.5 FC2	40	40
HMA Binder Course Superpave 19	130*	100**
Granular 'A' Base Course	200	150
Granular 'B' Type I Subbase Course	500	500
Structural Number Provided	145	125
Design Structural Number	140	125
Superpave Design Traffic Category	D	C

* 2x65 mm thick lifts

** 2x50 mm thick lifts

5.2.5 Existing Pavement Rehabilitation

The structural capacity of Bloomington Road was analyzed using AASHTO's pavement overlay design procedure. For a service life extension of 20 years, a structural number of 130 mm is required to support the 20-year design load of 13,432,300 ESAL's. The effective structural number of the existing pavement is 119 mm for sections that were rehabilitated under Contract 11-105, concluding that this pavement is structurally deficient. However, the remaining service life of Bloomington Road is estimated to be 11 years and road rehabilitation at this time may not be warranted.

There is a section of Bloomington Road from about Sta. 9+800 to 9+880 that was not rehabilitated under Contract 11-105. This section requires rehabilitation based on our pavement condition evaluation which indicates that the road is in fair condition. We recommend that this section be rehabilitated by full depth



reconstruction in accordance with the recommended pavement structure tabulated above for Bloomington Road.

5.2.6 Paved Shoulders

Where full or partially paved shoulders are required, it is recommended that the top two lifts of hot mix asphalt on the main lanes be extended over the shoulders i.e. 40 mm of the Superpave 12.5 FC2 Surface Course and 65 mm of the Superpave 19.0 Binder Course.

5.2.7 Material Types

The following mix types are considered suitable for this project.

- Superpave 12.5 FC2 Surface Course; and
- Superpave 19.0 Binder Course.

Granular A material should be used for the shoulders and as base material for all new roadways and Granular B Type I is recommended as subbase material. Both the Granular A and the Granular B Type I material should meet the OPSS.MUNI 1010 specifications and Superpave mixes shall conform to OPSS.MUNI 1151.

5.2.8 Padding

Superpave 9.5 is recommended as padding. Padding should be placed in lifts not exceeding 50 mm.

5.2.9 Asphalt Cement Grade

Performance graded asphalt cement PG 64-28 conforming to OPSS MUNI 1101 requirements, is recommended for the surface course and upper binder course. PG 58-28 should be used for all other mixes located below the upper 100 mm of the pavement surface.

5.2.10 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 or milled surfaces and between all new lifts.

5.2.11 Pavement Tapers

At the limits of construction, appropriate tapering of the pavement thickness to match the existing pavement structure should be implemented.

5.2.12 Drainage

In all areas where a curb and gutter arrangement is present (urban sections), full-length subdrains shall be placed beneath the curb in accordance with the OPSD 216.021. To provide positive drainage across the



pavement platform the top of pavement should be sloped (normally 2%) and the pavement subgrade should be sloped at 3% towards the sides.

Where a rural pavement cross-section is proposed, ditches are required to collect and remove excess surface water. The ditches should be installed in accordance with OPSD 200.020. To promote drainage of the pavement structure, the Granular A base course must extend across the full width of the highway and must daylight in the ditches.

5.2.13 Compaction of Base & Sub-Base Material

All granular base and subbase materials should be placed in 150 mm lifts and compacted to 100% of the material's SPMDD at $\pm 2\%$ of its OMC. Asphalt concrete should be placed and compacted in accordance with the appropriate OPSS.

5.2.14 Pavement Removals

The paved, partially paved and granular shoulders of Bloomington Road will be removed to facilitate pavement widening. Refer to the tabulated average pavement component thicknesses in Section 4.1 for the appropriate asphalt and granular thickness to use for estimating purposes.

5.2.15 Stripping & Sub-excavation

For estimating purposes assume an average topsoil thickness of 100 mm in the widening areas. In the wetland area where the depth of soft/weak soils was assessed with a steel probe; an average overburden thickness of 900 mm can be assumed as requiring sub-excavation.

5.2.16 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 frost susceptibility of the sand and sand and silt soils is low.

5.2.17 Soil Erodibility

Refer to the borehole logs for the derived "K" factors. The soil erodibility of the subgrade soils is generally low based on "K" factors of 0.09 and 0.22.



5.3 Culvert Foundation

5.3.1 Geotechnical Resistances

Based on the subsurface stratigraphy, the recommended founding depth and geotechnical resistances for a structure (culvert extension) founded on undisturbed competent natural soils are:

Borehole Number	Existing Ground Surface Elevation (m)	Recommended Bottom of Footing Level Below Existing Ground Surface (m)	Founding Elevation (m)	Geotechnical Resistance		Subgrade Soil
				Factored ULS (kPa)	SLS (kPa)	
1	301.1	Below 4.0	Below 297.1	225	150	Silty Sand

Notes: 1) Working mat or skim coat required on all footing bases and positive dewatering measures required to lower and temporarily maintain the ground water level at least 0.3 m below the footing subgrade during construction.
2) Soft weak soils if encountered at the founding subgrade must be removed and replaced with OPSS 1010 Granular "A" compacted to 95% Standard Proctor Maximum Dry Density.

The geotechnical resistances values tabulated above are for concentric, vertical loads only. Effects of load inclination and eccentricity should be taken into account as outlined in the *Canadian Highway Bridge Design Code (CHBDC) CAN/CSA-S6-06*, Clause 6.7.3 and Clause 6.7.4. The SLS values provided correspond to a settlement of up to 25 mm and the designs should accommodate settlement between the existing culvert and its extension.

5.3.2 Ultimate Coefficient of Friction

Resistance to lateral forces/sliding resistance between the concrete footing and the subgrade soils should be evaluated in accordance with the CHBDC 2006. The following ultimate coefficient of friction values are recommended between concrete and the bedding material or subgrade soils.

- OPSS Granular A bedding – ultimate coefficient of friction of 0.7,
- Silty sand – ultimate coefficient of friction of 0.57.

5.3.3 Design Frost Depth

For frost protection purposes it is not necessary to found a box culvert at or below the frost depth, as the box structure is tolerant of small magnitudes of movement related to freeze-thaw cycles, should these occur. However, frost treatment for a box culvert should conform to OPSD 803.010.

5.3.4 Subgrade Preparation and Verification

Since the silty sand subgrade soil at the culvert site is susceptible to disturbance below the ground water table; the bedding material should be placed expeditiously to avoid disturbance of the foundation bearing surfaces. An alternative to the granular bedding would be to place a 100 mm thick concrete working slab on the subgrade. In this case, a 75 mm thick layer of OPSS.MUNI 1010 Granular A or concrete fine aggregate meeting the gradation requirements set out in OPSS.MUNI 1002 should be placed on top of the concrete working slab to provide a "levelling pad" for the box culvert extension.

The founding subgrade should be inspected by a geotechnical engineer following excavation, in accordance with OPSS 902; to check that all existing fill, organic soils or other unsuitable material have been removed.



Where subexcavation is required to remove unsuitable materials, the subexcavated area should be backfilled with OPSS Granular A that is placed and compacted in accordance with the requirements of OPSS.MUNI 501.

5.3.5 Lateral Earth Pressure

Earth pressures are generally calculated using the following expression:

$$P_h = K(\gamma h + q)$$

where P_h = horizontal pressure on the wall (kPa)

K = lateral earth pressure coefficient

γ = unit weight of retained soil (kN/m³)

h = depth below top of fill where pressure is computed (m)

q = value of any surcharge (kPa)

Earth pressures acting on the structure should be computed in accordance with Clause 6.9 of the CHBDC 2006 and according to Clause 6.9.3 of the CHBDC 2006; a compaction surcharge should also be added. For soils with an angle of internal friction ranging from 30° to 35° the magnitude should be 12 kPa at the top of the fill decreasing linearly to 0 kPa at a depth of 1.7 m; or decreasing linearly to 0 kPa at a depth of 2.0 m for soils with an angle of internal friction that exceeds 35°. Compaction equipment including hand operated vibratory equipment should be in accordance with OPSS 501.

Earth pressure coefficients for backfill to the culvert are dependent on the material used as backfill and typical values are provided in the following table.

Wall Condition	Earth Pressure Coefficient (K)			
	OPSS Granular A or OPSS Granular B Type II $\phi = 35^\circ$; $\gamma = 22.8 \text{ kN/m}^3$		OPSS Granular B Type I $\phi = 32^\circ$; $\gamma = 21.2 \text{ kN/m}^3$	
	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)
Active (Unrestrained Wall)	0.27	0.38*	0.31	0.46*
At rest (Restrained Wall)	0.43	-	0.47	-
Passive (Movement Towards Soil Mass)	3.70	-	3.25	-

* For wing walls.

The lateral earth pressure coefficients in the table above are "ultimate" values that require certain structural movements for the respective conditions to be mobilized. The values to use for design can be estimated from Figure C6.16 in the Commentary to the CHBDC, 2006.



5.3.6 Bedding and Backfill

Bedding material should consist of OPSS Granular A material meeting the OPSS.MUNI 1010 specifications. Additional bedding requirements that may be imposed by the supplier must also be followed. The bedding material should be placed in 150 mm thick loose lifts and uniformly compacted to at least 95% of the materials Standard Proctor Maximum Dry Density (SPMDD) using suitable compaction equipment.

All disturbed or softened soils and deleterious material must be removed from the base of the excavation before bedding material is placed. Poor/unsuitable soils may be encountered at the foundation subgrade level and these soils should be excavated and replaced with compacted fill consisting of OPSS Granular A material.

Backfill around the culvert should be carried out as per OPSD 803.010. The backfill should consist of free-draining, non-frost susceptible granular materials in accordance with OPSS.MUNI 1010 specifications. The backfill should be placed in loose lifts not exceeding 150 mm thick and should be compacted to at least 95% of the materials SPMDD. For fills below the ground water level or immediately below the roadway, it is recommended that Granular A material be used.

Equal heights of backfill should be maintained on both sides of the structure during all stages of backfill placement, and backfilling operations should be undertaken in accordance with OPSS 902. Heavy compaction equipment should not be used adjacent to the walls and roof of the culvert. Compaction equipment should be restricted in accordance with OPSS.MUNI 501.

The excavated soils at these sites can be used for backfilling purposes provided they are free of organics and other deleterious material. To achieve the specified compaction, soils must neither be too wet nor too dry of their optimum moisture content. Soils that are too wet cannot be used immediately because the material will have to be dried to a moisture content of $\pm 2\%$ of optimum. If the construction operations are time sensitive, the use of imported granular material may be considered. Soils that are dry of optimum can be used immediately provided that the material is moisture conditioned (i.e. water added) to achieve a moisture content of $\pm 2\%$ of optimum.

5.3.7 Temporary Shoring

Temporary protection systems should be designed in accordance with OPSS.MUNI 539 by a licensed Professional Engineer experienced in shoring design. The shape of the soil pressure distribution diagram behind a temporary protection system depends upon the type of soil to be supported and the amount of movement that can be permitted. The sequence of work will also alter the shape of the pressure diagram during the various construction phases.

Earth pressure computations must also take into account the ground water level. Above the ground water level, earth pressure is computed using the bulk unit weight of the retained soil. Below the ground water level, the earth pressures are computed using the submerged unit weight of the soil. A hydrostatic pressure is also applied if the retained soil is not fully drained.

Flexible shoring should be designed on the basis of the active earth pressure coefficient (K_a). In this case, the performance level should be Level 2 – Angular Distortion 1:200 but shall not be more than 25 mm. Where limited shoring movement (Performance Level 1A or 1B) is required the design should be based on the at rest earth pressure coefficient (K_0). For “kick out” design the lateral resistance should be computed on the basis of the passive earth pressure coefficient (K_p). It should be noted that the lateral earth pressure



coefficients chosen for design require certain movements for the active and passive conditions to be mobilized.

The appropriate lateral earth pressure parameters for use in the design of structures subject to unbalanced earth pressures are provided in the following table. These values are guideline values and, selection of the appropriate design parameters is the responsibility of the shoring designer.

Stratigraphic Unit	Friction Angle ϕ (degrees)	Unit Weight γ (kN/m)	Active Earth Pressure Coefficient	At - Rest Earth Pressure Coefficient	Passive Earth Pressure Coefficient
			K_a	K_o	K_p
Existing Fill Soils	30	19	0.33	0.50	3.00
Peat	0	11	1.00	1.00	1.00
Silty Sand & Sand	31	20	0.32	0.48	3.12
Silty Clay	28	19	0.36	0.53	2.77

The lateral earth pressure coefficients given above are "ultimate values" and require specific wall movements for the active and passive conditions to be mobilized. The values to use in design can be estimated from Figure C6.16 in the Commentary to the CHBDC, 2006.

The earth pressure coefficients are based on the assumption that the ground surface behind the temporary protection system is horizontal. Where the retained ground is sloping, the lateral earth pressure coefficients must be adjusted to account for the slope and, these earth pressure coefficients can be estimated from the equations provided on Figures C6.17 and C6.18 of the CHBDC 2006.

5.3.8 Erosion Protection

Erosion protection should be provided at the culvert inlet and outlet (including the slopes and sides). At the inlet area a clay seal can be provided such that water flow is channelled through the culvert and does not seep through the backfill around and underneath the structure. Therefore, the clay seal should extend to cover all the granular backfill materials, should be a continuous layer around the culvert, should have a minimum compacted thickness of 0.6 m, and should extend at least 1 m above the high water level. The clay seal should also be protected by a layer of rip-rap. Material used for the clay seal should conform to the requirements stipulated in OPSS 1205. Alternatively, concrete cut-off and head walls can be constructed to protect the granular backfill and prevent seepage around the culvert.

Concrete cut-off and head walls can also be used to protect the granular fill around the culvert outlet from erosion. In this case, however, filtered erosion protection such as rip-rap should be provided along the channel and the sides beyond the concrete cut-off and head walls at the outlet.

Design of an erosion protection scheme for the stream bed in the inlet and outlet areas will depend on hydrologic, hydraulic and/or other concerns. Typically, rip-rap protection should be provided to these areas. The rip-rap layer should cover all surfaces on the embankment slopes with which water is likely to be in contact.

We recommend that a qualified Hydraulics engineer be consulted to design the specifics of the culvert outlet and inlet (i.e. thickness and extent of protection).



5.3.9 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; and
- Silty Sand – Type 3 soil above the ground water table and Type 4 soil below the ground water table.

The side slopes of temporary excavations may be formed no steeper than 1H:1V for Type 3 soils and 3H:1V or flatter for Type 4 soils. Excavations should be undertaken in accordance with OPSS 902.

5.3.10 Ground Water Control

To allow excavation and culvert installation to be carried out, control of surface water and ground water will be necessary. To permit construction to proceed in sufficiently dry conditions we recommend using flow check dams in the marsh areas as per OPSD 219.200, to temporarily divert water away from the construction area.

The design of the unwatering system should be the Contractor's responsibility. In the marsh area the ground water level can be controlled by gravity drainage and pumping from strategically placed filtered sumps. For the culvert extension, the excavation will extend to the water-bearing silty sand deposit and dewatering of this deposit will be required to maintain the water level at least 0.3 m below the founding level during construction.

5.3.11 Embankments

The embankment fills in road widening areas are less than 4.0 m based on IBI's drawings. The global, internal and surficial stability of the embankments will depend on the slope geometry and also to a large degree on the material used to construct the embankment. Embankments constructed with approved acceptable indigenous earth fill, select subgrade material or non-cohesive earth fill may be designed with a side slope inclination of 2 Horizontal to 1 Vertical (2H:1V) or flatter.

It is estimated that the new fill will induce less than 15 mm of settlement in the foundation soils assuming that the existing roadway profile will not be raised. Embankments comprised of local earth fill will also settle during construction (fill compression) and this settlement is expected to be about 1% of the fill height. The settlement of non-cohesive fill should be immediate in nature and essentially be complete shortly after construction is complete.

Materials used for embankment construction should be placed in un-compacted lifts not exceeding 300 mm, and each lift should be uniformly compacted to at least 95 % of the material's SPMDD. Embankment construction should be carried out in accordance with OPSS.MUNI 501, OPSS MUNI 206 and in marsh areas, OPSS.MUNI 209, OPSD 203.020 and OPSD 203.030. Borrow material must meet the requirements of OPSS.MUNI 212 and benching between existing fill and new fill should be undertaken in accordance with OPSD 208.010.



Proper erosion control measures should be implemented both during construction and permanently. Temporary erosion and sediment control must be provided in accordance with OPSS 803 and OPSS 804. It is also imperative that the designs include provisions for preventing the flow of surface water down the face of slopes. Surface water must be directed to armoured outfalls/outlets designed to drain into roadside ditches.

5.4 Soil Chemical Analysis

Four soil samples were submitted to Agat Laboratories for chemical characterization with respect to general inorganic parameters including metals, pH, sodium adsorption ratio (SAR) and electrical conductivity (EC) to assess options for reuse or disposal of excess soils that will be generated during construction. Based on visual and/or olfactory screening of soil samples, these nominal parameters are analysed when there are no indications of environmental impacts. The Certificates of Analysis are included in Appendix D.

The analytical results were compared to Table 1 (Agricultural) of the *MOE Soil, Ground Water and Sediment Standards for Use under Part XV.1 of the Environmental Protection Act*, April 15, 2011. Comparison of the test results to the MOE Standard indicates that the tested soil parameters were generally below the guideline values. However, exceedances in electrical conductivity and/or sodium adsorption ratio were reported for all tested samples. These soils can be reused within the project's right of way, provided that they are not placed closer than a horizontal distance of 30 m measured from the bank of a water course or marsh area.

One selected soil sample was also submitted to Agat Laboratories for waste classification testing consisting of the Toxicity Characteristic Leaching Procedure (TCLP) of select metals and inorganics in accordance with Ontario Regulation 558. The results indicate that the concentrations of the analyzed parameters were below the guideline values. The Certificate of Analysis (O.Reg. 558 Metals and Inorganics) is included in Appendix D.

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. Therefore, additional sampling/testing may 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.

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.

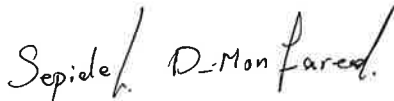
6.2 Changes in Site and Scope

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.

ASTM D1586 - 08a, *Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils*, 2008.

Canadian Standards Association (CSA), 2006. *Canadian Highway Bridge Design Code and Commentary on CAN/CSA S6 06*. CSA Special Publication, S6.1 06.

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

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.

Ministry of Transportation Ontario, *Adaption and Verification of AASHTO Pavement Design Guide for Ontario Conditions (MI-183)*, 2008.

Ministry of Transportation Ontario. *Pavement Design and Rehabilitation Manual (SDO 90-01)*, 1990.

Ministry of Transportation Ontario, *Manual for Condition Rating of Flexible Pavements - Distress Manifestations (SP-024)*, August 1989.

Ontario Provincial Standard Specifications (OPSS)

OPSS 206	Construction Specification for Grading.
OPSS.MUNI 209	Construction Specification for Embankments Over Swamps and Compressible Soils.
OPSS.MUNI 212	Construction Specification for Borrow.
OPSS.MUNI 501	Construction Specification for Compacting.
OPSS.MUNI 539	Construction Specification for Temporary Protection Systems.
OPSS 803	Construction Specification for Sodding.
OPSS 804	Construction Specification for Seed and Cover.
OPSS 902	Construction Specification for Excavating and Backfilling Structures.
OPSS.MUNI 1002	Material Specification for Aggregates – Concrete.
OPSS.MUNI 1010	Material Specification for Aggregates Base, Subbase, Select Subgrade and Backfill Material.
OPSS.MUNI 1101	Material Specification for Performance Graded Asphalt Cement.
OPSS.MUNI 1151	Material Specification for Superpave and Stone Mastic Asphalt Mixtures.
OPSS 1205	Material Specification for Clay Seal.

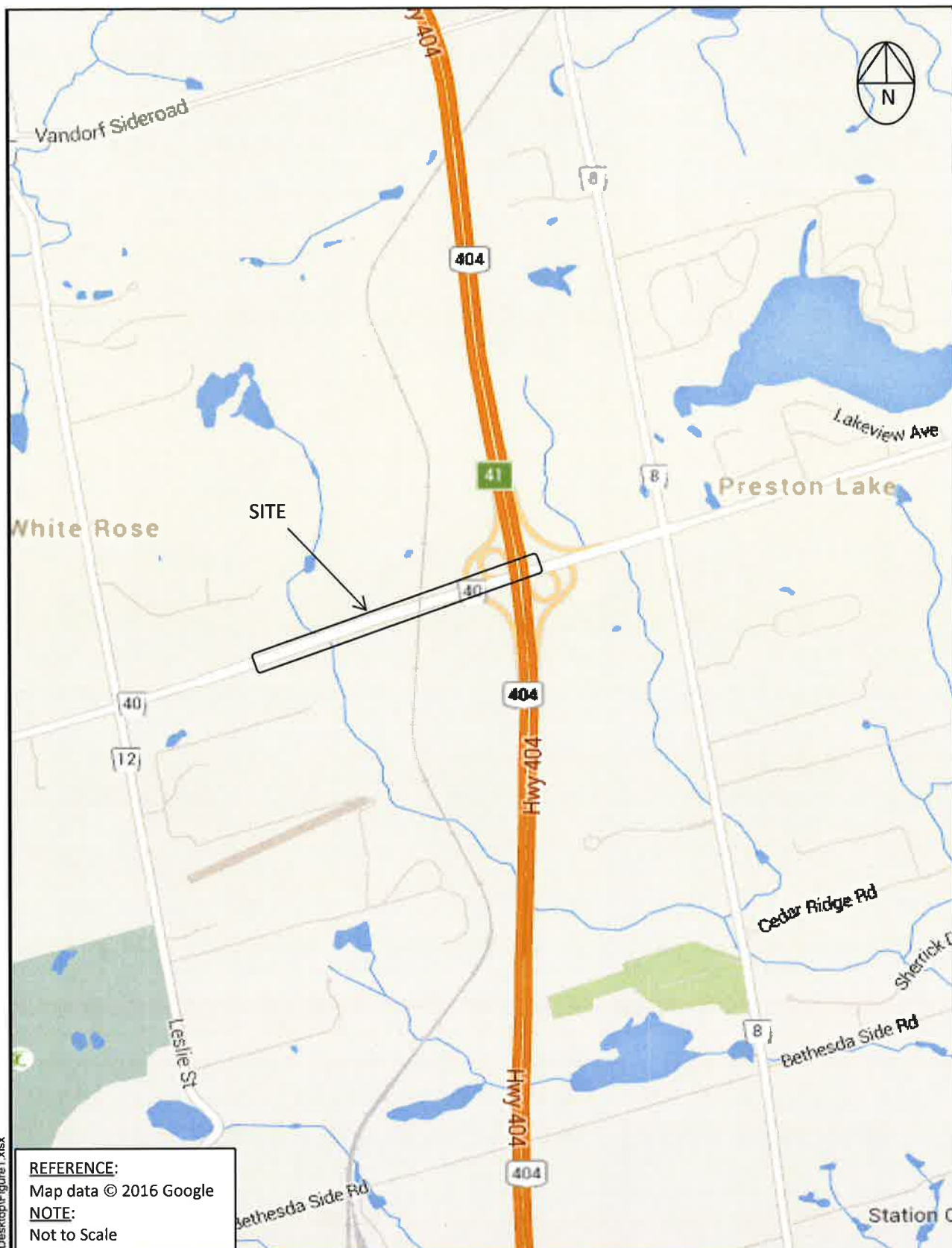
Ontario Provincial Standard Drawings (OPSD)

OPSD 200.020	Earth/Shale Grading, Divided Rural.
OPSD 203.020	Embankments Over Swamps, Existing Slope Excavated to 1H:1V.
OPSD 203.030	Embankments Over Swamps, Existing Slopes Maintained.
OPSD 208.010	Benching of Earth Slopes.
OPSD 216.021	Subdrain Pipe Connection and Outlet, Urban.
OPSD 219.200	Sandbag Flow Check Dam.
OPSD 803.010	Backfill and Cover For Concrete Culverts with Spans Less Than or Equal to 3 m.



FIGURES





SITE PHOTOGRAPHS

FIGURE 2



Photo1: Bloomington Road, West Project Limit, Looking East



Photo2: Bloomington Road, East Bound Lane Looking Towards East Project Limit

Project No. : 1-15-0795

Date : April, 2016



Terraprobe Inc.

Prepared by : SD

Checked by : RA

SITE PHOTOGRAPHS

FIGURE 3



Photo3: Bloomington Road, East Project Limit, Looking West



Photo4: Bloomington Road, West Bound Lane Looking Towards West Project Limit

Project No. : 1-15-0795

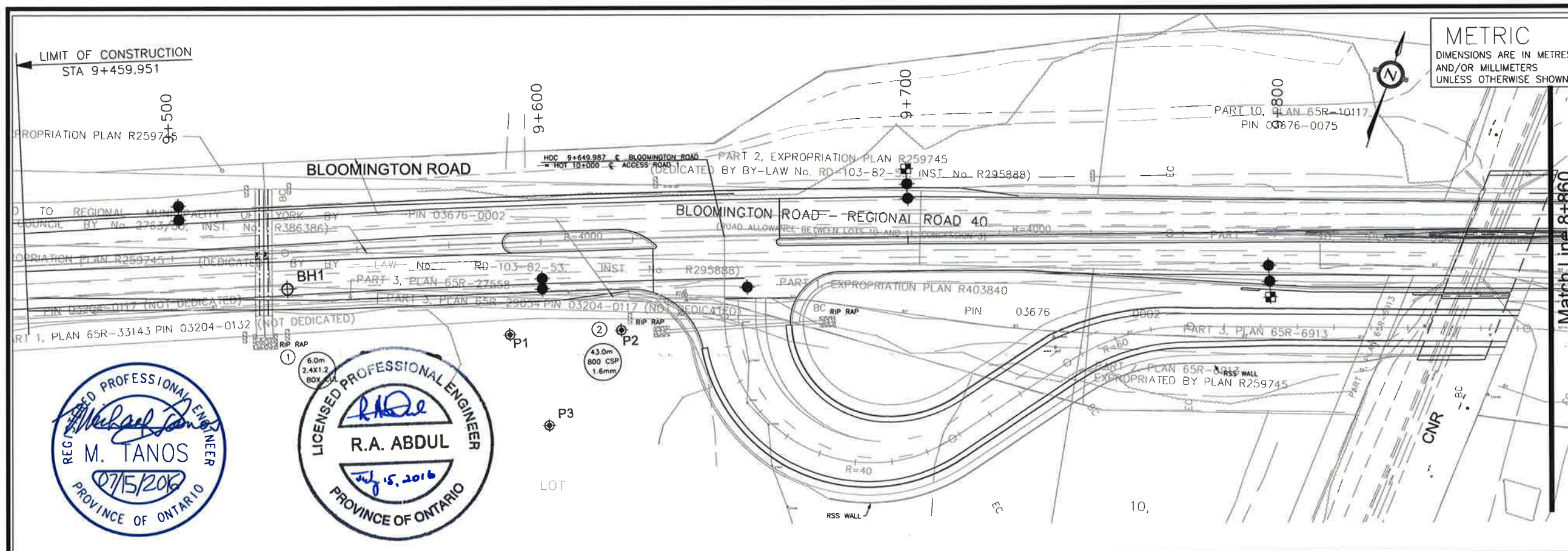
Date : April, 2016



Prepared by : SD

Checked by : RA

\\PDC\Server1\Project Files\001\15-0795 - Hwy 404 & Bloomington Rd Interchange - Reg of York\01-GEO Invert\A Dwg, Log\AutoCAD\15-0795 -Bloomington_MNC Figure 1-.dwg
Kamal

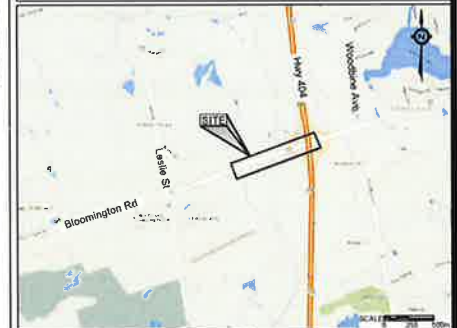


METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETERS
UNLESS OTHERWISE SHOWN

HIGHWAY 404 AND BLOOMINGTON
ROAD INTERCHANGE
YORK, ONTARIO
BOREHOLE LOCATION PLAN

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Construction Materials Engineering, Inspection & Testing
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KEY PLAN

LEGEND

- Pavement Borehole
- Probe
- Culvert Borehole
- Test Pit

No	ELEV.	COORDINATES	
		NORTHING	EASTING
BH1	301.1	4 870 407.0	628 248.0

SCALE



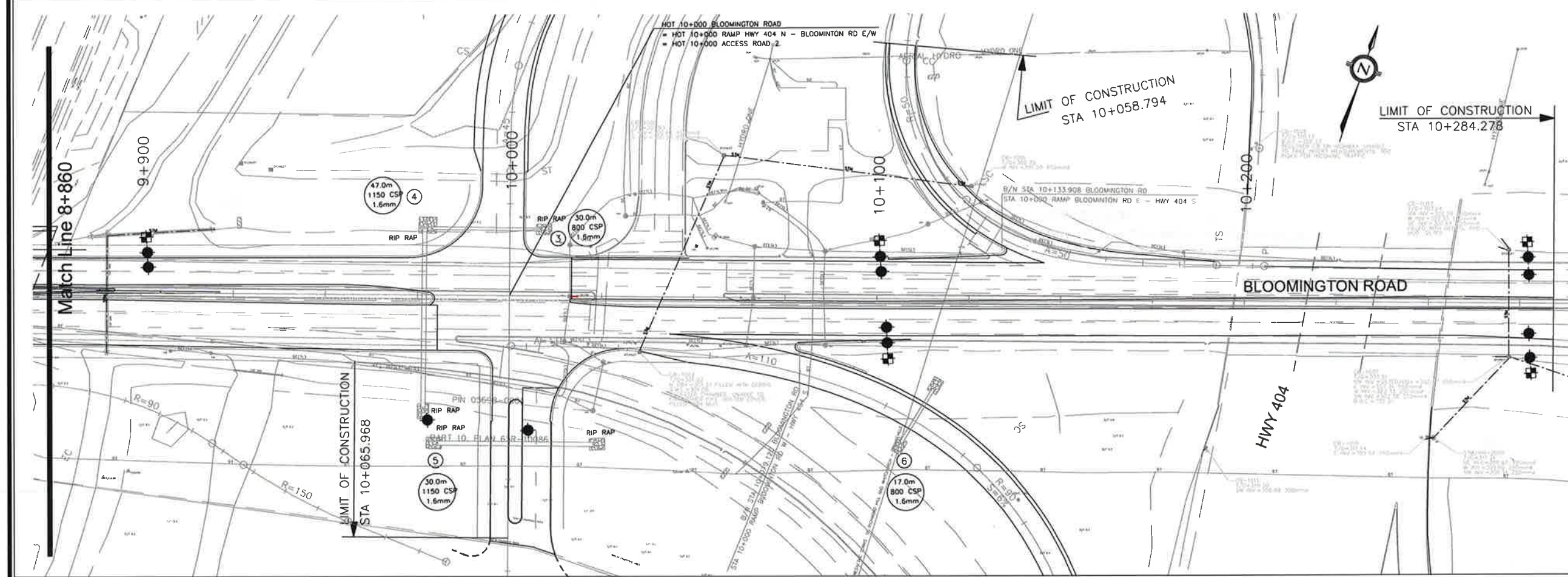
NOTE

Pavement boreholes are approximate locations. Refer to borehole logs.

REFERENCE

Drawing provided in digital format by IBI Group drawing file
Bloomington_BASE.dwg, Bloomington_MNC.dwg, Bloomington
Utility.dwg, Bloomington_MPROF.dwg received Jan. 28, 2016,
download from FTP site

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN RA	PROJECT No. 1-15-0795	DATE July 2016	
DRAWN KC	CHK RA	GEOCRETS No.: 30M14-44B FIGURE No. 4	



LIMIT OF CONSTRUCTION
STA 10+058.794

LIMIT OF CONSTRUCTION
STA 10+284.278

BLOOMINGTON ROAD

HWY 404

APPENDIX A

Borehole Logs & Core Data



Accep	acceptable	Gry	grey	Quant	quantity
Agg	aggregate	H	heavy	Reinf	reinforced
Amor	amorphous	Hi	highly	RF	rock fill
Asph	asphalt	HM	hot mix	RSS	remoulded shear strength
BH	borehole	HP	high plasticity	Sa (y)	sand (y)
Bl	blue	Ip	plasticity index	Sat	saturated
Bld (y)	boulder (y)	L	loose	SH	shale
Blds	boulders	Liq	liquid	Sh Rk	shot rock
Blk	black	Lo	loam	Si (y)	silt (y)
Br	brown	Lt	light	Sl (y)	slight (ly)
BR	bedrock	Matl	material	SP	slight plasticity
BU	break up	Max	maximum	SSM	select subgrade material
CF	channel face	MDD	maximum dry density	St	sensitivity
Cl (y)	clay (ey)	Med	medium	Stn (y)	stone (y)
Co	coarse	Mod	moderate	Stks	streaks
Cob	cobbles	Mott	mottled	Surf	surface
Comp	compact	MP	medium plasticity	Temp	temperature
Conc	concrete	Mrl	marl	TH	test hole
Contam	contaminated	Mul	mulch	TP	test pit
Cord	corduroy	MWD	maximum wet density	Tps	topsoil
Cr	crushed	NFP	no further progress	Tr	trace
D	dense	NFP (bls)	no further progress (boulders)	Unrein	unreinforced
Decomp	decomposed	Num	numerous	USS	undisturbed shear strength
Dk	dark	Ob	overburden	Varv	varved
DR	relative density	Occ	occasional	VF	very fine
E	earth	Ora	orange	w	field moisture content
F	fine	Org	organic	W	with
FB	frost boil	Org M	organic matter	WL	liquid limit
FH	frost heave	Pavt	pavement	Wd (y)	wood (y)
Fib	fibrous	Pedo	pedological	Weath	weathered
Fr Wat	free water	Pen Mac	penetration macadam	Wopt	optimum moisture content
Gr (y)	gravel (ly)	Poss	possible	Wp	plastic limit
Gran	granular	PST	prime and surface treated	WT	water table
Grn	green	Psty	polystyrene	Yel	yellow

SUSCEPTIBILITY TO FROST HEAVING

HSFH - High
MSFH - Medium
LSFH - Low

ONTARIO PROVINCIAL STANDARD DRAWING

ABBREVIATIONS

GEOTECHNICAL

Nov 2006 Rev 1



OPSD 100.060



SAMPLING METHODS	PENETRATION RESISTANCE
AS Auger sample GS Grab sample SS Split spoon ST Shelby tube WS Wash sample RC Rock core SC Soil core	<p>Standard Penetration Test (SPT) N-value (penetration resistance) is defined as the number of blows required to advance a standard 50 mm (2 in.) diameter split spoon sampler for a distance of 0.3 m (12 in.) with a hammer weighing 63.5 kg (140 lb.) falling freely for a distance of 0.76 m (30 in.).</p> <p>Dynamic Cone Penetration Test (DCPT) resistance is defined as the number of blows required to advance a conical steel point 50 mm (2 in.) base diameter tapered 60° to the apex and attached to 'A' size drill rods for a distance of 0.3 m (12 in.), with a hammer weighing 63.5 kg (140 lb.) falling freely for a distance of 0.76 m (30 in.).</p>

COHESIONLESS SOILS		COHESIVE SOILS			MINOR SOIL CONSTITUENTS	
Relative Density	N-value Blows/0.3m	Consistency	N-value Blows/0.3m	Undrained Shear Strength (kPa)	Modifier (e.g)	% by weight
Very loose	< 5	Very soft	< 2	< 12	trace (trace silt)	< 10
Loose	5 – 10	Soft	2 – 4	12 – 25	some (some silt)	10 – 20
Compact	10 – 30	Firm	4 – 8	25 – 50	(ey) or (y) (sandy)	20 – 35
Dense	30 – 50	Stiff	8 – 15	50 – 100	and (sand and silt)	> 35
Very dense	> 50	Very stiff	15 – 30	100 – 200		
		Hard	> 30	> 200		

TESTS AND SYMBOLS

MH	combined sieve and hydrometer analysis	▽	Unstabilized water level
w _i	water content	▽	1 st water level measurement
w _L	liquid limit	▽	2 nd water level measurement
w _P	plastic limit	▽	Most recent water level measurement
I _P	plasticity index	3.0 +	Undrained shear strength from field vane (with sensitivity)
k	coefficient of permeability	C _c	compression index (normally consolidated range)
γ	soil unit weight, bulk	C _r	recompression index (overconsolidated range)
G _s	specific gravity	c _v	coefficient of consolidation
φ'	effective angle of internal friction	m _v	coefficient of compressibility (volume change)
c'	effective cohesion	e	void ratio
c _u	undrained shear strength (φ = 0 analysis)		

FIELD MOISTURE DESCRIPTIONS

Dry	refers to a soil sample with a moisture content well below optimum ($w < w_{opt}$), absence of moisture, dusty, dry to the touch.
Moist	refers to a soil sample with a moisture content at or near optimum ($w \approx w_{opt}$), no visible pore water.
Wet	refers to a soil sample with a moisture content well above optimum ($w > w_{opt}$), has visible pore water.

PAVEMENT BOREHOLE LOGS

Bloomington Road, From Station 9+500 to Station 10+275

Hwy 404 and Bloomington Road Interchange

File No. 1-15-0795

9+600	EBL, SH
0 - 195	Asph
195 - 1.20	Br, Gr(y) Sa, Tr Si, Tr Cl, Dry to Moist
1.20 - 1.50	Br, Sa(y) Gr, Tr Cob, Moist
9+600	EBL, L2
0 - 190	Asph
190 - 1.30	Br, Gr(y) Sa, Tr Si, Tr Cl, Dry to Moist
1.30 - 1.50	Br, Sa(y) Gr, Tr Cob, Moist
9+650	EBL, DL, (D=-1.0 m)
0 - 75	Tps
75 - 1.75	Br, Gr(y) Sa, Tr to Some Si, Tr Cl, Moist
1.75 - 2.0	Br, Sa(y) Si, Tr Cl, Moist
2.0 - 2.40	Gry, Cl(ey) Si, Tr Sa, Moist
9+800	EBL, SH
0 - 1.50	Br, Sa and Gr, Tr Si, Moist
9+800	EBL, L2
0 - 170	Asph
170 - 330	Br, Gr(y) Sa, Tr Si, Tr Cl, Dry to Moist
330 - 1.50	Br, Sa, Some Si, Tr Cl, Tr Gr, Dry to Moist*
	*Sample Depth = 610 - 1.22
	Passing 4.75 mm = 96%
	2.00 mm = 94%
	425 µm = 71%
	75 µm = 16%
	5 µm = 8%
	2 µm = 5%
	w = 5%
	Frost Susc. = LSFH
	K Factor = 0.09
10+100	EBL, SH
0 - 70	Asph
70 - 360	Br, Gr(y) Sa, Tr Si, Tr Cl, Dry to Moist
360 - 1.50	Br, Sa, Tr Si, Tr Gr, Moist
10+100	EBL, L2
0 - 120	Asph
120 - 360	Br, Gr(y) Sa, Tr Si, Tr Cl, Dry to Moist
360 - 1.50	Br, Sa, Tr Si, Tr Gr, Moist
10+275	EBL, SH
0 - 75	Asph
75 - 350	Br, Gr(y) Sa, Tr Si, Tr Cl, Dry to Moist
350 - 1.50	Br, Sa, Tr Si, Tr Gr, Moist

10+275	EBL, L2
0 - 125	Asph
125 - 360	Br, Gr(y) Sa, Tr Si, Tr Cl, Dry to Moist
360 - 1.50	Br, Sa, Tr Si, Tr Gr, Moist
9+500	WBL, SH
0 - 155	Asph
155 - 1.20	Br, Sa and Gr, Tr Si, Dry to Moist
1.20 - 1.50	Br, Sa and Si, Some Cl, Tr Gr, Moist
9+500	WBL, L2
0 - 165	Asph
165 - 1.10	Br, Sa and Gr, Tr Si, Dry to Moist
1.10 - 1.50	Br, Sa and Si, Some Cl, Tr Gr, Moist*
	*Sample Depth = 610 - 1.22
	Passing 4.75 mm = 96%
	2.00 mm = 93%
	425 µm = 85%
	75 µm = 52%
	5 µm = 16%
	2 µm = 10%
	w = 9%
	Frost Susc. = LSFH
	K Factor = 0.22
9+700	WBL, SH
0 - 135	Asph
135 - 330	Br, Gr(y) Sa, Tr Si, Tr Cl, Dry to Moist
330 - 680	Br, Sa, Tr Si, Tr Gr, Moist
680 - 1.20	Br, Gr(y) Sa, Tr Si, Tr Cl, Dry to Moist
1.20 - 1.50	Br, Sa, Tr Si, Tr Gr, Moist
9+700	WBL, L2
0 - 175	Asph
175 - 340	Br, Gr(y) Sa, Tr to Some Si, Tr Cl, Dry*
340 - 620	Br, Sa, Tr Si, Tr Gr, Moist
620 - 1.50	Br, Sa(y) Gr, Tr Si, Moist
	*Sample Depth = 175 - 340
	Passing 26.5 mm = 100%
	19 mm = 99%
	13.2 mm = 92%
	9.5 mm = 87%
	4.75 mm = 70%
	1.18 mm = 52%
	300 µm = 32%
	75 µm = 13%
	w = 4%
	Unacceptable Granular A
	Unacceptable Granular B, Type I



PAVEMENT BOREHOLE LOGS

Bloomington Road, From Station 9+500 to Station 10+275

Hwy 404 and Bloomington Road Interchange

File No. 1-15-0795

9+900 WBL, SH
0 - 320 Br, Gr(y) Sa, Tr Si, Tr Cl, Dry to Moist
320 - 1.50 Br, Sa, Tr Si, Tr Gr, Moist

9+900 WBL, L2
0 - 180 Asph
180 - 360 Br, Gr(y) Sa, Tr Si, Tr Cl, Dry to Moist
360 - 1.50 Br, Sa, Tr Si, Tr to Some Gr, Moist

10+100 WBL, SH
0 - 145 Asph
145 - 320 Br, Gr(y) Sa, Tr Si, Tr Cl, Dry to Moist
350 - 1.50 Br, Sa, Tr Si, Tr Gr, Moist

10+100 WBL, L2
0 - 175 Asph
175 - 340 Br, Gr(y) Sa, Tr Si, Tr Cl, Dry*
340 - 1.50 Br, Sa, Tr Si, Tr Gr, Moist

*Sample Depth = 175 - 340
Passing 26.5 mm = 100%
19 mm = 100%
13.2 mm = 94%
9.5 mm = 90%
4.75 mm = 74%
1.18 mm = 54%
300 µm = 28%
75 µm = 12%
w = 3%

Unacceptable Granular A
Unacceptable Granular B, Type I

10+275 WBL, SH
0 - 100 Asph
100 - 350 Br, Gr(y) Sa, Tr Si, Tr Cl, Dry to Moist
350 - 1.50 Br, Sa, Tr Si, Tr Gr, Moist

10+275 WBL, L2
0 - 180 Asph
180 - 350 Br, Gr(y) Sa, Tr Si, Tr Cl, Dry to Moist
350 - 1.50 Br, Sa, Tr Si, Tr Gr, Moist

Access Road 2

10+035 20.0 m Rt of CL, (D=0.0)
0 - 150 Tps
150 - 2.30 Br, Sa, Tr to Some Si, Tr Gr, Moist to 1.2 m, Wet
Below 1.2 m
2.30 - 2.40 Gry, Sa, Some Si, Tr Cl, Wet

10+035 5.0 m Lt of CL, (D=0.0)
0 - 150 Tps
150 - 1.15 Br, Sa, Tr to Some Si, Tr Gr, Moist
1.15 - 1.40 Br, Sa Si, Tr Gr, Tr to Some Cl, Moist to Wet
1.40 - 2.40 Br, Sa, Tr to Some Si, Tr Gr, Moist to Wet



Bloomington Road

Station No.	Location	Topsoil Thickness (mm)
-------------	----------	---------------------------

10+275	WBL, 3.0 m North of Edge of Pavement	100
10+100	WBL, 3.0 m North of Edge of Pavement	260
9+900	WBL, 3.0 m North of Edge of Pavement	0
9+700	WBL, 3.0 m North of Edge of Pavement	110
9+800	EBL, 4.0 m South of Edge of Pavement	120
10+100	EBL, 3.0 m South of Edge of Pavement	100
10+275	EBL, 4.0 m South of Edge of Pavement	110

Station No.	Location	Soft/Weak Soils & Organic Deposits (mm)
-------------	----------	--

9+590	P1 25m Right of Bloomington Road C/L	915
9+620	P2 25m Right of Bloomington Road C/L	775
9+600	P3 50m Right of Bloomington Road C/L	725

Project No. : 1-15-0795

Client : IBI Group

Originated by : SD

Date started : March 15, 2016

Project : Highway 404 and Bloomington Road Interchange

Compiled by : SD

Sheet No. : 1 of 1

Location : York, Ontario

Checked by : RA

Position : E: 628248, N: 4870407 (UTM 17T)

Elevation Datum : Geodetic (NAD83)

Rig type : Truck-mounted

Drilling Method : Hollow stem augers

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT N' VALUE			20	40	60	80	100		
301.1	GROUND SURFACE													
300.9 0.2	180mm ASPHALTIC CONCRETE		1	SS	87									
	FILL, sand and gravel, dense to very dense, grey, dry to moist		2	SS	33									
299.7 1.4	FILL, gravel, trace sand, trace silt, compact, grey, wet		3	SS	20									
299.0 2.1	PEAT, fibrous, dark brown		4	SS	4									
			5	SS	3									
297.1 4.0	SILTY SAND, trace clay, trace gravel, compact, grey, wet		6	SS	18									
			7	SS	14									
295.5 5.6	SILTY CLAY, trace sand, firm, grey, moist to wet		8	SS	7									
294.0 7.1	SAND, trace to some silt, trace gravel, compact to dense, grey, wet		9	SS	14									
291.5 9.6			10	SS	41									

END OF BOREHOLE

Borehole caved at 6.4m below ground surface upon completion of drilling.

Piezometer installation consists of a 50mm diameter PVC pipe with a 1.5m slotted screen.

At 9.1m sand heaved to 8.2m.
Triconed to 9.1m to carry out SPT test.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Apr 12, 2016	1.8	299.3
Apr 22, 2016	1.8	299.3

ASPHALT CORE PHOTOGRAPHS AND DATA



1-15-0795-01
Bloomington Road; EBL
Station 10+100; L2

Bloomington Rd
EBL, Sta. 10+100, L2

Type	Core (mm)
HL3	30
HL8	90
Total	120



1-15-0795-01
Bloomington Road; WBL
Station 9+500; L2

Bloomington Rd
WBL, Sta. 9+500, L2

Type	Core (mm)
HL3	50
HL8	50
HL8	60
Total	160

Project No. : 1-15-0795

Date : May, 2016



Terraprobe Inc.

Prepared by : SD

Checked by : RA

APPENDIX B

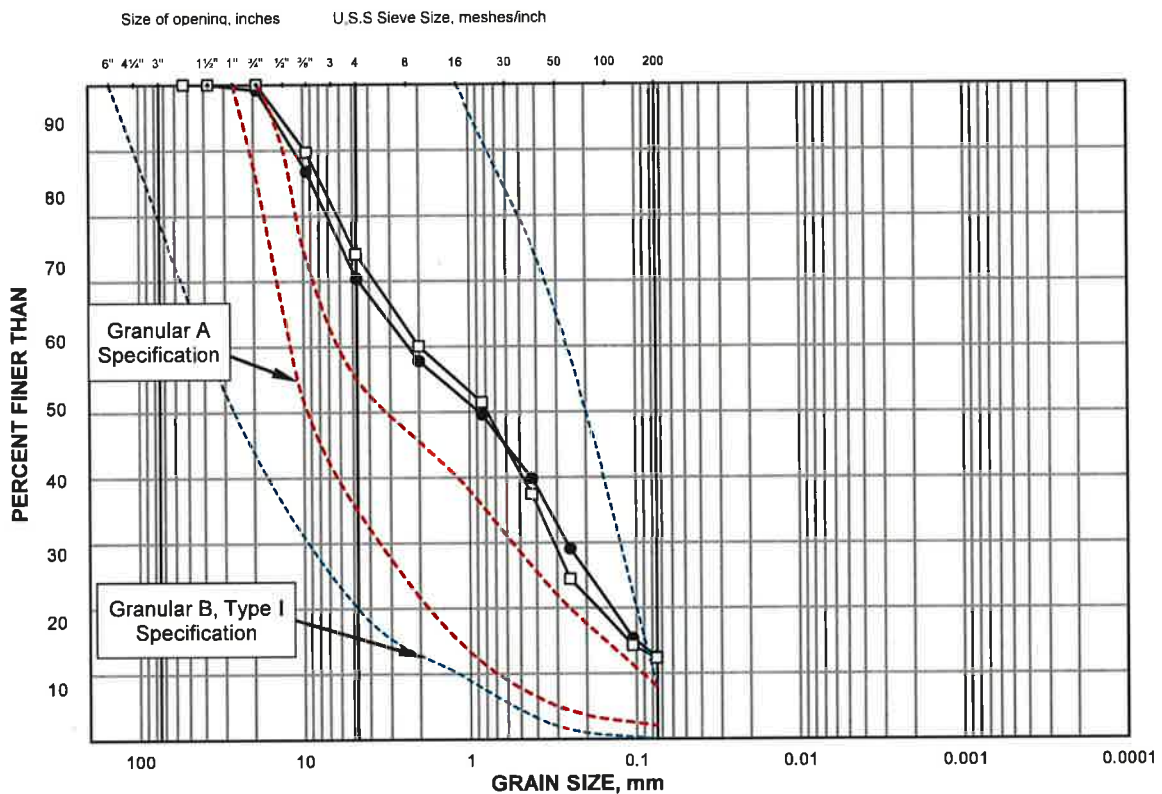
Laboratory Test Results



GRAIN SIZE DISTRIBUTION

FIGURE B1

GRANULAR BASE/SUBBASE



COBBLE SIZE	coarse	fine	coarse	medium	fine	SILT AND CLAY SIZE
	GRAVEL SIZE		SAND SIZE			

LEGEND

SYMBOL	STATION	LOCATION	DEPTH (m)
●	9+700	Bloomington Rd. WBL, L2	0.175 - 0.340
□	10+100	Bloomington Rd. WBL, L2	0.175 - 0.340

Project No: 1-15-0795
Date: April, 2015



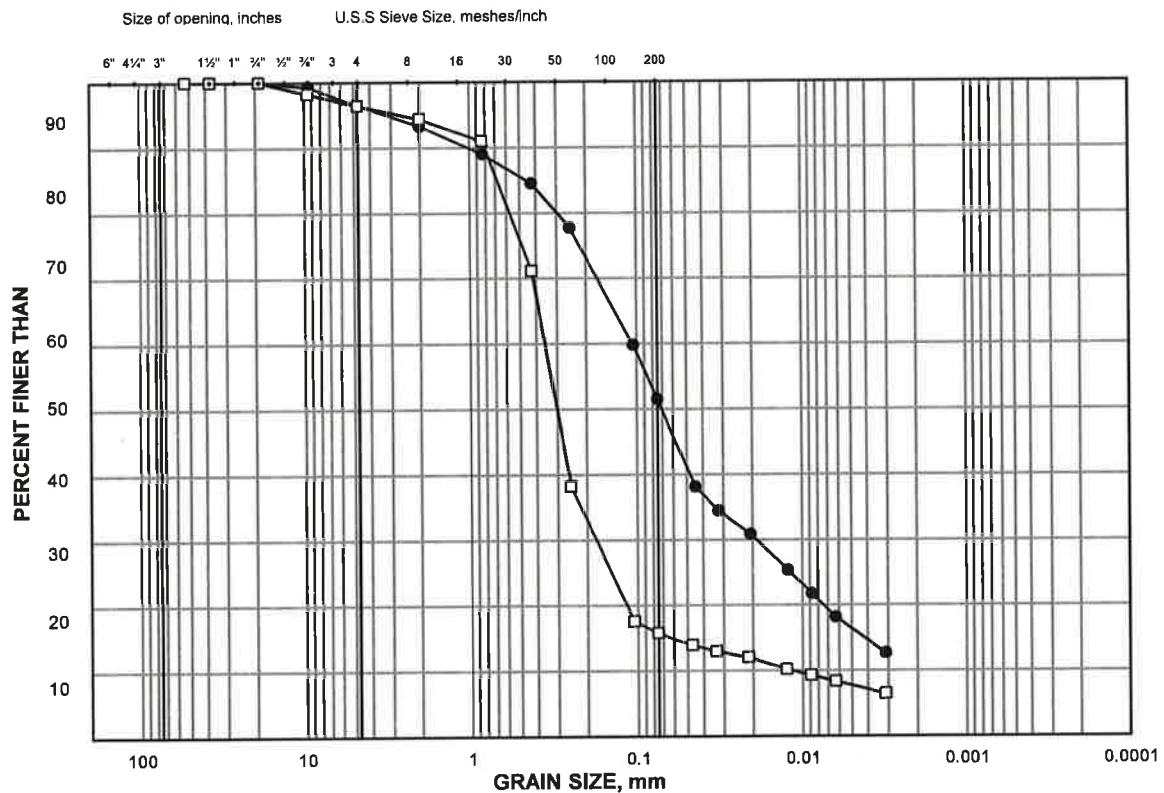
Terraprobe Inc.

Prepared by : SD
Checked by : RA

GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND to SAND and SILT



LEGEND

SYMBOL	STATION	LOCATION	DEPTH (m)
●	9+500	Bloomington Rd. WBL, L2	1.1 - 1.5
□	9+800	Bloomington Rd. EBL, L2	0.230 - 1.5

Project No: 1-15-0795
Date: April, 2015



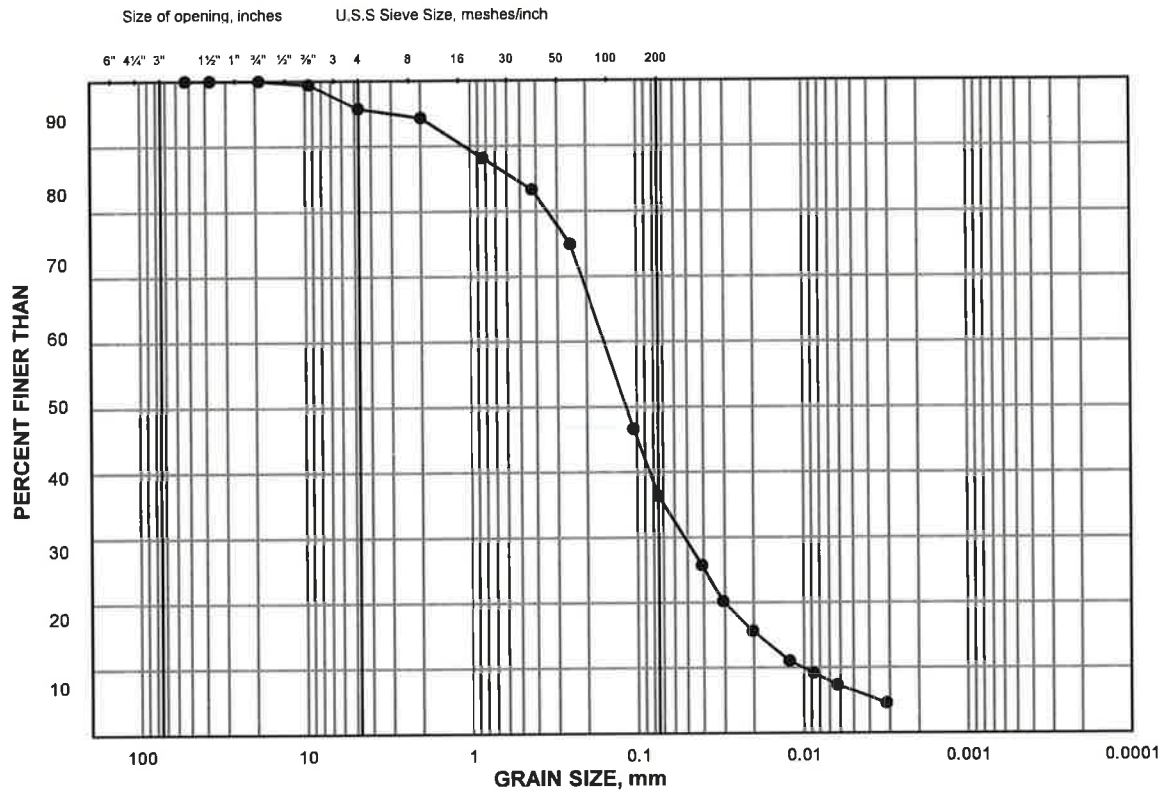
Terraprobe Inc.

Prepared by : SD
Checked by : RA

GRAIN SIZE DISTRIBUTION

FIGURE B3

SILTY SAND



COBBLE SIZE	coarse	fine	coarse	medium	fine	SILT AND CLAY SIZE
	GRAVEL SIZE		SAND SIZE			

LEGEND

SYMBOL	BH #	SAMPLE	DEPTH (m)	ELEVATION (m)
●	1	SS7	4.8	296.3

Project No: 1-15-0795
Date: April, 2015



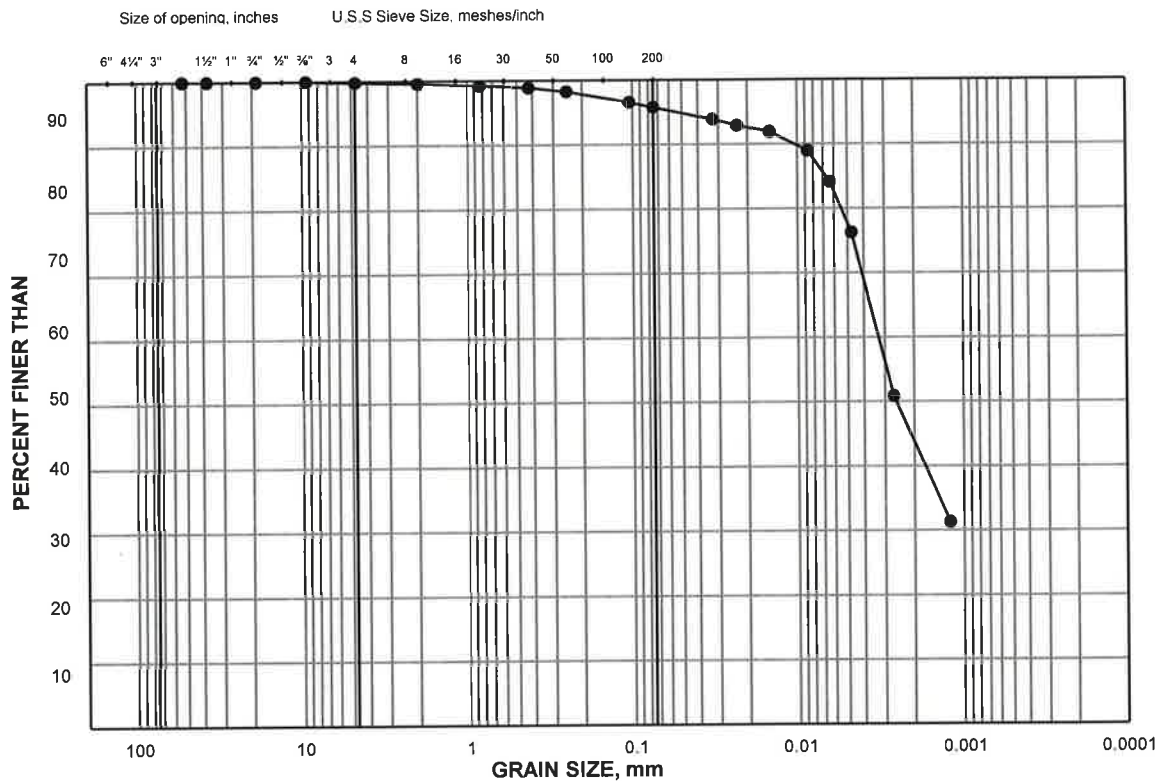
Terraprobe Inc.

Prepared by : SD
Checked by : RA

GRAIN SIZE DISTRIBUTION

FIGURE B4

SILTY CLAY



APPENDIX C

Flexible Pavement Condition Evaluation Forms



Evaluated by: Rehman Abdul. P. Eng.

Flexible Pavement Condition Evaluation Form

Location: _____

Bloomington Road

District

Highway

From: _____ Station 9+800 To: _____ Station 9+880

LHRS

begins

offset

ends

Section Length

km

m

Survey Date

year

month

day

hour

minute

second

PCR

RCR

Index

Contract No.

-

WP No.

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

Distress Comments: (items not covered above)

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

L

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

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

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

Other Comments: (e.g., subsections, additional contracts) WBL Fully Paved Shoulders, EBL Unpaved Shoulder

Evaluated by: Rehman Abdul. P.Eng.

Location:		Bloomington Road									
From:		Station 9+880				To:		Station 10+275			
LHRS		<div> <div></div> <div></div> <div></div> <div></div> <div></div> </div>				<div> <div></div> <div></div> <div>.</div> <div></div> </div> km		<div> <div>3</div> <div>9</div> <div>5</div> <div>m</div> </div>		<div> <div></div> <div></div> <div></div> </div>	
Survey Date		<div> <div>1</div> <div>6</div> </div> year		<div> <div>0</div> <div>3</div> </div> month		<div> <div>PCR</div> <div>8</div> <div>5</div> </div>		<div> <div>RCR</div> <div>8</div> <div>.</div> <div>5</div> </div>		<div> <div></div> <div></div> <div></div> </div>	
Contract No.		<div> <div></div> <div>-</div> <div></div> <div></div> <div></div> </div>		<div> <div>WP No.</div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> </div>		<div> <div></div> <div></div> <div></div> </div>		<div> <div></div> <div></div> <div></div> </div>		<div> <div></div> <div></div> <div></div> </div>	
District		<div> <div></div> <div></div> <div></div> <div></div> <div></div> </div>									
Traffic Direction		<div> <div>B</div> </div>									
Facility		<div> <div>A</div> </div>									
Class		<div> <div>L</div> </div>									

[illegible]

Maintenance Treatment		Extent of Occurrence, %				
		<10	10-20	20-50	50-80	>80
Pavement	Manual Patching	1	2	3	4	5
	Machine Patching					
	Spray Patching					
	Route and Seal Cracks					
Shoulders	Chip Seal					
	Manual Patching					
	Machine Patching					
	Route and Seal Cracks					
	Chip Seal					

Distress Comments: (items not covered above)

Other Comments: (e.g., subsections, additional contracts) Fully paved shoulder EBL and WBL from approx. Sta 10+275 to Sta 9+925 Unpaved WBL shoulder approx. Sta. 9+925 to Sta 9+880

Evaluated by: Rehman Abdul, P. Eng.

APPENDIX D

Certificate of Chemical Analysis (Soil Chemistry)



CLIENT NAME: TERRAPROBE INC.
11 INDELL LANE
BRAMPTON, ON L6T3Y3
(905) 796-2650

ATTENTION TO: Sepideh Monfared

PROJECT: Hwy 404 & Bloomington Rd (1-15-0705)

AGAT WORK ORDER: 16T086223

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Coordinator

DATE REPORTED: Apr 22, 2016

PAGES (INCLUDING COVER): 8

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

***NOTES**

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories (V1)

Member of: Association of Professional Engineers, Geologists and Geophysicists of Alberta (APEGGA)
Western Enviro-Agricultural Laboratory Association (WEALA)
Environmental Services Association of Alberta (ESAA)

AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.

*Results relate only to the items tested and to all the items tested
All reportable information as specified by ISO 17025:2005 is available from AGAT Laboratories upon request*



Laboratories

Certificate of Analysis

AGAT WORK ORDER: 16T086223

PROJECT: Hwy 404 & Bloomington Rd (1-15-0705)

CLIENT NAME: TERRAPROBE INC.

SAMPLING SITE:

ATTENTION TO: Sepideh Monfared

SAMPLED BY:

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

O. Reg. 153(511) - Metals & Inorganics (Soil)										DATE RECEIVED: 2016-04-18	DATE REPORTED: 2016-04-22
SAMPLE DESCRIPTION: 9+900-WBL-L2- (360-1.5) 10+100-WBL-L2- (360-1.5) 10+020-left-1B (1'3"-2')											
SAMPLE TYPE: Soil											
DATE SAMPLED: 3/14/2016											
Parameter	Unit	G / S	RDL	7496420	7496422	7496433	7496444	Soil	Soil	Soil	Soil
Antimony	µg/g	1.3	0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Arsenic	µg/g	18	1	1	2	1	2	1	2	1	2
Barium	µg/g	220	2	13	17	8	11	8	11	8	11
Beryllium	µg/g	2.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Boron	µg/g	36	5	<5	<5	<5	<5	<5	<5	<5	<5
Boron (Hot Water Soluble)	µg/g	NA	0.10	0.12	0.21	<0.10	0.11	<0.10	0.11	<0.10	0.11
Cadmium	µg/g	1.2	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	µg/g	70	2	7	6	3	4	3	4	3	4
Cobalt	µg/g	21	0.5	2.3	2.5	1.5	2.0	1.5	2.0	1.5	2.0
Copper	µg/g	92	1	4	6	2	4	2	4	2	4
Lead	µg/g	120	1	2	7	1	3	1	3	1	3
Molybdenum	µg/g	2	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nickel	µg/g	82	1	3	4	1	2	1	2	1	2
Selenium	µg/g	1.5	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Silver	µg/g	0.5	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Thallium	µg/g	1	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Uranium	µg/g	2.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Vanadium	µg/g	86	1	13	11	10	7	10	7	10	7
Zinc	µg/g	290	5	13	22	8	12	8	12	8	12
Chromium VI	µg/g	0.66	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cyanide	µg/g	0.051	0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
Mercury	µg/g	0.27	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Electrical Conductivity	mS/cm	0.57	0.005	1.10	0.476	0.288	0.872	0.288	0.872	0.288	0.872
Sodium Adsorption Ratio	NA	2.4	NA	21.9	2.77	3.42	20.0	3.42	20.0	3.42	20.0
pH, 2.1 CaCl2 Extraction	pH Units		NA	7.90	10.3	8.22	8.17	8.22	8.17	8.22	8.17

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard; Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use

7496420-7496444 EC & SAR were determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil). pH was determined on the 0.01M CaCl2 extract prepared at 2:1 ratio. Please note that samples were received and analyzed past hold time for Chromium VI, Cyanide, Electrical conductivity, pH and Mercury analyses.

Certified By:

Amarjot Bhela



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 16T086223

PROJECT: Hwy 404 & Bloomington Rd (1-15-0705)

CLIENT NAME: TERRAPROBE INC.

SAMPLING SITE:

ATTENTION TO: Sepideh Monfared

SAMPLED BY:

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

O. Reg. 558 Metals and Inorganics					DATE RECEIVED: 2016-04-18	DATE REPORTED: 2016-04-22
SAMPLE DESCRIPTION: BH1 (SS3+SS2)						
SAMPLE TYPE: Soil						
DATE SAMPLED: 3/15/2016						
Parameter	Unit	G / S	RDL	RD	7496419	
Arsenic Leachate	mg/L	2.5	0.010		<0.010	
Barium Leachate	mg/L	100	0.100		0.171	
Boron Leachate	mg/L	500	0.050		0.052	
Cadmium Leachate	mg/L	0.5	0.010		<0.010	
Chromium Leachate	mg/L	5	0.010		<0.010	
Lead Leachate	mg/L	5	0.010		<0.010	
Mercury Leachate	mg/L	0.1	0.01		<0.01	
Selenium Leachate	mg/L	1	0.010		<0.010	
Silver Leachate	mg/L	5	0.010		<0.010	
Uranium Leachate	mg/L	10	0.050		<0.050	
Fluoride Leachate	mg/L	150	0.05		0.27	
Cyanide Leachate	mg/L	20	0.05		<0.05	
(Nitrate + Nitrite) as N Leachate	mg/L	1000	0.70		<0.70	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to O. Reg. 558 - Schedule IV Leachate Quality Criteria

7496419

Please note that samples were received and analyzed past hold time for Cyanide, Fluoride, Mercury and (Nitrate + Nitrite) as N Leachates analyses.

Certified By:

Anayot Bhela



AGAT

Laboratories

Guideline Violation

AGAT WORK ORDER: 16T086223

PROJECT: Hwy 404 & Bloomington Rd (1-15-0705)

CLIENT NAME: TERRAPROBE INC.

ATTENTION TO: Sepideh Monfared

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	GUIDEVALUE	RESULT
7496420	9+900-WBL-L2-(360-1.5)	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity	0.57	1.10
7496420	9+900-WBL-L2-(360-1.5)	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio	2.4	21.9
7496422	9+700-WBL-SH-(680-1.2)	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio	2.4	2.77
7496433	10+100-EBL-L2-(360-1.5)	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio	2.4	3.42
7496444	10+020-left-1B(1'3"-2')	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity	0.57	0.872
7496444	10+020-left-1B(1'3"-2')	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio	2.4	20.0

Quality Assurance

CLIENT NAME: TERRAPROBE INC.

PROJECT: Hwy 404 & Bloomington Rd (1-15-0705)

SAMPLING SITE:

AGAT WORK ORDER: 16T086223

ATTENTION TO: Sepideh Monfared

SAMPLED BY:

Soil Analysis															
RPT Date: Apr 22, 2016			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

O. Reg. 558 Metals and Inorganics

Arsenic Leachate	7496419	7496419	<0.010	<0.010	NA	< 0.010	92%	90%	110%	91%	80%	120%	97%	70%	130%
Barium Leachate	7496419	7496419	0.171	0.178	NA	< 0.100	95%	90%	110%	92%	80%	120%	90%	70%	130%
Boron Leachate	7496419	7496419	0.052	0.054	NA	< 0.050	103%	90%	110%	106%	80%	120%	97%	70%	130%
Cadmium Leachate	7496419	7496419	<0.010	<0.010	NA	< 0.010	100%	90%	110%	97%	80%	120%	94%	70%	130%
Chromium Leachate	7496419	7496419	<0.010	<0.010	NA	< 0.010	96%	90%	110%	98%	80%	120%	95%	70%	130%
Lead Leachate	7496419	7496419	<0.010	<0.010	NA	< 0.010	94%	90%	110%	93%	80%	120%	84%	70%	130%
Mercury Leachate	7496419	7496419	<0.01	<0.01	NA	< 0.01	98%	90%	110%	81%	80%	120%	72%	70%	130%
Selenium Leachate	7496419	7496419	<0.010	<0.010	NA	< 0.010	98%	90%	110%	96%	80%	120%	90%	70%	130%
Silver Leachate	7496419	7496419	<0.010	<0.010	NA	< 0.010	95%	90%	110%	98%	80%	120%	97%	70%	130%
Uranium Leachate	7496419	7496419	<0.050	<0.050	NA	< 0.050	92%	90%	110%	91%	80%	120%	90%	70%	130%
Fluoride Leachate	7496419	7496419	0.27	0.27	0.0%	< 0.05	98%	90%	110%	91%	90%	110%	87%	70%	130%
Cyanide Leachate	7496419	7496419	<0.05	<0.05	NA	< 0.05	99%	90%	110%	96%	90%	110%	102%	70%	130%
(Nitrate + Nitrite) as N Leachate	7496419	7496419	<0.70	<0.70	NA	< 0.70	96%	80%	120%	101%	80%	120%	96%	70%	130%

O. Reg. 153(511) - Metals & Inorganics (Soil)

Antimony	7496420	7496420	<0.8	<0.8	NA	< 0.8	85%	70%	130%	97%	80%	120%	97%	70%	130%
Arsenic	7496420	7496420	1	1	NA	< 1	102%	70%	130%	95%	80%	120%	99%	70%	130%
Barium	7496420	7496420	13	13	0.0%	< 2	94%	70%	130%	92%	80%	120%	89%	70%	130%
Beryllium	7496420	7496420	<0.5	<0.5	NA	< 0.5	88%	70%	130%	99%	80%	120%	95%	70%	130%
Boron	7496420	7496420	<5	<5	NA	< 5	98%	70%	130%	99%	80%	120%	90%	70%	130%
Boron (Hot Water Soluble)	7496420	7496420	0.12	0.10	NA	< 0.10	114%	60%	140%	105%	70%	130%	102%	60%	140%
Cadmium	7496420	7496420	<0.5	<0.5	NA	< 0.5	103%	70%	130%	96%	80%	120%	100%	70%	130%
Chromium	7496420	7496420	7	7	NA	< 2	79%	70%	130%	97%	80%	120%	92%	70%	130%
Cobalt	7496420	7496420	2.3	2.3	NA	< 0.5	88%	70%	130%	96%	80%	120%	90%	70%	130%
Copper	7496420	7496420	4	4	NA	< 1	84%	70%	130%	102%	80%	120%	89%	70%	130%
Lead	7496420	7496420	2	2	NA	< 1	97%	70%	130%	94%	80%	120%	88%	70%	130%
Molybdenum	7496420	7496420	<0.5	<0.5	NA	< 0.5	100%	70%	130%	97%	80%	120%	108%	70%	130%
Nickel	7496420	7496420	3	3	NA	< 1	87%	70%	130%	97%	80%	120%	89%	70%	130%
Selenium	7496420	7496420	<0.4	<0.4	NA	< 0.4	102%	70%	130%	97%	80%	120%	104%	70%	130%
Silver	7496420	7496420	<0.2	<0.2	NA	< 0.2	81%	70%	130%	97%	80%	120%	99%	70%	130%
Thallium	7496420	7496420	<0.4	<0.4	NA	< 0.4	91%	70%	130%	92%	80%	120%	89%	70%	130%
Uranium	7496420	7496420	<0.5	<0.5	NA	< 0.5	87%	70%	130%	92%	80%	120%	93%	70%	130%
Vanadium	7496420	7496420	13	12	8.0%	< 1	86%	70%	130%	96%	80%	120%	95%	70%	130%
Zinc	7496420	7496420	13	13	NA	< 5	90%	70%	130%	100%	80%	120%	99%	70%	130%
Chromium VI	7499478		<0.2	<0.2	NA	< 0.2	93%	70%	130%	94%	80%	120%	99%	70%	130%
Cyanide	7495312		<0.040	<0.040	NA	< 0.040	95%	70%	130%	103%	80%	120%	118%	70%	130%
Mercury	7496420	7496420	<0.10	<0.10	NA	< 0.10	105%	70%	130%	90%	80%	120%	92%	70%	130%
Electrical Conductivity	7496420	7496420	1.10	1.10	0.0%	< 0.005	96%	90%	110%	NA			NA		
Sodium Adsorption Ratio	7496420	7496420	21.9	23.0	4.9%	NA	NA			NA			NA		

Quality Assurance

CLIENT NAME: TERRAPROBE INC.

PROJECT: Hwy 404 & Bloomington Rd (1-15-0705)

SAMPLING SITE:

AGAT WORK ORDER: 16T086223

ATTENTION TO: Sepideh Monfared

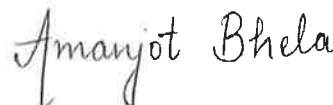
SAMPLED BY:

Soil Analysis (Continued)															
RPT Date: Apr 22, 2016			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
pH, 2:1 CaCl2 Extraction	7496422	7496422	10.3	10.3	0.0%	NA	101%	80%	120%	NA					

Comments: NA signifies Not Applicable.

Duplicate Qualifier: 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.

Certified By:



Method Summary

CLIENT NAME: TERRAPROBE INC.

PROJECT: Hwy 404 & Bloomington Rd (1-15-0705)

SAMPLING SITE:

AGAT WORK ORDER: 16T086223

ATTENTION TO: Sepideh Monfared

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Antimony	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Arsenic	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Barium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Beryllium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Boron	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Boron (Hot Water Soluble)	MET-93-6104	EPA SW 846 6010C; MSA, Part 3, Ch.21	ICP/OES
Cadmium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Chromium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Cobalt	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Copper	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Lead	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Molybdenum	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Nickel	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Selenium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Silver	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Thallium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Uranium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Vanadium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Zinc	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Chromium VI	INOR-93-6029	SM 3500 B; MSA Part 3, Ch. 25	SPECTROPHOTOMETER
Cyanide	INOR-93-6052	MOE CN-3015 & E 3009 A; SM 4500 CN	TECHNICON AUTO ANALYZER
Mercury	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Electrical Conductivity	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Sodium Adsorption Ratio	INOR-93-6007	McKeague 4.12 & 3.26 & EPA SW-846 6010B	ICP/OES
pH, 2:1 CaCl2 Extraction	INOR-93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Arsenic Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Barium Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Boron Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Cadmium Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Chromium Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Lead Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Mercury Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Selenium Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Silver Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Uranium Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Fluoride Leachate	INOR-93-6018	EPA SW-846-1311 & SM4500-F- C	ION SELECTIVE ELECTRODE
Cyanide Leachate	INOR-93-6052	EPA SW-846-1311 & MOE 3015 & SM 4500 CN- I	TECHNICON AUTO ANALYZER
(Nitrate + Nitrite) as N Leachate	INOR-93-6053	EPA SW 846-1311 & SM 4500 - NO3- I	LACHAT FIA

APPENDIX E

Pavement Design Data



Table E1
Bloomington Road Widening
Regional Municipality of York

Equivalent Single Axle Load Calculations (AADT DATA)

Description -Bloomington Road				
Traffic Data Year	2017	2021	2026	2037
Design Year			2017	
Analysis Period		4	5	11
1a) Average Annual Daily Traffic (AADT)	19,960	22,550	26,840	33,375
Annual Growth Rate (%)	3.10%	3.50%	2.00%	
1b) Truck fraction of total traffic	10.0%	10.0%	10.0%	
Number of lanes in one direction	2	2	2	
1c) Directional Factor	0.5	0.5	0.5	
1d) Lane distribution Factor	0.8	0.8	0.8	
Daily Truck Volume	799	902	1074	
Road Classification	Rural Minor Arterial			
2) Breakdown of Truck Proportions				
Class 1	45.0%	45.0%	45.0%	
Class 2	5.0%	5.0%	5.0%	
Class 3	35.0%	35.0%	35.0%	
Class 4	15.0%	15.0%	15.0%	
3) Daily Truck Volumes (4 Classes)		2017 to 2021	2021 to 2026	2026 to 2037
Class 1		360	406	483
Class 2		40	45	54
Class 3		280	316	376
Class 4		120	135	161
4) Truck Factors (4 Classes)				
Class 1		0.5	0.5	0.5
Class 2		2.3	2.3	2.3
Class 3		1.6	1.6	1.6
Class 4		5.5	5.5	5.5
5) Daily ESALs per Truck Class (4 Classes)				
Class 1		180	203	242
Class 2		92	104	124
Class 3		447	505	601
Class 4		659	744	886
6) Total Daily ESALs in Design Lane		1379	1556	1853
7) Total Base Year ESALs		2017	2021	2026
Number of Days of Truck Traffic		365	365	365
Total Base Year ESALs		503,335	567,940	676,345
8) Cumulative ESALs for Design Period				
Design Period		4	5	11
Annual Growth Rate (%)		3.10%	3.50%	2.00%
Geometric Growth Factor		4.2	5.4	12.2
Cumulative ESALs for the Design Period		2,114,007	3,066,876	8,251,409
				13,432,292

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 E2
Bloomington Road Widening
Regional Municipality of York

Equivalent Single Axle Load Calculations (AADT DATA)

Description -Bloomington Road				
Traffic Data Year	2017	2021	2026	2037
Design Year			2017	
Analysis Period		4	5	11
1a) Average Annual Daily Traffic (AADT)	4,300	5,700	8,400	19,705
Annual Growth Rate (%)	7.30%	8.06%	8.06%	
1b) Bus fraction of total traffic	7.0%	7.0%	7.0%	
Number of lanes in one direction	1	1	1	
1c) Directional Factor	0.5	0.5	0.5	
1d) Lane distribution Factor	1	1	1	
	Daily Truck Volume	151	200	294
Road Classification		Rural Minor Arterial		
2) Breakdown of Traffic Proportions				
	FHWA Vehicle Class 4	100.0%	100.0%	100.0%
	FHWA Vehicle Class 5	0.0%	0.0%	0.0%
	FHWA Vehicle Class 6	0.0%	0.0%	0.0%
	FHWA Vehicle Class 7	0.0%	0.0%	0.0%
3) Daily Truck Volumes (4 Classes)		2017 to 2021	2021 to 2026	2026 to 2037
	FHWA Vehicle Class 4	151	200	294
	FHWA Vehicle Class 5	0	0	0
	FHWA Vehicle Class 6	0	0	0
	FHWA Vehicle Class 7	0	0	0
4) Truck Factors (4 Classes)				
	FHWA Vehicle Class 4	2.0	2.0	2.0
	FHWA Vehicle Class 5	0.3	0.3	0.3
	FHWA Vehicle Class 6	0.9	0.9	0.9
	FHWA Vehicle Class 7	4.0	4.0	4.0
5) Daily ESALs per Truck Class (4 Classes)				
	FHWA Vehicle Class 4	302	400	588
	FHWA Vehicle Class 5	0	0	0
	FHWA Vehicle Class 6	0	0	0
	FHWA Vehicle Class 7	0	0	0
6) Total Daily ESALs in Design Lane		302	400	588
7) Total Base Year ESALs		2017	2021	2026
Number of Days of Truck Traffic		365	365	365
Total Base Year ESALs		110,230	146,000	214,620
8) Cumulative ESALs for Design Period				
Design Period		4	5	11
Annual Growth Rate (%)		7.30%	8.10%	8.10%
Geometric Growth Factor		4.5	5.9	16.8
		496,035	861,400	3,605,616
Cumulative ESALs for the Design Period				4,963,051

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.