# Geotechnical Investigation Report
# Proposed Reconstruction and Widening of Regional Road 38 (Martindale Road) and Storm Sewer Replacement

## St. Catharines, Ontario
## May 2012

Prepared for:
The Regional Municipality of Niagara
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Project No. 111-26201-00

May 30, 2012

Mr. Frank Tassone
The Regional Municipality of Niagara
2201 St. David's Road
Thorold, Ontario
L2V 4T7

**Re: Reconstruction and Widening of Regional Road 38 (Martindale Road) and Storm Sewer Replacement, St. Catharines, Ontario**

**Geotechnical Investigation Report**

Dear Mr. Tassone:

We are pleased to submit our draft Geotechnical Investigation Report for the reconstruction and widening of Regional Road 38 (Martindale Road) from Elderwood Drive to Corporate Park Drive, and Storm Sewer Replacement, in the City of St. Catharines, Ontario. The report is based on information obtained from a borehole investigation and a laboratory testing program completed in January, 2012. Investigation procedures, findings and our recommendations are discussed herein.

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

Yours truly,
**GENIVAR Inc.**



Stuart E. Baird, P. Eng.
Project Engineer



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# 1. Introduction

GENIVAR Inc. (GENIVAR) was retained by the Regional Municipality of Niagara (Region) to carry out a geotechnical investigation for the proposed reconstruction and widening of Regional Road 38 (Martindale Road) from Elderwood Drive to Corporate Park Drive located south of the Q.E.W, in the City of St. Catharines, Ontario. A Site Location Map is attached as Figure 1.

It is understood that 2,350 metres of Martindale Road will be reconstructed by widening of the roadway, including 50 metres of the intersecting side roads. In addition, a proposed new storm sewer will be replacing the existing pipe along the project limits at Martindale Road.

The purpose of the geotechnical investigation was to obtain information about the subsurface conditions at the site by advancing boreholes at thirty nine (39) locations including twenty three (23) boreholes drilled along Martindale Road at the centerline and shoulders, and sixteen (16) boreholes drilled at the side road locations (Martindale Road Intersection with the side road). Subsurface conditions were assessed using semi-empirical methods to provide design recommendations for the pavement structure of the road and the proposed storm sewer pipe installation, to describe requirements for excavations, backfill, earth pressure, and dewatering during the construction phase.

This report is provided on the basis of the terms of reference and approved scope of work, and on the assumption that the design will be in accordance with the applicable codes and standards. If there are any changes in the design features relevant to the geotechnical analyses, or if any questions arise concerning the geotechnical aspects of the codes and standards, GENIVAR should be contacted to review the design. It may then be necessary to carry out additional borings and reporting before the recommendations of this office can be relied upon.

The site investigation and recommendation follow generally accepted practice for geotechnical consultants in Ontario. Laboratory testing for the most part follow ASTM or CSA Standards or modifications of these standards that have become standard practice.

This report has been prepared for the Regional Municipality of Niagara and its designers. Third party use of this report without GENIVAR consent is prohibited.

# 2. Investigation Methodology

## 2.1 Borehole Investigation

The fieldwork for the project was carried out on January 11, 16, 18, 19, and 25, 2012. A total thirty-nine (39) boreholes designated as BH1, BH3, BH4 to BH40 were drilled along Martindale Road and the side roads intersecting with Martindale Road.

Twenty-three (23) boreholes were drilled along Martindale Road in locations at the centerline and shoulders to depths ranging between 2.3 m and 5.2 m below the existing grade. , Sixteen (16) boreholes were drilled at the side roads (Martindale Road intersection with the side road) to a depth of 1.5 m below the existing grade. Borehole Location Plans are presented as Figures 2A, 2B, 2C, and 2D.

The boreholes were drilled using a CME 45 truck-mounted drill rig equipped with solid-stem continuous flight augers, supplied and operated by a specialist drilling subcontractor under the supervision of GENIVAR technicians. Soil samples were retrieved at regular intervals with a 50 mm O.D split-barrel samplers driven with a drop hammer weighing 624 N and falling 760 mm in accordance with the Standard Penetration Test (SPT) method (ASTM D1586). The results of standard penetration tests in terms of N values are referred to in this report as consistency for cohesive soils and relative density for noncohesive materials. Soil samples were logged in the field and returned to the GENIVAR laboratory for detailed examination by the Geotechnical Engineer and for selected testing.

Water level observations were made during drilling and in the open boreholes at the completion of the drilling operations.

# 3. Site and Subsurface Conditions

The subsurface profile at the site is described in the Borehole Logs included in Appendix A.

The subsurface stratigraphy encountered at the borehole locations generally consists of a pavement structure of asphalt and granular base material underlain by a fill layer at some locations ranged in texture from clayey silt to sandy gravel, which in turn is underlain by a native clayey silt to silty clay till. Descriptions of individual stratigraphic units are as follows.

## 3.1 Existing Pavement Structure

A pavement structure was encountered in all of the boreholes that were drilled along Martindale Road and the side roads. The pavement structure consisted of an asphalt layer of varying thickness underlain by granular base materials.

The number of observations, the range and mean thickness of each layer for Martindale Road and the side roads are summarized in Table 3-1.

**Table 3-1 Existing Pavement Structure for Martindale Road**

| Pavement Component | No. of Observations | Thickness (mm), Range | Thickness (mm), Mean |
|---|---|---|---|
| Martindale Road | | | |
| Hot Mix Asphalt | 21 | 130-340 | 174 |
| Granular Base Material | 23 | 100-585 | 395 |
| Side Roads | | | |
| Hot Mix Asphalt | 14 | 25-130 | 100 |
| Granular Base Material | 14 | 120-500 | 338 |

Four samples of the granular base material were tested for particle size distribution. Laboratory test results indicate that the granular base sample was not within the acceptable limit as Granular "A" (OPSS 1010) for three of the tested samples, as shown in Figures B2, B3, and B4 in Appendix B, with results summarized as follows (MIT Scale):

| | |
|---|---|
| Gravel (>2 mm size): | 47- 64% |
| Sand (0.06 mm to 2 mm size): | 24- 53% |
| Silt and Clay (< 0.06 mm size): | 11- 20% |

We believe that the cold temperature and the frozen ground at the time of drilling operation and excessive grinding forces to break the frozen material may have resulted in an excessive amount of fine material in the samples. A sample of granular base material taken from BH1 was within the acceptable limit as Granular "A" (OPSS 1010), as shown in Figure B1 in Appendix B, with results summarized as follow (MIT Scale):

| | |
|---|---|
| Gravel (>2 mm size): | 71% |
| Sand (0.06 mm to 2 mm size): | 21% |
| Silt and Clay (< 0.06 mm size): | 8% |

Standard Penetration Test N values for the granular base ranged between 20 and 85 blows per 305 mm of penetration and indicate a compact to very dense relative density (generally compact). The higher N-value was due to the presence of large amount of gravel.

The moisture content of the tested samples of the fill ranged between 2% and 5% based on laboratory tests, indicating dry to moist conditions.

## 3.2 Organic Clayey Silt (Buried Topsoil)

A layer of organic clayey silt mixed with buried topsoil was encountered underneath the pavement structure of Martindale Road at four borehole locations with thicknesses of 500 mm, 180 mm, 120 mm, and 200 mm at boreholes BH4, BH10, BH11 and BH16, respectively.

A 400 mm thick layer of organic clayey silt was encountered at Willow Bank Circle, at borehole location BH15.

The moisture content of the tested samples of the organic clayey silt layer was between 20% and 38% based on laboratory tests.

## 3.3 Concrete

A layer of concrete was encountered at boreholes BH30 and BH32 with a thickness of 125 and 150 mm, respectively.

The concrete slab was encountered at the surface of borehole BH32, and below the asphalt layer at borehole BH30.

## 3.4 Fill: Clayey Silt

A fill material consisting of clayey silt with some sand and a trace of gravel was encountered below the pavement structure, at boreholes BH5, BH13, BH20, BH24, BH27, BH30, and BH31 with a thickness ranging from 0.4 m to 1.2 m.

The clayey silt fill material was encountered below the concrete slab at borehole BH32, extending to 0.8 m below the ground surface.

Standard Penetration Test N values for the fill ranged between 6 and 13 blows per 305 mm of penetration and indicate a firm to stiff consistency (generally firm).

The moisture content of tested samples of the fill ranged between 9% and 15% based on laboratory tests, indicating moist soil conditions.

## 3.5 Fill: Silty Sand to Sandy Gravel

A layer of granular fill material ranging texture from silty sand to sandy gravel was encountered underneath the pavement structure and or clayey silt fill at boreholes BH2, BH5, BH23, BH24, BH29, BH31, BH35 and BH40. The thickness of the fill material varied from 0.2 m at borehole BH31 to 1.1 m at borehole BH23.

The particle size distribution analysis for a selected sample of the sandy gravel fill layer is provided as Figure B5 in Appendix B, with results summarized as follows (MIT Scale):

| | |
|---|---|
| Gravel (>2 mm size): | 46% |
| Sand (0.06 mm to 2 mm size): | 31% |
| Silt and Clay (< 0.06 mm size): | 23% |

Standard Penetration Test N values for the silty sand ranged between 6 and 8 blows per 305 mm of penetration and indicate a loose relative density. N values for the sandy gravel fill ranged between 6 and 24 blows indicating a loose to compact relative density (generally compact).

The moisture content of tested samples of this layer ranged between 5 and 8 percent based on laboratory tests, indicating moist soil conditions.

## 3.6 Native: Clayey Silt to Silty Clay Till

A glacial till layer consisting of clayey silt to silty clay with a trace to some sand and shale fragments, was contacted underneath the pavement structure or fill layer at all the drilled boreholes except for boreholes BH20, BH23, BH24, BH25, BH29 and BH40.

The native clayey silt to silty clay till extended to the borehole termination depth of 1.5 m at boreholes BH6, BH9, BH12, BH15, BH17, BH21, BH25, BH27, BH28, BH30, BH32, BH33, and BH38, 3.7 m at boreholes BH1, BH2, BH4, BH5, BH7, BH8, BH10, BH11, BH13, BH16, BH19, BH22, BH26, BH34, BH35, and BH37, and to depths of between 4.2 m and 5.2 m for boreholes BH14, BH18, BH36 and BH39.

The particle size distribution analyses for four (4) selected samples of the till layer are provided as Figures B6 to B9 in Appendix B, with results summarized as follows (MIT Scale):

| | |
|---|---|
| Gravel (>2 mm size): | 1 - 2% |
| Sand (0.06 mm to 2 mm size): | 7 - 15% |
| Silt (0.002 mm to 0.06 mm size) | 40 - 49% |
| Clay(<0.002 mm size): | 34 - 52% |

SPT N values in the clayey silt to silty clay till layer ranged between 9 and 45 blows per 305 mm of penetration and indicate a stiff to hard consistency (generally very stiff).

Two (2) selected samples of the clayey silt to silty clay till were tested in the laboratory for Atterberg Limits. The testing yielded the following results:

| | |
|---|---|
| Liquid Limit (LL) | 33% - 36% |
| Plastic Limit (PL) | 15% - 16% |
| Plasticity Index (PI) | 18% - 20% |

The results are plotted on a plasticity chart, Figure B10 in Appendix B where the soil can be classified as Type CL- CI (Unified System) which indicates inorganic clay and silt of low to medium plasticity.

The moisture content for the clayey silt to silty clay till ranged between 12% and 22% based on laboratory tests, indicating moist to wet soil conditions (generally moist), and typically the moisture content is located at or slightly below the plastic limit range.

## 3.7 Groundwater Conditions

Soil moisture and groundwater levels in the open boreholes were inspected during and on completion of drilling. Soil colour changes from brown to grey, the presence of rusty coloured mottling, and wet spoon samplers are general indicators of variable moisture conditions and oxidization.

During drilling and at the completion of drilling, groundwater was encountered in only two boreholes, BH5 where water was found at 1.8 m below the ground surface, and BH35 where water was measured at 2.7 m below the ground surface. It is inferred that the groundwater level at the time of our investigation was typically below the exploration depth for all the borehole locations except for boreholes BH5 and BH35.

It should be noted that groundwater levels can vary and are subject to seasonal fluctuations in response to major weather events.

# 4. Pavement Condition Survey

A site visit was conducted by our engineer on May 17, 2012. The pavement condition evaluation consisted of an engineer walking the pavement section, identifying and classifying the existing cracks and distress features and plotting them, taking pictures for the road sections and driving over the pavement section at posted speed.

The pavement condition for the Martindale Road was inspected starting from Elderwood Drive from the south (Station 9+000) to Corporate Park Drive to the north (Station 11+146). The inspection was conducted by dividing the subject study to ten (10) road sections with lengths varied from 80 m to 400 m depending on the quality and rating of the pavement condition for the road sections.

Based on the crack mapping and visual observation a completed Form of the Pavement Surface Distress Manifestations shown in Figure A-1 was prepared for each road sections as shown in Appendix E. The distress manifestations include the following:

- Riding Condition Rate (RCR), which indicates the degree of riding comfort that pavement provides to the travelling public.
- Driving over the pavement section at the posted speed and classified the Pavement's Riding Condition according to Ministry of Transportation of Ontario (MTO) standards as shown in Table 4-1 below:

**Table 4-1 Ride Condition Rating Guide**

| Riding Condition Rate (RCR) | | Guidelines |
|---|---|---|
| **8- 10** | Excellent | Very smooth ride |
| **6-8** | Good | Smooth ride with just a few to intermittent bumps of depressions |
| **4-6** | Fair | Still comfortable ride with intermittent bumps or depressions |
| **2-4** | Poor | Uncomfortable ride with frequent bumps or depression |
| **0-2** | Very Poor | Uncomfortable ride with constant bumps. Cannot maintain posted speed and must steer to avoid bumps. |

- Pavement Surface Distress Manifestations, which are evaluated by walking and /or driving and marking surface distress, surface distortion or deformation, and cracking for pavement section. See Figure A-1 for the road sections in the Appendix A. Samples of photographs for each road section are presented in Appendix F.

- Pavement Condition Rating (PCR), which is derived from the pavement riding comfort and from pavement surface distress and classified per MTO Guideline presented in Table 4-2 below:

**Table 4-2 Pavement Condition Rating Guide**

| Pavement Condition Rating (PCR) | Guidelines |
|---|---|
| **90-100** | Pavement is in excellent condition with few cracks |
| **75-90** | Pavement is in good condition with frequent very slight or slight cracking |
| **65-75** | Pavement is in fairly good condition with slight cracking, slight or very slight dishing and few areas of slight alligatoring |
| **50-65** | Pavement is in fair condition with intermittent moderate and frequent slight cracking, with intermittent slight or moderate alligatoring and dishing |
| **40-50** | Pavement is in poor to fair condition with frequent moderate cracking and dishing and intermittent moderate alligatoring |
| **30-40** | Pavement is in poor condition with frequent moderate alligatoring and extensive moderate cracking and dishing |
| **20-30** | Pavement is in poor condition with moderate alligatoring and extensive sever cracking and dishing |
| **0-20** | Pavement is in poor to very poor condition with extensive severe cracking, alligatoring and dishing |

## 4.1 Summary of the Pavement Condition Survey

Table 4-3 summarizes the Riding Condition Rate (RCR), Pavement Surface Distress Manifestations, and Pavement Condition Rating (PCR) for the ten (10) road sections of Martindale Road between Elderwood Drive from the south to Corporate Park Drive from the north. The pavement condition rating forms are attached in Appendix E and the photographs (see Figure A-1, in Appendix E and Photographs for the pavement condition for each section are attached in Appendix F.

**Table 4-3 Summary of Pavement Condition Survey**

| Section Number | Staring Station(m) | Ending Station(m) | Length of Section (m) | PCR | RCR |
|---|---|---|---|---|---|
| 1 | 9+000 | 9+200 | 200 | 80 | 8.5 |
| 2 | 9+200 | 9+400 | 200 | 85 | 9.0 |
| 3 | 9+400 | 9+680 | 280 | 85 | 9.0 |
| 4 | 9+680 | 9+760 | 80 | 50 | 5.0 |
| 5 | 9+760 | 9+880 | 120 | 65 | 6.5 |
| 6 | 9+880 | 10+200 | 320 | 85 | 8.5 |

| Section Number | Staring Station(m) | Ending Station(m) | Length of Section (m) | PCR | RCR |
|---|---|---|---|---|---|
| 7 | 10+200 | 10+600 | 400 | 70 | 7.5 |
| 8 | 10+600 | 10+700 | 100 | 85 | 8.5 |
| 9 | 10+700 | 10+950 | 250 | 50 | 5.5 |
| 10 | 10+950 | 11+146 | 196 | 95 | 9.5 |

Based on the Pavement Condition Rating (PCR) and Riding Condition Rate (RCR) listed above a summary of the road condition is as follow:

- Road sections 1, 2, 3, 6 and 8 are in good condition with intermittent to few very slight or slight cracking. Rideability is good with a smooth ride with just a few bumps or depressions.
- Road sections 5 and 7, the pavement is in fairly good condition with slight cracking, slight or very slight dishing and few areas of slight alligatoring. Rideability is fairly good with intermittent rough and uneven sections.
- Road sections 4 and 9 have poor to fair pavement condition with frequent moderate cracking and dishing, and intermittent moderate alligatoring. Rideability is fair and surface is slightly rough and uneven with intermittent bumps or depressions.
- Road section 10, the pavement is in excellent condition with few to no cracks. Rideability is very smooth ride.

# 5. Recommendations for the Pavement Design

We understand that the proposed 2,350 metres of Martindale Road will be reconstructed by widening of the roadway, including the adjacent 50 metres of all side roads. In addition, the existing storm sewer with diameter up to 1050 mm along Martindale Road will be replaced by new same size diameter pipe with invert depth varied from 3.0 to 4.5 m below the ground surface. Martindale Road is a regional roadway under the jurisdiction of Niagara Region. It presently functions as a two-lane arterial road serving north/south traffic flows and provides access to residential, commercial, and industrial uses and it is proposed to be widened to four lanes. The project limit for the proposed reconstruction and widening starts at Corporate Park Drive in the north to Elderwood Drive in the south.

In general, the soil investigation shows a pavement structure consisting of asphalt with a mean thickness of 174 mm and granular base with a mean thickness of 395 mm along Martindale Road underlain at some locations by firm to stiff clayey silt fill and/or loose to compact silty sand to sandy gravel fill, which in turn is underlain by stiff to hard clayey silt to silty clay till. The glacial till extended to the end of the borehole depths between 1.5 and 5.2 m below the ground surface.

During drilling and at the completion of drilling, groundwater was found in only two borehole locations, which indicates that the groundwater level at the time of our investigation was typically below the exploration depth of all the borehole locations except for boreholes BH5 and BH35, where groundwater was encountered at depths of 1.8 m and 2.7 m respectively.

## 5.1 Road Classification and Traffic Data

Regional Road 38 (Martindale Road) within the project limits is classified as Urban Arterial with traffic volumes AADT, Annual Traffic Growth, and % Commercial as presented in Table 5-1.

**Table 5-1 Traffic Volume, Annual Traffic Growth and Commercial Percentage**

| AADT | Annual Traffic Growth (%) | % Commercial |
|---|---|---|
| Year 2011 = 15,000 | 2.0 | 3.0 |

The existing road at the subject area has a two-lane cross-section, one lane in each direction, and has a posted 50 km/h speed limit.

## 5.2 Equivalent Single Axle Loads (ESALs)

The equivalent single axle loads (ESAL) for the widening were calculated based on traffic data presented in Table 5-1. The input parameters for the design lane ESAL calculation were derived from MTO publication MI-183 “Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions” and ‘Procedures for Estimating Traffic Loads for Pavement Design, 1995”. Table 5-2 presents the input parameters used to calculate ESALs in the design lanes.

**Table 5-2 Input Parameters for ESAL Calculations**

| AADT[1] (2011) | Avg. Truck Factor | DD[2] | LD[3] | Design No. Of Days per Year | Design Period (Year)[4] | Cumulative ESALs |
|---|---|---|---|---|---|---|
| 15,000 | 1.31 | 0.5 | 0.9 | 365 | 20 | 2,877,535 |

1. AADT provided by the client for year2011
2. Directional Distribution
3. Lane Distribution
4. Design Period of 20 years from the base year 2011

## 5.3 Pavement Thickness Design

Pavement structure thickness design for the reconstruction and widening of Martindale Road within the project limits was determined using the AASHTO 1993 design guide and the MTO Pavement Design Manual. The completed geotechnical investigations show that the predominant subgrade soils within the project limit varied from stiff to hard clayey silt to silty clay till.

Input parameters for the pavement design are shown in Table 5-3 below, and the design output sheets are presented in Appendix C for WinPAS Software.

**Table 5-3 Input Parameters for Pavement Structure Calculations**

| **Initial / Terminal Serviceability** | **$P_i$=4.5, $p_t$=2.5** |
|---|---|
| Design Period | 20 years |
| Traffic | See Table 4-2 |
| Cumulative ESALs | 2,877,535 |
| Subgrade Resilient Modulus ($M_R$) | 30 MPa |
| Structural Coefficients ('a' values) | New HMA[1]=0.42<br>New Base(Gran A)=0.14 |
| Drainage Coefficient | m= 0.9 (One or two minor encroachments include the percentage of fines (<0.075 mm) just over the upper limits, or marginal to inadequate ditching in cuts) |
| Reliability and Standard Deviation | R= 95%; SD=0.49 |

1- HMA = Hot mix asphalt

The required pavement structure for the new extensions and the intersections, based on the MTO routine and AASHTO design methods, for the input parameters noted in Table 5-3 and considering very stiff clayey silt to silty clay subgrade, is shown in Table 5-4.

**Table 5-4 Pavement Design Summary**

| **Design Methodology** | **Material Thickness (mm)** | **SN*** | **GBE**(mm)** |
|---|---|---|---|
| MTO Routine | 130 mm hot mix, 420 mm Granular "A" | 102 | 830 |
| AASHTO | 180 mm hot mix, 500 mm Granular "A" | 130 | 860 |

* Structural Number (Minimum Requirement)
**GBE Granular Base Equivalency Thickness (MTO Routine)

Table 5-4 shows that the pavement structure recommended by the AASHTO pavement design method is stronger than that for the MTO routine method. Past experience also indicates that the AASHTO method provides a more reliable pavement design. The results from AASHTO method were compared with the Regional Standard of 180 mm hot mix, 475 mm Granular "A" and, GBE = 835. Therefore, AASHTO results were used as a guideline for layer thickness determination.

## 5.4 Pavement Recommendations

### 5.4.1 Pavement Construction

On the basis of the pavement condition survey presented in Section 4.0 of this report, we recommend full construction for the following road sections:

- Road section 4 and 5 , from Sta. 9+680 to Sta. 9+880,
- Road section 9 , from Sta. 10+700 to Sta. 10+950

On the basis of the pavement analysis and design in Section 5.3, and to facilitate subsurface drainage, the following pavement structure is recommended for the lane widening and the full construction of road sections 4, 5 and 9 and all side roads:

**Martindale Road**

Excavate to provide for:

- **60 mm HL3HS surface course asphalt concrete** compacted to 97% of the Bulk Relative Density (BRD).
- **120 mm HL8HS binder course asphalt concrete**, (40 mm upper binder course, 40 mm middle binder course, and 40 mm lower binder course), compacted to 97% of the Bulk Relative Density (BRD).
- **500 mm Granular "A" base course**, compacted to 100% of the Standard Proctor Maximum Dry Density (SPMDD).

**All Side Roads**

Excavate to provide for:

- **40 mm HL3 surface** course asphalt concrete, compacted to 97% of the Bulk Relative Density (BRD).
- **80 mm HL8HS binder course** asphalt concrete, (40 mm upper binder course, and 40 mm lower binder course), compacted to 97% of the Bulk Relative Density (BRD).
- **400 mm Granular "A" base course**, compacted to 100% of the Standard Proctor Maximum Dry Density (SPMDD).

All materials must meet the latest OPSS specifications and or MTO specifications. All topsoil, fill materials, and any unsuitable materials anticipated along the widening especially the buried topsoil should be excavated and removed off site prior to the placement of the granular base.

It should be noted that the existing granular base materials are not within the requirement of Ontario Provincial Standard Specification (OPSS1010) and should not be used as Granular "A" for roadway reconstruction or pavement rehabilitation without further testing during construction but can be used as Granular "B" Type I for the backfilling of the storm sewer pipe.

### 5.4.2 Pavement Rehabilitation

Based on the visual condition survey of the existing pavement, road sections from Station 9+000 to 9+680 m and Station 9+880 to Station 10+700 are in good to fairly good condition and no buried organics were encountered. Thus, rehabilitation instead of reconstruction is recommended for the fairly good to good pavement condition to accommodate the 20 years pavement design period.

It should be noted that road section (10) from Station 10+950 to Station 11+146 m has an excellent pavement condition and therefore, no rehabilitation will be needed for this road section.

The rehabilitation alternatives that satisfy the minimum structural requirement (SN=130) are tabulated in Table 5-5 below.

**Table 5-5 Summary of the Pavement Rehabilitation Options.**

| Rehabilitation Strategy | | Pavement Structure | SN* |
|---|---|---|---|
| 1 | Remove asphalt pavement full depth | Remove existing asphalt pavement full depth<br>Place new 100 mm Granular A, then<br>Pave 180 mm HMA(60 mm HL3HS, 120 mm HL8HS) | 133 |
| 2 | Full depth reclamation with pre-milling | Mill 50 mm existing asphalt pavement<br>Pulverize 250 mm (125 mm existing asphalt pavement and 125 mm base ), then<br>Place new 100 mm Granular A, then<br>Pave 130 mm HMA (40 mm HL3, over 40 mm HL8,over 50 mm HL8) | 133 |
| 3 | Full depth Reclamation without pre-milling | Pulverize 325 mm ( existing asphalt and minimum 150 mm base), then<br>Place new 100 mm Granular A, then<br>Pave 130 HMA (40 mm HL3, over 40 mm HL8, over 50 mm HL8) | 141 |

SN* was calculated using the layer coefficient factors: New HMA=0.42, Existing Granular Base=0.11, New Base (Gran A) = 0.14, Pulverized material=0.14.

The design assumes that the allowable maximum grade raise for Options 1, 2, and 3 are 106 mm, 180 mm, and 230 mm respectively. We recommend that Option 1 will be more feasible and suitable option for the pavement rehabilitation since it will require minimum grade raise.

### 5.4.3 Stripping, Sub-excavation and Grading

The site should be stripped of all topsoil, loose fill and any organic or otherwise unsuitable soils to the full depth of the widening roadway, both in cut and fill areas.

Following stripping, the site should be graded to the subgrade level and approved. The subgrade should then be proof-rolled, in the presence of the Geotechnical Engineer, by at least several passes of a heavy compactor having a rated capacity of at least 8 tonnes. Any soft spots thus exposed should be removed and replaced by select fill material, similar to the existing subgrade soil and approved by the Geotechnical Engineer. The subgrade should then be recompacted from the surface to at least 98% of its Standard Proctor Maximum Dry Density (SPMDD). The final subgrade should be cambered or otherwise shaped properly to prevent the formation of local depressions in which water could accumulate. Otherwise, any water collected in the granular base materials could be trapped thus causing problems due to softened subgrade, differential frost heave, etc. For the same reason, damaging the subgrade during and after placement of the granular materials by heavy construction traffic should be avoided. If the moisture content of the local material cannot be maintained at ± 2% of the optimum moisture content, imported granular material may need to be used.

Any fill required for regrading the site or for backfill should be select, clean material, free of topsoil, organic or other foreign and unsuitable matter. The fill should be placed in thin layers and compacted to at least 95% of its SPMDD. The degree of compaction should be increased to 98% within the top 1.0 m of the subgrade, or as per the MTO Standards. The compaction of the new fill should be checked by frequent field tests.

### 5.4.4 Construction

Once the subgrade has been inspected and approved, the Granular “A” material should be placed in layers not exceeding 200 mm (uncompacted thickness) and should be compacted to at least 100% of their respective SPMDD. The grading of the material should conform to current OPS Specifications.

It should be noted that several samples from the existing granular base materials are not within the requirement of Ontario Provincial Standard Specification (OPSS1010) as previously discussed in Section 3.1 in this report. However, we believe that the cold temperature and the frozen ground at the time of drilling operation and excessive grinding forces to break the frozen material may have resulted in an excessive amount of fine material in the samples. Therefore, we recommend that more laboratory tests will be needed during the construction phase to approve the reuse of the base material.

The placing, spreading and rolling of the asphalt should be in accordance with OPS Specifications or, as required by the MTO and Regional Standards. The finished pavement surface and underlying subgrade should be free of depressions and should be sloped as required by MTO specifications.

### 5.4.5 Drainage

A subdrain system is recommended below the proposed edge of the pavement. A 150 mm diameter subdrain pipe wrapped with geotextile (Class 1 nonwoven FOS 75-150 µm) to prevent the loss of (and clogging by) soil fines placed at an invert depth of 1.3 m and surrounded with 19.0 mm diameter clear stone is recommended. The subdrain system shall be connected to the adjacent catchbasins. Surface water should not be allowed to pond adjacent to the outside edges of pavement areas.

All paved surfaces should be sloped to provide satisfactory drainage towards catchbasins. As discussed in the preceding paragraphs, by means of good planning, any water trapped in the granular sub-base materials should be drained rapidly towards subdrains or other interceptors.

# 6. Recommendations for the Storm Sewer Replacement

It is our understanding that the existing storm sewer with diameter up to 1050 mm along Martindale Road will be replaced by new same size diameter pipe with invert depths ranging from 3.0 m to 4.5 m below the ground surface.

In general, the soil investigation shows a pavement structure consisting of asphalt and granular base underlain by loose to compact fill materials consisting of silty sand to clayey silt. The fill layer or the granular base was underlain by a stiff to hard clayey silt to silty clay till layer which extended to the boreholes' terminal depths of between 3.7 m to 5.2 m below the ground surface.

During drilling and at completion of drilling, groundwater levels were typically below the exploration depth for all the borehole locations except for boreholes BH5 and BH35 where water was encountered at depths 1.8 m and 2.7 m respectively.

## 6.1 Trench and Excavation

It is anticipated that the invert depth for the new storm sewer will be located between 3.0 m to 4.5 m below the existing ground surface. Below the pavement structure of the roadway, the trenches will be dug

through a fill layer, and then clayey silt to silty clay till. Thus, the proposed new utility pipes will generally be situated in the very stiff to hard till layer.

It is our opinion that the native very stiff to hard clayey silt to silty clay till is suitable to support the new storm sewer pipe. If loose or soft soil material is encountered below the proposed invert level of the utility pipes, it would be prudent to remove any loose material below the invert of the pipes and replace it with suitable granular fill such as Granular “B” Type II engineered fill, compacted in layers not exceeding 200 mm in thickness to 98% of Standard Proctor Maximum Dry Density (SPMDD).

The excavation through the granular fill and the till may require shoring during the construction of the trench.

Based on soil conditions and the availability of space, different methods may be selected for installation of the new storm sewer pipe which is discussed in the following sections.

### 6.1.1 Open Cut Excavation

The most common and cost-effective construction method is normally an open-cut excavation, and based on the borehole information, no major problems with groundwater are anticipated.

Groundwater was not encountered during the borehole drilling except at two borehole locations, BH 5 and BH 35, at depths that ranged between 2.0 m and 3.0 m below the ground surface. Minor seepage can be expected at the bottom of the open cut excavations. The seepage, however, should be manageable through gravity drainage and/ or a filtered sump and pump system. Closely spaced filtered sumps may be needed if the excavation procedures are conducted during seasonally wet conditions. All dewatering should be in accordance with OPSS 517.

It would be prudent to open the trenches in relatively short sections and complete the laying of the pipe and backfilling expeditiously in order to reduce the length of time the trench will be open.

The excavations should be carried out in accordance with the Safety Regulation of the Province (i.e., Occupational Health and Safety Act (OHSA) Reg. 213/91), as well as SP105 S19-Protection Systems.

The boreholes show that the excavations for the construction of the sanitary sewer and watermain pipes can be expected to extend through fill materials and glacial till soils. These soils can be classified as follows:

| | |
|---|---|
| Granular Fill | Type 3 above water level |
| Fill: Silty Sand to clayey silt | Type 3 above water level |
| | Type 4 below water level |
| Stiff to Hard Clayey Silt to Silty Clay Till | Type 1 above water level |
| | Type 2 below water level |

A bank slope of 1H:1V is required for excavations in Type 3 soils and 3H:1V in Type 4 soils in accordance with the Ontario Health and Safety Regulations.

### 6.1.2 Use of Trench Box for Utility Trench Wall Support

Where permissible under the OHSA, contractors often elect to utilize trench boxes for temporary trench support.

While in many situations, the use of trench boxes can result in a high rate of productivity in trenching, it is not without some technical drawbacks. These include:

- Increased loss of ground relative to many other shoring methods; and
- Reduced ability to compact backfill between the trench wall and trench box.

Ground loss, ravelling and /or loosening of soils will occur when using a trench box prior to its installation and while moving the box, particularly in pre-existing fill which is present at this site. It is important that the trench not be over-excavated to ensure a tight fit between the box and the trench walls. Trench boxes need to be installed expediently. When moving the box, the void space between its outer walls and the trench must be backfilled and compacted. This may require raising the box sequentially prior to sliding it laterally. If this is not done, post-construction settlements will occur along the trench walls.

In areas where the proposed utility pipe encroaches existing utility trenches or backfill to structures, unstable trench conditions can occur, particularly where granular backfill, clear stone, or poorly compacted fill of any type are present. In such cases, ravelling of the pre-existing fill and high rates of water infiltration through utility bedding can potentially occur which can, in severe cases, put the stability of adjacent utilities in jeopardy. As such, a higher standard of care in shoring is needed where the pipe trenches are located closer than 0.75H to an adjacent trench, where H is the depth of the deeper cut. The use of trench boxes is poorly suited in this instance, since they do not provide adequate lateral support to the sides of the cut and considerable loss of ground can occur prior to insertion of the box. Closed sheeting or other pre-installed shoring measures are more suitable.

## 6.2 Bearing Capacity

If footings are required (e.g., for manholes), spread footings may be used if applicable and the following geotechnical bearing resistance are available:

- Factored Geotechnical Resistance at Ultimate Limit State (ULS) = 400 kPa, and Serviceability Limit State (SLS) = 300 kPa for the foundation on very stiff to hard clayey silt to silty clay till
- Factored Geotechnical Resistance at Ultimate Limit State (ULS) = 180 kPa, and Serviceability Limit State (SLS) = 120 kPa for the foundation on Granular "B" engineered fill

The minimum footing sizes, footing thickness, excavations and other footing requirements should be designed in accordance to the latest edition of the Ontario Building Code.

The footing subgrade should be inspected and evaluated by the geotechnical engineer prior to the placement of concrete to confirm that the footings are founded on competent subgrade capable of supporting the recommended design pressure.

The design frost penetration for the general area is 1.2 m. Therefore, a permanent soil cover of 1.2 m or its thermal equivalent is required for frost protection of foundations.

For footings designed and constructed in accordance with the above criteria, total and differential settlements should be less than 25 mm and 19 mm, respectively.

## 6.3 Bedding

The very stiff to hard clayey silt to silty clay till will provide adequate support for the proposed utility pipes, and will allow the use of normal Class B Type bedding. The bedding should confirm to the current Ontario Provincial Standard Specifications and/or standards set by the Regional Municipality of Niagara. At locations where loose or soft soils are encountered below the invert level, should be removed and replaced with compacted suitable granular fill.

The recommended minimum thickness of granular bedding below the invert of the pipes is 150 mm. The bedding material should consist of well graded granular material such as OPSS 1010 Granular "A" or "B". Where necessary, proper tapering as per standards should be provided.

Consideration could be given to the use of non shrinkable fill (OPSS 1351) above the pipes. This material does not require compaction, and will protect the utility pipes from damage due to overloading.

After installing the pipe on the bedding, a granular surround of approved bedding material, which extends at least 300 mm above the obvert of the pipe, or as set out by local authority, should be placed.

To avoid the loss of soil fines from the subgrade, uniformly graded clear stone should not be used unless a suitable, approved filter fabric (geotextile) is place. The geotextile should extend along the sides of the trench and should be wrapped all around the poorly graded bedding material.

## 6.4 Backfilling

Where engineered fill is required to replace the loose materials or to develop the design grades and elevations, an approved clean soil should be used. Based on the visual and tactile examination of the soil samples, the on-site excavated fill material, and the native clayey silt to silty clay till may be used as backfill provided any organic matter, asphalt and any deleterious materials are removed and moisture contents are approximately ± 2% of optimum moisture content.

All fill materials imported to the site must meet applicable municipal, provincial and federal guidelines and requirements associated with environmental characterization of the materials. The placement of any backfill should be supervised and tested for specified compaction requirements on a full time basis by qualified engineering staff. Engineered fill should be placed in maximum 200 mm thick loose lifts at or near (± 2%) their optimum moisture content and each layer should be compacted to at least 98% of SPMDD.

To avoid damaging or laterally dislocating of the installed pipe, extra care should be exercised during the compaction of the fill adjacent to and immediately on top of the pipe and compaction equipment should be restricted in size as per MTO convention. The backfilling operation for the utility pipes should be carried out simultaneously on both sides of the pipes as per MTO specifications.

## 6.5 Shoring

The lateral earth pressure acting on temporary shoring may be calculated from the following expression:

All walls below grade can be designed using the following expression.

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

Where

**p** = lateral earth pressure in kPa acting at depth h
**K** = earth pressure coefficient, see Table 5-1 below
$\gamma$ = unit weight to backfill, a value of 20.0 KN/m$^3$ may be assumed
**h** = depth to point of interest in metres
**q** = equivalent value of surcharge on the ground surface in kPa

The above expression assumes that the perimeter drainage system prevents the build up of any hydrostatic pressure behind the wall and that granular fill is used.

The coefficients of lateral earth pressure given in Table 6-1 below may be used for the design of temporary shoring and for lateral loading considerations.

**Table 6-1 Lateral Earth Pressure Coefficient (Unfactored)**

| Soil Type | $K_{active}$ | K (at rest) | $K_{passive}$ | Unit Weight (kN/m$^3$) |
|---|---|---|---|---|
| Loose to Compacted Fill | 0.34 | 0.51 | 2.9 | 18.0 |
| Clayey Silt to Silty Clay | 0.36 | 0.54 | 2.7 | 19.0 |
| Silty Sand to Sandy Gravel | 0.31 | 0.46 | 3.5 | 19.5 |

## 6.6 Frost Penetration Depth

The frost penetration depth for this project is, f = 1.2 m. Therefore a permanent soil cover of 1.2 m or its thermal equivalent is required for frost protection of foundations.

## 6.7 Corrosivity

A selected sample BH8-SS4 was tested for corrosivity to determine the potential for corrosion. Laboratory test results were compared to the ANSI/AWWA corrosivity rating system, as shown on Table 6-2 below. Copies of the laboratory reports of analysis are provided in Appendix C.

Based on the information available, the soil is determined to be virtually not corrosive.

**Table 6-2 Corrosivity Test Results\BH8-SS4**

| Parameter | Test Results | ANSI/AWWA Point Rating |
|---|---|---|
| Resistivity (Ω·cm) | 2500 | 0 |
| pH | 8.0 | 3 |
| Redox Potential (mV) | N/A | -- |
| Sulphide | N/A | -- |
| Moisture Content (%) | Good drainage | 0 |
| Total Points | - | 3 |

The sample was not analyzed for Redox Potential or sulphides but based on the ANSI/AWWA rating system and even assuming a worst case scenario for these parameters the soil is not considered corrosive as the total number of points would still be below 10.

Please note that there may be other overriding factors in the assessment of corrosion potential, such as the nature of effluent conveyed, the application of de-icing salts on any access roads and subsequent leaching into the subsoils and stray currents.

The laboratory test results also indicate that the soluble sulphates concentration of the tested sample is approximately 0.1%. Based on this concentration (less than 0.10%), there is a negligible potential for sulphate attack on concrete. Accordingly, normal Type 10 Portland cement can be used in concrete.

## 6.8 Soil Disposal\Chemical Analyses

Soil samples collected from each borehole were examined and logged during the field investigation for evidence of contamination and visual and/or olfactory observations were recorded. Field observations of the soil samples did not indicate contamination. Soil samples selected for chemical analysis were placed in laboratory-supplied bottles, including methanol preservation for petroleum hydrocarbon F1 and BTEX analysis, and submitted to EXOVA laboratories under standard chain-of-custody procedures.

The chemical results were compared to the Ministry of Environment (MOE) soil standards for land uses considered equivalent or less sensitive than the current land-use of the Site. The site is considered to be a community land-use in a potable groundwater condition as is defined by O.Reg 153/04, as amended by O.Reg 511/09.

As such, the Table 2 Standard for potable groundwater conditions or Industrial/ Commercial and Community uses were used for comparison purposes. These Standards were set out by the MOE in their document entitled Soil, Ground Water and Sediment Standards for Use under Part XV.1 of the Environmental Protection Act, dated April 15, 2011. Chemistry results from the submitted soil samples are summarized in Tables 6-3 and 6-4. Copies of the laboratory reports of analysis are provided in the Appendix D.

The results of analysis indicate that, for the parameters tested, the soil is suitable for reuse on sites zoned for Industrial/Commercial/Community land use in either a potable or nonpotable groundwater situation. Additional/composite testing may be required for acceptance at the destination site, in particular for sites which carry a more sensitive land-use zoning. Approval from the MOE may be required to reuse the soil at a site(s) with a more sensitive land use.

## 6.9 Design Review, Testing and Inspections

We recommend that geotechnical testing and inspections be carried out during construction operations to examine and approve fill materials, granular base courses, asphalt placement, and compaction.

**Table 6-3 Chemical Test Results for Soil: Metals**

| CHEMICAL | SGWSS Table 2 | UNITS | BH5 SS1 11-Jan-12 | BH6 SS1 11-Jan-12 | BH8 SS4 11-Jan-12 | BH13 SS1 16-Jan-12 | BH18 SS5 11-Jan-12 | BH31 SS1 18-Jan-12 | BH36 SS5 11-Jan-12 |
|---|---|---|---|---|---|---|---|---|---|
| **METALS** | | | | | | | | | |
| Chloride | | % | - | - | 0.026 | - | - | - | - |
| Electrical Conductivity | 1.4 | mS/cm | - | - | 0.4 | - | - | - | - |
| pH | | | - | - | 8 | - | - | - | - |
| Resistivity | | ohm-cm | - | - | 2500 | - | - | - | - |
| Sulphate | | % | - | - | 0.05 | - | - | - | - |
| Antimony | 40 | mg/g | <1 | - | - | <1 | - | <1 | - |
| Arsenic | 18 | mg/g | 4 | - | - | 5 | - | 5 | - |
| Barium | 670 | mg/g | 107 | - | - | 138 | - | 116 | - |
| Beryllium | 8 | mg/g | <1 | - | - | <1 | - | <1 | - |
| Boron | 120 | mg/g | 20 | - | - | 30 | - | 30 | - |
| Cadmium | 1.9 | mg/g | <0.5 | - | - | 0.5 | - | <0.5 | - |
| Chromium | 160 | mg/g | 17 | - | - | 25 | - | 23 | - |
| Cobalt | 80 | mg/g | 9.0 | - | - | 12.0 | - | 15.0 | - |
| Copper | 230 | mg/g | 28 | - | - | 32 | - | 31 | - |
| Lead | 120 | mg/g | 16 | - | - | 7 | - | 9 | - |
| Mercury | 3.9 | mg/g | <0.1 | - | - | <0.1 | - | <0.1 | - |
| Molybdenum | 40 | mg/g | <1 | - | - | <1 | - | <1 | - |
| Nickel | 270 | mg/g | 21 | - | - | 30 | - | 30 | - |
| Selenium | 5.5 | mg/g | <1 | - | - | <1 | - | <1 | - |
| Silver | 40 | mg/g | <0.2 | - | - | <0.2 | - | <0.2 | - |
| Thallium | 1.9 | mg/g | <1 | - | - | <1 | - | <1 | - |
| Uranium | 33 | mg/g | <0.5 | - | - | <0.5 | - | 0.5 | - |
| Vanadium | 86 | mg/g | 26 | - | - | 36 | - | 34 | - |
| Zinc | 340 | mg/g | 55 | - | - | 63 | - | 58 | - |

Notes:
1. SGWSS: Soil, Groundwater and Sediment Standards for Use Under Part XV.1 of the *Environmental Protection Act* , April 15, 2011
i) Full Depth Generic Site Condition Standards in a Potable Ground Water Condition (Table 2).
2. mg/g: micrograms per gram.
3. --: parameter not tested.

**Table 6-4 Chemical Test Results for Soil: VOCs and PHCs**

| CHEMICAL | SGWSS Table 2 | UNITS | BH5 SS1 11-Jan-12 | BH6 SS1 11-Jan-12 | BH8 SS4 11-Jan-12 | BH13 SS1 16-Jan-12 | BH18 SS5 11-Jan-12 | BH31 SS1 18-Jan-12 | BH36 SS5 11-Jan-12 |
|---|---|---|---|---|---|---|---|---|---|
| **VOLATILE ORGANIC COMPOUNDS (VOCs)** | | | | | | | | | |
| Benzene | 0.32 | µg/g | - | <0.02 | - | <0.02 | <0.02 | - | <0.02 |
| Toluene | 6.4 | µg/g | - | <0.20 | - | <0.20 | <0.20 | - | <0.20 |
| Ethylbenzene | 1.1 | µg/g | - | <0.05 | - | <0.05 | <0.05 | - | <0.05 |
| Xylene Mixture (Total) | 26 | µg/g | - | <0.05 | - | <0.05 | <0.05 | - | <0.05 |
| **PETROLEUM HYDROCARBONS (PHCs)** | | | | | | | | | |
| C6 - C10 (F1) | 55 | µg/g | - | <10 | - | <10 | <10 | - | <10 |
| C6 - C10 (F1 minus BTEX) | 55 | µg/g | - | <10 | - | <10 | <10 | - | <10 |
| C>10 - C16 (F2) | 230 | µg/g | - | <10 | - | <10 | <10 | - | <10 |
| C>16 - C34 (F3) | 1700 | µg/g | - | <20 | - | <20 | <20 | - | <20 |
| C>34 - C50 (F4) | 3300 | µg/g | - | <20 | - | <20 | <20 | - | <20 |
| Moisture Content | | % | - | 12.3 | - | 15.9 | 14.3 | - | 17.7 |

Notes:
1. SGWSS: Soil, Groundwater and Sediment Standards for Use Under Part XV.1 of the *Environmental Protection Act* , April 15, 2011
i) Full Depth Generic Site Condition Standards in a Potable Ground Water Condition (Table 2).
2. mg/g: micrograms per gram.
3. --: parameter not tested.

## 6.10 General Comments

GENIVAR should be retained for a general review of the final design and specifications to verify that this report has been properly interpreted and implemented.

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

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

Submitted by,
**GENIVAR Inc.**



Raid Khamis, P. Eng., PMP
Geotechnical Engineer

Reviewed by:



Stuart E. Baird, P. Eng.
Project Engineer

# Figures

# Appendix A

# Borehole Logs

# Appendix B

## Particle Size Distribution Analyses (Figures B1 to B9)

## Atterberg Limits Plasticity Chart

## Figure B10

# Appendix C

# Pavement Thickness Design (WinPAS Output)

# Appendix D

## Corrosivity Test Results
## Soil Chemistry Results

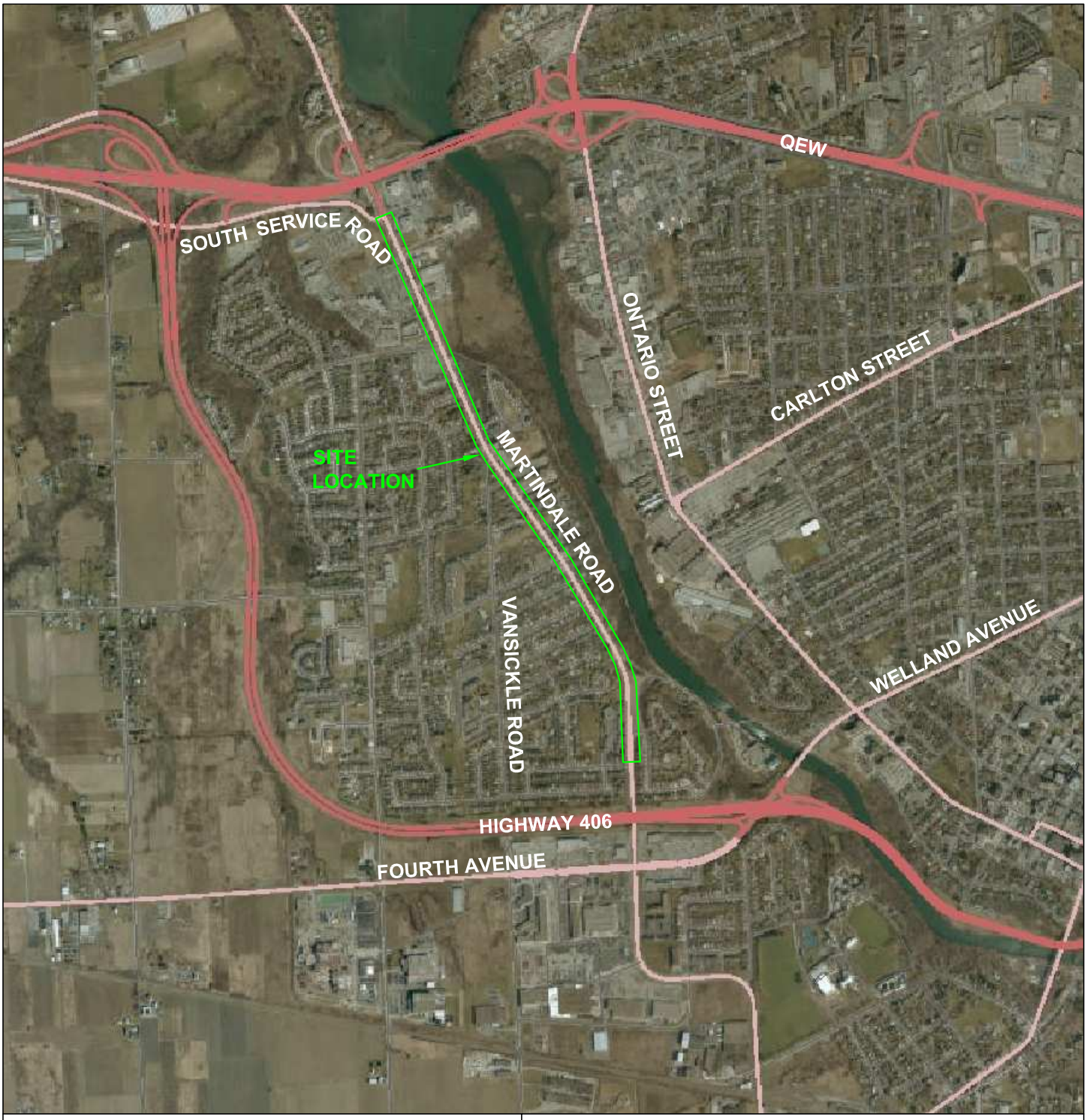
# Appendix E

# Pavement Condition Rating Forms

# Appendix F

# Photographs

# Figures




# SITE LOCATION

MARTINDALE ROAD RECONSTRUCTION
ST. CATHARINES, ONTARIO
for
The Regional Municipality of Niagara

| | |
|---|---|
| DATE: JANUARY 2012 | SCALE: 1 : 20,000 |
| PROJECT: 111-26201-00 | REF. NO.: 26201-116-F1-LP |

0 400 800 m

GENIVAR

FIGURE 1




LEGEND

BH1 APPROXIMATE BOREHOLE LOCATION AND DESIGNATION

0 10 20 m

SOURCE:
ORIGINAL BASE MAP PROVIDED BY AMEC ENVIRONMENTAL AND INFRASTRUCTURE (DECEMBER 9, 2011).

# BOREHOLE LOCATION PLAN

MARTINDALE ROAD RECONSTRUCTION
ST. CATHARINES, ONTARIO
for
The Regional Municipality of Niagara

| | |
|---|---|
| DATE: MAY 2012 | SCALE: 1 : 500 |
| PROJECT: 111-26201-00 | REF. NO.: 26201-116-F2-SP |

GENIVAR

FIGURE 2A

LEGEND

BH1 APPROXIMATE BOREHOLE LOCATION AND DESIGNATION

0 10 20 m

SOURCE:
ORIGINAL BASE MAP PROVIDED BY AMEC ENVIRONMENTAL AND INFRASTRUCTURE (DECEMBER 9, 2011).

# BOREHOLE LOCATION PLAN

MARTINDALE ROAD RECONSTRUCTION
ST. CATHARINES, ONTARIO
for
The Regional Municipality of Niagara

| | |
|---|---|
| DATE: MAY 2012 | SCALE: 1 : 500 |
| PROJECT: 111-26201-00 | REF. NO.: 26201-116-F2-SP |

GENIVAR

FIGURE 2B




LEGEND

BH1 APPROXIMATE BOREHOLE LOCATION AND DESIGNATION

0 10 20 m

SOURCE:
ORIGINAL BASE MAP PROVIDED BY AMEC ENVIRONMENTAL AND INFRASTRUCTURE (DECEMBER 9, 2011).

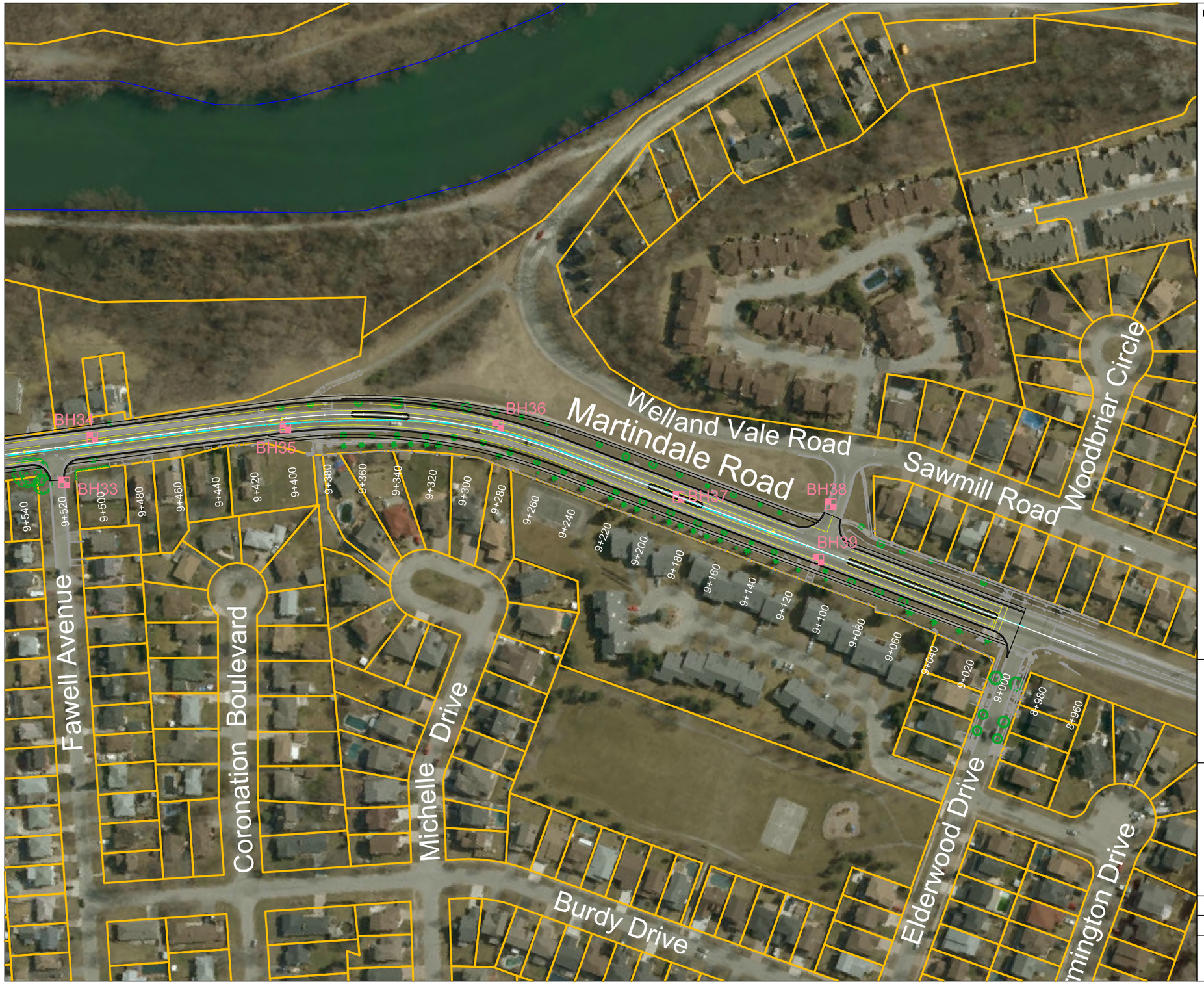
# BOREHOLE LOCATION PLAN

MARTINDALE ROAD RECONSTRUCTION
ST. CATHARINES, ONTARIO
for
The Regional Municipality of Niagara

| | |
|---|---|
| DATE: MAY 2012 | SCALE: 1 : 500 |
| PROJECT: 111-26201-00 | REF. NO.: 26201-116-F2-SP |

GENIVAR

FIGURE 2C




LEGEND

BH1 APPROXIMATE BOREHOLE LOCATION AND DESIGNATION

0 10 20 m

SOURCE:
ORIGINAL BASE MAP PROVIDED BY AMEC ENVIRONMENTAL AND INFRASTRUCTURE (DECEMBER 9, 2011).

# BOREHOLE LOCATION PLAN

MARTINDALE ROAD RECONSTRUCTION
ST. CATHARINES, ONTARIO
for
The Regional Municipality of Niagara

| | |
|---|---|
| DATE: MAY 2012 | SCALE: 1 : 500 |
| PROJECT: 111-26201-00 | REF. NO.: 26201-116-F2-SP |

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FIGURE **2D**

# Appendix A

# Borehole Logs

# BOREHOLE LOG EXPLANATION FORM

This explanatory section provides the background to assist in the use of the borehole logs. Each of the headings used on the borehole log, is briefly explained.

## DEPTH

This column gives the depth of interpreted geologic contacts in metres below ground surface.

## STRATIGRAPHIC DESCRIPTION

This column gives a description of the soil based on a tactile examination of the samples and/or laboratory test results. Each stratum is described according to the following classification and terminology.

| Soil Classification* | | Terminology | Proportion |
|---|---|---|---|
| Clay | <0.002 mm | | |
| Silt | 0.002 to 0.06 mm | "trace" (e.g. trace sand) | <10% |
| Sand | 0.06 to 2 mm | "some" (e.g. some sand) | 10% - 20% |
| Gravel | 2 to 60 mm | adjective (e.g. sandy) | 20% - 35% |
| Cobbles | 60 to 200 mm | "and" (e.g. and sand) | 35% - 50% |
| Boulders | >200 mm | noun (e.g. sand) | >50% |

* Extension of MIT Classification system unless otherwise noted.

The use of the geologic term "till" implies that both disseminated coarser grained (sand, gravel, cobbles or boulders) particles and finer grained (silt and clay) particles may occur within the described matrix.

The compactness of cohesionless soils and the consistency of cohesive soils are defined by the following:

| COHESIONLESS SOIL | | COHESIVE SOIL | |
|---|---|---|---|
| Compactness | Standard Penetration Resistance "N", Blows / 0.3 m | Consistency | Standard Penetration Resistance "N", Blows / 0.3 m |
| Very Loose | 0 to 4 | Very Soft | 0 to 2 |
| Loose | 4 to 10 | Soft | 2 to 4 |
| Compact | 10 to 30 | Firm | 4 to 8 |
| Dense | 30 to 50 | Stiff | 8 to 15 |
| Very Dense | Over 50 | Very Stiff | 15 to 30 |
| | | Hard | Over 30 |

The moisture conditions of cohesionless and cohesive soils are defined as follows.

| COHESIONLESS SOILS | COHESIVE SOILS | | |
|---|---|---|---|
| Dry | DTPL | - | Drier Than Plastic Limit |
| Moist | APL | - | About Plastic Limit |
| Wet | WTPL | - | Wetter Than Plastic Limit |
| Saturated | MWTPL | - | Much Wetter Than Plastic Limit |

## STRATIGRAPHY

Symbols may be used to pictorially identify the interpreted stratigraphy of the soil and rock strata.

## MONITOR DETAILS

This column shows the position and designation of standpipe and/or piezometer ground water monitors installed in the borehole. Also the water level may be shown for the date indicated.


Standpipe


Geotextile Material / Liner


Granular Backfill


Piezometer


Borehole Seal (Bentonite Grout)


Granular (Filter) Pack


Screened Interval


Cement Seal


Native Soil Backfill / Cave / Slough


Borehole Seal (Peltonite, Bentonite or Hole Plug)

Where monitors are placed in separate boreholes, these are shown individually in the "Monitor Details" column. Otherwise, monitors are in the same borehole. For further data regarding seals, screens, etc., the reader is referred to the summary of monitor details table.

## SAMPLE

These columns describe the sample type and number, the "N" value, the water content, the percentage recovery, and Rock Quality Designation (RQD), of each sample obtained from the borehole where applicable. The information is recorded at the approximate depth at which the sample was obtained. The legend for sample type is explained below.

| | | | |
|---|---|---|---|
| SS = | Split Spoon | GS = | Grab Sample |
| ST = | Thin Walled Shelby Tube | CS = | Channel Sample |
| AS = | Auger Flight Sample | WS = | Wash Sample |
| CC = | Continuous Core | RC = | Rock Core |

$$\% \text{ Recovery} = \frac{\text{Length of Core Recovered Per Run}}{\text{Total Length of Run}} \times 100$$

Where rock drilling was carried out, the term RQD (Rock Quality Designation) is used. The RQD is an indirect measure of the number of fractures and soundness of the rock mass. It is obtained from the rock cores by summing the length of core recovered, counting only those pieces of sound core that are 100 mm or more in length. The RQD value is expressed as a percentage and is the ratio of the summed core lengths to the total length of core run. The classification based on the RQD value is given below.

| RQD Classification | RQD (%) |
|---|---|
| Very poor quality | < 25 |
| Poor quality | 25 - 50 |
| Fair quality | 50 - 75 |
| Good quality | 75 - 90 |
| Excellent quality | 90 - 100 |

## TEST DATA

The central section of the log provides graphs which are used to plot selected field and laboratory test results at the depth at which they were carried out. The plotting scales are shown at the head of the column.

Dynamic Penetration Resistance - The number of blows required to advance a 51 mm diameter, 60° steel cone fitted to the end of 45 mm OD drill rods, 0.3 m into the subsoil. The cone is driven with a 63.5 kg hammer over a fall of 750 mm.

Standard Penetration Resistance - Standard Penetration Test (SPT) "N" Value - The number of blows required to advance a 51 mm diameter standard split-spoon sampler 300 mm into the subsoil, driven by means of a 63.5 kg hammer falling freely a distance of 750 mm. In cases where the split spoon does not penetrate 300 mm, the number of blows over the distance of actual penetration in millimetres is shown as $\frac{xBlows}{mm}$

Water Content - The ratio of the mass of water to the mass of oven-dry solids in the soil expressed as a percentage.

$W_P$ - Plastic Limit of a fine-grained soil expressed as a percentage as determined from the Atterberg Limit Test.

$W_L$ - Liquid Limit of a fine-grained soil expressed as a percentage as determined from the Atterberg Limit Test.

## REMARKS

The last column describes pertinent drilling details, field observations and/or provides an indication of other field or laboratory tests that were performed.

# BOREHOLE NO. BH1



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38 **PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA **DATE COMPLETED:** Jan 11, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON **SUPERVISOR:** MRW

**GROUND ELEVATION:** NOT SURVEYED **REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH | WATER CONTENT % ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | **ASPHALT:** 190 mm THICK | | | | | | | | | | |
| 0.2 | **GRANULAR BASE** 545 mm THICK | | | | | 3 | | | | | **GRANULAR BASE GSA:** GRAVEL 71% SAND 21% SILT 8% |
| 0.7 | **CLAYEY SILT TILL** BROWN TO GREY CLAYEY SILT, MOTTLED GREY/BROWN ABOVE 1.2 m DEPTH, TRACE TO SOME CLAY, TRACE FINE SAND AND GRAVEL, OCCASIONAL GREY VERTICAL FISSURES, APL, VERY STIFF TO HARD | | | SS1 | 15 | 4 | 100 | 0.76 | | | |
| 1.0 | | | | | | | | | | | |
| | | | | SS2 | 34 | 14 | 100 | .52 | | | |
| 2.0 | | | | | | | | | | | |
| | | | | SS3 | 28 | 16 | 100 | 1.1 | | | |
| 3.0 | | | | | | | | | | | |
| | | | | SS4 | 32 | 12 | 100 | .91 | | | |
| 3.7 | BOREHOLE TERMINTATED AT 3.7 m BELOW GROUND SURFACE IN SILT | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH2



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38 **PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA **DATE COMPLETED:** Jan 11, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON **SUPERVISOR:** MRW

**GROUND ELEVATION:** NOT SURVEYED **REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH | WATER CONTENT % ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | **ASPHALT:** 180 mm THICK | | | | | | | | | | |
| 0.2 | **GRANULAR BASE** 100 mm THICK | | | | | | | | | | |
| 0.3 | **SILTY SAND AND GRAVEL FILL** BROWN SILTY SAND AND GRAVEL FILL, MOIST | | | | | | | | | | |
| 0.6 | **SILT AND CLAY TILL** BROWN SILT AND CLAY TILL, TRACE TO SOME SAND, TRACE GRAVEL AND RED SHALE FRAGMENTS, OCCASIONAL GREY VERTICAL FISSURES, DTPL, VERY STIFF TO HARD | | | SS1 | 21 | 24 | 100 | 3.4 | | | **SS1 GSA:** GRAVEL 1% SAND 14% SILT 49% CLAY 36% **SS1 ATTERBERG LIMITS:** LIQUID LIMIT 33% PLASTIC LIMIT 15% |
| 1.0 | | | | | | | | | | | |
| | | | | SS2 | 38 | 14 | 100 | 2.9 | | | |
| 2.0 | | | | | | | | | | | |
| | | | | SS3 | 45 | 15 | 100 | 1.5 | 45 | | |
| 3.0 | | | | | | | | | | | |
| | | | | SS4 | 45 | 15 | 100 | 0.89 | 45 | | |
| 3.7 | BOREHOLE TERMINTATED AT 3.7 m BELOW GROUND SURFACE IN SILT AND CLAY TILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

# BOREHOLE NO. BH4



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38 **PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA **DATE COMPLETED:** Jan 11, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON **SUPERVISOR:** MRW

**GROUND ELEVATION:** NOT SURVEYED **REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH | WATER CONTENT % ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | **GRANULAR BASE**<br>360 mm THICK, TRACE ASPHALT AND TAR | | | | | 7 | | | | | |
| 0.4 | **ORGANIC CLAYEY SILT**<br>DARK BROWN TO GREY ORGANIC CLAYEY SILT (BURIED TOPSOIL) | | | | | 35 | | | | | |
| 0.9 | **CLAYEY SILT TILL**<br>MOTTLED GREY/BROWN TO BROWN CLAYEY SILT TILL, TRACE SAND, GRAVEL AND RED SHALE FRAGMENTS, OCCASIONAL GREY VERTICAL FISSURES, DTPL, STIFF TO HARD | | | SS1 | 9 | 20 | 89 | 2.7 | | | |
| 1.0 | | | | | | | | | | | |
| | | | | SS2 | 30 | 15 | 94 | 2.9 | | | |
| 2.0 | | | | | | | | | | | |
| | | | | SS3 | 33 | 15 | 100 | 3.2 | | | |
| 3.0 | | | | | | | | | | | |
| | | | | SS4 | 34 | 15 | 100 | 0.76 | | | |
| 3.7 | BOREHOLE TERMINTATED AT 3.7 m BELOW GROUND SURFACE IN CLAYEY SILT TILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH5



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38 **PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA **DATE COMPLETED:** Jan 11, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON **SUPERVISOR:** MRW

**GROUND ELEVATION:** NOT SURVEYED **REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH | WATER CONTENT % ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | **GRANULAR BASE**<br>405 mm THICK | | | | | 5 | | | | | |
| 0.4 | **CLAYEY SILT FILL**<br>BROWN CLAYEY SILT FILL, TRACE SAND, GRAVEL, ASPHALT AND WOOD FRAGMENTS, OCCASIONAL DARK GREY ORGANIC INCLUSIONS, APL, STIFF | | | SS1 | 8 | 14 | 78 | 2.4 | | | |
| 1.4 | **SAND AND GRAVEL FILL**<br>REDDISH-BROWN SAND AND GRAVEL FILL, TRACE SILT, MOIST, SATURATED BELOW 1.8 m DEPTH, LOOSE | | | SS2 | 5 | 7 | 50 | 1.4 | | | CAVE AT 2 m DEPTH AND WATER AT 1.8 m DEPTH UPON COMPLETION |
| 2.1 | **CLAYEY SILT TILL**<br>BROWN CLAYEY SILT TILL, TRACE SAND, GRAVEL AND RED SHALE FRAGMENTS, OCCASIONAL GREY VERTICAL FISSURES, DTPL, VERY STIFF TO HARD | | | SS3 | 25 | 16 | 100 | 1.5 | | | |
| | | | | SS4 | 33 | 11 | 75 | 0.91 | | | |
| 3.7 | BOREHOLE TERMINTATED AT 3.7 m BELOW GROUND SURFACE IN CLAYEY SILT TILL | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |



GENIVAR

# BOREHOLE NO. BH6



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38

**PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA

**DATE COMPLETED:** Jan 11, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON

**SUPERVISOR:** MRW

**GROUND ELEVATION:** NOT SURVEYED

**REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH | WATER CONTENT % ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | | | | | |
| 0.1 | **ASPHALT:** 130 mm THICK | | | | | | | | | | |
| | **GRANULAR BASE** 355 mm THICK | | | | | | | | | | |
| 0.5 | **CLAYEY SILT TILL** MOTTLED GREY/BROWN CLAYEY SILT TILL, TRACE SAND, GRAVEL AND RED SHALE FRAGMENTS, DTPL, VERY STIFF | | | SS1 | 18 | | 100 | 0.1 | ● | | |
| 1.0 | | | | | | | | | | | |
| 1.5 | BOREHOLE TERMINTATED AT 1.5 m BELOW GROUND SURFACE IN CLAYEY SILT TILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 2.0 | | | | | | | | | | | |
| 3.0 | | | | | | | | | | | |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH7



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38
**PROJECT NO.:** 111-26201-00
**CLIENT:** REGION OF NIAGARA
**DATE COMPLETED:** Jan 16, 2012
**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON
**SUPERVISOR:** MRW
**GROUND ELEVATION:** NOT SURVEYED
**REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH | WATER CONTENT % ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | **ASPHALT:** 165 mm THICK | | | | | | | | | | |
| 0.2 | **GRANULAR BASE** 380 mm THICK | | | | | 5 | | | | | |
| 0.5 | **CLAYEY SILT TILL** MOTTLED GREY/BROWN TO BROWN CLAYEY SILT TILL, TRACE TO SOME SAND, TRACE GRAVEL AND RED SHALE FRAGMENTS, APL TO DTPL, VERY STIFF TO HARD | | | SS1 | 21 | 15 | 72 | 2.7 | | | |
| 1.0 | | | | | | | | | | | |
| 2.0 | | | | SS2 | 39 | 16 | 100 | 2.9 | | | |
| 3.0 | | | | SS3 | 31 | 17 | 100 | 2 | | | |
| 3.7 | BOREHOLE TERMINTATED AT 3.7 m BELOW GROUND SURFACE IN CLAYEY SILT TILL | | | SS4 | 45 | 19 | 50 | 2 | 45 | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

CONE PENETRATION "N" VALUE: 10 20 30 — SHEAR STRENGTH
WATER CONTENT %: 10 20 30 — $W_P$ $W_L$

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

# BOREHOLE NO. BH8



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38 **PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA **DATE COMPLETED:** Jan 11, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON **SUPERVISOR:** MRW

**GROUND ELEVATION:** NOT SURVEYED **REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH | WATER CONTENT % ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | **ASPHALT:** 190 mm THICK | | | | | | | | | | |
| 0.2 | **GRANULAR BASE** 400 mm THICK | | | | | 5 | | | | | |
| 0.6 | **CLAYEY SILT TILL** BROWN CLAYEY SILT TILL, TRACE TO SOME SAND, TRACE GRAVEL AND RED SHALE FRAGMENTS, OCCASIONAL GREY VERTICAL FISSURES, DTPL, VERY STIFF TO HARD | | | SS1 | 29 | 18 | 100 | 2.1 | | | |
| 1.0 | | | | | | | | | | | |
| | | | | SS2 | 45 | 14 | 100 | 1.9 | 45 | | |
| 2.0 | | | | | | | | | | | |
| | | | | SS3 | 33 | 16 | 100 | 2.3 | | | |
| 3.0 | | | | | | | | | | | |
| | | | | SS4 | 32 | 16 | 100 | 3.1 | | | |
| 3.7 | BOREHOLE TERMINTATED AT 3.7 m BELOW GROUND SURFACE IN CLAYEY SILT TILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH9



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38 **PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA **DATE COMPLETED:** Jan 11, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON **SUPERVISOR:** MRW

**GROUND ELEVATION:** NOT SURVEYED **REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE 10 20 30 / SHEAR STRENGTH | WATER CONTENT % 10 20 30 / $W_P$ $W_L$ | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | | | | | |
| 0.1 | **ASPHALT:** 115 mm THICK | | | | | | | | | | |
| | **GRANULAR BASE** 370 mm THICK | | | | | | | | | | |
| 0.5 | **CLAYEY SILT TILL** BROWN CLAYEY SILT TILL, TRACE SAND, GRAVEL AND RED SHALE FRAGMENTS, DTPL, VERY STIFF | | | SS1 | 20 | | 100 | 3 | ● | | |
| 1.0 | | | | | | | | | | | |
| 1.5 | BOREHOLE TERMINTATED AT 1.5 m BELOW GROUND SURFACE IN CLAYEY SILT TILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 2.0 | | | | | | | | | | | |
| 3.0 | | | | | | | | | | | |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH10



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38
**PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA
**DATE COMPLETED:** Jan 16, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON
**SUPERVISOR:** MRW

**GROUND ELEVATION:** NOT SURVEYED
**REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE 10 20 30 / SHEAR STRENGTH | WATER CONTENT % 10 20 30 / $W_P$ $W_L$ | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | | | | | |
| 0.2 | **ASPHALT:** 150 mm THICK | | | | | | | | | | |
| | **GRANULAR BASE** 585 mm THICK | | | | | 4 | | | | | |
| 0.7 | | | | | | | | | | | |
| 0.9 | **ORGANIC CLAYEY SILT** GREENISH-GREY ORGANIC CLAYEY SILT, SOME SAND, TRACE ROOTLETS, APL | | | | | 33 | | | | | |
| 1.0 | **CLAYEY SILT TILL** BROWN CLAYEY SILT TILL, TRACE TO SOME SAND, TRACE GRAVEL AND RED SHALE FRAGMENTS, OCCASIONAL GREY VERTICAL FISSURES, DTPL, VERY STIFF TO HARD | | | SS1 | 17 | | 100 | 2.3 | | | |
| 2.0 | | | | SS2 | 34 | 15 | 100 | 2.5 | | | |
| 3.0 | | | | SS3 | 31 | 16 | 100 | 0.6 | | | |
| | | | | SS4 | 29 | 17 | 100 | 1.7 | | | |
| 3.7 | BOREHOLE TERMINTATED AT 3.7 m BELOW GROUND SURFACE IN CLAYEY SILT TILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH11



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38
**PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA
**DATE COMPLETED:** Jan 16, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON
**SUPERVISOR:** MRW

**GROUND ELEVATION:** NOT SURVEYED
**REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH (10 20 30) | WATER CONTENT % (10 20 30) $W_P$ $W_L$ | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | **ASPHALT:** 180 mm THICK | | | | | | | | | | |
| 0.2 | **GRANULAR BASE** 480 mm THICK | | | | | 3 | | | | | **GRANULAR BASE GSA:** GRAVEL 56% SAND 24% SILT 16% |
| 0.7 | **BURIED TOPSOIL** | | | | | | | | | | |
| 0.8 | DARK BROWN ORGANIC SILT (BURIED TOPSOIL), MOIST | | | | | | | | | | |
| 1.0 | **CLAYEY SILT TILL** BROWN CLAYEY SILT TILL, TRACE TO SOME SAND, TRACE GRAVEL AND RED SHALE FRAGMENTS, DTPL, STIFF TO VERY STIFF | | | SS1 | 14 | 20 | 44 | 1.9 | | | |
| 2.0 | | | | SS2 | 27 | 17 | 100 | 2.1 | | | |
| 3.0 | | | | SS3 | 24 | 19 | 100 | 0.19 | | | |
| 3.7 | BOREHOLE TERMINTATED AT 3.7 m BELOW GROUND SURFACE IN CLAYEY SILT TILL | | | SS4 | 25 | 20 | 100 | 1.1 | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH12



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38 **PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA **DATE COMPLETED:** Jan 11, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON **SUPERVISOR:** MRW

**GROUND ELEVATION:** NOT SURVEYED **REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE 10 20 30 / SHEAR STRENGTH | WATER CONTENT % 10 20 30 ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | | | | | |
| 0.1 | **ASPHALT:** 90 mm THICK | | | | | | | | | | |
| | **GRANULAR BASE** 395 mm THICK | | | | | | | | | | |
| 0.5 | **CLAYEY SILT TILL** BROWN CLAYEY SILT TILL, SOME SAND, TRACE GRAVEL, DTPL, VERY STIFF | | | SS1 | 18 | | 79 | 3.4 | ● | | |
| 1.0 | | | | | | | | | | | |
| 1.5 | BOREHOLE TERMINTATED AT 1.5 m BELOW GROUND SURFACE IN CLAYEY SILT TILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 2.0 | | | | | | | | | | | |
| 3.0 | | | | | | | | | | | |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH13



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38 **PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA **DATE COMPLETED:** Jan 16, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON **SUPERVISOR:** MRW

**GROUND ELEVATION:** NOT SURVEYED **REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH (10 20 30) | WATER CONTENT % (10 20 30; $W_P$ $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | **ASPHALT:** 340 mm THICK | | | | | | | | | | |
| 0.3 | **GRANULAR BASE** 215 mm THICK | | | | | | | | | | |
| 0.6 | **CLAYEY SILT FILL** BROWN CLAYEY SILT FILL, TRACE SAND AND GRAVEL, DARK BROWN ORGANIC INCLUSIONS, REWORKED APPEARANCE, APL, STIFF | | | | | | | | | | |
| 1.0 | **CLAYEY SILT TILL** BROWN CLAYEY SILT TILL, SOME SAND, TRACE GRAVEL AND RED SHALE FRAGMENTS, OCCASIONAL GREY VERTICAL FISSURES, DTPL, VERY STIFF TO HARD | | | SS1 | 11 | | 78 | 2.9 | | | |
| 2.0 | | | | SS2 | 28 | | 100 | 2.9 | | | |
| 3.0 | | | | SS3 | 29 | | 100 | 2.4 | | | **SS4 GSA:** GRAVEL 2% SAND 15% SILT 49% CLAY 34% |
| 3.7 | BOREHOLE TERMINTATED AT 3.7 m BELOW GROUND SURFACE IN CLAYEY SILT TILL | | | SS4 | 31 | | 100 | 1.4 | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH14



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38 **PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA **DATE COMPLETED:** Jan 16, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON **SUPERVISOR:** MRW

**GROUND ELEVATION:** NOT SURVEYED **REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH | WATER CONTENT % ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | **ASPHALT:** 330 mm THICK | | | | | | | | | | |
| 0.3 | **GRANULAR BASE** 230 mm THICK | | | | | | | | | | |
| 0.6 | **CLAYEY SILT TILL** GREY TO BROWN CLAYEY SILT TILL, MOTTLED BROWN/GREY ABOVE 1.2 m DEPTH, TRACE SAND, GRAVEL AND RED SHALE FRAGMENTS, DTPL TO APL, FIRM TO HARD | | | SS1 | 8 | | 72 | 3.1 | | | |
| 1.0 | | | | | | | | | | | |
| | | | | SS2 | 37 | | 94 | 2.0 | | | |
| 2.0 | | | | | | | | | | | |
| | | | | SS3 | 30 | | 100 | 0.97 | | | |
| 3.0 | | | | | | | | | | | |
| | | | | SS4 | 30 | | 83 | 1.5 | | | |
| 4.0 | | | | | | | | | | | |
| | | | | SS5 | 16 | | 50 | 1.8 | | | |
| 5.0 | | | | | | | | | | | |
| 5.2 | BOREHOLE TERMINTATED AT 5.2 m BELOW GROUND SURFACE IN CLAYEY SILT TILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH15



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38 **PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA **DATE COMPLETED:** Jan 16, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON **SUPERVISOR:** MRW

**GROUND ELEVATION:** NOT SURVEYED **REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH | WATER CONTENT % ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | | | | | |
| 0.1 | **ASPHALT:** 75 mm THICK<br>**GRANULAR BASE** 530 mm THICK | | | | | 4 | | | | | |
| 0.6 | **ORGANIC CLAYEY SILT** DARK GREY ORGANIC CLAYEY SILT, TRACE SAND AND GRAVEL, APL | | | | | 38 | | | | | |
| 1.0 | **CLAYEY SILT TILL** BROWN CLAYEY SILT TILL, TRACE SAND AND GRAVEL, OCCASIONAL GREY VERTICAL FISSURES, DTPL, STIFF | | | SS1 | 12 | 16 | | | | | |
| 1.5 | BOREHOLE TERMINTATED AT 1.5 m BELOW GROUND SURFACE IN CLAYEY SILT TILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 2.0 | | | | | | | | | | | |
| 3.0 | | | | | | | | | | | |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

# BOREHOLE NO. BH16



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38 **PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA **DATE COMPLETED:** Jan 18, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON **SUPERVISOR:** MRW

**GROUND ELEVATION:** NOT SURVEYED **REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH | WATER CONTENT % ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | **ASPHALT:** 280 mm THICK, LOWER 50 mm PULVERIZED | | | | | | | | | | |
| 0.3 | **GRANULAR BASE** 280 mm THICK | | | SS1 | 55 | | 25 | | 55 | | |
| 0.6 | **ORGANIC CLAYEY SILT** DARK BROWN ORGANIC CLAYEY SILT (BURIED TOPSOIL), MOIST | | | | | | | | | | |
| 0.8 | **CLAYEY SILT TILL** MOTTLED GREY/BROWN TO BROWN CLAYEY SILT TILL, SOME SAND, TRACE GRAVEL AND RED SHALE FRAGMENTS, OCCASIONAL GREY VERTICAL FISSURES, DTPL, VERY STIFF | | | SS2 | 18 | | 50 | 0.25 | | | |
| 1.4 | **SILTY CLAY TILL** BROWN SILTY CLAY TILL, SOME SAND, TRACE GRAVEL DTPL, VERY STIFF TO HARD | | | SS3 | 38 | | 67 | 0.1 | | | |
| | | | | SS4 | 27 | | 100 | 1.1 | | | |
| 2.9 | **CLAYEY SILT TILL** BROWN CLAYEY SILT TILL, SOME SAND AND GRAVEL, DTPL, VERY STIFF | | | SS5 | 18 | | 100 | 0.37 | | | |
| 3.7 | BOREHOLE TERMINTATED AT 3.7 m BELOW GROUND SURFACE IN CLAYEY SILT TILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH17



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38

**PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA

**DATE COMPLETED:** Jan 11, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON

**SUPERVISOR:** MRW

**GROUND ELEVATION:** NOT SURVEYED

**REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE 10 20 30 / SHEAR STRENGTH | WATER CONTENT % 10 20 30 / $W_P$ $W_L$ | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | | | | | |
| 0.1 | **ASPHALT:** 125 mm THICK | | | | | | | | | | |
| 0.3 | **GRANULAR BASE** 200 mm THICK | | | | | | | | | | |
| | **CLAYEY SILT TILL** BROWN CLAYEY SILT TILL, TRACE SAND, GRAVEL AND RED SHALE FRAGMENTS, DTPL, VERY STIFF | | | SS1 | 27 | | 75 | 3.2 | ● | | |
| 1.0 | | | | | | | | | | | |
| 1.5 | BOREHOLE TERMINTATED AT 1.5 m BELOW GROUND SURFACE IN CLAYEY SILT TILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 2.0 | | | | | | | | | | | |
| 3.0 | | | | | | | | | | | |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH18



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38 **PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA **DATE COMPLETED:** Jan 18, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON **SUPERVISOR:** MRW

**GROUND ELEVATION:** NOT SURVEYED **REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH | WATER CONTENT % ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | | | | | |
| 0.1 | **ASPHALT:** 130 mm THICK | | | | | | | | | | |
| | **GRANULAR BASE** 480 mm THICK | | | | | | | | | | |
| 0.6 | **CLAYEY SILT TILL** BROWN CLAYEY SILT TILL, TRACE SAND, GRAVEL AND RED SHALE FRAGMENTS, DTPL, VERY STIFF TO HARD | | | SS1 | 85 | | 67 | 0.51 | 85 → | | |
| 1.0 | | | | SS2 | 18 | 15 | 75 | 1.2 | | | |
| 2.0 | | | | SS3 | 31 | 15 | 83 | 1.4 | | | |
| 2.2 | **SILTY CLAY TILL** BROWN TO GREY SILTY CLAY TILL, TRACE SAND AND GRAVEL , APL TO WTPL, VERY STIFF TO STIFF | | | SS4 | 18 | 21 | 100 | 1.96 | | | |
| 3.0 | | | | | | | | | | | |
| 4.0 | | | | SS5 | 21 | 19 | 83 | 2.1 | | | |
| 5.0 | | | | SS6 | 9 | 19 | 100 | 2.1 | | | |
| 5.2 | BOREHOLE TERMINTATED AT 3.7 m BELOW GROUND SURFACE IN SILTY CLAY TILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH19



PROJECT NAME: RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38

PROJECT NO.: 111-26201-00

CLIENT: REGION OF NIAGARA

DATE COMPLETED: Jan 18, 2012

BOREHOLE TYPE: 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON

SUPERVISOR: MRW

GROUND ELEVATION: NOT SURVEYED

REVIEWER: RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE 10 20 30 / SHEAR STRENGTH | WATER CONTENT % 10 20 30 ($W_P$ $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | **ASPHALT:** 150 mm THICK | | | | | | | | | | |
| 0.2 | **GRANULAR BASE** 460 mm THICK | | | | | | | | | | |
| 0.6 | **CLAYEY SILT TILL** BROWN CLAYEY SILT TILL, TRACE TO SOME GRAVEL, TRACE SAND AND RED SHALE FRAGMENTS, OCCASIONAL SILTY SAND SEAMS BELOW 3 m DEPTH, DTPL, VERY STIFF | | | SS1 | 18 | | 72 | 1.1 | | | |
| 1.0 | | | | | | | | | | | |
| | | | | SS2 | 18 | | 100 | 0.93 | | | |
| 2.0 | | | | | | | | | | | |
| | | | | SS3 | 22 | | 100 | 0.56 | | | |
| 3.0 | | | | | | | | | | | |
| | | | | SS4 | 28 | | 100 | 1.3 | | | |
| 3.7 | BOREHOLE TERMINTATED AT 3.7 m BELOW GROUND SURFACE IN CLAYEY SILT TILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH20



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38 **PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA **DATE COMPLETED:** Jan 18, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON **SUPERVISOR:** MRW

**GROUND ELEVATION:** NOT SURVEYED **REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE 10 20 30 / SHEAR STRENGTH | WATER CONTENT % 10 20 30 / $W_P$ $W_L$ | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | | | | | |
| 0.1 | **ASPHALT:** 90 mm THICK | | | | | | | | | | |
| | **GRANULAR BASE** 320 mm THICK | | | | | | | | | | |
| 0.4 | **CLAYEY SILT FILL** BROWN CLAYEY SILT FILL, SOME GRAVEL, TRACE SAND AND DARK BROWN ORGANIC INCLUSIONS, APL, STIFF TO VERY STIFF | | | SS1 | 16 | | 67 | 1.2 | | | |
| 1.0 | | | | SS2 | 9 | | 67 | 1.0 | | | |
| 1.5 | BOREHOLE TERMINTATED AT 1.5 m BELOW GROUND SURFACE IN CLAYEY SILT FILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 2.0 | | | | | | | | | | | |
| 3.0 | | | | | | | | | | | |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH21



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38

**PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA

**DATE COMPLETED:** Jan 25, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON

**SUPERVISOR:** SK

**GROUND ELEVATION:** NOT SURVEYED

**REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH (10 20 30) | WATER CONTENT % (10 20 30; $W_P$ $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | | | | | |
| 0.1 | **ASPHALT:** 75 mm THICK | | | | | | | | | | |
| | **GRANULAR BASE** 305 mm THICK | | | | | | | | | | |
| 0.4 | **CLAYEY SILT TILL** BROWN CLAYEY SILT, TRACE SAND AND GRAVEL, DTPL, VERY STIFF | | | SS1 | 17 | | 75 | 0.4 | | | |
| 1.0 | | | | SS2 | 26 | | 100 | 0 | | | |
| 1.5 | BOREHOLE TERMINTATED AT 1.5 m BELOW GROUND SURFACE IN CLAYEY SILT TILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 2.0 | | | | | | | | | | | |
| 3.0 | | | | | | | | | | | |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH22



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38
**PROJECT NO.:** 111-26201-00
**CLIENT:** REGION OF NIAGARA
**DATE COMPLETED:** Jan 18, 2012
**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON
**SUPERVISOR:** MRW
**GROUND ELEVATION:** NOT SURVEYED
**REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH | WATER CONTENT % ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | **ASPHALT:** 150 mm THICK | | | | | | | | | | |
| 0.2 | **GRANULAR BASE** 355 mm THICK | | | | | 3 | | | | | **GRANULAR BASE GSA:** GRAVEL 64% SAND 53% SILT 11% |
| 0.5 | **CLAYEY SILT TILL** BROWN CLAYEY SILT TILL, TRACE SAND, GRAVEL AND RED SHALE FRAGMENTS, OCCASIONAL GREY VERTICAL FISSURES, DTPL, VERY STIFF TO STIFF | | | SS1 | 17 | 13 | 67 | 1.0 | | | |
| 1.0 | | | | | | | | | | | |
| | | | | SS2 | 14 | 13 | 44 | 0.48 | | | |
| 2.0 | | | | | | | | | | | |
| 2.1 | **SILTY CLAY TILL** BROWN SILTY CLAY TILL, TRACE SAND AND GRAVEL A, APL TO DTPL, VERY STIFF | | | SS3 | 18 | 27 | 72 | 0.71 | | | |
| 3.0 | | | | | | | | | | | |
| | | | | SS4 | 19 | 18 | 100 | 0.8 | | | |
| 3.7 | BOREHOLE TERMINTATED AT 3.7 m BELOW GROUND SURFACE IN SILTY CLAY TILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH23



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38 **PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA **DATE COMPLETED:** Jan 25, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON **SUPERVISOR:** SK

**GROUND ELEVATION:** NOT SURVEYED **REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH | WATER CONTENT % ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | | | | | |
| 0.1 | **ASPHALT:** 100 mm THICK | | | | | | | | | | |
| | **GRANULAR 'A'** 255 mm THICK | | | | | | | | | | |
| 0.4 | **SAND AND GRAVEL FILL** BROWN SAND AND GRAVEL FILL, MOIST, COMPACT TO LOOSE | | | SS1 | 17 | 3 | 42 | 0.6 | | | |
| 1.0 | | | | SS2 | 6 | 5 | 42 | 0.2 | | | |
| 1.5 | BOREHOLE TERMINTATED AT 1.5 m BELOW GROUND SURFACE IN SAND AND GRAVEL FILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 2.0 | | | | | | | | | | | |
| 3.0 | | | | | | | | | | | |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH24



PROJECT NAME: RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38

PROJECT NO.: 111-26201-00

CLIENT: REGION OF NIAGARA

DATE COMPLETED: Jan 25, 2012

BOREHOLE TYPE: 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON

SUPERVISOR: SK

GROUND ELEVATION: NOT SURVEYED

REVIEWER: RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH | WATER CONTENT % ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | **ASPHALT:** 150 mm THICK | | | | | | | | | | |
| 0.2 | **GRANULAR BASE** 255 mm THICK | | | | | | | | | | |
| 0.4 | **CLAYEY SILT FILL** BROWN CLAYEY SILT FILL, SOME SAND AND GRAVEL, APL, STIFF | | | SS1 | 14 | 3 | 67 | 0 | | | |
| 1.0 | | | | SS2 | 9 | 13 | 79 | 0.11 | | | |
| 2.0 | | | | SS3 | 6 | 9 | 79 | 0 | | | |
| 2.0 | **SILTY SAND FILL** REDDISH-BROWN SILTY SAND FILL, MOIST, LOOSE | | | | | | | | | | |
| 2.3 | BOREHOLE TERMINTATED AT 2.3 m BELOW GROUND SURFACE IN SILTY SAND FILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 3.0 | | | | | | | | | | | |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH25



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38 **PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA **DATE COMPLETED:** Jan 25, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON **SUPERVISOR:** SK

**GROUND ELEVATION:** NOT SURVEYED **REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE 10 20 30 / SHEAR STRENGTH | WATER CONTENT % 10 20 30 / $W_P$ $W_L$ | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | | | | | |
| 0.1 | **ASPHALT:** 125 mm THICK | | | | | | | | | | |
| 0.3 | **GRANULAR BASE** 150 mm THICK | | | | | | | | | | |
| | **CLAYEY SILT TILL** BROWN CLAYEY SILT TILL, TRACE SAND, GRAVEL AND RED SHALE FRAGMENTS, DTPL, FIRM TO HARD | | | SS1 | 8 | | 50 | 0.2 | | | |
| 1.0 | | | | SS2 | 34 | | 100 | 0 | | | |
| 1.5 | BOREHOLE TERMINTATED AT 1.5 m BELOW GROUND SURFACE IN CLAYEY SILT TILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 2.0 | | | | | | | | | | | |
| 3.0 | | | | | | | | | | | |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH26



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38 **PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA **DATE COMPLETED:** Jan 25, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON **SUPERVISOR:** SK

**GROUND ELEVATION:** NOT SURVEYED **REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH | WATER CONTENT % ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | **ASPHALT:** 150 mm THICK | | | | | | | | | | |
| 0.2 | **GRANULAR BASE** 305 mm THICK | | | | | | | | | | |
| 0.5 | **CLAYEY SILT TILL** BROWN CLAYEY SILT TILL, TRACE SAND AND GRAVEL DTPL, HARD TO VERY STIFF | | | SS1 | 28 | | 75 | 0 | | | |
| 1.0 | | | | SS2 | 32 | | 100 | 0 | | | |
| 2.0 | | | | SS3 | 28 | | 100 | 0 | | | |
| 3.0 | | | | SS4 | 24 | | 100 | 0 | | | |
| 3.7 | BOREHOLE TERMINTATED AT 3.7 m BELOW GROUND SURFACE IN CLAYEY SILT TILL | | | SS5 | 19 | | 100 | 0 | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH27



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38
**PROJECT NO.:** 111-26201-00
**CLIENT:** REGION OF NIAGARA
**DATE COMPLETED:** Jan 25, 2012
**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON
**SUPERVISOR:** SK
**GROUND ELEVATION:** NOT SURVEYED
**REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE 10 20 30 / SHEAR STRENGTH | WATER CONTENT % 10 20 30 ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | | | | | |
| 0.1 | **ASPHALT:** 100 mm THICK | | | | | | | | | | |
| 0.3 | **GRANULAR BASE** 120 mm THICK | | | | | | | | | | |
| | **CLAYEY SILT FILL** BROWN CLAYEY SILT FILL, SOME BLACK STAINING, APL, STIFF | | | SS1 | 13 | 4 | 50 | 0.1 | | | |
| 0.8 | **CLAYEY SILT TILL** BROWN CLAYEY SILT, TRACE SAND AND GRAVEL, DTPL, VERY STIFF | | | SS2 | 21 | 16 | 100 | 0 | | | |
| 1.0 | | | | | | | | | | | |
| 1.5 | BOREHOLE TERMINTATED AT 3.7 m BELOW GROUND SURFACE IN CLAYEY SILT TILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 2.0 | | | | | | | | | | | |
| 3.0 | | | | | | | | | | | |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH28



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38
**PROJECT NO.:** 111-26201-00
**CLIENT:** REGION OF NIAGARA
**DATE COMPLETED:** Jan 25, 2012
**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON
**SUPERVISOR:** SK
**GROUND ELEVATION:** NOT SURVEYED
**REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE 10 20 30 / SHEAR STRENGTH | WATER CONTENT % 10 20 30 / $W_P$ $W_L$ | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | | | | | |
| 0.1 | **ASPHALT:** 125 mm THICK | | | | | | | | | | |
| | **GRANULAR BASE** 380 mm THICK, DENSE | | | SS1 | 34 | | 75 | 0.3 | | | |
| 0.5 | **CLAYEY SILT TILL** YELLOWISH-BROWN CLAYEY SILT TILL, TRACE SAND, GRAVEL AND RED SHALE FRAGMENTS, OCCASIONAL GREY VERTICAL FISSURES, DTPL, STIFF | | | | | | | | | | |
| 1.0 | | | | SS2 | 9 | | 100 | 0 | | | |
| 1.5 | BOREHOLE TERMINTATED AT 1.5 m BELOW GROUND SURFACE IN CLAYEY SILT TILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 2.0 | | | | | | | | | | | |
| 3.0 | | | | | | | | | | | |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH29



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38
**PROJECT NO.:** 111-26201-00
**CLIENT:** REGION OF NIAGARA
**DATE COMPLETED:** Jan 19, 2012
**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON
**SUPERVISOR:** MRW
**GROUND ELEVATION:** NOT SURVEYED
**REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH | WATER CONTENT % ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | **ASPHALT:** 150 mm THICK | | | | | | | | | | |
| 0.2 | **GRANULAR BASE** 430 mm THICK, DENSE | | | SS1 | 33 | | 67 | 0.51 | | | |
| 0.6 | **SANDY GRAVEL FILL** REDDISH-BROWN SANDY GRAVEL FILL, TRACE SILT, MOIST, COMPACT | | | SS2 | 17 | | 67 | 0.62 | | | **SS2 GSA:** GRAVEL 46% SAND 31% SILT 23% |
| 1.0 | | | | SS3 | 15 | | 33 | 0.94 | | | |
| 2.0 | BOREHOLE TERMINTATED AT 2 m BELOW GROUND SURFACE IN SANDY GRAVEL FILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 3.0 | | | | | | | | | | | |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH30



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38

**PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA

**DATE COMPLETED:** Jan 25, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON

**SUPERVISOR:** SK

**GROUND ELEVATION:** NOT SURVEYED

**REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH (10 20 30) | WATER CONTENT % (10 20 30) $W_P$ $W_L$ | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | **ASPHALT** 25 mm THICK | | | | | | | | | | |
| 0.2 | **CONCRETE:** 125 mm THICK | | | | | | | | | | |
| | **CLAYEY SILT FILL** MOTTLED GREY/BROWN CLAYEY SILT FILL, TRACE SAND, GRAVEL AND ROOTLETS, FIRM | | | SS1 | 8 | | 50 | 0 | | | |
| 0.8 | **CLAYEY SILT TILL** BROWN CLAYEY SILT, TRACE SAND AND GRAVEL, DTPL, VERY STIFF | | | SS2 | 18 | | 100 | 0 | | | |
| 1.0 | | | | | | | | | | | |
| 1.5 | BOREHOLE TERMINTATED AT 1.5 m BELOW GROUND SURFACE IN CLAYEY SILT TILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 2.0 | | | | | | | | | | | |
| 3.0 | | | | | | | | | | | |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH31



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38 **PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA **DATE COMPLETED:** Jan 19, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON **SUPERVISOR:** MRW

**GROUND ELEVATION:** NOT SURVEYED **REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH | WATER CONTENT % ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | | | | | |
| 0.2 | **ASPHALT:** 150 mm THICK | | | | | | | | | | |
| | **GRANULAR BASE** 455 mm THICK | | | SS1 | 42 | | 88 | 0.1 | 42 | | |
| 0.6 | **CLAYEY SILT FILL** BROWN CLAYEY SILT FILL, TRACE SAND, GRAVEL AND ASPHALT, DTPL, FIRM | | | SS2 | 6 | | 56 | 0.27 | | | |
| 1.0 | | | | | | | | | | | |
| | | | | SS3 | 8 | | 83 | 0.8 | | | |
| 1.8 | **SAND AND GRAVEL FILL** REDDISH-BROWN SAND AND GRAVEL FILL, TRACE SILT, MOIST, LOOSE | | | | | | | | | | |
| 2.0 | BOREHOLE TERMINTATED AT 2 m BELOW GROUND SURFACE IN SAND AND GRAVEL FILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 3.0 | | | | | | | | | | | |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH32



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38 **PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA **DATE COMPLETED:** Jan 25, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON **SUPERVISOR:** SK

**GROUND ELEVATION:** NOT SURVEYED **REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH | WATER CONTENT % ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | **CONCRETE:** 150 mm THICK | | | | | | | | | | |
| 0.2 | **SILTY CLAY FILL** BROWN SILTY CLAY FILL, TRACE SAND, GRAVEL AND ROOTLETS, APL, FIRM | | | SS1 | 8 | | 63 | 0 | | | |
| 0.8 | **CLAYEY SILT TILL** BROWN CLAYEY SILT, TRACE SAND AND GRAVEL, DTPL, VERY STIFF | | | SS2 | 20 | | 100 | 0 | | | |
| 1.0 | | | | | | | | | | | |
| 1.5 | BOREHOLE TERMINTATED AT 1.5 m BELOW GROUND SURFACE IN CLAYEY SILT TILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 2.0 | | | | | | | | | | | |
| 3.0 | | | | | | | | | | | |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH33



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38

**PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA

**DATE COMPLETED:** Jan 25, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON

**SUPERVISOR:** SK

**GROUND ELEVATION:** NOT SURVEYED

**REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE 10 20 30 / SHEAR STRENGTH | WATER CONTENT % 10 20 30 / $W_P$ $W_L$ | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | **GRANULAR BASE** 380 mm THICK | | | | | | | | | | |
| 0.4 | **CLAYEY SILT TILL** BROWN CLAYEY SILT, TRACE SAND AND GRAVEL, DTPL, VERY STIFF | | | SS1 | 41 | | 83 | 1.5 | 41 | | |
| 1.0 | | | | SS2 | 16 | | 100 | 0 | | | |
| 1.5 | BOREHOLE TERMINTATED AT 1.5 m BELOW GROUND SURFACE IN CLAYEY SILT | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 2.0 | | | | | | | | | | | |
| 3.0 | | | | | | | | | | | |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH34



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38

**PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA

**DATE COMPLETED:** Jan 19, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON

**SUPERVISOR:** MRW

**GROUND ELEVATION:** NOT SURVEYED

**REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH | WATER CONTENT % ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | **ASPHALT:** 150 mm THICK | | | | | | | | | | |
| 0.2 | **GRANULAR BASE** 430 mm THICK, DENSE | | | | | 4 | | | | | **SS1 GSA:** GRAVEL 47% SAND 33% SILT 20% |
| | | | | SS1 | 32 | | 88 | 0.1 | | | |
| 0.6 | **SILT AND CLAY TILL** BROWN SILT AND CLAY TILL, TRACE SAND, GRAVEL AND RED SHALE FRAGMENTS, APL, VERY STIFF | | | | | | | | | | **SS2 GSA:** GRAVEL 1% SAND 9% SILT 46% CLAY 44% |
| 1.0 | | | | SS2 | 20 | 20 | 100 | 0.07 | | | |
| | | | | SS3 | 20 | 19 | 100 | 0 | | | |
| 2.0 | | | | | | | | | | | |
| | | | | SS4 | 20 | 18 | 100 | 0.01 | | | |
| 3.0 | | | | | | | | | | | |
| | | | | SS5 | 13 | 19 | 75 | 0.83 | | | |
| 3.7 | BOREHOLE TERMINTATED AT 3.7 m BELOW GROUND SURFACE IN SILT AND CLAY TILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH35



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38 **PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA **DATE COMPLETED:** Jan 18, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON **SUPERVISOR:** MRW

**GROUND ELEVATION:** NOT SURVEYED **REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH | WATER CONTENT % ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | | | | | |
| 0.2 | **ASPHALT:** 150 mm THICK | | | | | | | | | | |
| | **GRANULAR BASE** 580 mm THICK | | | | | | | | | | |
| 0.7 | **SILTY SAND FILL** REDDISH-BROWN SILTY SAND, TRACE GRAVEL, SATURATED, LOOSE | | | SS1 | 8 | 16 | 72 | 0.51 | | | |
| 1.0 | | | | | | | | | | | |
| 1.1 | **SILTY CLAY TILL** BROWN TO GREYISH-BROWN SILTY CLAY TILL, TRACE SAND AND GRAVEL, OCCASIONAL GREY VERTICAL FISSURES, DTPL, STIFF TO VERY STIFF | | | SS2 | 13 | 20 | 100 | 0.29 | | | |
| 2.0 | | | | | | | | | | | |
| | | | | SS3 | 16 | 22 | 100 | 1.0 | | | BOREHOLE OPEN AND WATER AT 2.7 m DEPTH UPON COMPLETION |
| 3.0 | | | | | | | | | | | |
| | | | | SS4 | 16 | 22 | 100 | 1.3 | | | |
| 3.7 | BOREHOLE TERMINTATED AT 3.7 m BELOW GROUND SURFACE IN SILTY CLAY TILL | | | | | | | | | | |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

# BOREHOLE NO. BH36



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38 **PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA **DATE COMPLETED:** Jan 19, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON **SUPERVISOR:** MRW

**GROUND ELEVATION:** NOT SURVEYED **REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | N VALUE | % WATER | % RECOVERY | PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH | WATER CONTENT % ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | | | | | |
| 0.1 | **ASPHALT:** 140 mm THICK<br>**GRANULAR BASE** 470 mm THICK | | | | | | | | | | |
| 0.6 | **SILTY CLAY TILL**<br>GREYISH-BROWN TO GREY SILTY CLAY TILL, TRACE SAND AND GRAVEL, DTPL TO WTPL, VERY STIFF TO STIFF | | | SS1 | 17 | | 100 | 0.05 | | | |
| 1.0 | | | | SS2 | 16 | | 100 | 0.81 | | | |
| 2.0 | | | | SS3 | 10 | | 89 | .06 | | | |
| 3.0 | | | | SS4 | 8 | | 100 | 0.9 | | | |
| 4.0 | | | | SS5 | 9 | | 100 | 1.3 | | | |
| 4.3 | BOREHOLE TERMINTATED AT 4.3 m BELOW GROUND SURFACE IN SILTY CLAY TILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH37



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38 **PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA **DATE COMPLETED:** Jan 25, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON **SUPERVISOR:** SK

**GROUND ELEVATION:** NOT SURVEYED **REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH | WATER CONTENT % ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | **ASPHALT:** 165 mm THICK | | | | | | | | | | |
| 0.2 | **GRANULAR BASE** 455 mm THICK | | | | | | | | | | |
| | | | | SS1 | 78 | | 75 | 0.2 | 78 | | |
| 0.6 | **CLAYEY SILT TILL** BROWN TO GREY CLAYEY SILT TILL, TRACE SAND AND GRAVEL, DTPL TO APL, STIFF TO VERY STIFF | | | SS2 | 15 | | 75 | 0 | | | |
| 1.0 | | | | | | | | | | | |
| | | | | SS3 | 16 | | 100 | 0 | | | |
| 2.0 | | | | | | | | | | | |
| | | | | SS4 | 12 | | 100 | 0 | | | |
| 3.0 | | | | | | | | | | | |
| | | | | SS5 | 16 | | 100 | 0 | | | |
| 3.7 | BOREHOLE TERMINTATED AT 3.7 m BELOW GROUND SURFACE IN CLAYEY SILT TILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

CONE PENETRATION "N" VALUE: 10 20 30 — SHEAR STRENGTH

WATER CONTENT %: 10 20 30 — $W_P$ $W_L$

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH38



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38
**PROJECT NO.:** 111-26201-00
**CLIENT:** REGION OF NIAGARA
**DATE COMPLETED:** Jan 19, 2012
**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON
**SUPERVISOR:** MRW
**GROUND ELEVATION:** NOT SURVEYED
**REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE 10 20 30 / SHEAR STRENGTH | WATER CONTENT % 10 20 30 / $W_P$ $W_L$ | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | | | | | |
| 0.1 | **ASPHALT:** 90 mm THICK<br>**GRANULAR BASE** 445 mm THICK | | | | | | | | | | |
| 0.5 | **SILTY CLAY TILL** BROWN SILTY CLAY TILL, TRACE SAND AND GRAVEL, APL, VERY STIFF | | | SS1 | 16 | | 92 | 1.8 | ● | | |
| 1.0 | | | | | | | | | | | |
| 1.5 | BOREHOLE TERMINTATED AT 1.5 m BELOW GROUND SURFACE IN SILTY CLAY TILL | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 2.0 | | | | | | | | | | | |
| 3.0 | | | | | | | | | | | |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH39



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38
**PROJECT NO.:** 111-26201-00
**CLIENT:** REGION OF NIAGARA
**DATE COMPLETED:** Jan 19, 2012
**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON
**SUPERVISOR:** MRW
**GROUND ELEVATION:** NOT SURVEYED
**REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE / SHEAR STRENGTH | WATER CONTENT % ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | **ASPHALT:** 165 mm THICK | | | | | | | | | | |
| 0.2 | **GRANULAR BASE** 445 mm THICK | | | | | 6 | | | | | |
| 0.6 | **CLAY AND SILT TILL** BROWN TO GREY CLAY AND SILT TILL, TRACE SAND, GRAVEL AND RED SHALE FRAGMENTS, APL TO WTPL, VERY STIFF TO FIRM | | | SS1 | 16 | 24 | 33 | 0.01 | | | |
| 1.0 | | | | SS2 | 12 | 24 | 100 | 0.01 | | | |
| 2.0 | | | | SS3 | 13 | 24 | 33 | 0.11 | | | |
| 3.0 | | | | SS4 | 10 | 26 | 100 | 0.09 | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 4.0 | | | | | | | | | | | **SS5 GSA:** GRAVEL 1% SAND 7% SILT 40% CLAY 52% |
| 5.0 | BOREHOLE TERMINTATED AT 5.0 m BELOW GROUND SURFACE IN CLAY AND SILT TILL | | | SS5 | 6 | 26 | 100 | 1.2 | | | **SS5 ATTERBERG LIMITS:** LIQUID LIMIT 36% PLASTIC LIMIT 16% |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# BOREHOLE NO. BH40



**PROJECT NAME:** RECONSTRUCTION AND WIDENING OF REGIONAL ROAD 38

**PROJECT NO.:** 111-26201-00

**CLIENT:** REGION OF NIAGARA

**DATE COMPLETED:** Jan 25, 2012

**BOREHOLE TYPE:** 168 mm SOLID STEM AUGER / 50 mm O.D. SPLIT SPOON

**SUPERVISOR:** SK

**GROUND ELEVATION:** NOT SURVEYED

**REVIEWER:** RK

| DEPTH (m) | STRATIGRAPHIC DESCRIPTION | STRATIGRAPHY | MONITOR DETAILS | SAMPLE TYPE | SAMPLE N VALUE | SAMPLE % WATER | SAMPLE % RECOVERY | SAMPLE PID/TOV (ppm) | CONE PENETRATION "N" VALUE 10 20 30 / SHEAR STRENGTH | WATER CONTENT % 10 20 30 ($W_P$ – $W_L$) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | | | | | |
| 0.1 | **ASPHALT:** 125 mm THICK | | | | | | | | | | |
| | **GRANULAR BASE** 500 mm THICK | | | SS1 | 60 | | 83 | 0.2 | 60 | | |
| 0.7 | **SAND AND GRAVEL FILL** SAND AND GRAVEL FILL, MOIST, COMPACT | | | | | | | | | | |
| 1.0 | | | | SS2 | 24 | | 75 | 0.4 | | | |
| 1.5 | BOREHOLE TERMINTATED AT 1.5 m BELOW GROUND SURFACE IN FILL. | | | | | | | | | | BOREHOLE OPEN AND DRY UPON COMPLETION |
| 2.0 | | | | | | | | | | | |
| 3.0 | | | | | | | | | | | |
| 4.0 | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | |

GENIVAR GEOTECH (M) 111-26201-LOGS.GPJ JAGGER HIMS BASIC.GDT 2/10/12

GENIVAR

# Appendix B

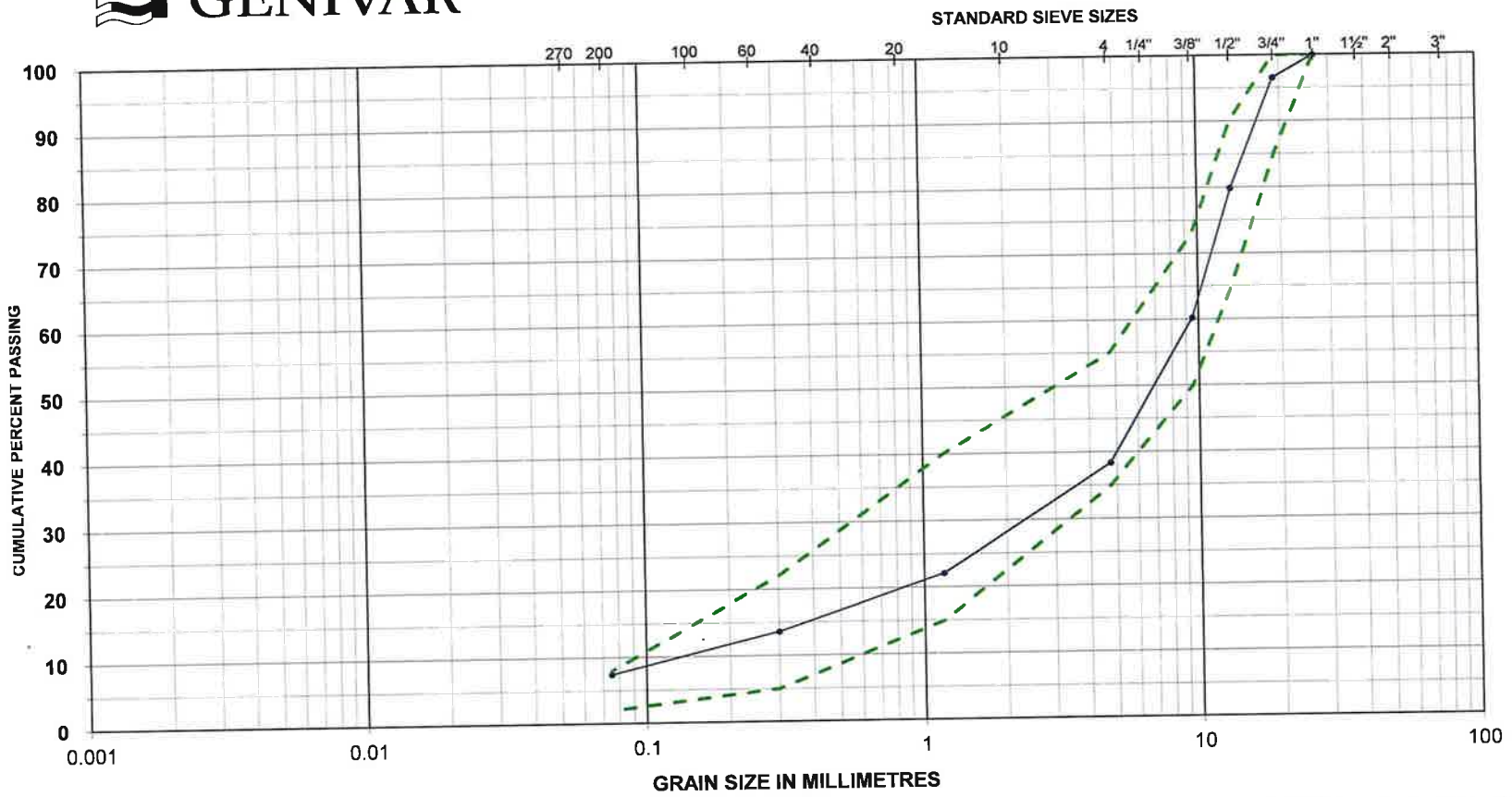
## Particle Size Distribution Analyses (Figures B1 to B9)

## Atterberg Limits Plasticity Chart

## Figure B10

GENIVAR

# PARTICLE SIZE DISTRIBUTION
# OPSS 1010/LS602 GRANULAR A



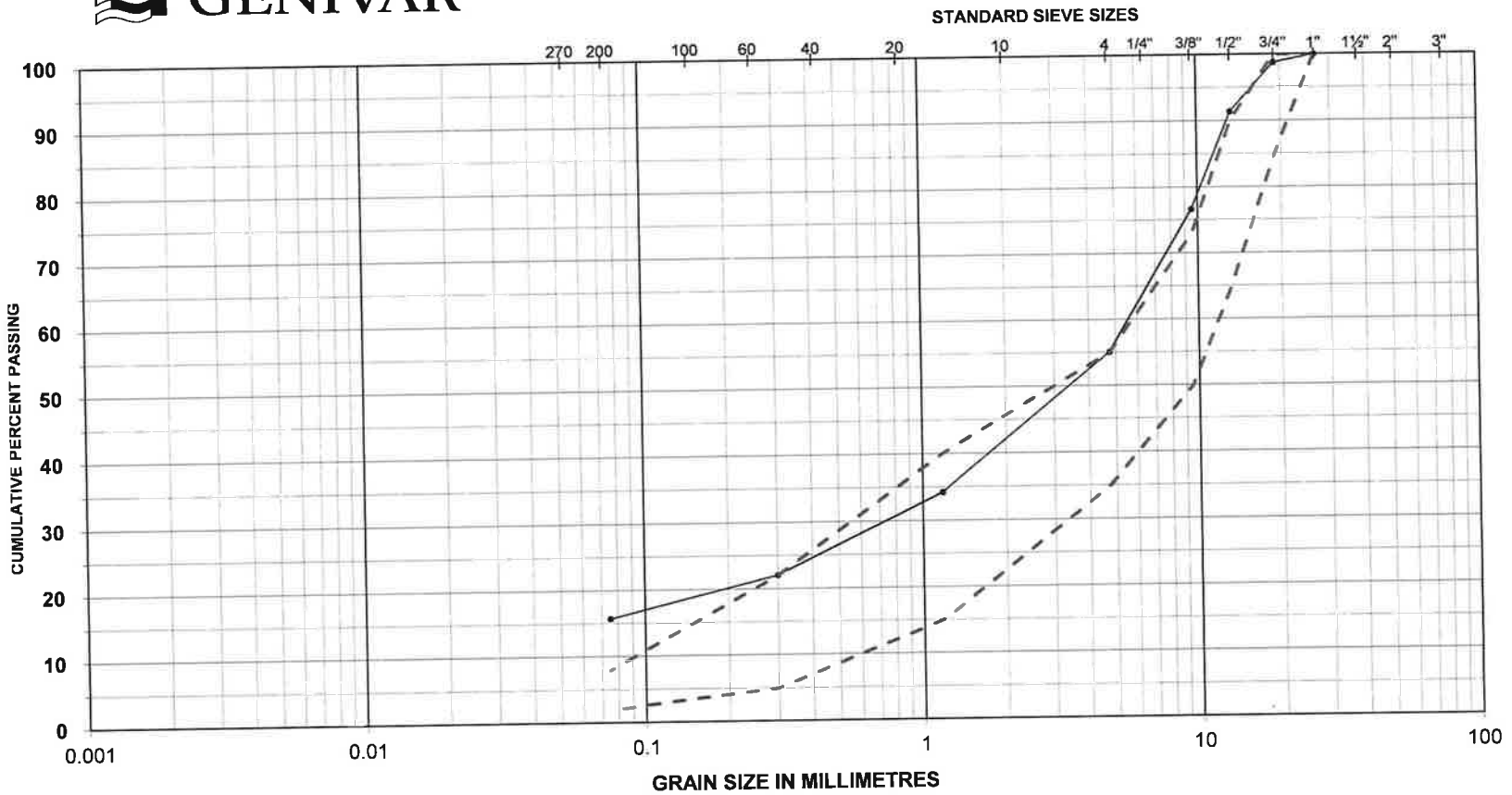

| | | | | | |
|---|---|---|---|---|---|
| **Project Name:** | Martindale Road | | | **Project No.:** | 111-26201-00 |
| **Location ID.:** | BH1 | **Sample No./Depth:** | Granular Base | **Figure No.** | **B1** |

| Sieve Size | % Passing | Spec |
|---|---|---|
| 26.5 mm | 100.0 | 100.0 |
| 19 mm | 96.6 | 85-100 |
| 13.2 mm | 79.9 | 65-90 |
| 9.5 mm | 60.3 | 50-73 |
| 4.75 mm | 38.4 | 35-55 |
| 1.18 mm | 22.1 | 15-40 |
| 0.300 mm | 13.6 | 5-22 |
| 0.075 mm | 7.5 | 2-8 |

| Aggregate Properties | | | |
|---|---|---|---|
| From Gradation Graph (mm): | | | |
| D75 | 13.0 | D8 | |
| D60 | 9.5 | D10 | 0.1 |
| Cu | 95.00 | | |
| | | | |
| % Crush | N/A | | |

GENIVAR

# PARTICLE SIZE DISTRIBUTION
## OPSS 1010/LS602 GRANULAR A



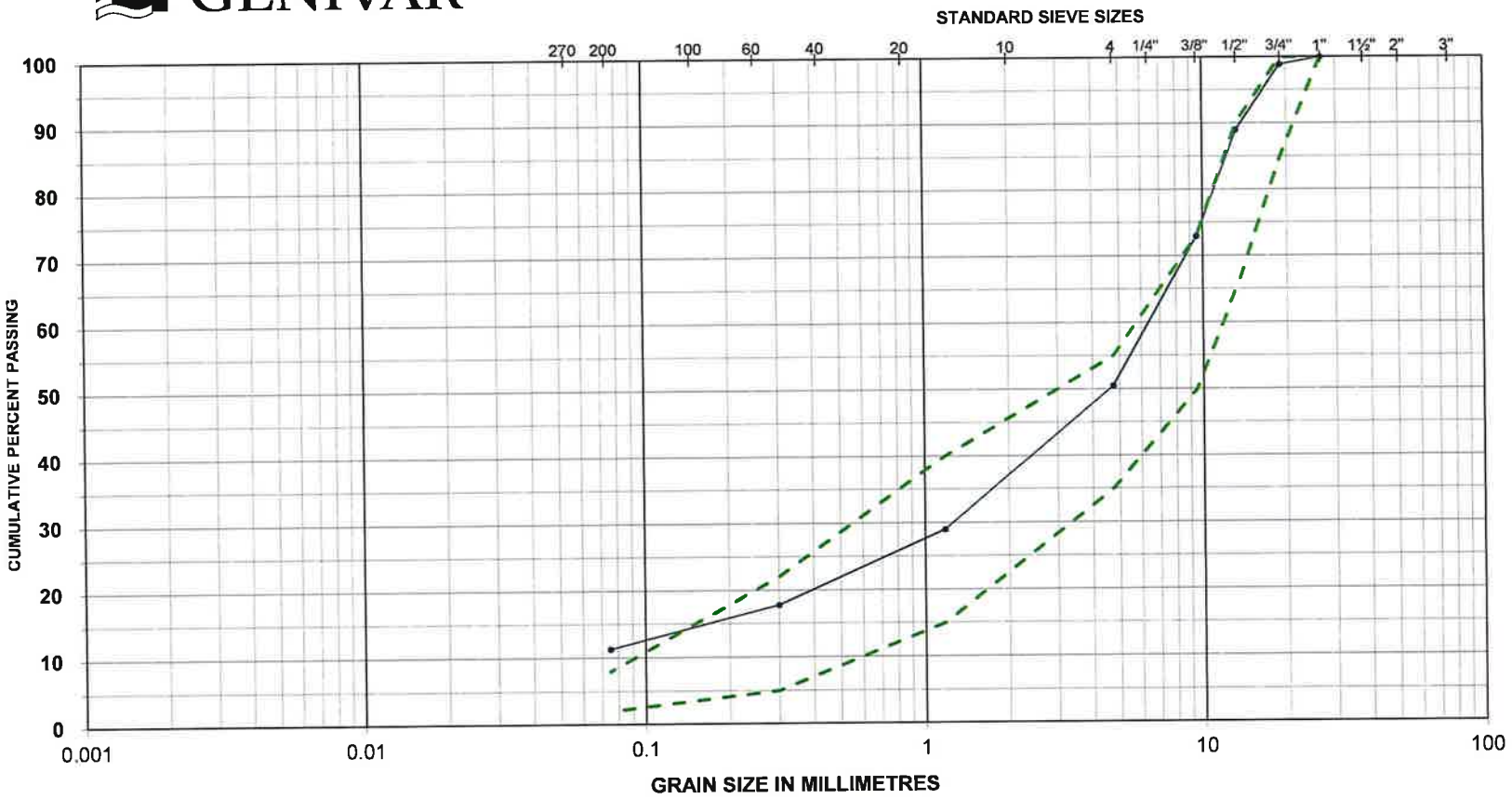

| | | | | | |
|---|---|---|---|---|---|
| **Project Name:** | Martindale Road | | | **Project No.:** | 111-26201-00 |
| **Location ID.:** | BH11 | **Sample No./Depth:** | Granular Base | **Figure No.:** | **B2** |

| **Sieve Size** | % Passing | Spec |
|---|---|---|
| **26.5 mm** | 100.0 | 100.0 |
| **19 mm** | 98.8 | 85-100 |
| **13.2 mm** | 91.4 | 65-90 |
| **9.5 mm** | 76.7 | 50-73 |
| **4.75 mm** | 55.1 | 35-55 |
| **1.18 mm** | 34.3 | 15-40 |
| **0.300 mm** | 22.1 | 5-22 |
| **0.075 mm** | 15.8 | 2-8 |

| **Aggregate Properties** | | | |
|---|---|---|---|
| **From Gradation Graph (mm):** | | | |
| **D75** | 9.0 | **D8** | |
| **D60** | 5.5 | **D10** | 0.0 |
| **Cu** | 275.00 | | |
| | | | |
| **% Crush** | **N/A** | | |

GENIVAR

# PARTICLE SIZE DISTRIBUTION
## OPSS 1010/LS602 GRANULAR A



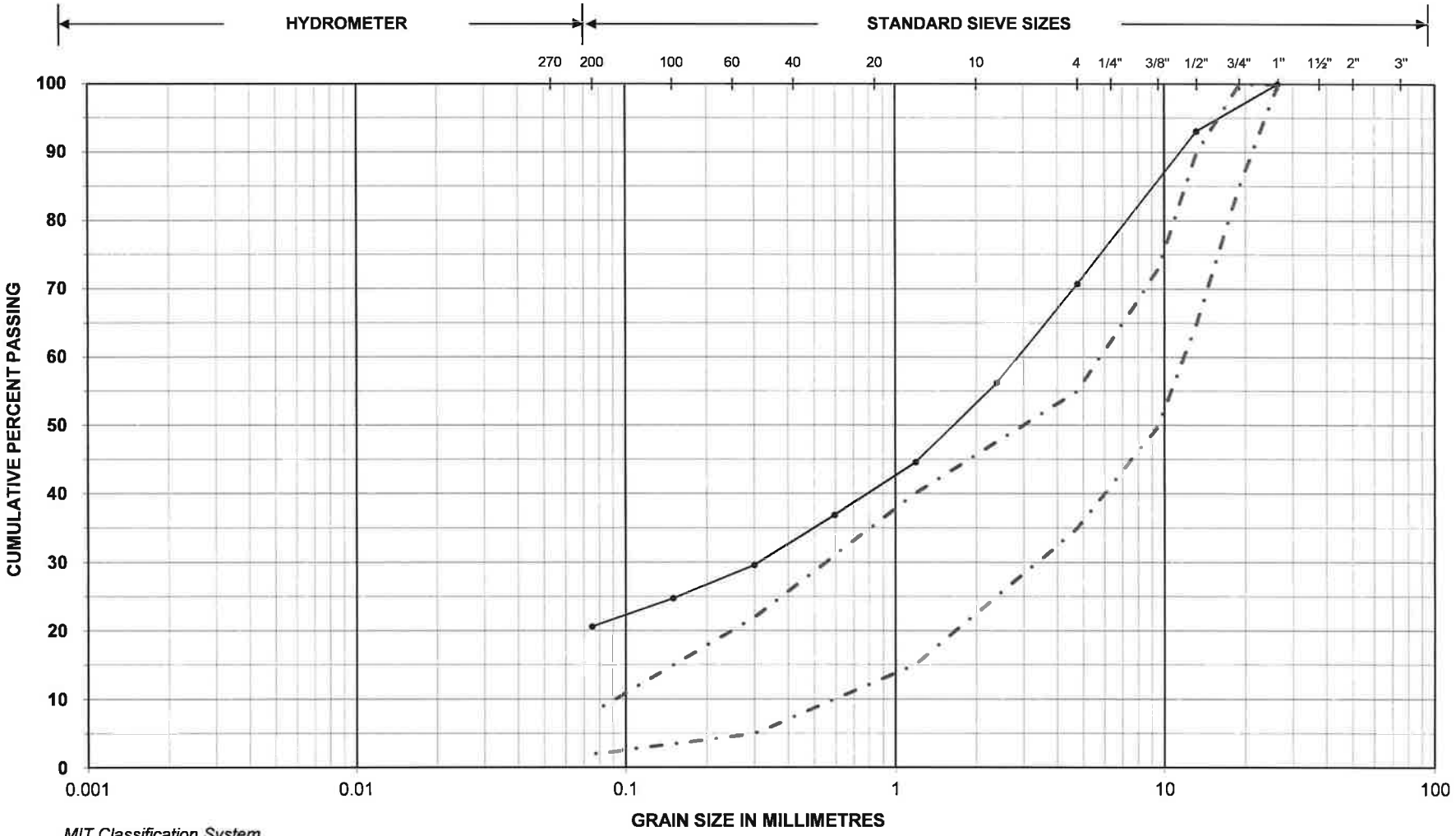

| | | | | | |
|---|---|---|---|---|---|
| **Project Name:** | Martindale Road | | | **Project No.:** | 111-26201-00 |
| **Location ID.:** | BH22 | **Sample No./Depth:** | Granular Base | **Figure No.:** | B3 |

| Sieve Size | % Passing | Spec |
|---|---|---|
| 26.5 mm | 100.0 | 100.0 |
| 19 mm | 98.9 | 85-100 |
| 13.2 mm | 89.0 | 65-90 |
| 9.5 mm | 73.0 | 50-73 |
| 4.75 mm | 50.5 | 35-55 |
| 1.18 mm | 29.0 | 15-40 |
| 0.300 mm | 17.8 | 5-22 |
| 0.075 mm | 11.3 | 2-8 |

| Aggregate Properties | | | |
|---|---|---|---|
| From Gradation Graph (mm): | | | |
| D75 | 10.0 | D8 | |
| D60 | 6.3 | D10 | 0.1 |
| Cu | 105.00 | | |
| | | | |
| % Crush | N/A | | |

GENIVAR

# PARTICLE SIZE DISTRIBUTION



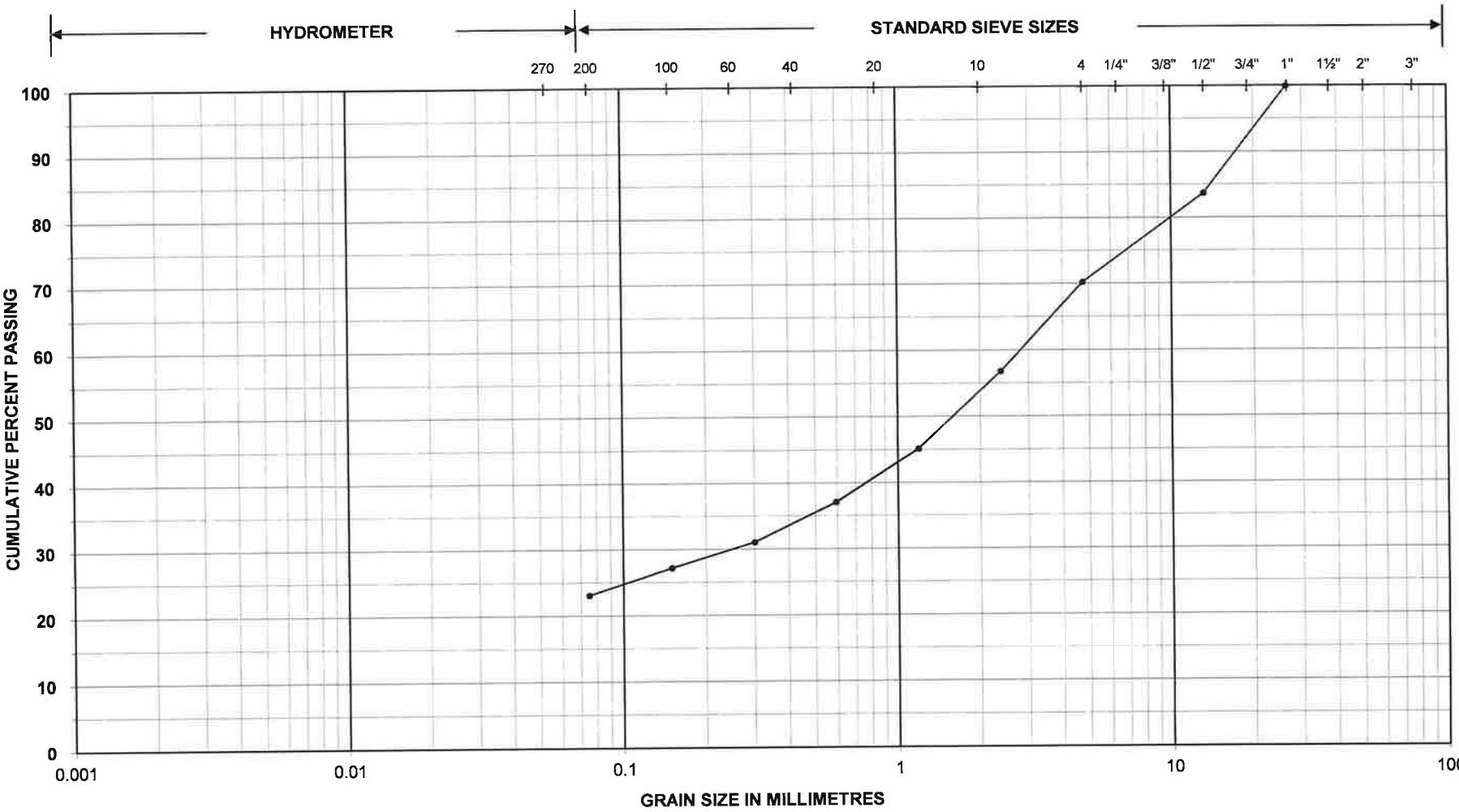

*MIT Classification System*

| CLAY | SILT | | | SAND | | | GRAVEL | | | COBBLES |
|---|---|---|---|---|---|---|---|---|---|---|
| | Fine | Medium | Coarse | Fine | Medium | Coarse | Fine | Medium | Coarse | |

| | | | | | |
|---|---|---|---|---|---|
| **Project Name:** | Martindale Road | | **Project No.:** 111-26201-00 | **Figure No.:** | **B4** |
| **Location ID.:** | BH34 | **Sample No./Depth:** SS1 | **Remarks:** Sandy, silty gravel | | |

GENIVAR

# PARTICLE SIZE DISTRIBUTION




*MIT Classification System*

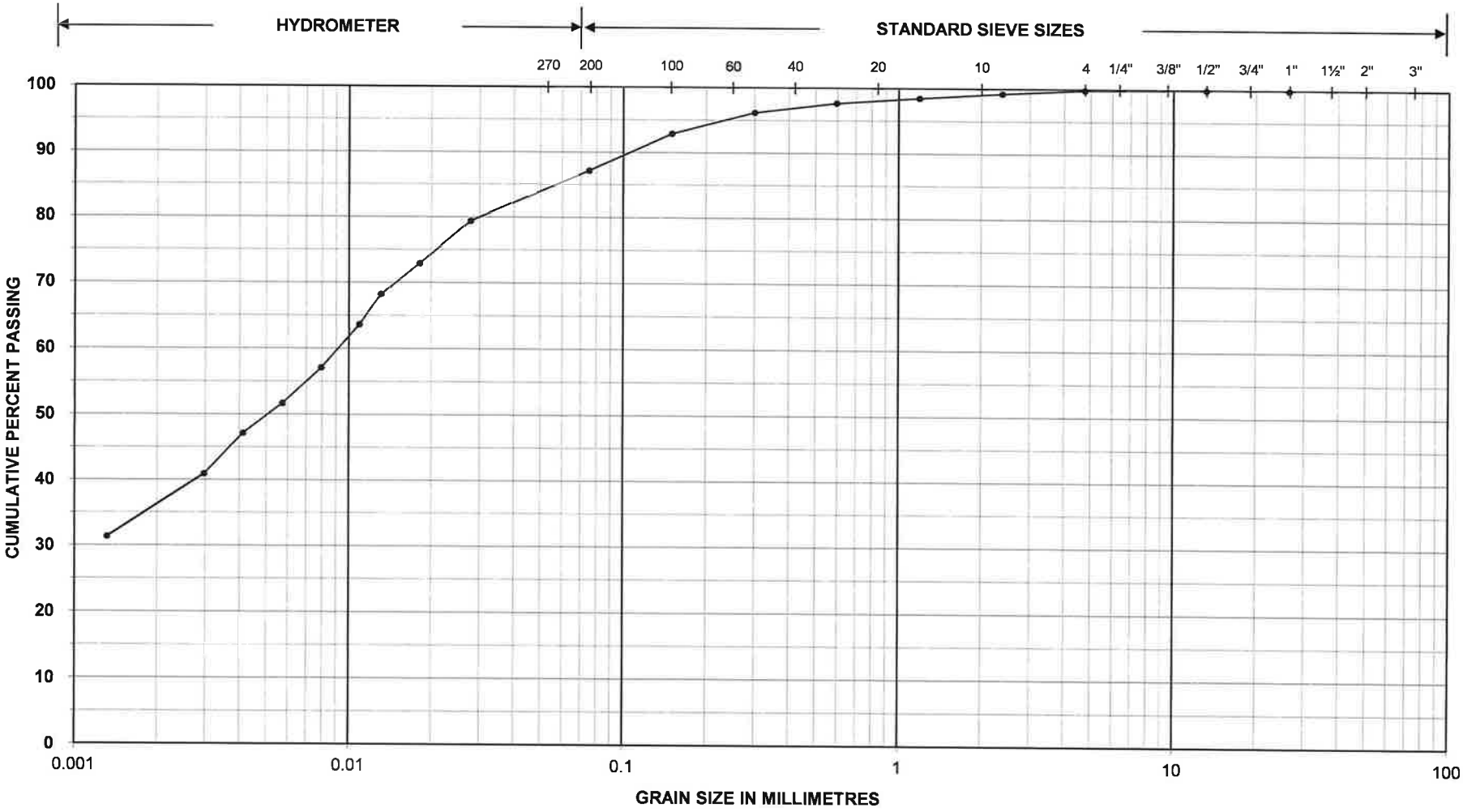
| CLAY | SILT | | | SAND | | | GRAVEL | | | COBBLES |
|---|---|---|---|---|---|---|---|---|---|---|
| | Fine | Medium | Coarse | Fine | Medium | Coarse | Fine | Medium | Coarse | |

**Project Name:** Martindale Road **Project No.:** 111-26201-00 **Figure No.:** B5

**Location ID.:** BH29 **Sample No./Depth:** SS2 **Remarks:** Fill: Sandy, silty gravel

GENIVAR

# PARTICLE SIZE DISTRIBUTION



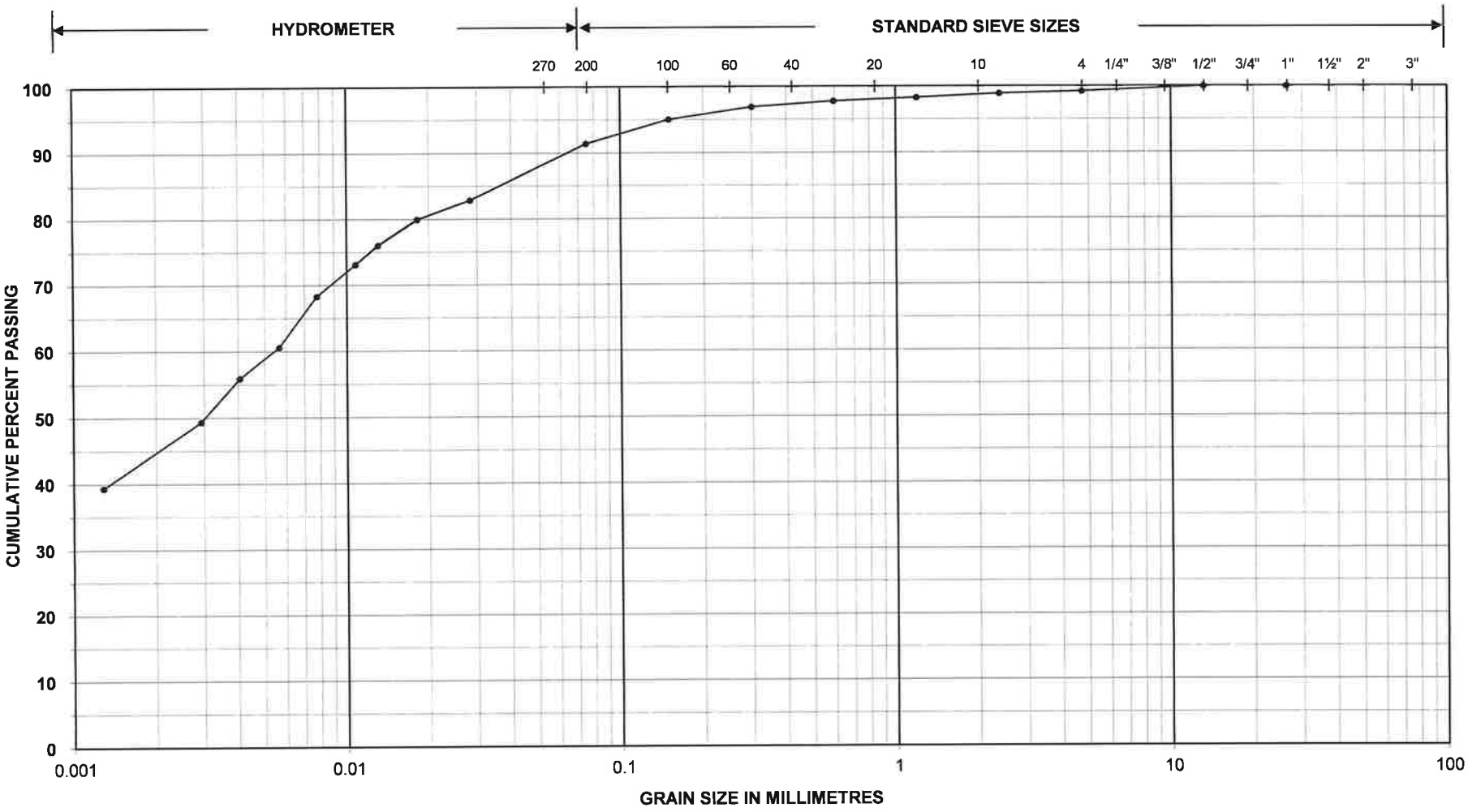

*MIT Classification System*

| CLAY | SILT | | | SAND | | | GRAVEL | | | COBBLES |
|---|---|---|---|---|---|---|---|---|---|---|
| | Fine | Medium | Coarse | Fine | Medium | Coarse | Fine | Medium | Coarse | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Project Name:** | Martindale Road | | | **Project No.:** | 111-26201-00 | **Figure No.:** B6 |
| **Location ID.:** | BH2 | **Sample No./Depth:** | SS1 | **Remarks:** | Silt and clay, some sand, trace gravel | |

GENIVAR

# PARTICLE SIZE DISTRIBUTION



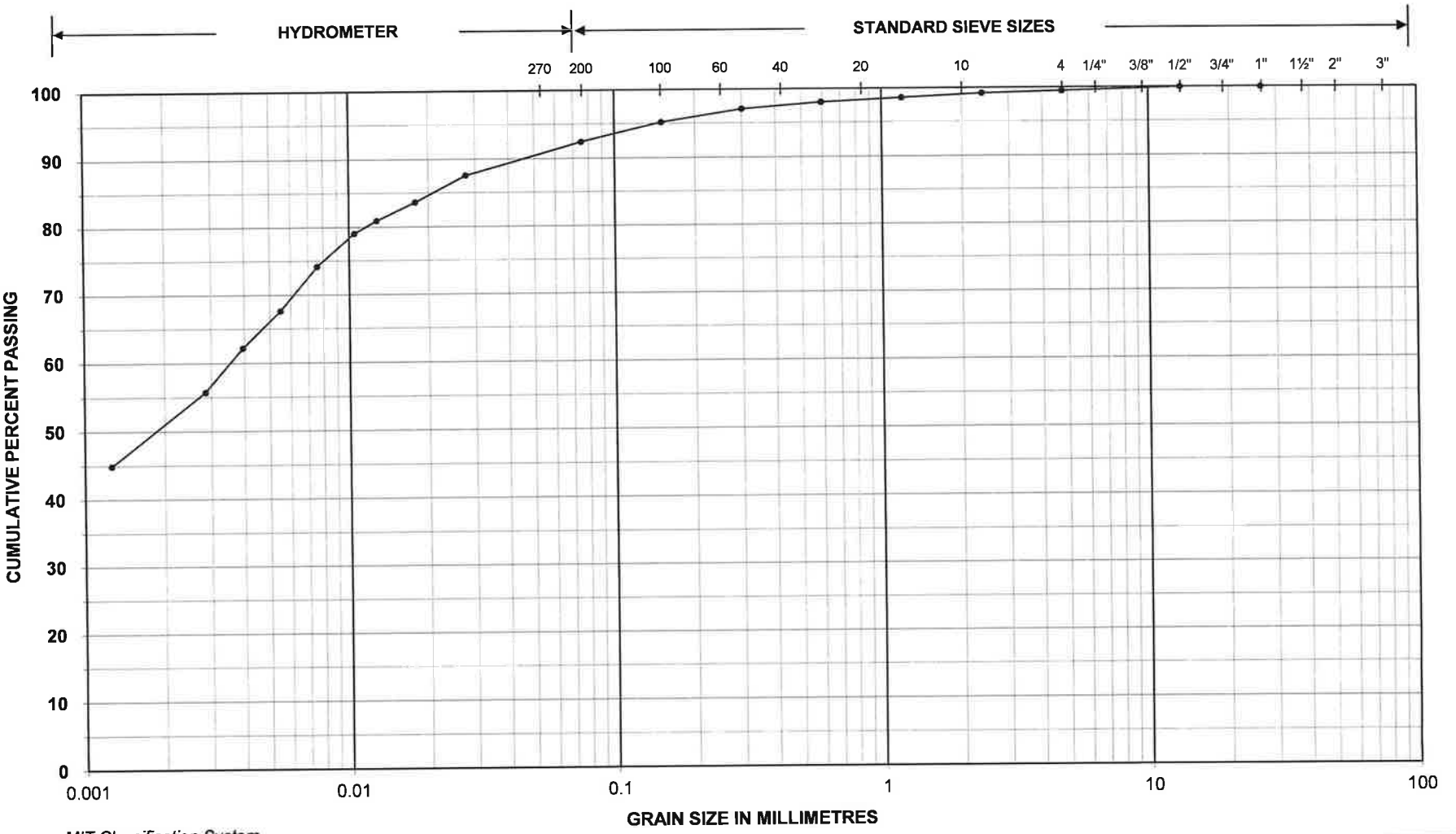

*MIT Classification System*

| CLAY | SILT | | | SAND | | | GRAVEL | | | COBBLES |
|---|---|---|---|---|---|---|---|---|---|---|
| | Fine | Medium | Coarse | Fine | Medium | Coarse | Fine | Medium | Coarse | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Project Name:** | Martindale Road | | | **Project No.:** | 111-26201-00 | **Figure No.:** B7 |
| **Location ID.:** | BH34 | **Sample No./Depth:** | SS2 | **Remarks:** | Silt and clay, trace sand, trace gravel | |

GENIVAR

# PARTICLE SIZE DISTRIBUTION




*MIT Classification System*

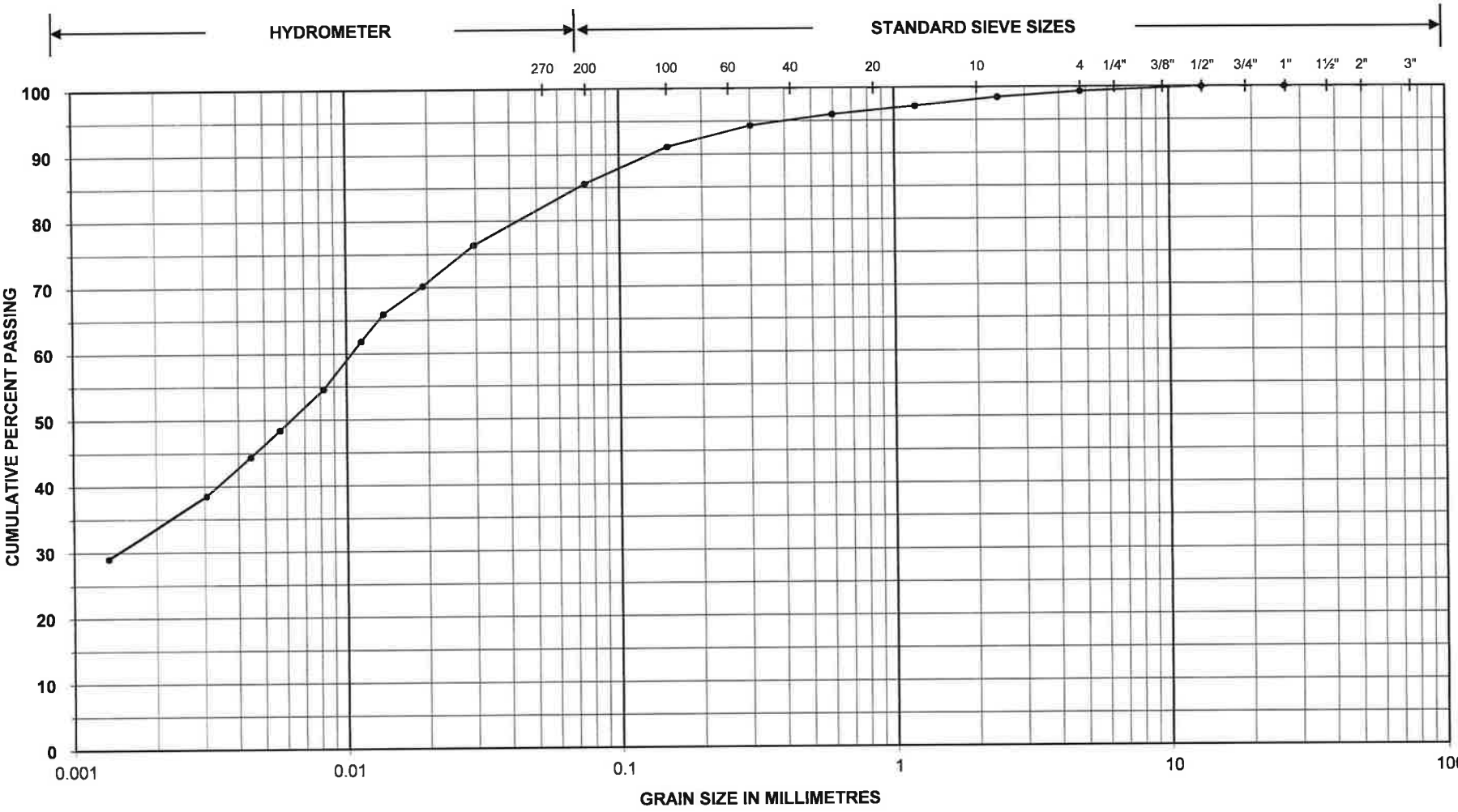
| CLAY | SILT | | | SAND | | | GRAVEL | | | COBBLES |
|---|---|---|---|---|---|---|---|---|---|---|
| | Fine | Medium | Coarse | Fine | Medium | Coarse | Fine | Medium | Coarse | |

**Project Name:** Martindale **Project No.:** 111-26201-00 **Figure No.:** B8

**Location ID.:** BH39 **Sample No./Depth:** SS5 **Remarks:** Clay and silt, trace sand, trace gravel

GENIVAR

# PARTICLE SIZE DISTRIBUTION

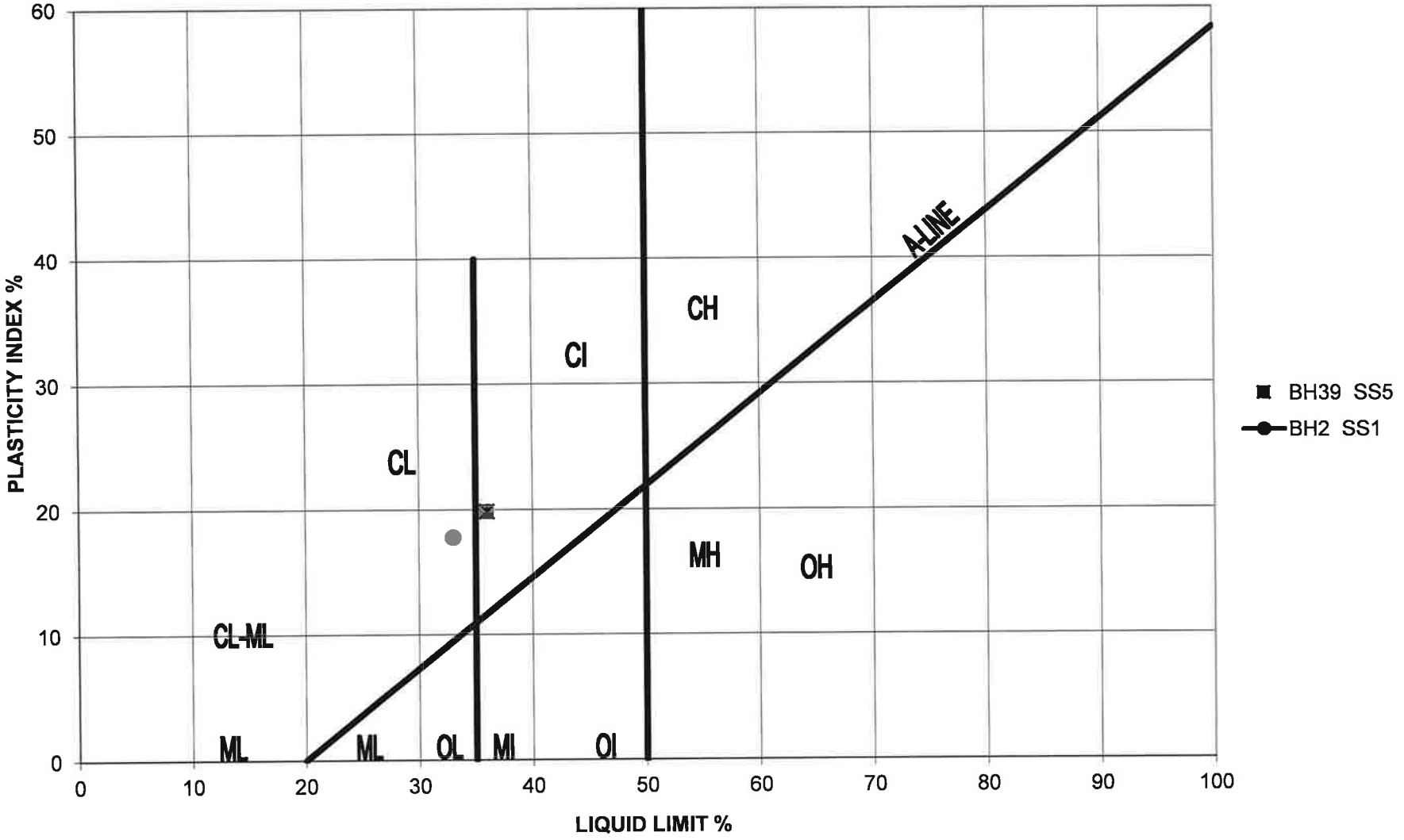



*MIT Classification System*

| CLAY | SILT | | | SAND | | | GRAVEL | | | COBBLES |
|---|---|---|---|---|---|---|---|---|---|---|
| | Fine | Medium | Coarse | Fine | Medium | Coarse | Fine | Medium | Coarse | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Project Name:** | Martindale Road | | | **Project No.:** | 111-26201-00 | **Figure No.:** B9 |
| **Location ID.:** | BH13 | **Sample No./Depth:** | SS4 | **Remarks:** | Clayey, sandy silt, trace gravel | |

**FIGURE B10**
**Atterberg Limits Plasticity Chart**




C:\Documents and Settings\Raid.Khamis\Desktop\Martindale 111-26201-00 Phase 116 Sub-Phase 0624010\Lab resultes\Copy of Atterberg Limits BH39 SS5 01 25 12 (2) COMBINED.xls

# Appendix C

# Pavement Thickness Design (WinPAS Output)

# WinPAS

Pavement Thickness Design According to

## 1993 AASHTO Guide for Design of Pavements Structures

American Concrete Pavement Association

## Flexible Design Inputs

Agency:
Company: GENIVAR INC.
Contractor:
roject Description: Reconstruction and Widening of Martindale Road
Location: Martindale Road- City of St. Catharines

**Flexible Pavement Design/Evaluation**

| | | | | |
|---|---|---|---|---|
| **Structural Number** | 129.85 | | **Soil Resilient Modulus** | 30.00 **MPa** |
| **Design ESALs** | 2,877,535 | | **Initial Serviceability** | 4.50 |
| **Reliability** | 95.00 | **percent** | **Terminal Serviceability** | 2.50 |
| **Overall Deviation** | 0.49 | | | |

**Layer Pavement Design/Evaluation**

| Layer Material | Layer Coefficient | Drainage Coefficient | Layer Thickness | Layer SN |
|---|---|---|---|---|
| Asphalt Cement Concrete | 0.42 | 0.90 | 180.00 | 68.04 |
| Granular "A" | 0.14 | 0.90 | 500.00 | 63.00 |
| | 0.00 | 0.00 | 0.00 | 0.00 |
| | 0.00 | 0.00 | 0.00 | 0.00 |
| | 0.00 | 0.00 | 0.00 | 0.00 |
| | 0.00 | 0.00 | 0.00 | 0.00 |
| | | | ΣSN | 131.04 |

# Appendix D

## Corrosivity Test Results
## Soil Chemistry Results

**EXOVA ACCUTEST**

# REPORT OF ANALYSIS

Exova Accutest

**Client:** GENIVAR (Ancaster)
1425 Cormorant Road, Suite 300

Ancaster, Hamilton, ON
L9G 4V5
**Attention:** Ms. Matt Welsh

**Niagara Report:** N12-0069
**Report Number:** 1201049
**Date:** 2012-01-26
**Date Submitted:** 2012-01-18

**Project:** 111-26201-00

**P.O. Number:**
**Matrix:** Soil

**Chain of Custody Number:** 155533

| | | | LAB ID: | 936609 | 936611 | 936612 | | | GUIDELINE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sample Date: | 2012-01-11 | 2012-01-11 | 2012-01-16 | | | | | |
| | | | Sample ID: | BH5 SS1 | BH8 SS4 | BH13 SS1 | | | | | |
| PARAMETER | UNITS | MRL | | | | | | | TYPE | LIMIT | UNITS |
| Chloride | % | 0.002 | | 0.026 | | | | | | | |
| Electrical Conductivity | mS/cm | 0.05 | | 0.40 | | | | | | | |
| pH | | | | 8.0 | | | | | | | |
| Resistivity | ohm-cm | 1 | | 2500 | | | | | | | |
| Sulphate | % | 0.01 | | 0.05 | | | | | | | |
| Antimony | ug/g | 1 | <1 | | <1 | | | | | | |
| Arsenic | ug/g | 1 | 4 | | 5 | | | | | | |
| Barium | ug/g | 1 | 107 | | 138 | | | | | | |
| Beryllium | ug/g | 1 | <1 | | <1 | | | | | | |
| Boron | ug/g | 10 | 20 | | 30 | | | | | | |
| Cadmium | ug/g | 0.5 | <0.5 | | 0.5 | | | | | | |
| Chromium | ug/g | 1 | 17 | | 25 | | | | | | |
| Cobalt | ug/g | 1 | 9 | | 12 | | | | | | |
| Copper | ug/g | 1 | 28 | | 32 | | | | | | |
| Lead | ug/g | 1 | 16 | | 7 | | | | | | |
| Mercury | ug/g | 0.1 | <0.1 | | <0.1 | | | | | | |
| Molybdenum | ug/g | 1 | <1 | | <1 | | | | | | |
| Nickel | ug/g | 1 | 21 | | 30 | | | | | | |
| Selenium | ug/g | 1 | <1 | | <1 | | | | | | |
| Silver | ug/g | 0.2 | <0.2 | | <0.2 | | | | | | |
| Thallium | ug/g | 1 | <1 | | <1 | | | | | | |
| Uranium | ug/g | 0.5 | <0.5 | | <0.5 | | | | | | |
| Vanadium | ug/g | 2 | 26 | | 36 | | | | | | |
| Zinc | ug/g | 2 | 55 | | 63 | | | | | | |

MRL = Method Reporting Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:

APPROVAL: _____
Lorna Wilson
Inorganic Lab Supervisor

Methods references and/or additional QA/QC information available on request.



Results relate only to the parameters tested on the samples submitted.

# REPORT OF ANALYSIS



**Client:** **GENIVAR (Ancaster)**
1425 Cormorant Road, Suite 300

Ancaster, Hamilton, ON
L9G 4V5
**Attention:** **Ms. Matt Welsh**

**Niagara Report:** N12-0069
**Report Number:** 1201049
**Date:** 2012-01-26
**Date Submitted:** 2012-01-18

**Project:** 111-26201-00

**P.O. Number:**
**Matrix:** Soil

**Chain of Custody Number:** 155533

| | | | LAB ID: | | | | | GUIDELINE | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sample Date: | | | | | | | |
| | | | Sample ID: | LAB BLANK | LAB QC % RECOVERY | QC RECOVERY RANGE | DATE ANALYSED | | | |
| **PARAMETER** | **UNITS** | **MRL** | | | | | | **TYPE** | **LIMIT** | **UNITS** |
| Chloride | % | 0.002 | | <0.002 | 106 | 90-110 | 2012-01-19 | | | |
| Electrical Conductivity | mS/cm | 0.05 | | <0.05 | 100 | 80-120 | 2012-01-23 | | | |
| pH | | | | <2.0 | 99 | 90-110 | 2012-01-23 | | | |
| Resistivity | ohm-cm | 1 | | <1 | | - | 2012-01-23 | | | |
| Sulphate | % | 0.01 | | <0.01 | 127 | 70-130 | 2012-01-23 | | | |
| Antimony | ug/g | 1 | | <1 | 72 | 20-180 | 2012-01-19 | | | |
| Arsenic | ug/g | 1 | | <1 | 128 | 50-150 | 2012-01-19 | | | |
| Barium | ug/g | 1 | | <1 | 111 | 85-115 | 2012-01-19 | | | |
| Beryllium | ug/g | 1 | | <1 | 107 | 75-125 | 2012-01-19 | | | |
| Boron | ug/g | 10 | | <10 | 88 | - | 2012-01-23 | | | |
| Cadmium | ug/g | 0.5 | | <0.5 | 98 | 50-150 | 2012-01-19 | | | |
| Chromium | ug/g | 1 | | <1 | 92 | 70-130 | 2012-01-19 | | | |
| Cobalt | ug/g | 1 | | <1 | 82 | 70-130 | 2012-01-19 | | | |
| Copper | ug/g | 1 | | <1 | 107 | 80-120 | 2012-01-19 | | | |
| Lead | ug/g | 1 | | <1 | 78 | 74-126 | 2012-01-19 | | | |
| Mercury | ug/g | 0.1 | | <0.1 | 100 | 70-130 | 2012-01-24 | | | |
| Molybdenum | ug/g | 1 | | <1 | 89 | 40-160 | 2012-01-19 | | | |
| Nickel | ug/g | 1 | | <1 | 104 | 68-132 | 2012-01-19 | | | |
| Selenium | ug/g | 1 | | <1 | 110 | 50-150 | 2012-01-19 | | | |
| Silver | ug/g | 0.2 | | <0.2 | 144 | 0-200 | 2012-01-19 | | | |
| Thallium | ug/g | 1 | | <1 | 75 | 60-140 | 2012-01-19 | | | |
| Uranium | ug/g | 0.5 | | <0.5 | 88 | 80-120 | 2012-01-19 | | | |
| Vanadium | ug/g | 2 | | <2 | 100 | 38-162 | 2012-01-19 | | | |
| Zinc | ug/g | 2 | | <2 | 104 | 84-116 | 2012-01-19 | | | |

MRL = Method Reporting Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration
Comment:

APPROVAL: _____
Lorna Wilson
Inorganic Lab Supervisor

Methods references and/or additional QA/QC information available on request.



Results relate only to the parameters tested on the samples submitted.

**EXOVA ACCUTEST**

# REPORT OF ANALYSIS

Exova Accutest

**Client:** GENIVAR (Ancaster)
1425 Cormorant Road, Suite 300

Ancaster, Hamilton, ON
L9G 4V5
**Attention:** Ms. Matt Welsh

**Niagara Report:** N12-0069
**Report Number:** 1201049
**Date:** 2012-01-26
**Date Submitted:** 2012-01-18

**Project:** 111-26201-00

**P.O. Number:**
**Matrix:** Soil

**Chain of Custody Number:** 155533

| | | | | | | | | GUIDELINE | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | **LAB ID:** | 936610 | 936612 | | | | | |
| | | | **Sample Date:** | 2012-01-11 | 2012-01-16 | | | | | |
| | | | **Sample ID:** | BH6SS1 | BH13 SS1 | | | | | |
| **PARAMETER** | **UNITS** | **MRL** | | | | | | **TYPE** | **LIMIT** | **UNITS** |
| **PERCENT MOISTURE** | | | | | | | | | | |
| Moisture | % | 0.1 | | 12.3 | 15.9 | | | | | |
| **VOLATILE ORGANIC COMPOUNDS - VOCs** | | | | | | | | | | |
| Ethylbenzene | ug/g | 0.05 | | <0.05 | <0.05 | | | | | |
| Toluene | ug/g | 0.2 | | <0.20 | <0.20 | | | | | |
| Benzene | ug/g | 0.02 | | <0.02 | <0.02 | | | | | |
| m/p-xylene | ug/g | 0.05 | | <0.05 | <0.05 | | | | | |
| o-xylene | ug/g | 0.05 | | <0.05 | <0.05 | | | | | |
| **VOC SURROGATES** | | | | | | | | | | |
| Toluene-d8 | % | | | 96 | 99 | | | | | |
| **CCME Total Petroleum Hydrocarbons** | | | | | | | | | | |
| F1 (C6-C10) | ug/g | 10 | | <10 | <10 | | | | | |
| F1-BTEX (C6-C10) | ug/g | 10 | | <10 | <10 | | | | | |
| F2 (C10-C16) | ug/g | 10 | | <10 | <10 | | | | | |
| F3 (C16-C34) | ug/g | 20 | | <20 | <20 | | | | | |
| F4 (C34-C50) | ug/g | 20 | | <20 | <20 | | | | | |

MRL = Method Reporting Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:

APPROVAL: _____
Charlie Qu
Organic Lab Team Leader

Methods references and/or additional QA/QC information available on request.



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# REPORT OF ANALYSIS

Exova Accutest

**Client:** GENIVAR (Ancaster)
1425 Cormorant Road, Suite 300

Ancaster, Hamilton, ON
L9G 4V5
**Attention:** Ms. Matt Welsh

**Niagara Report:** N12-0069
**Report Number:** 1201049
**Date:** 2012-01-26
**Date Submitted:** 2012-01-18

**Project:** 111-26201-00

**P.O. Number:**
**Matrix:** Soil

**Chain of Custody Number:** 155533

| PARAMETER | UNITS | MRL | LAB ID: / Sample Date: / Sample ID: | LAB BLANK | LAB QC % RECOVERY | QC RECOVERY RANGE | DATE ANALYSED | | GUIDELINE TYPE | GUIDELINE LIMIT | GUIDELINE UNITS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **PERCENT MOISTURE** | | | | | | | | | | | |
| Moisture | % | 0.1 | | <0.1 | 100 | 80-120 | 2012-01-23 | | | | |
| **VOLATILE ORGANIC COMPOUNDS - VOCs** | | | | | | | | | | | |
| Ethylbenzene | ug/g | 0.05 | | <0.05 | 101 | 80-120 | 2012-01-21 | | | | |
| Toluene | ug/g | 0.2 | | <0.20 | 116 | 80-120 | 2012-01-21 | | | | |
| Benzene | ug/g | 0.02 | | <0.02 | 112 | 80-120 | 2012-01-21 | | | | |
| m/p-xylene | ug/g | 0.05 | | <0.05 | 104 | 80-120 | 2012-01-21 | | | | |
| o-xylene | ug/g | 0.05 | | <0.05 | 97 | 80-120 | 2012-01-21 | | | | |
| **VOC SURROGATES** | | | | | | | | | | | |
| Toluene-d8 | % | | | 97 | 98 | 70-130 | 2012-01-21 | | | | |
| **CCME Total Petroleum Hydrocarbons** | | | | | | | | | | | |
| F1 (C6-C10) | ug/g | 10 | | <10 | 92 | 80-120 | 2012-01-23 | | | | |
| F1-BTEX (C6-C10) | ug/g | 10 | | <10 | | - | 2012-01-23 | | | | |
| F2 (C10-C16) | ug/g | 10 | | <10 | 87 | 50-120 | 2012-01-23 | | | | |
| F3 (C16-C34) | ug/g | 20 | | <20 | 87 | 50-120 | 2012-01-23 | | | | |
| F4 (C34-C50) | ug/g | 20 | | <20 | 87 | 50-120 | 2012-01-23 | | | | |

MRL = Method Reporting Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:

APPROVAL: _____
Charlie Qu
Organic Lab Team Leader

Methods references and/or additional QA/QC information available on request.



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**EXOVA ACCUTEST**

# REPORT OF ANALYSIS

Exova Accutest

**Client:** **GENIVAR (Ancaster)**
1425 Cormorant Road, Suite 300

Ancaster, Hamilton, ON
L9G 4V5
**Attention:** **Ms. Matt Welsh**

**Niagara Report:** N12-0103
**Report Number:** 1201332
**Date:** 2012-01-30
**Date Submitted:** 2012-01-24

**Project:** 111-26201-00

**P.O. Number:**
**Matrix:** Soil

**Chain of Custody Number:** 155534

| | | | LAB ID: | 937496 | 937497 | | | | GUIDELINE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sample Date: | 2012-01-18 | 2012-01-18 | | | | | | |
| | | | Sample ID: | BH20 SS1 | BH31 SS1 | | | | | | |
| PARAMETER | UNITS | MRL | | | | | | | TYPE | LIMIT | UNITS |
| Antimony | ug/g | 1 | | <1 | <1 | | | | | | |
| Arsenic | ug/g | 1 | | 4 | 5 | | | | | | |
| Barium | ug/g | 1 | | 142 | 116 | | | | | | |
| Beryllium | ug/g | 1 | | <1 | <1 | | | | | | |
| Boron | ug/g | 10 | | 30 | 30 | | | | | | |
| Cadmium | ug/g | 0.5 | | <0.5 | <0.5 | | | | | | |
| Chromium | ug/g | 1 | | 24 | 23 | | | | | | |
| Cobalt | ug/g | 1 | | 14 | 15 | | | | | | |
| Copper | ug/g | 1 | | 30 | 31 | | | | | | |
| Lead | ug/g | 1 | | 9 | 9 | | | | | | |
| Mercury | ug/g | 0.1 | | <0.1 | <0.1 | | | | | | |
| Molybdenum | ug/g | 1 | | <1 | <1 | | | | | | |
| Nickel | ug/g | 1 | | 29 | 30 | | | | | | |
| Selenium | ug/g | 1 | | <1 | <1 | | | | | | |
| Silver | ug/g | 0.2 | | <0.2 | <0.2 | | | | | | |
| Thallium | ug/g | 1 | | <1 | <1 | | | | | | |
| Uranium | ug/g | 0.5 | | 0.7 | 0.5 | | | | | | |
| Vanadium | ug/g | 2 | | 36 | 34 | | | | | | |
| Zinc | ug/g | 2 | | 60 | 58 | | | | | | |

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Comment:

APPROVAL: _____
Lorna Wilson
Inorganic Lab Supervisor

Methods references and/or additional QA/QC information available on request.



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Client: GENIVAR (Ancaster)
1425 Cormorant Road, Suite 300

Ancaster, Hamilton, ON
L9G 4V5
Attention: Ms. Matt Welsh

Niagara Report: N12-0103
Report Number: 1201332
Date: 2012-01-30
Date Submitted: 2012-01-24

Project: 111-26201-00

P.O. Number:
Matrix: Soil

Chain of Custody Number: 155534

| | | | LAB ID: | | | | | GUIDELINE | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sample Date: | | | | | | | |
| | | | Sample ID: | LAB BLANK | LAB QC % RECOVERY | QC RECOVERY RANGE | DATE ANALYSED | | | |
| PARAMETER | UNITS | MRL | | | | | | TYPE | LIMIT | UNITS |
| Antimony | ug/g | 1 | <1 | 69 | 20-180 | 2012-01-26 | | | | |
| Arsenic | ug/g | 1 | <1 | 114 | 50-150 | 2012-01-26 | | | | |
| Barium | ug/g | 1 | <1 | 101 | 85-115 | 2012-01-26 | | | | |
| Beryllium | ug/g | 1 | <1 | 105 | 75-125 | 2012-01-26 | | | | |
| Boron | ug/g | 10 | <10 | 93 | - | 2012-01-27 | | | | |
| Cadmium | ug/g | 0.5 | <0.5 | 107 | 50-150 | 2012-01-26 | | | | |
| Chromium | ug/g | 1 | <1 | 88 | 70-130 | 2012-01-26 | | | | |
| Cobalt | ug/g | 1 | <1 | 83 | 70-130 | 2012-01-26 | | | | |
| Copper | ug/g | 1 | <1 | 92 | 80-120 | 2012-01-26 | | | | |
| Lead | ug/g | 1 | <1 | 88 | 74-126 | 2012-01-26 | | | | |
| Mercury | ug/g | 0.1 | <0.1 | 100 | 70-130 | 2012-01-27 | | | | |
| Molybdenum | ug/g | 1 | <1 | 86 | 40-160 | 2012-01-26 | | | | |
| Nickel | ug/g | 1 | <1 | 96 | 68-132 | 2012-01-26 | | | | |
| Selenium | ug/g | 1 | <1 | 107 | 50-150 | 2012-01-26 | | | | |
| Silver | ug/g | 0.2 | <0.2 | 132 | 0-200 | 2012-01-26 | | | | |
| Thallium | ug/g | 1 | <1 | 85 | 60-140 | 2012-01-26 | | | | |
| Uranium | ug/g | 0.5 | <0.5 | 90 | 80-120 | 2012-01-26 | | | | |
| Vanadium | ug/g | 2 | <2 | 99 | 38-162 | 2012-01-26 | | | | |
| Zinc | ug/g | 2 | <2 | 96 | 84-116 | 2012-01-26 | | | | |

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Comment:

APPROVAL: _____
Lorna Wilson
Inorganic Lab Supervisor

Methods references and/or additional QA/QC information available on request.



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**EXOVA ACCUTEST**

# REPORT OF ANALYSIS

Exova Accutest


**Client:** GENIVAR (Ancaster)
1425 Cormorant Road, Suite 300

Ancaster, Hamilton, ON
L9G 4V5
**Attention:** Ms. Matt Welsh


**Niagara Report:** N12-0103
**Report Number:** 1201332
**Date:** 2012-01-30
**Date Submitted:** 2012-01-24

**Project:** 111-26201-00

**P.O. Number:**
**Matrix:** Soil

**Chain of Custody Number:** 155534

| | | | | | | | | GUIDELINE | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | **LAB ID:** | 937498 | 937499 | | | | | |
| | | | **Sample Date:** | 2012-01-18 | 2012-01-18 | | | | | |
| | | | **Sample ID:** | BH18 SS5 | BH36 SS5 | | | | | |
| **PARAMETER** | **UNITS** | **MRL** | | | | | | **TYPE** | **LIMIT** | **UNITS** |
| **PERCENT MOISTURE** | | | | | | | | | | |
| Moisture | % | 0.1 | | 14.3 | 17.7 | | | | | |
| **VOLATILE ORGANIC COMPOUNDS - VOCs** | | | | | | | | | | |
| Ethylbenzene | ug/g | 0.05 | | <0.05 | <0.05 | | | | | |
| Toluene | ug/g | 0.2 | | <0.20 | <0.20 | | | | | |
| Benzene | ug/g | 0.02 | | <0.02 | <0.02 | | | | | |
| m/p-xylene | ug/g | 0.05 | | <0.05 | <0.05 | | | | | |
| o-xylene | ug/g | 0.05 | | <0.05 | <0.05 | | | | | |
| **VOC SURROGATES** | | | | | | | | | | |
| Toluene-d8 | % | | | 102 | 101 | | | | | |
| **CCME Total Petroleum Hydrocarbons** | | | | | | | | | | |
| F1 (C6-C10) | ug/g | 10 | | <10 | <10 | | | | | |
| F1-BTEX (C6-C10) | ug/g | 10 | | <10 | <10 | | | | | |
| F2 (C10-C16) | ug/g | 10 | | <10 | <10 | | | | | |
| F3 (C16-C34) | ug/g | 20 | | <20 | <20 | | | | | |
| F4 (C34-C50) | ug/g | 20 | | <20 | <20 | | | | | |

MRL = Method Reporting Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

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Organic Lab Supervisor

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1425 Cormorant Road, Suite 300

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L9G 4V5
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**Project:** 111-26201-00

**P.O. Number:**
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**Chain of Custody Number:** 155534

| | | | LAB ID: | | | | | GUIDELINE | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sample Date: | | | | | | | |
| | | | Sample ID: | LAB BLANK | LAB QC % RECOVERY | QC RECOVERY RANGE | DATE ANALYSED | | | |
| PARAMETER | UNITS | MRL | | | | | | TYPE | LIMIT | UNITS |
| **PERCENT MOISTURE** | | | | | | | | | | |
| Moisture | % | 0.1 | <0.1 | 99 | 80-120 | 2012-01-27 | | | | |
| **VOLATILE ORGANIC COMPOUNDS - VOCs** | | | | | | | | | | |
| Ethylbenzene | ug/g | 0.05 | <0.05 | 91 | 80-120 | 2012-01-25 | | | | |
| Toluene | ug/g | 0.2 | <0.20 | 101 | 80-120 | 2012-01-25 | | | | |
| Benzene | ug/g | 0.02 | <0.02 | 101 | 80-120 | 2012-01-25 | | | | |
| m/p-xylene | ug/g | 0.05 | <0.05 | 91 | 80-120 | 2012-01-25 | | | | |
| o-xylene | ug/g | 0.05 | <0.05 | 92 | 80-120 | 2012-01-25 | | | | |
| **VOC SURROGATES** | | | | | | | | | | |
| Toluene-d8 | % | | 98 | 97 | 70-130 | 2012-01-25 | | | | |
| **CCME Total Petroleum Hydrocarbons** | | | | | | | | | | |
| F1 (C6-C10) | ug/g | 10 | <10 | 99 | 80-120 | 2012-01-25 | | | | |
| F1-BTEX (C6-C10) | ug/g | 10 | <10 | | - | 2012-01-25 | | | | |
| F2 (C10-C16) | ug/g | 10 | <10 | 87 | 50-120 | 2012-01-27 | | | | |
| F3 (C16-C34) | ug/g | 20 | <20 | 87 | 50-120 | 2012-01-27 | | | | |
| F4 (C34-C50) | ug/g | 20 | <20 | 87 | 50-120 | 2012-01-27 | | | | |

MRL = Method Reporting Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:

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Charlie Qu
Organic Lab Supervisor

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## Table 1: Soil Chemistry Results - Metals
## Glanbrook Landfill Compost Pad

| PARAMETER | Units | MDL | BH8 SS4 11-Jan-12 |
|---|---|---|---|
| Chloride | % | 0.002 | 0.0 |
| Electrical Conductivity | mS/cm | 0.05 | 0 |
| pH | | | 8 |
| Resistivity | ohm-cm | 1 | 2500.0 |
| Sulphate | % | 0.01 | 0.1 |

# Appendix E

# Pavement Condition Rating Forms

Martindale Road (Sec. 1)

Ministry of Transportation, Ontario

# FLEXIBLE PAVEMENT CONDITION EVALUATION FORM

**Location From:** Station 9+000 **To:** Station 9+200

**LHRS** BEGINS ____ OFFSET ____ km **Section Length** 0.2 km LENGTH **District** ____

**Survey Date** 12 YEAR 5 MONTH **PCR** 80 **RCR** 8.5 **Traffic Direction** B (B: BOTH DIRECTIONS; N: NORTH BOUND; S: SOUTH BOUND; E: EAST BOUND; W: WEST BOUND) **Highway** 38

**Contract No.** ____ **WP No.** ____ **Facility** A (A: ALL LANES; C: COLLECTOR; E: EXPRESS; O: OTHERS (Additional Lanes)) **Class** A (F: FREEWAY; A: ARTERIAL; C: COLLECTOR; L: LOCAL; S: SECONDARY)

**Ride Condition Rating (at 80 km/h)**

- 10 EXCELLENT — Smooth and pleasant
- 8 GOOD — Comfortable
- 6 FAIR — Uncomfortable
- 4 POOR — Very rough and bumpy
- 2 VERY POOR — Dangerous at 80 km/h
- 0

| Pavement | | | SEVERITY OF DISTRESS: Very Slight (1) | Slight (2) | Moderate (3) | Severe (4) | Very Severe (5) | DENSITY OF DISTRESS, Extent of Occurrence,%: Few <10 (1) | Intermittent 10-20 (2) | Frequent 20-50 (3) | Extensive 50-80 (4) | Throughout 80-100 (5) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SURFACE DEFECTS | | Ravelling & C. Agg. Loss | 1 | ✓ | | | | | ✓ | | | |
| | | Flushing | 2 | ✓ | | | | | ✓ | | | |
| SURFACE DEFORMATIONS | | Rippling and Shoving | 3 | ✓ | | | | | ✓ | | | |
| | | Wheel Track Rutting | 4 | | ✓ | | | | ✓ | | | |
| | | Distortion | 5 | | | | | | | | | |
| CRACKING | Longitudinal Wheel Track | Single and Multiple | 6 | ✓ | | | | | ✓ | | | |
| | | Alligator | 7 | | | | | | | | | |
| | Centre Line | Single and Multiple | 8 | | | | | | | | | |
| | | Alligator | 9 | | | | | | | | | |
| | Pavement Edge | Single and Multiple | 10 | ✓ | | | | | ✓ | | | |
| | | Alligator | 11 | ✓ | | | | | ✓ | | | |
| | Transverse | Half, Full and Multiple | 12 | | ✓ | | | | ✓ | | | |
| | | Alligator | 13 | | | | | | | | | |
| | Longitudinal Meander and Midlane | | 14 | | | | | | | | | |
| | Random | | 15 | ✓ | | | | | ✓ | | | |

| Shoulders | ONE ✓ | DISTRESS | SEVERITY OF DISTRESS RIGHT Mod (1) | RIGHT Severe (2) | LEFT Mod (1) | LEFT Severe (2) | DENSITY OF DISTRESS, Extent of Occurrence,% RIGHT 10-30 (1) | RIGHT >30 (2) | LEFT 10-30 (1) | LEFT >30 (2) |
|---|---|---|---|---|---|---|---|---|---|---|
| DOMINANT TYPE | | | | | | | | | | |
| PAVED FULL | | Cracking | | | | | | | | |
| | | Pavement Edge/ Curb Separation | | | | | | | | |
| PAVED PARTIAL | ✓ | Distortion | ✓ | | ✓ | | | | | |
| SURFACE TREATED | | Breakup/Separation | | | | | | | | |
| | | Edge Break | | | | | | | | |
| PRIMED | | Breakup | | | | | | | | |
| GRAVEL | | | | | | | | | | |

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

**Distress Comments** (Items not covered above) ____

**Other Comments** (e.g. subsections, additional contracts) ____

Evaluated by Raid Khamis P. Eng.

PH-D-584 86-01

Figure A-1 Pavement Condition Rating Form

Martindale Road (Sec 2)

Ministry of Transportation
Ontario

# FLEXIBLE PAVEMENT CONDITION EVALUATION FORM

**Location From:** Station 9+200 **To:** Station 9+400

**LHRS** BEGINS ____ OFFSET ____ km **Section Length** 0.2 km LENGTH **District** ____

**Survey Date** 12 YEAR 5 MONTH **PCR** 85 **RCR** 9.0 **Traffic Direction** B (B : BOTH DIRECTIONS; N : NORTH BOUND; S : SOUTH BOUND; E : EAST BOUND; W: WEST BOUND) **Highway** 38

**Contract No.** ____ **WP No.** ____ **Facility** A (A : ALL LANES; C . COLLECTOR; E : EXPRESS; O : OTHERS (Additional Lanes)) **Class** A (F : FREEWAY; A : ARTERIAL; C : COLLECTOR; L : LOCAL; S : SECONDARY)

**Ride Condition Rating (at 80 km/h)**

- 10 EXCELLENT — Smooth and pleasant
- 8 GOOD — Comfortable
- 6 FAIR — Uncomfortable
- 4 POOR — Very rough and bumpy
- 2 VERY POOR — Dangerous at 80 km/h
- 0

| Pavement | | | | SEVERITY OF DISTRESS: Very Slight (1) | Slight (2) | Moderate (3) | Severe (4) | Very Severe (5) | DENSITY OF DISTRESS, Extent of Occurrence,%: Few < 10 (1) | Intermittent 10-20 (2) | Frequent 20-50 (3) | Extensive 50-80 (4) | Throughout 80-100 (5) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SURFACE DEFECTS | | Ravelling & C. Agg. Loss | 1 | ✓ | | | | | ✓ | | | | |
| | | Flushing | 2 | ✓ | | | | | ✓ | | | | |
| SURFACE DEFORMATIONS | | Rippling and Shoving | 3 | | | | | | | | | | |
| | | Wheel Track Rutting | 4 | ✓ | | | | | ✓ | | | | |
| | | Distortion | 5 | | | | | | | | | | |
| CRACKING | Longitudinal Wheel Track | Single and Multiple | 6 | ✓ | | | | | ✓ | | | | |
| | | Alligator | 7 | | | | | | | | | | |
| | Centre Line | Single and Multiple | 8 | | ✓ | | | | ✓ | | | | |
| | | Alligator | 9 | | | | | | | | | | |
| | Pavement Edge | Single and Multiple | 10 | ✓ | | | | | ✓ | | | | |
| | | Alligator | 11 | | | | | | | | | | |
| | Transverse | Half, Full and Multiple | 12 | ✓ | | | | | ✓ | | | | |
| | | Alligator | 13 | | | | | | | | | | |
| | Longitudinal Meander and Midlane | | 14 | ✓ | | | | | ✓ | | | | |
| | Random | | 15 | | | | | | | | | | |

| Shoulders | | | SEVERITY OF DISTRESS: RIGHT Mod (1) | RIGHT Severe (2) | LEFT Mod (1) | LEFT Severe (2) | DENSITY OF DISTRESS, Extent of Occurrence,%: RIGHT 10-30 (1) | RIGHT >30 (2) | LEFT 10-30 (1) | LEFT >30 (2) |
|---|---|---|---|---|---|---|---|---|---|---|
| DOMINANT TYPE | ONE ✓ | DISTRESS | | | | | | | | |
| PAVED FULL | ✓ | Cracking | | | | | | | | |
| | | Pavement Edge/ Curb Separation | | | | | | | | |
| PAVED PARTIAL | | Distortion | | | | | | | | |
| SURFACE TREATED | | Breakup/Separation | | | | | | | | |
| | | Edge Break | | | | | | | | |
| PRIMED | | Breakup | | | | | | | | |
| GRAVEL | | | | | | | | | | |

| Maintenance Treatment | | | EXTENT OF OCCURRENCE, %: <10 (1) | 10-20 (2) | 20-50 (3) | 50-80 (4) | >80 (5) |
|---|---|---|---|---|---|---|---|
| PAVEMENT | | Manual Patching | | | | | |
| | | Machine Patching | | | | | |
| | | Spray Patching | | | | | |
| | | Rout and Seal Cracks | | | | | |
| | | Chip Seal | | | | | |
| SHOULDERS | | Manual Patching | | | | | |
| | | Machine Patching | | | | | |
| | | Rout and Seal Cracks | | | | | |
| | | Chip Seal | | | | | |

**Distress Comments** (Items not covered above) ____

**Other Comments** (e.g. subsections, additional contracts) ____

Evaluated by Raid Khamis P. Eng.

PH-D-584 86-01

**Figure A-1 Pavement Condition Rating Form**

Martindale Road (Sec. 3)

Ministry of Transportation
Ontario

# FLEXIBLE PAVEMENT CONDITION EVALUATION FORM

**Location From:** Station 9+400 **To:** Station 9+680

**LHRS** BEGINS ____ OFFSET ____ km **Section Length** 0.28 km LENGTH **District** ____

**Survey Date** YEAR 12 MONTH 5 **PCR** 85 **RCR** 9.0 **Traffic Direction** B (B : BOTH DIRECTIONS; N : NORTH BOUND; S : SOUTH BOUND; E : EAST BOUND; W : WEST BOUND) **Highway** 38

**Contract No.** ____ **WP No.** ____ **Facility** A (A : ALL LANES; C : COLLECTOR; E : EXPRESS; O : OTHERS (Additional Lanes)) **Class** A (F : FREEWAY; A : ARTERIAL; C : COLLECTOR; L : LOCAL; S : SECONDARY)

**Ride Condition Rating (at 80 km/h)**

- 10 EXCELLENT — Smooth and pleasant
- 8 GOOD — Comfortable
- 6 FAIR — Uncomfortable
- 4 POOR — Very rough and bumpy
- 2 VERY POOR — Dangerous at 80 km/h
- 0

| Pavement | | | SEVERITY OF DISTRESS: Very Slight | Slight | Moderate | Severe | Very Severe | DENSITY OF DISTRESS (Extent of Occurrence,%): Few (<10) | Intermittent (10-20) | Frequent (20-50) | Extensive (50-80) | Throughout (80-100) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| SURFACE DEFECTS | Ravelling & C. Agg. Loss | 1 | ✓ | | | | | ✓ | | | | |
| | Flushing | 2 | ✓ | | | | | ✓ | | | | |
| SURFACE DEFORMATIONS | Rippling and Shoving | 3 | | | | | | | | | | |
| | Wheel Track Rutting | 4 | ✓ | | | | | ✓ | | | | |
| | Distortion | 5 | | | | | | | | | | |
| CRACKING — Longitudinal Wheel Track | Single and Multiple | 6 | | ✓ | | | | ✓ | | | | |
| | Alligator | 7 | | | | | | | | | | |
| CRACKING — Centre Line | Single and Multiple | 8 | | ✓ | | | | ✓ | | | | |
| | Alligator | 9 | | | | | | | | | | |
| CRACKING — Pavement Edge | Single and Multiple | 10 | | | | | | | | | | |
| | Alligator | 11 | | | | | | | | | | |
| CRACKING — Transverse | Half, Full and Multiple | 12 | ✓ | | | | | ✓ | | | | |
| | Alligator | 13 | | | | | | | | | | |
| CRACKING — Longitudinal Meander and Midlane | | 14 | ✓ | | | | | ✓ | | | | |
| CRACKING — Random | | 15 | | | | | | | | | | |

| Shoulders | | | SEVERITY OF DISTRESS: RIGHT Mod | RIGHT Severe | LEFT Mod | LEFT Severe | DENSITY OF DISTRESS (Extent of Occurrence,%): RIGHT 10-30 | RIGHT >30 | LEFT 10-30 | LEFT >30 |
|---|---|---|---|---|---|---|---|---|---|---|
| DOMINANT TYPE | ONE ✓ | DISTRESS | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| PAVED FULL | ✓ | Cracking | | | | | | | | |
| | | Pavement Edge/ Curb Separation | | | | | | | | |
| PAVED PARTIAL | | Distortion | | | | | | | | |
| SURFACE TREATED | | Breakup/Separation | | | | | | | | |
| | | Edge Break | | | | | | | | |
| PRIMED | | Breakup | | | | | | | | |
| GRAVEL | | | | | | | | | | |

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

**Distress Comments** (Items not covered above)
Few moderate cracks arround the Catch basin covers.

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

Evaluated by Raid Khamis P. Eng.

PH-D-584 86-01

**Figure A-1 Pavement Condition Rating Form**

Martindale Road (Sec. 4)

Ministry of Transportation, Ontario

# FLEXIBLE PAVEMENT CONDITION EVALUATION FORM

**Location From:** Station 9+680 **To:** Station 9+760

**LHRS** (BEGINS) ____ **km** (OFFSET) ____ **Section Length** 08 **km** (LENGTH) **District** ____

**Survey Date** 12 (YEAR) 5 (MONTH) **PCR** 50 **RCR** 5.0 **Traffic Direction** B (B : BOTH DIRECTIONS; N : NORTH BOUND; S : SOUTH BOUND; E : EAST BOUND; W : WEST BOUND) **Highway** 38

**Contract No.** ____ **WP No.** ____ **Facility** A (A : ALL LANES; C : COLLECTOR; E : EXPRESS; O : OTHERS (Additional Lanes)) **Class** A (F : FREEWAY; A : ARTERIAL; C : COLLECTOR; L : LOCAL; S : SECONDARY)

**Ride Condition Rating (at 80 km/h)**

- 10 EXCELLENT — Smooth and pleasant
- 8 GOOD — Comfortable
- 6 FAIR — Uncomfortable
- 4 POOR — Very rough and bumpy
- 2 VERY POOR — Dangerous at 80 km/h
- 0

| Pavement | | | SEVERITY OF DISTRESS: Very Slight (1) | Slight (2) | Moderate (3) | Severe (4) | Very Severe (5) | DENSITY OF DISTRESS, Extent of Occurrence,%: Few (<10) (1) | Intermittent (10-20) (2) | Frequent (20-50) (3) | Extensive (50-80) (4) | Throughout (80-100) (5) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SURFACE DEFECTS | Ravelling & C. Agg. Loss | 1 | | | ✓ | | | | | ✓ | | |
| | Flushing | 2 | | | ✓ | | | | | ✓ | | |
| SURFACE DEFORMATIONS | Rippling and Shoving | 3 | | ✓ | | | | ✓ | | | | |
| | Wheel Track Rutting | 4 | | | ✓ | | | | ✓ | | | |
| | Distortion | 5 | | | ✓ | | | | ✓ | | | |
| CRACKING — Longitudinal Wheel Track | Single and Multiple | 6 | | | ✓ | | | | ✓ | | | |
| | Alligator | 7 | | ✓ | | | | ✓ | | | | |
| CRACKING — Centre Line | Single and Multiple | 8 | | | ✓ | | | | | ✓ | | |
| | Alligator | 9 | | | ✓ | | | | ✓ | | | |
| CRACKING — Pavement Edge | Single and Multiple | 10 | | ✓ | | | | | ✓ | | | |
| | Alligator | 11 | | ✓ | | | | | ✓ | | | |
| CRACKING — Transverse | Half, Full and Multiple | 12 | | | ✓ | | | | ✓ | | | |
| | Alligator | 13 | | | ✓ | | | | ✓ | | | |
| Longitudinal Meander and Midlane | | 14 | | | ✓ | | | | ✓ | | | |
| Random | | 15 | | ✓ | | | | ✓ | | | | |

| Shoulders | | | SEVERITY OF DISTRESS: RIGHT Mod (1) | RIGHT Severe (2) | LEFT Mod (1) | LEFT Severe (2) | DENSITY OF DISTRESS, Extent of Occurrence,%: RIGHT 10-30 (1) | RIGHT >30 (2) | LEFT 10-30 (1) | LEFT >30 (2) |
|---|---|---|---|---|---|---|---|---|---|---|
| DOMINANT TYPE | ONE ✓ | DISTRESS | | | | | | | | |
| PAVED FULL | ✓ | Cracking | ✓ | | ✓ | | ✓ | | | |
| | | Pavement Edge/ Curb Separation | | | | | | | | |
| PAVED PARTIAL | | Distortion | | | | | | | | |
| SURFACE TREATED | | Breakup/Separation | | | | | | | | |
| | | Edge Break | | | | | | | | |
| PRIMED | | Breakup | | | | | | | | |
| GRAVEL | | | | | | | | | | |

| Maintenance Treatment | | EXTENT OF OCCURRENCE, %: <10 (1) | 10-20 (2) | 20-50 (3) | 50-80 (4) | >80 (5) |
|---|---|---|---|---|---|---|
| PAVEMENT | Manual Patching | | | | | |
| | Machine Patching | | | | | |
| | Spray Patching | | | | | |
| | Rout and Seal Cracks | | | | | |
| | Chip Seal | | | | | |
| SHOULDERS | Manual Patching | | | | | |
| | Machine Patching | | | | | |
| | Rout and Seal Cracks | | | | | |
| | Chip Seal | | | | | |

**Distress Comments** (Items not covered above) ____

**Other Comments** (e.g. subsections, additional contracts) ____

Evaluated by Raid Khamis P. Eng.

PH-D-584 86-01

**Figure A-1 Pavement Condition Rating Form**

Martindale Road (Sec. 5)

Ministry of Transportation
Ontario

# FLEXIBLE PAVEMENT CONDITION EVALUATION FORM

**Location From:** Station 9+760 **To:** Station 9+880

**LHRS** BEGINS ____ OFFSET ____ km **Section Length** 0.12 km LENGTH **District** ____

**Survey Date** YEAR 12 MONTH 5 **PCR** 65 **RCR** 6.5 **Traffic Direction** B (B: BOTH DIRECTIONS; N: NORTH BOUND; S: SOUTH BOUND; E: EAST BOUND; W: WEST BOUND) **Highway** 38

**Contract No.** ____ – ____ **WP No.** ____ – ____ – ____ **Facility** A (A: ALL LANES; C: COLLECTOR; E: EXPRESS; O: OTHERS (Additional Lanes)) **Class** 4 (F: FREEWAY; A: ARTERIAL; C: COLLECTOR; L: LOCAL; S: SECONDARY)

**Ride Condition Rating (at 80 km/h)**

- 10 EXCELLENT — Smooth and pleasant
- 8 GOOD — Comfortable
- 6 FAIR — Uncomfortable
- 4 POOR — Very rough and bumpy
- 2 VERY POOR — Dangerous at 80 km/h
- 0

| Pavement | | | SEVERITY OF DISTRESS: Very Slight (1) | Slight (2) | Moderate (3) | Severe (4) | Very Severe (5) | DENSITY OF DISTRESS, Extent of Occurrence,%: Few (<10) (1) | Intermittent (10-20) (2) | Frequent (20-50) (3) | Extensive (50-80) (4) | Throughout (80-100) (5) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SURFACE DEFECTS | Ravelling & C. Agg. Loss | 1 | | ✓ | | | | ✓ | | | | |
| | Flushing | 2 | | ✓ | | | | ✓ | | | | |
| SURFACE DEFORMATIONS | Rippling and Shoving | 3 | | ✓ | | | | ✓ | | | | |
| | Wheel Track Rutting | 4 | | ✓ | | | | ✓ | | | | |
| | Distortion | 5 | | ✓ | | | | ✓ | | | | |
| CRACKING — Longitudinal Wheel Track | Single and Multiple | 6 | | | ✓ | | | | ✓ | | | |
| | Alligator | 7 | | ✓ | | | | ✓ | | | | |
| CRACKING — Centre Line | Single and Multiple | 8 | | | ✓ | | | ✓ | | | | |
| | Alligator | 9 | | ✓ | | | | ✓ | | | | |
| CRACKING — Pavement Edge | Single and Multiple | 10 | | | ✓ | | | | ✓ | | | |
| | Alligator | 11 | | ✓ | | | | ✓ | | | | |
| CRACKING — Transverse | Half, Full and Multiple | 12 | | | ✓ | | | ✓ | | | | |
| | Alligator | 13 | | | ✓ | | | ✓ | | | | |
| CRACKING — Longitudinal Meander and Midlane | | 14 | | ✓ | | | | ✓ | | | | |
| CRACKING — Random | | 15 | | | ✓ | | | ✓ | | | | |

| Shoulders | | | SEVERITY OF DISTRESS: RIGHT Mod (1) | RIGHT Severe (2) | LEFT Mod (1) | LEFT Severe (2) | DENSITY OF DISTRESS, Extent of Occurrence,%: RIGHT 10-30 (1) | RIGHT >30 (2) | LEFT 10-30 (1) | LEFT >30 (2) |
|---|---|---|---|---|---|---|---|---|---|---|
| DOMINANT TYPE | ONE ✓ | DISTRESS | | | | | | | | |
| PAVED FULL | | Cracking | | | | | | | | |
| PAVED PARTIAL | | Pavement Edge/ Curb Separation | | | | | | | | |
| SURFACE TREATED | | Distortion | | | | | | | | |
| PRIMED | | Breakup/Separation | | | | | | | | |
| GRAVEL | | Edge Break | | | | | | | | |
| | | Breakup | | | | | | | | |

| Maintenance Treatment | | EXTENT OF OCCURRENCE, %: <10 (1) | 10-20 (2) | 20-50 (3) | 50-80 (4) | >80 (5) |
|---|---|---|---|---|---|---|
| PAVEMENT | Manual Patching | | | | | |
| | Machine Patching | | | | | |
| | Spray Patching | | | | | |
| | Rout and Seal Cracks | | | | | |
| | Chip Seal | | | | | |
| SHOULDERS | Manual Patching | | | | | |
| | Machine Patching | | | | | |
| | Rout and Seal Cracks | | | | | |
| | Chip Seal | | | | | |

**Distress Comments** (Items not covered above) ____

**Other Comments** (e.g. subsections, additional contracts) ____

Evaluated by Raid Khamis P. Eng.

PH-D-584 86-01

**Figure A-1 Pavement Condition Rating Form**

Martindale Road (Sec. 6)

Ministry of Transportation, Ontario

# FLEXIBLE PAVEMENT CONDITION EVALUATION FORM

**Location From:** Station 9+880 **To:** Station 10+200

**LHRS** BEGINS ____ **OFFSET** ____ km **Section Length** 0.32 km LENGTH **District** ____

**Survey Date** YEAR 12 MONTH 5 **PCR** 85 **RCR** 8.5 **Traffic Direction** B (B : BOTH DIRECTIONS; N : NORTH BOUND; S : SOUTH BOUND; E : EAST BOUND; W : WEST BOUND) **Highway** 38

**Contract No.** ____ **WP No.** ____ **Facility** A (A : ALL LANES; C : COLLECTOR; E : EXPRESS; O : OTHERS (Additional Lanes)) **Class** A (F : FREEWAY; A : ARTERIAL; C : COLLECTOR; L : LOCAL; S : SECONDARY)

**Ride Condition Rating (at 80 km/h)**

- 10 EXCELLENT Smooth and pleasant
- 8 GOOD Comfortable
- 6 FAIR Uncomfortable
- 4 POOR Very rough and bumpy
- 2 VERY POOR Dangerous at 80 km/h
- 0

| Pavement | | | SEVERITY OF DISTRESS: Very Slight (1) | Slight (2) | Moderate (3) | Severe (4) | Very Severe (5) | DENSITY OF DISTRESS, Extent of Occurrence,%: Few < 10 (1) | Intermittent 10-20 (2) | Frequent 20-50 (3) | Extensive 50-80 (4) | Throughout 80-100 (5) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SURFACE DEFECTS | Ravelling & C. Agg. Loss | 1 | ✓ | | | | | ✓ | | | | |
| | Flushing | 2 | ✓ | | | | | ✓ | | | | |
| SURFACE DEFORMATIONS | Rippling and Shoving | 3 | | | | | | | | | | |
| | Wheel Track Rutting | 4 | ✓ | | | | | ✓ | | | | |
| | Distortion | 5 | | ✓ | | | | ✓ | | | | |
| CRACKING: Longitudinal Wheel Track | Single and Multiple | 6 | | ✓ | | | | ✓ | | | | |
| | Alligator | 7 | | | | | | | | | | |
| CRACKING: Centre Line | Single and Multiple | 8 | | | | | | | | | | |
| | Alligator | 9 | | | | | | | | | | |
| CRACKING: Pavement Edge | Single and Multiple | 10 | | ✓ | | | | ✓ | | | | |
| | Alligator | 11 | | | | | | | | | | |
| CRACKING: Transverse | Half, Full and Multiple | 12 | | ✓ | | | | ✓ | | | | |
| | Alligator | 13 | | | | | | | | | | |
| CRACKING: Longitudinal Meander and Midlane | | 14 | ✓ | ✓ | | | | ✓ | | | | |
| CRACKING: Random | | 15 | ✓ | | | | | ✓ | | | | |

| Shoulders | | | SEVERITY OF DISTRESS: RIGHT Mod (1) | RIGHT Severe (2) | LEFT Mod (1) | LEFT Severe (2) | DENSITY OF DISTRESS, Extent of Occurrence,%: RIGHT 10-30 (1) | RIGHT >30 (2) | LEFT 10-30 (1) | LEFT >30 (2) |
|---|---|---|---|---|---|---|---|---|---|---|
| DOMINANT TYPE | ONE ✓ | DISTRESS | | | | | | | | |
| PAVED FULL | ✓ | Cracking | | | | | | | | |
| | | Pavement Edge/ Curb Separation | | | | | | | | |
| PAVED PARTIAL | | Distortion | | | | | | | | |
| SURFACE TREATED | | Breakup/Separation | | | | | | | | |
| | | Edge Break | | | | | | | | |
| PRIMED | | Breakup | | | | | | | | |
| GRAVEL | | | | | | | | | | |

| Maintenance Treatment | | EXTENT OF OCCURRENCE, %: <10 (1) | 10-20 (2) | 20-50 (3) | 50-80 (4) | >80 (5) |
|---|---|---|---|---|---|---|
| PAVEMENT | Manual Patching | | | | | |
| | Machine Patching | | | | | |
| | Spray Patching | | | | | |
| | Rout and Seal Cracks | | | | | |
| | Chip Seal | | | | | |
| SHOULDERS | Manual Patching | | | | | |
| | Machine Patching | | | | | |
| | Rout and Seal Cracks | | | | | |
| | Chip Seal | | | | | |

**Distress Comments** (Items not covered above) ____

**Other Comments** (e.g. subsections, additional contracts) ____

Evaluated by Raid Khamis P. Eng

PH-D-584 86-01

**Figure A-1 Pavement Condition Rating Form**

Martindale Road (Sec. 7)

Ministry of Transportation, Ontario

# FLEXIBLE PAVEMENT CONDITION EVALUATION FORM

**Location From:** Station 10+200 **To:** Station 10+600

**LHRS** (BEGINS) **OFFSET** km **Section Length** 0.4 km (LENGTH) **District**

**Survey Date** 12 (YEAR) 5 (MONTH) **PCR** 70 **RCR** 7.5 **Traffic Direction** B (B: BOTH DIRECTIONS, N: NORTH BOUND, S: SOUTH BOUND, E: EAST BOUND, W: WEST BOUND) **Highway** 38

**Contract No.** – – **WP No.** – – **Facility** A (A: ALL LANES, C: COLLECTOR, E: EXPRESS, O: OTHERS (Additional Lanes)) **Class** A (F: FREEWAY, A: ARTERIAL, C: COLLECTOR, L: LOCAL, S: SECONDARY)

**Ride Condition Rating (at 80 km/h)**

- 10 EXCELLENT — Smooth and pleasant
- 8 GOOD — Comfortable
- 6 FAIR — Uncomfortable
- 4 POOR — Very rough and bumpy
- 2 VERY POOR — Dangerous at 80 km/h
- 0

## Pavement

| | | | SEVERITY OF DISTRESS: Very Slight (1) | Slight (2) | Moderate (3) | Severe (4) | Very Severe (5) | DENSITY OF DISTRESS, Extent of Occurrence, %: Few (<10) (1) | Intermittent (10-20) (2) | Frequent (20-50) (3) | Extensive (50-80) (4) | Throughout (80-100) (5) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SURFACE DEFECTS | | Ravelling & C. Agg. Loss | 1 | | | | | ✓ | | | | |
| | | Flushing | 2 | ✓ | | | | ✓ | | | | |
| SURFACE DEFORMATIONS | | Rippling and Shoving | 3 | | ✓ | | | ✓ | | | | |
| | | Wheel Track Rutting | 4 | ✓ | | | | ✓ | | | | |
| | | Distortion | 5 | | ✓ | | | ✓ | | | | |
| CRACKING | Longitudinal Wheel Track | Single and Multiple | 6 | | ✓ | | | ✓ | | | | |
| | | Alligator | 7 | ✓ | | | | ✓ | | | | |
| | Centre Line | Single and Multiple | 8 | | ✓ | | | ✓ | | | | |
| | | Alligator | 9 | ✓ | | | | ✓ | | | | |
| | Pavement Edge | Single and Multiple | 10 | ✓ | | | | ✓ | | | | |
| | | Alligator | 11 | ✓ | | | | ✓ | | | | |
| | Transverse | Hall, Full and Multiple | 12 | | | ✓ | | ✓ | | | | |
| | | Alligator | 13 | | ✓ | | | ✓ | | | | |
| | Longitudinal Meander and Midlane | | 14 | | ✓ | | | ✓ | | | | |
| | Random | | 15 | ✓ | | | | ✓ | | | | |

## Shoulders

| DOMINANT TYPE | ONE ✓ | DISTRESS | SEVERITY OF DISTRESS RIGHT Mod (1) | RIGHT Severe (2) | LEFT Mod (1) | LEFT Severe (2) | DENSITY OF DISTRESS Extent of Occurrence, % RIGHT 10-30 (1) | RIGHT >30 (2) | LEFT 10-30 (1) | LEFT >30 (2) |
|---|---|---|---|---|---|---|---|---|---|---|
| PAVED FULL | ✓ | Cracking | | | | | | | | |
| | | Pavement Edge/ Curb Separation | | | | | | | | |
| PAVED PARTIAL | | Distortion | | | | | | | | |
| SURFACE TREATED | | Breakup/Separation | | | | | | | | |
| | | Edge Break | | | | | | | | |
| PRIMED | | Breakup | | | | | | | | |
| GRAVEL | | | | | | | | | | |

## Maintenance Treatment

| | | EXTENT OF OCCURRENCE, % <10 (1) | 10-20 (2) | 20-50 (3) | 50-80 (4) | >80 (5) |
|---|---|---|---|---|---|---|
| PAVEMENT | Manual Patching | ✓ | | | | |
| | Machine Patching | | | | | |
| | Spray Patching | ✓ | | | | |
| | Rout and Seal Cracks | ✓ | | | | |
| | Chip Seal | | | | | |
| SHOULDERS | Manual Patching | | | | | |
| | Machine Patching | | | | | |
| | Rout and Seal Cracks | | | | | |
| | Chip Seal | | | | | |

**Distress Comments** (Items not covered above)

**Other Comments** (e.g. subsections, additional contracts) Most of the Severe & intermittent cracks are treated by Rout & Seal Cracks

Evaluated by Raid Khanais P. Eng.

PH-0-584 86-01

**Figure A-1 Pavement Condition Rating Form**

Martindale Road (Sec. 8)

Ministry of Transportation, Ontario

# FLEXIBLE PAVEMENT CONDITION EVALUATION FORM

**Location From:** Station 10+600 **To:** Station 10+700

**LHRS** (BEGINS) **OFFSET** km **Section Length** 0.1 km (LENGTH) **District**

**Survey Date** YEAR 12 MONTH 5 **PCR** 85 **RCR** 8.5 **Traffic Direction** B (B: BOTH DIRECTIONS; N: NORTH BOUND; S: SOUTH BOUND; E: EAST BOUND; W: WEST BOUND) **Highway** 38

**Contract No.** – **WP No.** – – **Facility** A (A: ALL LANES; C: COLLECTOR; E: EXPRESS; O: OTHERS (Additional Lanes)) **Class** A (F: FREEWAY; A: ARTERIAL; C: COLLECTOR; L: LOCAL; S: SECONDARY)

**Ride Condition Rating (at 80 km/h)**

- 10 EXCELLENT — Smooth and pleasant
- 8 GOOD — Comfortable
- 6 FAIR — Uncomfortable
- 4 POOR — Very rough and bumpy
- 2 VERY POOR — Dangerous at 80 km/h
- 0

## Pavement

| | | | SEVERITY OF DISTRESS: Very Slight (1) | Slight (2) | Moderate (3) | Severe (4) | Very Severe (5) | DENSITY OF DISTRESS, Extent of Occurrence, %: Few <10 (1) | Intermittent 10-20 (2) | Frequent 20-50 (3) | Extensive 50-80 (4) | Throughout 90-100 (5) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SURFACE DEFECTS | Ravelling & C. Agg. Loss | 1 | ✓ | | | | | ✓ | | | | |
| | Flushing | 2 | ✓ | | | | | ✓ | | | | |
| SURFACE DEFORMATIONS | Rippling and Shoving | 3 | | | | | | | | | | |
| | Wheel Track Rutting | 4 | ✓ | | | | | ✓ | | | | |
| | Distortion | 5 | | | | | | | | | | |
| CRACKING: Longitudinal Wheel Track | Single and Multiple Alligator | 6 | | | | | | | | | | |
| | | 7 | | | | | | | | | | |
| CRACKING: Centre Line | Single and Multiple Alligator | 8 | ✓ | | | | | ✓ | | | | |
| | | 9 | | | | | | | | | | |
| CRACKING: Pavement Edge | Single and Multiple Alligator | 10 | | | | | | | | | | |
| | | 11 | | | | | | | | | | |
| CRACKING: Transverse | Half, Full and Multiple Alligator | 12 | ✓ | | | | | ✓ | | | | |
| | | 13 | | | | | | | | | | |
| CRACKING: Longitudinal Meander and Midlane Random | | 14 | | ✓ | | | | ✓ | | | | |
| | | 15 | | | | | | | | | | |

## Shoulders

| DOMINANT TYPE | ONE ✓ | DISTRESS | SEVERITY OF DISTRESS RIGHT Mod (1) | RIGHT Severe (2) | LEFT Mod (1) | LEFT Severe (2) | DENSITY OF DISTRESS Extent of Occurrence, % RIGHT 10-30 (1) | RIGHT >30 (2) | LEFT 10-30 (1) | LEFT >30 (2) |
|---|---|---|---|---|---|---|---|---|---|---|
| PAVED FULL | | Cracking | | | | | | | | |
| PAVED PARTIAL | | Pavement Edge/ Curb Separation | | | | | | | | |
| SURFACE TREATED | | Distortion | | | | | | | | |
| PRIMED | | Breakup/Separation | | | | | | | | |
| GRAVEL | | Edge Break | | | | | | | | |
| | | Breakup | | | | | | | | |

## Maintenance Treatment

| | | EXTENT OF OCCURRENCE, % <10 (1) | 10-20 (2) | 20-50 (3) | 50-80 (4) | >80 (5) |
|---|---|---|---|---|---|---|
| PAVEMENT | Manual Patching | | | | | |
| | Machine Patching | | | | | |
| | Spray Patching | | | | | |
| | Rout and Seal Cracks | | | | | |
| | Chip Seal | | | | | |
| SHOULDERS | Manual Patching | | | | | |
| | Machine Patching | | | | | |
| | Rout and Seal Cracks | | | | | |
| | Chip Seal | | | | | |

**Distress Comments** (Items not covered above)

Erion Road and Martindale Road Intersection undergoing resurfacing for HL3. RCR = 8.5 is based on after completion of the resurfacing

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

Evaluated by Raid Khamis P. Eng.

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Figure A-1 Pavement Condition Rating Form

Ministry of Transportation
Ontario

Martindale Road (Sec. 9)

# FLEXIBLE PAVEMENT CONDITION EVALUATION FORM

**Location From:** Station 10+700 **To:** Station 10+950

**LHRS** BEGINS ____ OFFSET ____ km

**Section Length** 0.25 km (LENGTH)

**District** ____

**Survey Date** YEAR 12 MONTH 5

**PCR** 50 **RCR** 5.5

**Traffic Direction** B (B : BOTH DIRECTIONS; N : NORTH BOUND; S : SOUTH BOUND; E : EAST BOUND; W: WEST BOUND)

**Highway** 38

**Contract No.** ____ – ____

**WP No.** ____ – ____ – ____

**Facility** A (A : ALL LANES; C : COLLECTOR; E : EXPRESS; O : OTHERS (Additional Lanes))

**Class** A (F : FREEWAY; A : ARTERIAL; C : COLLECTOR; L : LOCAL; S : SECONDARY)

**Ride Condition Rating (at 80 km/h)**

10 EXCELLENT Smooth and pleasant
8 GOOD Comfortable
6 FAIR Uncomfortable
4 POOR Very rough and bumpy
2 VERY POOR Dangerous at 60 km/h
0

## Pavement

| | | | SEVERITY OF DISTRESS: Very Slight (1) | Slight (2) | Moderate (3) | Severe (4) | Very Severe (5) | DENSITY OF DISTRESS, Extent of Occurrence,%: Few <10 (1) | Intermittent 10-20 (2) | Frequent 20-50 (3) | Extensive 50-80 (4) | Throughout 80-100 (5) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SURFACE DEFECTS | | Ravelling & C. Agg. Loss | 1 | | | | | | | | | |
| | | Flushing | 2 | | | | | | | | | |
| SURFACE DEFORMATIONS | | Rippling and Shoving | 3 | | | | | | | | | |
| | | Wheel Track Rutting | 4 | | | | | | | | | |
| | | Distortion | 5 | | | | | | | | | |
| CRACKING | Longitudinal Wheel Track | Single and Multiple | 6 | | | | | | | | | |
| | | Alligator | 7 | | | | | | | | | |
| | Centre Line | Single and Multiple | 8 | | | | | | | | | |
| | | Alligator | 9 | | | | | | | | | |
| | Pavement Edge | Single and Multiple | 10 | | | | | | | | | |
| | | Alligator | 11 | | | | | | | | | |
| | Transverse | Half, Full and Multiple | 12 | | | | | | | | | |
| | | Alligator | 13 | | | | | | | | | |
| | Longitudinal Meander and Midlane | | 14 | | | | | | | | | |
| | Random | | 15 | | | | | | | | | |

## Shoulders

| DOMINANT TYPE | ONE ✓ | DISTRESS | SEVERITY OF DISTRESS RIGHT Mod (1) | RIGHT Severe (2) | LEFT Mod (1) | LEFT Severe (2) | DENSITY OF DISTRESS Extent of Occurrence,% RIGHT 10-30 (1) | RIGHT >30 (2) | LEFT 10-30 (1) | LEFT >30 (2) |
|---|---|---|---|---|---|---|---|---|---|---|
| PAVED FULL | | Cracking | | | | | | | | |
| | | Pavement Edge/ Curb Separation | | | | | | | | |
| PAVED PARTIAL | ✓ | Distortion | | | | | | | | |
| SURFACE TREATED | | Breakup/Separation | | | | | | | | |
| | | Edge Break | | | | | | | | |
| PRIMED | | Breakup | | | | | | | | |
| GRAVEL | | | | | | | | | | |

## Maintenance Treatment

| | | EXTENT OF OCCURRENCE, % <10 (1) | 10-20 (2) | 20-50 (3) | 50-80 (4) | >80 (5) |
|---|---|---|---|---|---|---|
| PAVEMENT | Manual Patching | | ✓ | | | |
| | Machine Patching | | | | | |
| | Spray Patching | | | | | |
| | Rout and Seal Cracks | | | ✓ | | |
| | Chip Seal | | | ✓ | | |
| SHOULDERS | Manual Patching | | | | | |
| | Machine Patching | | | | | |
| | Rout and Seal Cracks | | | | | |
| | Chip Seal | | | | | |

**Distress Comments** (Items not covered above) ____

**Other Comments** (e.g. subsections, additional contracts) About 50% of the cracks were treated.

Evaluated by Raid Khamis P. Eng.

PH-D-584 86-01

**Figure A-1 Pavement Condition Rating Form**

Ministry of Transportation
Ontario

Martindale Road (Sec. 10)

# FLEXIBLE PAVEMENT CONDITION EVALUATION FORM

**Location From:** Station 10+950 **To:** Station 11+146

**LHRS** (BEGINS) **OFFSET** km **Section Length** 0.19 km (LENGTH) **District**

**Survey Date** 12 (YEAR) 5 (MONTH) **PCR** 95 **RCR** 9.5 **Traffic Direction** B (B: BOTH DIRECTIONS; N: NORTH BOUND; S: SOUTH BOUND; E: EAST BOUND; W: WEST BOUND) **Highway** 38

**Contract No.** – **WP No.** – – **Facility** A (A: ALL LANES; C: COLLECTOR; E: EXPRESS; O: OTHERS (Additional Lanes)) **Class** A (F: FREEWAY; A: ARTERIAL; C: COLLECTOR; L: LOCAL; S: SECONDARY)

**Ride Condition Rating (at 80 km/h)**

- 10 EXCELLENT — Smooth and pleasant
- 8 GOOD — Comfortable
- 6 FAIR — Uncomfortable
- 4 POOR — Very rough and bumpy
- 2 VERY POOR — Dangerous at 80 km/h
- 0

## Pavement

| | | | SEVERITY OF DISTRESS: Very Slight (1) | Slight (2) | Moderate (3) | Severe (4) | Very Severe (5) | DENSITY OF DISTRESS, Extent of Occurrence,%: Few <10 (1) | Intermittent 10-20 (2) | Frequent 20-50 (3) | Extensive 50-80 (4) | Throughout 80-100 (5) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SURFACE DEFECTS | | 1 Ravelling & C. Agg. Loss | | | | | | | | | | |
| | | 2 Flushing | | | | | | | | | | |
| SURFACE DEFORMATIONS | | 3 Rippling and Shoving | | | | | | | | | | |
| | | 4 Wheel Track Rutting | | | | | | | | | | |
| | | 5 Distortion | | | | | | | | | | |
| CRACKING | Longitudinal Wheel Track | 6 Single and Multiple | ✓ | | | | | ✓ | | | | |
| | | 7 Alligator | | | | | | | | | | |
| | Centre Line | 8 Single and Multiple | ✓ | | | | | ✓ | | | | |
| | | 9 Alligator | | | | | | | | | | |
| | Pavement Edge | 10 Single and Multiple | | | | | | | | | | |
| | | 11 Alligator | | | | | | | | | | |
| | Transverse | 12 Half, Full and Multiple | | | | | | | | | | |
| | | 13 Alligator | | | | | | | | | | |
| | Longitudinal Meander and Midlane | 14 | | | | | | | | | | |
| | Random | 15 | ✓ | | | | | ✓ | | | | |

## Shoulders

| DOMINANT TYPE | ONE ✓ | DISTRESS | SEVERITY OF DISTRESS RIGHT Mod (1) | RIGHT Severe (2) | LEFT Mod (1) | LEFT Severe (2) | DENSITY OF DISTRESS Extent of Occurrence,% RIGHT 10-30 (1) | RIGHT >30 (2) | LEFT 10-30 (1) | LEFT >30 (2) |
|---|---|---|---|---|---|---|---|---|---|---|
| PAVED FULL | | Cracking | | | | | | | | |
| | | Pavement Edge/ Curb Separation | | | | | | | | |
| PAVED PARTIAL | | Distortion | | | | | | | | |
| SURFACE TREATED | | Breakup/Separation | | | | | | | | |
| | | Edge Break | | | | | | | | |
| PRIMED | | Breakup | | | | | | | | |
| GRAVEL | | | | | | | | | | |

## Maintenance Treatment

| | | EXTENT OF OCCURRENCE, %: <10 (1) | 10-20 (2) | 20-50 (3) | 50-80 (4) | >80 (5) |
|---|---|---|---|---|---|---|
| PAVEMENT | Manual Patching | | | | | |
| | Machine Patching | | | | | |
| | Spray Patching | | | | | |
| | Rout and Seal Cracks | | | | | |
| | Chip Seal | | | | | |
| SHOULDERS | Manual Patching | | | | | |
| | Machine Patching | | | | | |
| | Rout and Seal Cracks | | | | | |
| | Chip Seal | | | | | |

**Distress Comments** (Items not covered above)

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

Evaluated by Raid Khamis P. Eng.

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**Figure A-1 Pavement Condition Rating Form**

# Appendix F

# Photographs



Photograph 1: Martindale Road (Sec.1), from Station 9+000 to Station 9+200 m.



Photograph 2: Martindale Road (Sec.1), from Station 9+000 to Station 9+200 m.



Photograph 3: Martindale Road (Sec.2), from Station 9+200 to Station 9+400 m.


Photograph 4: Martindale Road (Sec.2), from Station 9+200 to Station 9+400 m.



Photograph 5: Martindale Road (Sec.3), from Station 9+400 to Station 9+680 m.



Photograph 6: Martindale Road (Sec.3), from Station 9+400 to Station 9+680 m.



Photograph 7: Martindale Road (Sec.4), from Station 9+680 to Station 9+760 m.



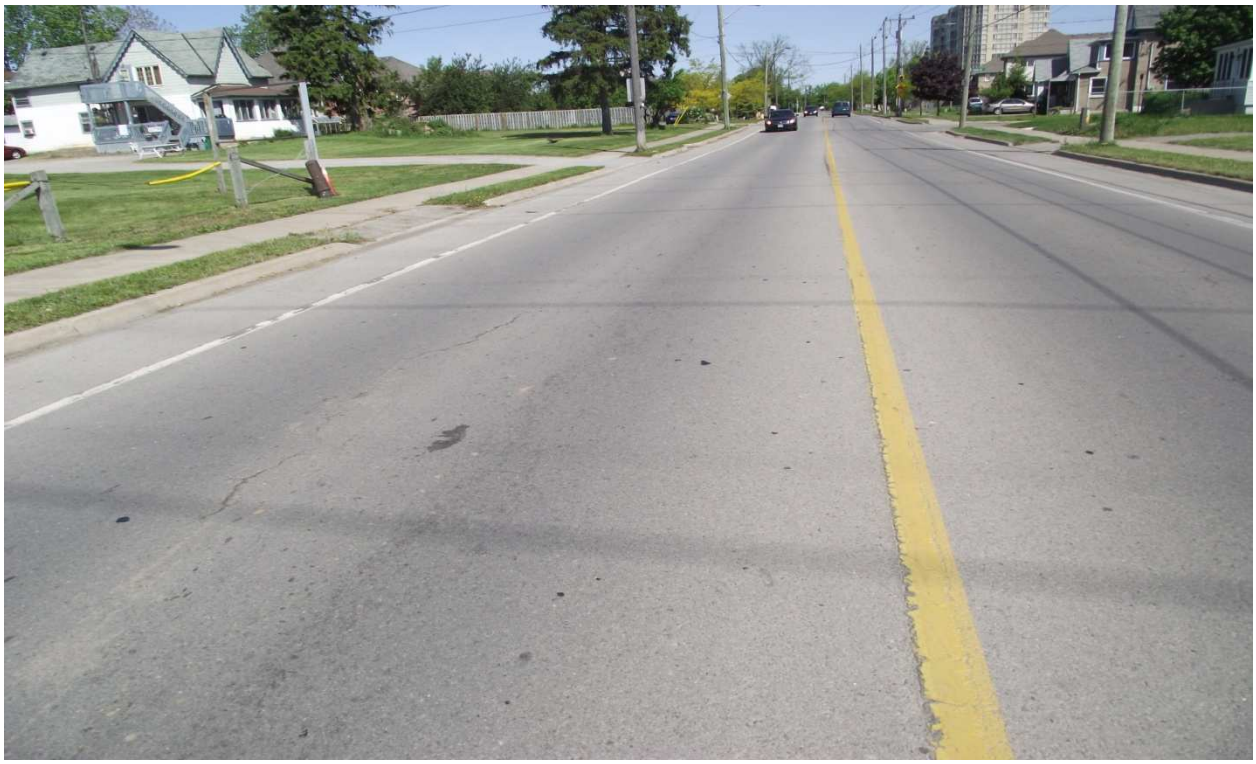
Photograph 8: Martindale Road (Sec.4), from Station 9+680 to Station 9+760 m.



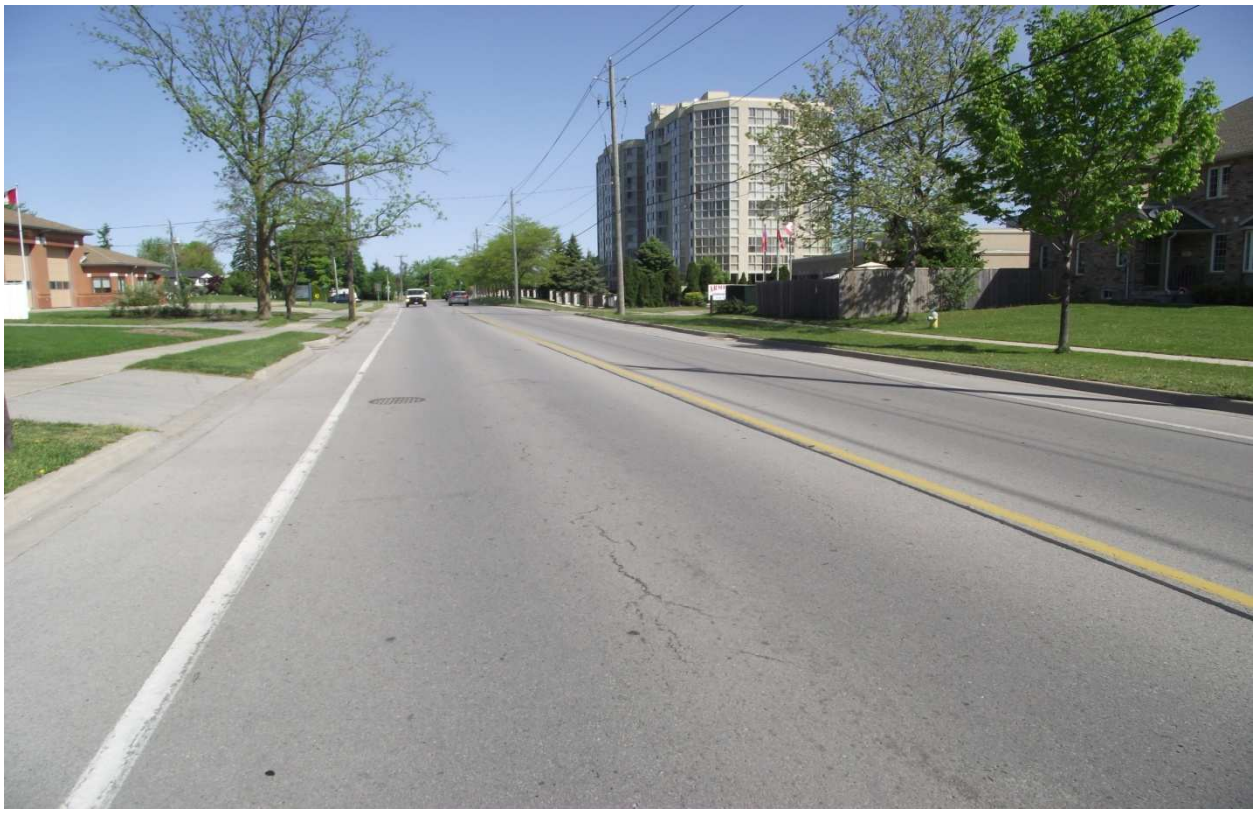
Photograph 9: Martindale Road (Sec.5), from Station 9+760 to Station 9+880 m.



Photograph 10: Martindale Road (Sec.5), from Station 9+760 to Station 9+880 m.



Photograph 11: Martindale Road (Sec.6), from Station 9+880 to Station 10+200 m.



Photograph 12: Martindale Road (Sec.6), from Station 9+880 to Station 10+200 m.



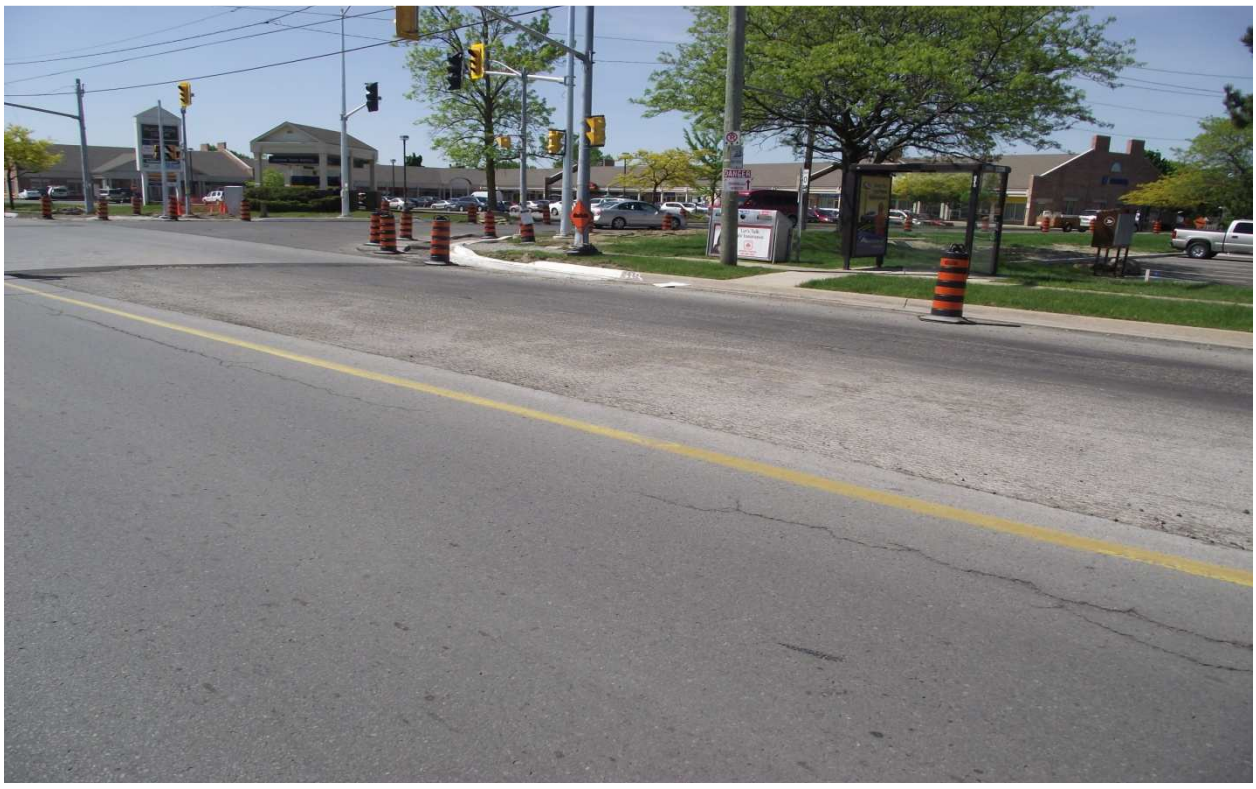
Photograph 13: Martindale Road (Sec.7), from Station 10+200 to Station 10+600 m.



Photograph 14: Martindale Road (Sec.7), from Station 10+200 to Station 10+600 m.



Photograph 15: Martindale Road (Sec.8), from Station 10+600 to Station 10+700 m.



Photograph 16: Martindale Road (Sec.8), from Station 10+600 to Station 10+700 m.



Photograph 17: Martindale Road (Sec.9), from Station 10+700 to Station 10+950 m.



Photograph 18: Martindale Road (Sec.9), from Station 10+700 to Station 10+950 m.



Photograph 19: Martindale Road (Sec.10), from Station 10+950 to Station 11+146 m.



Photograph 20: Martindale Road (Sec.10), from Station 10+950 to Station 11+146 m.