



**May 2012**

## **PRELIMINARY PAVEMENT DESIGN REPORT**

**Bowmanville Commercial Vehicle Inspection Facility  
Work Order Project No. 10-20010  
Purchase Order Number: 2009-E-0046  
Ministry of Transportation, Ontario - Central Region**

**Submitted to:**

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**REPORT**



**Report Number:** 10-1132-0152-1000-R01

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### Executive Summary

Work Order Project Number (W.P.) 10-20010 comprises the preliminary design of a Bowmanville Commercial Vehicle Inspection Facility (CVIF). Three sites were originally considered. None of the sites had any major pavement engineering constraints and all were considered feasible for the proposed CVIF. Site 3 located at kilometre 453 was selected for non-geotechnical considerations. Preliminary site investigations (Pavement and Foundations) were carried out on the preferred site. This report addresses the pavement design aspects of the preliminary design of the project.

The preferred site is located along the existing Highway 401 westbound lanes between the East Townline Road underpass and Wesleyville Road Interchange, across from an eastbound Service Center.

The purpose of the site investigation and Preliminary Pavement Design Report is to determine the subsurface soil and groundwater conditions and to provide geotechnical engineering recommendations for the design of the new pavements.

Boreholes were drilled at the site and representative samples of the soils encountered were obtained. Laboratory classification testing was carried out on selective samples. The subgrade soils generally consisted of sand with silt and till materials grading from sandy silt to clayey silt.

Based on the results of the investigation and flexible pavement analyses, the new asphalt pavements at the proposed Bowmanville CVIF, which will include entrance and exit ramps and inspection area, should consist of 190 millimetres (mm) of asphalt, 150 mm of Granular A and 650 mm of Granular B Type I for a total pavement structure of 990 mm.

A rigid pavement analysis was also conducted. If concrete pavements are the selected alternative, the new concrete pavements which will include the entrance and exit ramps and the inspection area, should consist of 260 millimetres of Portland cement concrete and 500 millimetres of Granular A. The design should include 0.5 metre monolithic tied shoulders.

The flexible pavement for the new employee parking area should consist of 90 mm of asphalt, 150 mm of Granular A and 300 mm of Granular B Type I.

The grading will involve cuts of up to 3 metres (m) deep and fills of up to 5 m high. Final cut side slopes and embankments should not exceed 2 horizontal to 1 vertical and should be appropriately vegetated as soon as practical. The presence of cobbles and boulders in the native soils should be anticipated.

Four areas on the site were considered for in-ground sewage disposal. Percolation testing was carried out to estimate the "T" time for the design of the disposal system.



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### 1.0 INTRODUCTION

This report provides the results of a preliminary pavement investigation (under W.P. 10-20010) for a proposed Commercial Vehicle Inspection Facility (CVIF) located along Highway 401 westbound near Bowmanville.

Three sites were originally considered as part of this assignment. In the technical memorandum dated October 26, 2011 prepared by Golder Associates Ltd. (Golder), the results of a review of the available topographic, physiographical and geologic mapping, and a limited site reconnaissance for the three sites, were provided. The memorandum concluded that all three sites did not appear to have any pavement engineering constraints and all would be considered feasible for the proposed CVIF. There was no pavement engineering preference of any of the sites.

Site 3, located at kilometre 453, was selected for non-geotechnical considerations.



## **2.0 SCOPE OF WORK**

Site 3 was selected and preliminary site investigations were completed, consistent with the Ministry of Transportation, Ontario's (MTO's) requirements as follows:

- 1) Review and evaluate the available geological and subsurface data, including the MTO Geocres Library.
- 2) Conduct the preliminary pavements investigation to establish soil stratigraphy and groundwater conditions.
- 3) Conduct laboratory testing for geotechnical classification, including routine testing on at least 25 per cent (%) of all samples collected.
- 4) Prepare a Preliminary Pavement Design Report for the preferred site.
- 5) Liaise with the Total Project Management (TPM) team, communicate and integrate pavement engineering requirements into the preliminary design.



## **3.0 PAVEMENT FIELD INVESTIGATION**

### **3.1 Soils Investigation**

The geotechnical field investigation was carried out on February 3, 2012 and further sampling was conducted on March 8, 2012. Fifteen pavement boreholes (numbered 100-107 and 112-118) were advanced to a depth of at least 1.5 metres (m) below the proposed profile grade using track mounted power augers supplied and operated by a specialist drilling contractor, K.C. Drilling, under Golder's supervision. An additional four testholes (numbered 108-111) were advanced to a 10 m depth as part of a complementary Preliminary Foundations Investigation. The Preliminary Foundations Investigation and Design recommendations provided are under separate cover.

Survey and staking of the testhole locations was provided by AGM Surveying and Engineering and these locations are shown on the Plan, Figure A-3 in Appendix A.

The subsurface stratigraphy and shallow ground water conditions in the testholes were logged by Golder's field staff, in accordance with MTO soil classifications and field procedures. A soils classification testing program was carried out in Golder's Whitby laboratory on the representative native soil types. The Testhole Logs and Laboratory Soil Test Data are provided in Appendix B. The Borehole Location Plan is provided in Appendix A on Figure A-3.

### **3.2 Laboratory Testing**

The soils laboratory testing program consisted of the following:

<b>Soils Laboratory Test</b>	<b>No. of Tests</b>
Moisture Content	13
Particle Size Analysis (Sieve and Hydrometer)	6
Atterberg Limits	2
Standard Proctor Compaction	2

Results of the laboratory testing are included on the Testhole Logs and Laboratory Test Data in Appendix B.



### 3.3 Percolation Testing

In situ percolation testing was carried out in boreholes 101 and 103 which were drilled in the west and north tile bed sites, respectively. The results of the percolation testing are summarized as follows:

Borehole	"T" Time (min/cm)	Material
201	60	Fine sand some silt
203	>60	Silty fine sand

The results of the related laboratory testing are enclosed in Appendix B.

### 3.4 Physiography and Bedrock

The site is located in the physiographical region of Ontario known as the Lake Iroquois Plain which is in an area of low relief covered by the waters of Lake Iroquois during the Pleistocene age. Surficial deposits of silts and sands generally over glacial till are predominate.

The glacial till surface is irregular and drumlinized with the till present at surface in many areas.





## **4.0 SUMMARIZED SUBSURFACE CONDITIONS**

### **4.1 Topsoil**

The topsoil cover, where encountered, generally consists of dark brown silt, ranging in thickness from 170 to 260 millimetres (mm) depth with an average depth of 220 mm.

### **4.2 Native Soils**

The native soils encountered are generally consistent, comprising of sand with silt below the surficial topsoil, underlain by sandy silt to clayey silt till. Occasional cobbles and boulders were contacted throughout the deposits. The in-situ moisture content of the sand with silt ranges between 7 and 14%. The in-situ moisture content of the till material ranges between 14 and 20%. Atterberg limit testing indicates that the till is generally non-plastic but locally of low plasticity with a liquid limit of 26% and a plastic limit of 14%. Standard Proctor Compaction testing indicates that the sandy silt till has a maximum dry density of 1826 to 1866 kilograms per cubic metre ( $\text{kg/m}^3$ ) and an optimum moisture content of 12 to 13%. The Proctor water content and dry density curves are included in Appendix A on Figures 1 and 2.

#### **4.2.1 Frost Susceptibility**

The native materials encountered on the project have low susceptibility to frost heave characteristics based on the gradation fraction between 75 micrometre ( $\mu\text{m}$ ) and 5  $\mu\text{m}$ .

### **4.3 Fill**

No fill was encountered in any of the testholes. The majority of the site is agricultural fields so periodic reworking of the surficial materials in the upper 300 mm should be assumed.

### **4.4 Bedrock**

No bedrock was encountered in any of the testholes conducted for this assignment.



## **4.5 Groundwater**

Groundwater seepage was encountered in three of the testholes at relatively shallow depths ranging from 0.90 to 1.80 m of the existing ground surface. The native soils were generally wet below these depths. However, it should be recognised that the free water depth (i.e. "Fr Wat @") indicated on the testhole logs should not strictly be inferred as the local groundwater table depth. This observation refers to water seepage conditions in the open testhole at the particular time of augering, and is highly influenced by the prevailing weather conditions. In general, experience indicates that the local groundwater levels are expected to fluctuate and be higher during wet periods and in the spring.



## **5.0 RECOMMENDATIONS**

The pavement design recommendations for the preliminary report scope of work include:

- 1) Identification of potential problem soils and preliminary remedial treatment;
- 2) General suitability of cut materials(s) to be used in the project;
- 3) Preliminary proposed slope geometry in cut and fill areas including the requirements for berms and erosion control;
- 4) Topsoil depths;
- 5) Preliminary design of new pavement structures;
- 6) Identification of SuperPave mix types for all hot mix asphalt paving;
- 7) Identification of the type and depth of any rock encountered (see Section 4.4); and
- 8) Preliminary design recommendations for the in-ground sewage disposal system (septic beds).

### **5.1 Poor Soils/Problem Area**

No poor soils or problem areas were identified during the course of the field investigation. Native soils encountered were compact to dense (locally stiff/hard for cohesive tills). It is anticipated that the subexcavation of poor material will not be a requirement of the project.

### **5.2 Cut Materials and Design**

Cuts of up to about 3.0 m will be required along the proposed new CVIF lanes. The excavations are expected to encounter surficial topsoil overlying silty sand and sandy silt to clayey silt till. All temporary excavations should be constructed in accordance with the current Occupational Health and Safety Act and regulations for construction projects. Temporary excavations should have a maximum slope inclination of 1 horizontal to 1 vertical.

Groundwater flows are expected to be minimal and can probably be handled by pumping from properly filtered sumps. Care should be taken to direct all surface water away from the excavations.

The soils have an erodibility that is slight to moderate. Final cut side slopes should not exceed 2 horizontal to 1 vertical and should be appropriately vegetated as soon as practical. The presence of cobbles and boulders in the native soils should be anticipated.



With the proper construction procedures, the sand with silt materials generated from the cut excavations are anticipated to be suitable for reuse as embankment fill.

The till material has a maximum dry density of 1826 to 1866 kg/m<sup>3</sup> and an in-situ moisture content that is close to or wetter than its optimum moisture content of 12 to 13%. Till materials with in-situ moisture content wetter than 2% of the optimum moisture content will be difficult to dry in the field and should not be considered for reuse on the project. Materials should be compacted at or wet of their optimum moisture contents.

### 5.3 Embankment Design

Some minor embankment widening/construction, on the order of about 5 m in height, will be required at the east end of the site. The fill material will consist of either approved earth borrow or suitable native materials generated from the proposed cut areas.

Care will be required to ensure the new fill is properly benched into the existing fills in accordance with the Ontario Provincial Standard Drawing (OPSD) 200 series. The fill should be placed in maximum 300 mm thick loose lifts and compacted.

Following filling, the slopes should be trimmed to a final inclination of 2 horizontal to 1 vertical or flatter and appropriately vegetated as soon as practical.

### 5.4 Topsoil Depth

The average topsoil depth may be taken as 220 mm for quantity estimating.

### 5.5 Preliminary Pavement Design

The Bowmanville CVIF will involve new construction. The new ramps and inspection area will consist of either flexible or rigid pavements. Pavement sliver widening will be required beyond the Highway 401 bullnose for construction of the speed change lane. Further investigations will be required during Detail Design to provide recommendations for the highway widenings.



### 5.5.1 Pavement Design Methods

The proposed pavement section has been analyzed using the American Association of State Highway and Transportation Officials (AASHTO) design method (both flexible and rigid) with our knowledge of previous MTO experiences and standards. Detailed pavement calculations are provided in Appendix C.

### 5.5.2 Traffic Loading

The traffic loading, in terms of equivalent single axle loads (ESAL's), was calculated based on 2,160 trucks per day for 365 days per year and a truck factor of 2.5. Based on these data, and the Terms of Reference which requires a 20 year initial service life, some 39.5 million ESALs are anticipated for the pavements.

### 5.5.3 AASHTO Analyses – Flexible Pavement Design

Based on the nature of the subsoils and our related experience, a subgrade soil resilient modulus of 50 MPa, as per the MTO Materials Information Report M1-183 "Adaptation and Verification of AASHTO Pavement Design Parameters for Ontario Conditions", is considered appropriate and is consistent with the recommendations for silty sand/acceptable earth borrow and till materials as indicated in Table 8.9 of the "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions."

An initial serviceability index (ISI) of 4.4 and a terminal serviceability (TSI) of 2.6 were used for the AASHTO analyses. The other parameters used in the analyses are summarized in the following table:

Parameter	Value
Initial serviceability index (ISI)	4.4
Terminal Serviceability Index (TSI)	2.6
Reliability	95%
Overall Standard Deviation	0.45
Subgrade Soil Resilient Modulus	50 MPa



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Utilizing the above information, a structural number of 159 mm is required for a 20 year initial service life. Based on our calculations the proposed pavement structure should consist of:

Component	Thickness (mm)
Asphalt	190
Granular A Base	150
Granular B Type I Subbase	650
<b>Total Pavement Structure</b>	<b>990</b>
Structural Number	159

The 190 mm thick asphalt should comprise of the following SuperPave lifts:

Component	Lift Thickness (mm)
SuperPave 12.5 FC 2 (surface course)	50
SuperPave 19.0 (upper binder course)	70
SuperPave 19.0 (lower binder course)	70
<b>Total</b>	<b>190</b>

Within the CVIF, paved shoulders should consist of two lifts of asphalt. The shoulders should consist of 50 mm of SuperPave 19.0 and 40 mm of SuperPave 12.5 FC 2.

### 5.5.4 AASHTO Analyses – Rigid Pavement Design

Based on the nature of the subgrade soils and our related experience, an effective modulus of subgrade reaction of 110 megapascals per metre (MPa/m) is considered appropriate and is consistent with the recommendations for silty sand/acceptable earth borrow and till materials indicated in Table 8.9 of the “Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions” document.

An initial serviceability index (ISI) of 4.5 and a terminal serviceability index (TSI) of 2.6 were used for the AASHTO analyses.

The other parameters used in the analyses are summarized in the following table:



## PRELIMINARY PAVEMENT DESIGN REPORT BOWMANVILLE CVIF

Parameter	Value
Initial serviceability index (ISI)	4.5
Terminal serviceability index (TSI)	2.6
Overall input standard deviation	0.47
Composite modulus of subgrade reaction	110 MPa/m*
Concrete modulus of rupture	5 MPa
Concrete elastic modulus	30,000 MPa
Drainage coefficient	1.1
Load transfer coefficient	2.6

\*based on 500 millimetres of Granular A.

Utilizing the above information, Portland cement concrete (PCC) slab thicknesses of 258 millimetres is required based on the AASHTO method. The overall pavement for the rigid pavement alternative should consist of:

Component	Thickness (mm)
Portland Cement Concrete	260
Granular A Base	500
<b>Total</b>	<b>760</b>

The above-noted pavement design assumes that 0.5 metre wide monolithic, tied shoulders are provided. Appropriate dowels should be provided to ensure proper load transfer between adjacent slabs.

### 5.5.5 CVIF Employee Parking Area

The pavement for the CVIF employee parking area is to consist of a flexible pavement. Since the loadings on the proposed parking area will consist predominantly of passenger vehicles with only nominal heavy loads that cannot be quantified, the AASHTO method is not well suited for pavement design. Thus, we have utilized our in-house pavement design methodology which is capable of accommodating low volume pavements of this type. Further details can be found in Golder Report No. 773034 entitled "Report on Benkelman Beam Test Sections, Monitoring Programme and Guide for the Design of Flexible Pavements, London, Ontario" dated April 1978. Based on the above, the new pavement should consist of the following:

Component	Thickness (mm)
Asphalt	90
Granular A Base	150
Granular B Type I Subbase	300
<b>Total</b>	<b>540</b>



## PRELIMINARY PAVEMENT DESIGN REPORT BOWMANVILLE CVIF

The 90 mm thick asphalt should comprise of the following SuperPave lifts:

Component	Lift Thickness (mm)
SuperPave 12.5 FC 2 (surface course)	40
SuperPave 19.0 (binder course)	50
<b>Total</b>	<b>90</b>

### 5.5.6 Asphalt Cement Grades

The SuperPave asphalt mixes should be designed for Traffic Category C. The asphalt cement types should be PGAC 64-28 in the commercial traffic areas and PGAC 58-28 in the non-commercial areas (personnel parking).

### 5.5.7 Tack Coat

Tack coat should be applied between all asphaltic lifts consistent with SP 308F01.

## 5.6 Sewage Disposal System

Based on the information provided, three conventional tile bed sites were considered for the on site disposal of sanitary sewage. The east site is generally not feasible due to the topography and the high groundwater level. The north and west sites are preferable; however, based on the measured percolation rates, the soil stratigraphy and groundwater levels, at least partially raised tile beds will be required. Based on the daily sanitary flow of 4,275 litres/day (L/day) and a constant seepage rate of 1 litre per square metre per day, the recommended tile bed size is 30 by 145 metres plus a 15 metre perimeter buffer area. The in-ground disposal system will require a 100% contingency area. A schematic sketch plan of the system is provided on Figure A-4.





## **6.0 CLOSURE**

We trust that this report provides sufficient geotechnical information for your immediate needs. If any point requires further clarification, please do not hesitate to contact us.

**GOLDER ASSOCIATES LTD.**

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bowmanville.docx



# **APPENDIX A**

**Figures A-1 to A-4**

# LABORATORY COMPACTION TEST

Sandy Silt

Date Sampled: March 8, 2012

FIGURE A-1

## Test Results Summary

TEST: Standard

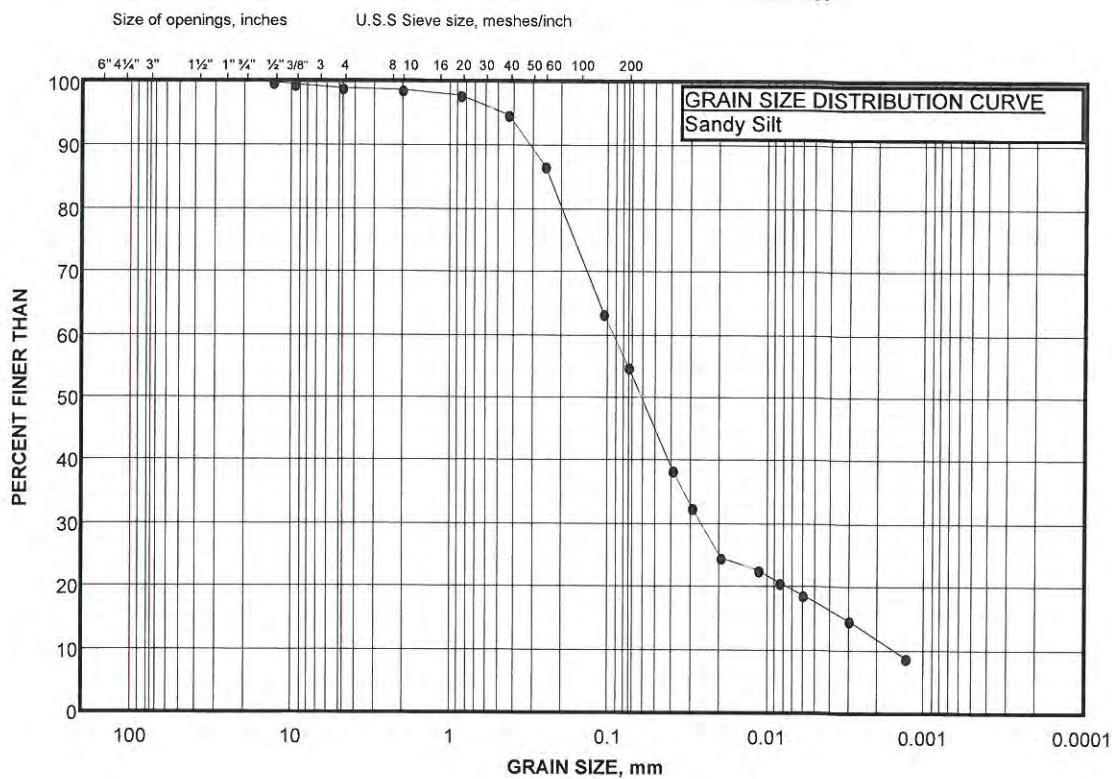
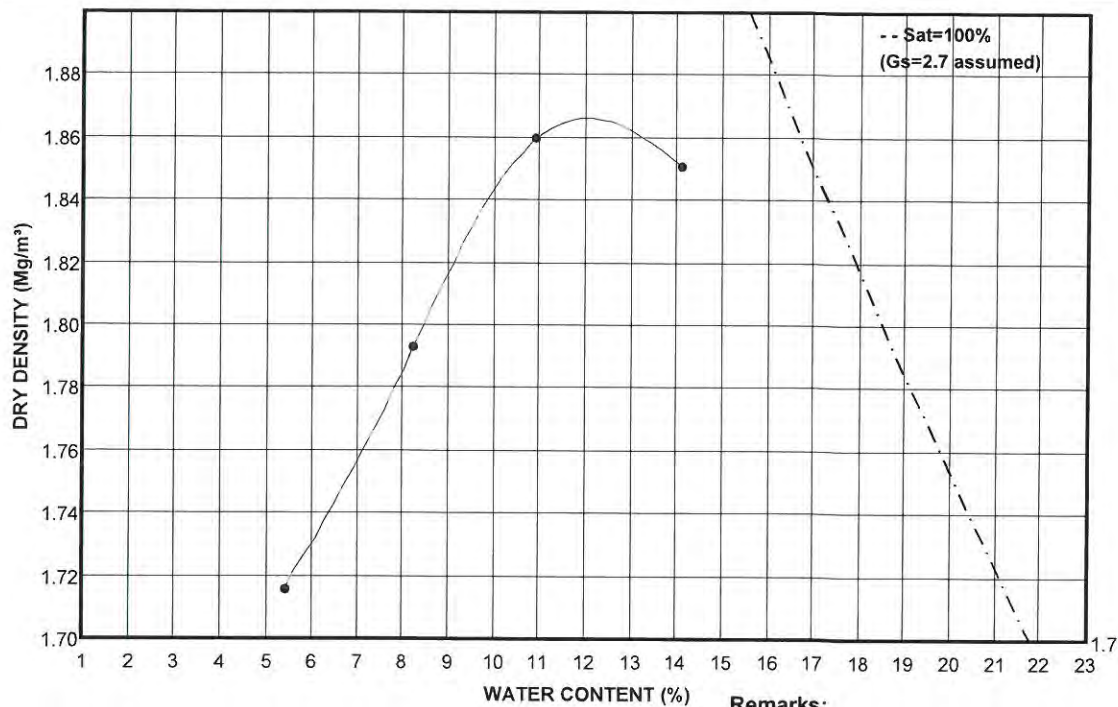
MAX. DRY DENSITY(Mg/m³): 1.866

NATURAL WATER CONTENT(%): 11.3

OPTIMUM WATER CONTENT(%): 12.2

SAMPLE: 1

SOURCE: BOREHOLE 215



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

Project Number: 10-1132-0152

Checked By:

Golder Associates

LABID: '12-349'

Date: 16-Mar-12

# LABORATORY COMPACTION TEST

Sandy Silt

Date Sampled: March 8, 2012

FIGURE A-2

## Test Results Summary

TEST: Standard

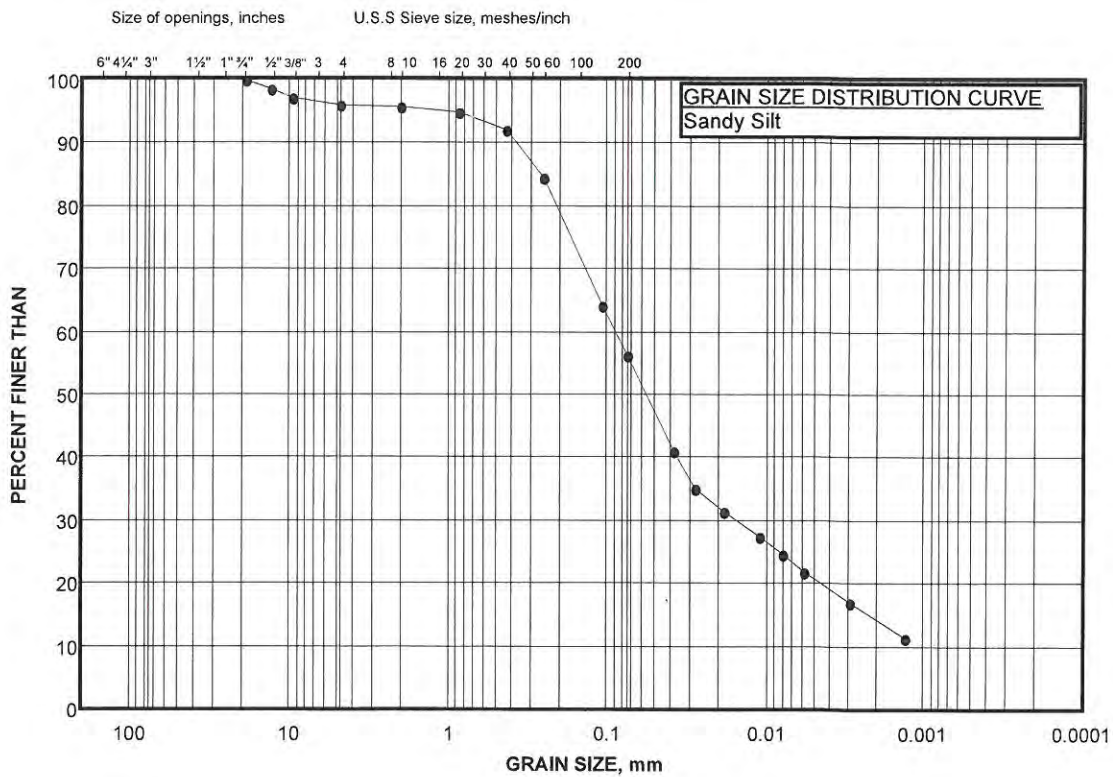
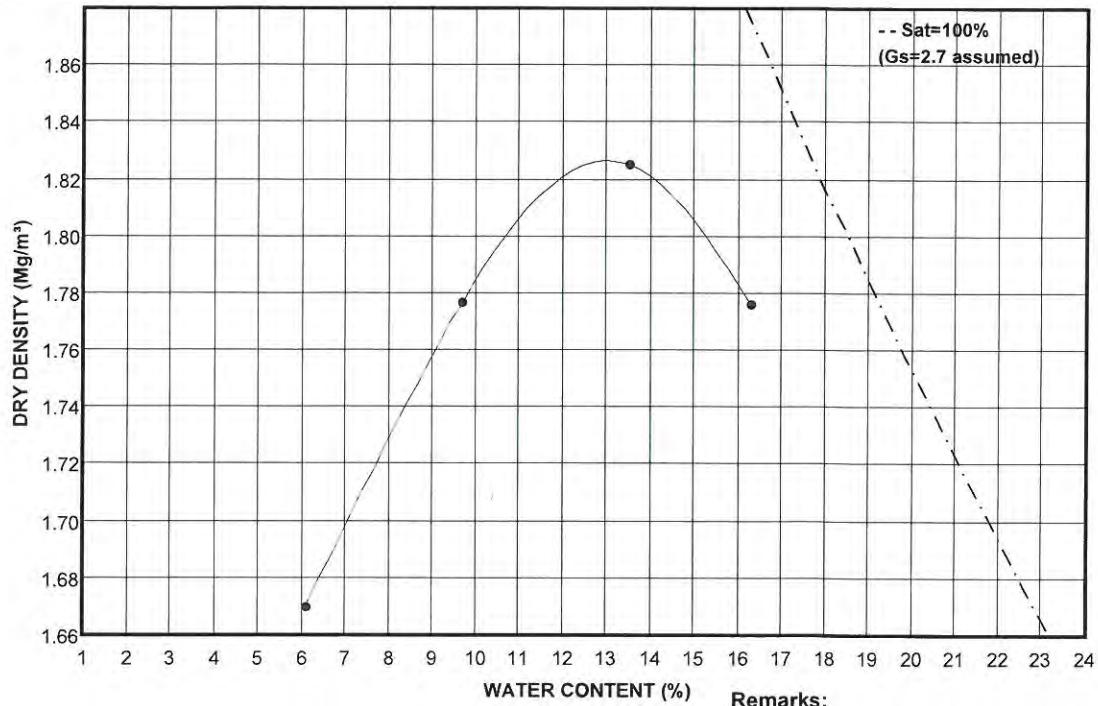
MAX. DRY DENSITY(Mg/m<sup>3</sup>): 1.826

NATURAL WATER CONTENT(%): 20.3

OPTIMUM WATER CONTENT(%): 13.3


SAMPLE: 2

SOURCE: BOREHOLE 217



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

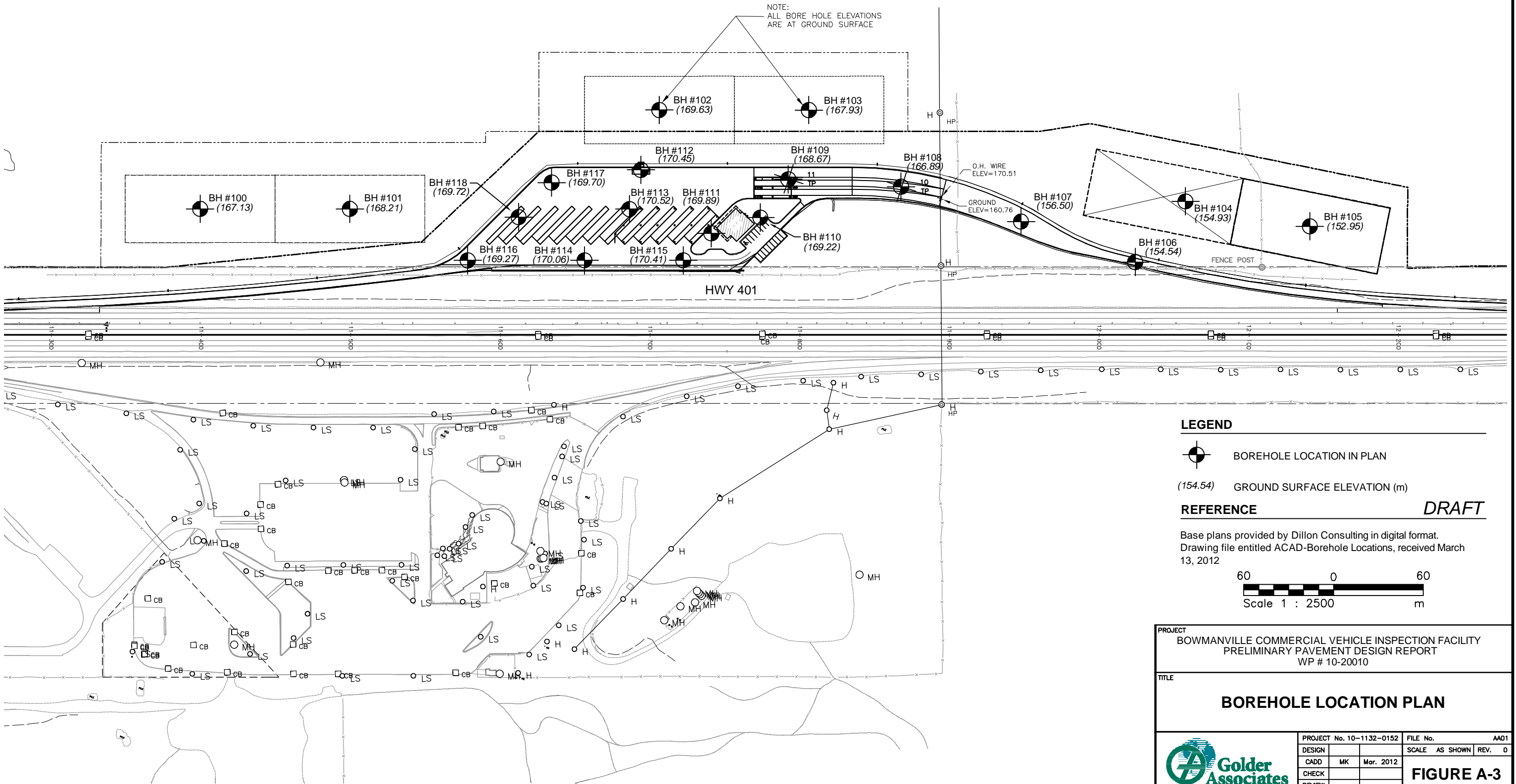
Project Number: 10-1132-0152

Checked By: 

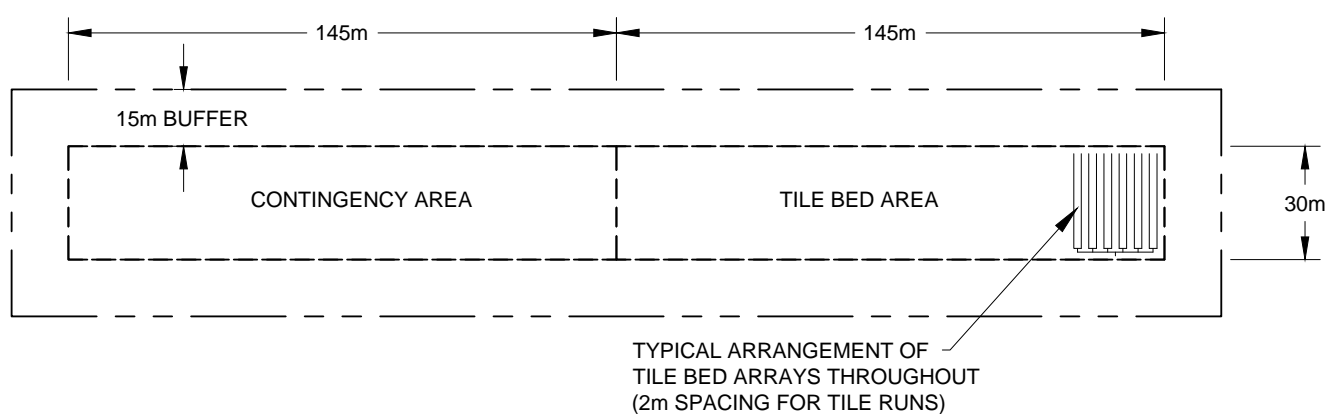
Golder Associates

LABID: '12-350'

Date: 16-Mar-12







## NOTE

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

PROJECT  
BOWMANVILLE COMMERCIAL VEHICLE INSPECTION FACILITY  
PRELIMINARY PAVEMENT DESIGN REPORT  
WP # 10-20010

TITLE

## SCHEMATIC TILE BED LAYOUT



PROJECT No. 10-1132-0152			FILE No. 1011320152-1000-R010A4		
CADD	WDF	May 03/12	SCALE	N.T.S.	REV. 0
CHECK			<b>FIGURE A-4</b>		



# **APPENDIX B**

## **Testhole Logs and Laboratory Test Data**

**Bowmanville CVIF**

BH #100 to BH #118, See Figure 3 for Borehole Locations

10-1132-0152

March, 2012

**BH #100 167.13 PA**

0 - 230 Dk Br Si Tps  
230 - 1.60 Lt Br Sa W Si, Moist\*  
1.60 - 3.00 Lt Br Si Sa, Moist

\* Sample Depth = 300 - 600  
w = 28 %

**BH #101 168.21 PA**

0 - 180 Dk Br Si Tps  
180 - 600 Br Sa W Si Tr Gr, Moist\*  
600 - 3.00 Br Sa Si W Cl Tr Gr, Moist\*\*

\* Sample Depth = 300 - 600  
Passing 4.75 mm = 100 %  
2.00 mm = 100 %  
425 um = 94 %  
75 um = 18 %  
w = 7 %  
Classification = SM  
Frost Susc. = LSFH  
'K' Factor = 0.10

\*\* Sample Depth = 700 - 1.10  
Passing 4.75 mm = 93 %  
2.00 mm = 91 %  
425 um = 83 %  
75 um = 53 %  
5 um = 18 %  
2 um = 13 %  
w = 14 %  
Plasticity = Non-plastic  
Classification = SM  
Frost Susc. = LSFH  
'K' Factor = 0.25

\*\*\* Sample Depth = 1.40 - 1.70  
w = 10 %



**Bowmanville CVIF**

BH #100 to BH #118, See Figure 3 for Borehole Locations

10-1132-0152

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**BH #102 169.63 PA**

0 - 260 Dk Br Si Tps  
260 - 700 Br Sa Si Tr Cl Tr Gr, Moist\*  
700 - 3.00 Br Sa Si Tr Gr, Moist

\* Sample Depth = 300 - 600  
w = 16 %

**BH #103 167.93 PA**

0 - 250 Dk Br Si Tps  
250 - 650 Br Sa W Si, Moist\*  
650 - 3.00 Br Cl Si W Sa, Moist\*\*

\* Sample Depth = 300 - 600  
Passing 4.75 mm = 100 %  
2.00 mm = 100 %  
425 um = 96 %  
75 um = 25 %  
w = 14 %  
Classification = SM  
Frost Susc. = LSFH  
'K' Factor = 0.10

\*\* Sample Depth = 1.00 - 1.30  
Passing 4.75 mm = 100 %  
2.00 mm = 100 %  
425 um = 97 %  
75 um = 70 %  
5 um = 42 %  
2 um = 30 %  
w = 20 %  
WL = 26 % WP = 14 % IP = 12 %  
Classification = CL  
Frost Susc. = LSFH  
'K' Factor = 0.15

\*\*\* Sample Depth = 1.40 - 1.70  
w = 19 %

**Bowmanville CVIF**

10-1132-0152

BH #100 to BH #118, See Figure 3 for Borehole Locations

March, 2012

**BH #104 154.93 PA**

0 - 230 Dk Br Si Tps  
230 - 700 Br Sa Si W Gr Tr Cl, Wet\*  
700 - 3.00 Br Si Sa, Wet, Fr Wat @ 1.80

\* Sample Depth = 300 - 600  
w = 12 %

**BH #105 152.95 PA**

0 - 260 Dk Br Si Tps  
260 - 3.00 Br Si Sa, Wet, Fr Wat @ 1.10

**BH #106 154.54 PA**

0 - 230 Dk Br Si Tps  
230 - 3.00 Br Si Sa, Wet, Fr Wat @ 900\*

\* Sample Depth = 300 - 600  
w = 17 %

**BH #107 156.50 PA**

0 - 210 Dk Br Si Tps  
210 - 3.00 Br Si Sa Tr Gr, Moist

**BH #108 166.89 PA**

0 - 200 Dk Br Si Tps  
200 - 600 Br Sa Si Tr Gr, Moist  
600 - 3.00 Br Si Sa W Gr W Cob, Moist

**BH #109 168.67 PA**

0 - 230 Dk Br Si Tps  
230 - 690 Br Sa Si Tr Cl, Moist  
690 - 1.40 Br Cl Si W Sa  
1.40 - 3.00 Br Si Sa W Gr Occ Cob

**BH #110 169.22 PA**

0 - 250 Dk Br Si Tps  
250 - 1.40 Br Sa Si Tr Cl, Moist  
1.40 - 3.00 Br Si Sa W Gr Tr Cl Occ Cob Occ  
Blds, Moist

**BH #111 169.89 PA**

0 - 200 Dk Br Si Tps  
200 - 1.40 Br Sa Si Tr Cl Tr Gr, Moist  
1.40 - 3.00 Br Si Sa W Gr Tr Cl Occ Cob Occ  
Blds, Moist

**BH #112 170.45 PA**

0 - 170 Dk Br Si Tps  
170 - 750 Br Sa Si Tr Cl Tr Gr, Moist\*  
750 - 3.00 Br Si Sa Tr Cl, Moist

\* Sample Depth = 350 - 650  
w = 11 %

**Bowmanville CVIF**

BH #100 to BH #118, See Figure 3 for Borehole Locations

10-1132-0152

March, 2012

**BH #113 170.52 PA**

0 - 220 Dk Br Si Tps  
220 - 3.00 Gry Br Sa Si Tr Cl Tr Gr Occ Cob,  
Moist\*

\* Sample Depth = 1.00 - 1.30  
w = 10 %

**BH #114 170.06 PA**

0 - 220 Dk Br Si Tps  
220 - 1.00 Lt Br Sa Si Tr Cl Occ Cob, Moist\*  
1.00 - 3.00 Lt Br Sa Si, Moist

\* Sample Depth = 300 - 600  
w = 11 %

**BH #115 170.41 PA**

0 - 180 Dk Br Si Tps  
180 - 800 Br Sa Si W Cl Tr Gr, Moist\*  
800 - 3.00 Br Sa Si Tr Gr, Moist\*\*

\* Sample Depth = 300 - 600  
Passing 4.75 mm = 99 %  
2.00 mm = 98 %  
425 um = 95 %  
75 um = 55 %  
5 um = 19 %  
2 um = 11 %  
w = 11 %  
Plasticity = Non-plastic  
Classification = SM  
Frost Susc. = LSFH  
'K' Factor = 0.35  
Std. Proctor MWD = 1866 kg/m<sup>3</sup>  
MDD = 2094 kg/m<sup>3</sup>  
w opt = 12 %

\*\* Sample Depth = 1.00 - 1.30  
w = 9 %

**BH #116 169.27 PA**

0 - 250 Dk Br Si Tps  
250 - 3.00 Lt Br Si Sa Tr Gr Occ Cob Occ Blds,  
Moist\*

\* Sample Depth = 2.50 - 2.80  
w = 7 %

**Bowmanville CVIF**

10-1132-0152

BH #100 to BH #118, See Figure 3 for Borehole Locations

March, 2012

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BH #117 169.70 PA

0 - 240 Dk Br Si Tps  
240 - 3.00 Gry Br Sa Si Tr Gr Occ Cob, Moist\*

\* Sample Depth = 300 - 600

Passing 4.75 mm = 96 %

2.00 mm = 95 %

425 um = 93 %

75 um = 55 %

5 um = 21 %

2 um = 15 %

w = 20 %

Plasticity = Non-plastic

Classification = SM

Frost Susc. = LSFH

'K' Factor = 0.30

Std. Proctor MWD = 1826 kg/m<sup>3</sup>"

MDD = 2068 kg/m<sup>3</sup>"

w opt = 13 %

BH #118 169.72 PA

0 - 200 Dk Br Si Tps  
200 - 3.00 Gry Br Sa Si Tr Gr Occ Cob Occ  
Blds, Moist



# **APPENDIX C**

## **AASHTO DARWin Analysis**

# 1997 AASHTO Pavement Design

## DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare  
Computer Software Product

### Rigid Structural Design Module

#### Rigid Structural Design

Pavement Type	JPCP
80-kN ESALs Over Initial Performance Period	39,500,000
Initial Serviceability	4.5
Terminal Serviceability	2.6
28-day Mean PCC Modulus of Rupture	5,000 kPa
28-day Mean Elastic Modulus of Slab	30,000,000 kPa
Mean Effective k-value	110 kPa/mm
Reliability Level	90 %
Overall Standard Deviation	0.47
Load Transfer Coefficient, J	2.6
Overall Drainage Coefficient, Cd	1.1
Calculated Design Thickness	258 mm

#### Layer Information

<u>Layer</u>	<u>Material Description</u>	Thickness (mm)	One Dir Width (m)
1	JPCP	258.2165019	-
Total	-	258	-

# 1997 AASHTO Pavement Design

## DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare  
Computer Software Product

### Flexible Structural Design Module

#### Flexible Structural Design

80-kN ESALs Over Initial Performance Period	39,500,000
Initial Serviceability	4.4
Terminal Serviceability	2.6
Reliability Level	95 %
Overall Standard Deviation	0.45
Roadbed Soil Resilient Modulus	50,000 kPa
Stage Construction	1

Calculated Design Structural Number                      159 mm

#### Specified Layer Design

<u>Layer</u>	<u>Material Description</u>	Struct Coef. <u>(Ai)</u>	Drain Coef. <u>(Mi)</u>	Thickness <u>(Di)(mm)</u>	Width <u>(m)</u>	Calculated SN <u>(mm)</u>
1	New HMA	0.42	1	190	-	80
2	New Granular A	0.14	1	150	-	21
3	New Granular B, Type I	0.09	1	650	-	59
Total	-	-	-	990	-	159

#### Layered Thickness Design

Thickness precision

Actual

<u>Layer</u>	<u>Material Description</u>	Struct Coef. <u>(Ai)</u>	Drain Coef. <u>(Mi)</u>	Spec Thickness <u>(Di)(mm)</u>	Min Thickness <u>(Di)(mm)</u>	Elastic Modulus <u>(kPa)</u>	Width <u>(m)</u>	Calculated Thickness <u>(mm)</u>	Calculated SN <u>(mm)</u>
1	New HMA	0.42	1	-	-	2,750,000	-	236	99
2	New Granular A	0.14	1	-	-	210,000	-	205	29
3	New Granular B, Type I	0.09	1	-	-	100,000	-	348	31
Total	-	-	-	-	-	-	-	789	159

**EQUIVALENT SINGLE AXLE LOAD CALCULATION**PRELIMINARY PAVEMENT DESIGN FOR  
Bowanville Truck Inspection Station  
\* \* \* \* \***1) Traffic Analysis**

Traffic Data Year	<u>2014</u>	<u>2034</u>
Design Year	<b>2014</b>	
Traffic Analysis Period		20
Average Annual Daily Traffic (AADT)	2,160	2,160
Average Rate of Increase in Traffic (%)		0.000
Truck Fraction of Total Traffic	100.0%	100.0%
Average Rate of Increase in Truck Fraction (%)		0.000
Number of Lanes in One Direction	1	1
Directional Factor	1	1
Lane Distribution Factor	1	1
<b>Daily Truck Volume</b>	<b>2,160</b>	<b>2,160</b>

**2) Daily ESALs Analysis**

Road Classification	<u>Rural Collector</u>	
Breakdown of Truck Proportions		
Class 1	1	
Class 2	0	
Class 3	0	
Class 4	0	
Daily Truck Volumes for 4 Classes	<u>2014</u>	<u>2034</u>
Class 1	2160	2,160
Class 2	0	0
Class 3	0	0
Class 4	0	0
Truck Factors for 4 Classes of Truck		
Class 1	2.5	
Class 2	0.0	
Class 3	0	
Class 4	0	
<b>Weighted Average Truck Factor</b>	<b>2.500</b>	
Daily ESALs per Truck Class		
Class 1	5,400	5,400
Class 2	0	0
Class 3	0	0
Class 4	0	0
<b>Total Daily ESALs in Design Lane</b>	<b>5,400</b>	<b>5,400</b>

**3) Total ESALs for Base Year**

Base Year	<u>2014</u>	<u>2034</u>
Number of Days of Truck Traffic	365	365
<b>Total ESALs for Base Year</b>	<b>1,971,000</b>	<b>1,971,000</b>

**4) Cumulative ESALs for the Design Period**

Design Period	20
Span of Design Period	<u>2014 to 2034</u>
Average Rate of Increase in Truck Volume (%)	0.00
Growth Factor	20.00
	39,420,867
<b>Cumulative ESALs for the Design Period</b>	<b>39,420,867</b>

**Note:** The ESAL calculations are based on the Guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", March 19, 2008.

Designed: \_\_\_\_\_  
Checked: \_\_\_\_\_



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